# New Mexico State University

# 2010 Annual Progress Report

Agricultural Science Center
At Farmington
April 2011

# Forty-fourth Annual Progress Report For 2010 New Mexico State University Agricultural Science Center at Farmington P. O. Box 1018 Farmington, NM 87401

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**Cover**: Kyler Beaty assisting in weed control trial (Rick Arnold); hops flower clusters grown in the hops variety trial (Mick O'Neill); Maimbo Malesu is presented with reistra froma a chile vendor during his visit from Kenya to New Mexico, sponsored by the Jose Fernandez Chair, the Lowenstein Speaker Series and International Programs (Mick O'Neill).

## Temporary Employees

### 2010Student Employees

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| Kyler Beaty<br>Project Aide | Dustin Thomas<br>Lab Aide |
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# Collaborators List

***New Mexico State University, College of Agricultural, Consumer and Environmental Sciences and College of Health and Social Services***

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| John Mexal | Professor, Tree Physiologist |
| Ted Sammis | Professor, Irrigation Engineer |
| Mary O'Connell | Professor, Geneticist |
| Chris Cramer | Professor, Onion Breeder |
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| Jill Schroeder | Professor, Weed Science |
| Tracy Sterling | Professor, Weed Science |
| Rolston St. Hilaire | Professor, Horticulture |
| Robert Flynn | Professor, Soil Scientist |
| Kathleen Huttlinger | Professor, Nursing (CHSS) |
| April Ulery | Professor, Soil Chemist |
| Manoj Shukla | Associate Professor, Soil Physisist |
| Sue Forster-Cox | Associate Professor, Health (CHSS) |
| Sangu Angadi | Assistant Professor, Agronomist |
| Rex Kirksey | College Prof. & Super. ASC- Tucumcari & Clovis |
| Leonard Lauriault | College Asso., Alfalfa Agronomist |
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| Bernd Maier | Extension Viticulture Specialist |
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| Curtis Smith | Extension Horticultural Specialist |
| Craig Runyan | Rio Grande Basin Initiative |

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# Notice to Users of This Report

This report has been prepared as an aid to the Agricultural Science Center faculty and staff in analyzing the results of the various researches during the past year and for recording pertinent data for future reference. This is not a formal Agricultural Experiment Station Report of research results.

Information in this report represents results from only one year's research. The reader is cautioned against drawing conclusions or making recommendations because of data in this report. In many instances, data in this report represents only one of several years of research results that will constitute the final formal report. It should be pointed out, however, that staff members have made every effort to check the accuracy of the data presented. This report was not as a formal release. Therefore, none of the data or information herein is authorized for release or publication without the written approval of the New Mexico State University Agricultural Experiment Station.

Mention of a proprietary pesticide does not imply registration under FIFRA as amended or endorsement by New Mexico State University

# Acknowledgements

We want to take this opportunity to express our sincere gratitude to the administration, faculty and staff of the NMSU College of Agricultural, Consumer and Environmental Sciences for continuing to support the Agricultural Science Center at Farmington. The Administration of the Agricultural Experiment Station, the Department of Plant and Environmental Sciences, the Department of Entomology, Plant Pathology, and Weed Science, the Department of Extension Plant Sciences, and the Cooperative Extension Service have wisely pooled resources for the continued benefit of the residents of the Four Corners region and they should be commended.

The Center staff continues to be fully committed to the mandate of the Center. Their hard work and dedication is to be commended. The staff are involved in both on-station and on-farm research in the areas of variety introductions, crop & turf water use, biofuel production, weed control, range rehabilitation. They work closely with the Cooperative Extension Service of San Juan County in a number of dissemination activities including demonstrations, workshops, seminars, and farmers' markets. It has been a pleasure working with the Center Advisory Committee in charting a new and diversified course for the Center into the new millennium.

We must express our gratitude to those governments, organizations and institutions that have provided financial support to the Center so our mandate can be carried out. Special recognition must be extended to State Representative Ray Begay and State Senator William Sharer for their perseverance in obtaining enhancement funds through the legislature. Recognition and thanks must also be extended to the State of New Mexico, the NM State Engineers Office, the United States Department of Agriculture, the United States Bureau of Indian Affairs, the United States Bureau of Reclamation, the United States Bureau of Land Management Farmington Field Office and the Navajo Nation. The Navajo Indian Irrigation Project, the Navajo Agricultural Products Industry, and Wilber-Ellis-NAPI continue to support the Center with water, fertilizer, equipment, laboratory analysis, and human resources.

Finally, we wish to extend our sincere appreciation to the following companies for providing technical assistance, products, and/or financial assistance: Bayer CropSciences, BASF, E.I. Dupont, FMC, Monsanto, Navajo Agricultural Products Industry, Pioneer Hi-Bred, Syngenta Crop Protection, Dow AgroSciences, Bureau of Land Management Farmington Field Office, and Southwest Seed.

Rick Arnold, Interim Superintendent and College Professor – Weed Controll Specialist
Mick O'Neill, Professor – Agronomist
Dan Smeal, College Professor – Irrigation Specialist
Kevin Lombard, Assistant Professor – Horticulturalist

# Executive Summary

Adaptive field crops research is concerned with the identification of crops varieties that perform well in the Four Corners region. On-station trials this year included alfalfa (3 tests), canola (2), corn (4), and winter wheat (1). The 2007-planted alfalfa test consisted of 24 varieties and the 2009-planted alfalfa trial also had 24 varieties from private seed companies and NMSU. In the 2010 growing season for the 2007-planted variety trial, 17 entries yielded over 10 dry tons per acre for the 4 cuttings. The highest yielding entry was Mountaineer 2.0 with a total yield of 11.3 dry tons per acre. At a farm gate sales price of $159 per ton of hay (National Agricultural Statistice for New Mexico – 2010), this would represent a sales price of $1,797 per acre. The average yield for the 24 varieties in 2010 was 10.2 tons per acre and the 3-year average (2008-2010) was 9.0 tons per acre, both substantially greater that the average alfalfa yield of 5.2 tons per acre for New Mexico in 2010. Mean Relative Feed Value over two cuts was 149 and all 24 entres were rated for either Prime Dairy (RFV > 151) or Good Dairy (RFV = 125-150).

Two corn variety trials with a total of 11 entries had an average yield of 256 bu/ac. The highest yielding entry in the Early Maturity trial was PO751HR from Pioneer with a total yield of 281 bu/acre while the the highest yielding entry in the Full Maturity trial was DKC54-16 (VT3) from Monsanto with a total yield of 270 bu/acre. Combined over both trials, all 11 entries had grain yields greater than 235 bu/ac, representing approximately $1,497/acre at $6.37/bu (Chicago Board of Trade close price for December 31, 2010).

With the current interest in biofuels as alternate sources of energy as outlined in the USDA/USDOE 1 Billion Ton Repot, ASC-Farmington continued to position itself as a leader in the adaptation of technologies appropriate for the Four Corners Region. We conducted one on-station collaborative canola oilseed variety trial. The National Winter Canola Variety Trial is a program also coordinated through the Kansas State University. The highest producing variety of the 42 entries tested in 2010, Sitro, had a yield of 4,459 lb/acre ($1,204 per acre at the December 31, 2010 close price of $0.27 per pound). Although corn was 24% more profitable than canola in 2010 on a per acre basis, reduced input requirements for canola may make this this oilseed crop more profitable than corn, not considering input costs. As demand for biodiesel increased, farm gate prices for canola will also increase.

In 2010, there were three broadleaf weed control trials conducted on ASC-Farmington with corn. There were also broadleaf weed control trials for grain sorghum winter wheat and cool season grasses. There were also two broadleaf weed control demonstrations on NAPI fields in pumpkins and in dry beans (Pintos). With appropriate irrigation and combinations of preemergence and postemergence herbicides, adequate control of broadleaf weeds in corn was achieved. The control plots averaged 76 bu/acre while the herbicide treated plots ranged from 239 to 279 bu/acre across the three trials.

A plant demonstration garden, which exhibits about 100, mostly native, xeric-adapted plant species that have potential for use in urban xeric landscapes, was maintained for the eighth year at the science center. Depending on irrigation level, total seasonal irrigation (May – Oct) ranged from only precipitation (5.5 inches) to about 176 gallons per plant. As in previous years, most species exhibited acceptable plant quality when irrigated weekly at irrigation levels between 4 to 8 gallons of water per week (20% to 40% of $ET_{RS}$).

A study was initiated to evaluate the performance of selected drip irrigation point source emitters and three drip lines at water pressures less than those specified or recommended by the drip component manufacturer or dealer. Flow rates were measured from 17 different models of point source emitters in two separate tests and from three models of drip line with built in emitters. A low water pressure of about 2.5 psi was maintained during the tests from an elevated water barrel. Application uniformity (AU) for each emitter model was calculated. Measured flow rates of all emitters were lower than the manufacturer's specified flow rates but AU values greater than 0.85 were exhibited by about 1/3 of the emitters in the tests.

Soil erosion and crop damage by wind can be a major limiting factor to potential agricultural and horticultural crop production in the arid Four Corners Region, particularly where excessive tillage has occurred and where soils surrounding cropped areas have been left bare. A project started in 2009 to evaluate the establishment and growth potential of several woody species that might be used for soil conservation. A total of 14 woody species were planted outside of cropped areas and irrigated at 4 application levels. Total irrigation volume applied per plant during the 2010 season ranged from 22.6 to 69.8 gallons at the low and high irrigation treatments, respectively, plus an additional 9.8 inches of precipitation.

Horticultural research at the center spans a diverse range of trials and demonstration activities from table and wine grape variety trials, and hops trials, to medicinal plants, gardening for health, and the development of a viable horticulture program at San Juan College. There are 15 table grape and 20 wine grape varieties that were planted in 2007, 2 vinifera scion grafted to 9 rootstock planted in 2008, and 6 Riesling varieties planted in 2009. It appears that a number of varieties are well adapted to the region but the trials are still in the establishment stage. Key 2010 accomplishments for the collaborative horticulture program at San Juan college include completion of Outdoor Learning Center demonstration plots funded from a state energy grant, students graduating with associates of sciences degrees in horticulture. Other activities include a continuation of collaborative efforts between the ASC-Farmington and the Fred Hutchinson Cancer Research Center, delivery of workshops on Southwest Medicinal Herbs funded by the Western Center for Risk Management Education, collaboration with Todd Bates and native New Mexico Hops cultivation and the launch of the Center for Landscape Water Conservation (http://www.xericenter.com/main.php).

The oldest hybrid poplar test, planted at a density of 435 trees per acre in 2002, continued to demonstrate the genetic variability of hybrid poplar with respect to irrigated production in an arid region. After 9 seasons, the clone OP-367 remained the tallest entry reaching a mean height of 63 feet. OP-367 also had the largest mean DBH at 10.6 inches and maximum wood volume of 5,968 $ft^3$/ac. A water application trial was established in 2007 with OP-367 and three other clones crossed from the same species. Clone OP-367 led for all growth parameters. Also, while there is significant interaction between clones and irrigation treatments, the 120% ET irrigation treatment produced the most growth.

I would like to thank my colleagues and staff for their exceptional performance while I was superintendent at the center. The eleven years in this position were rewarding and exciting. I wish Rick Arnold all the best as he assums the role of superintendent. I also want to thank all the collaborators and resource people who have contributed to the research and dissemination activities carried out by center personnel. Without your contributions, we would not be able to fulfill our mandate and provide you with this annual report. I hope you find the information helpful for your own projects and appreciate the work that has made it possible.

Mick O'Neill – April, 2011

# Dedication to Kyler Beaty

It was one of those poignant moments in life; we all remember when we learned of the untimely and tragic passing of Kyler Beaty on June 24, 2010. Ever since he started coming to the center, when he was about 7 years old with Grampa Rick, Kyler loved to be at the ―farm”. He was just as happy as could be playing in the fields, helping in the garage, and running all over the place. As he got older, Kyler started to learn about vehicles and had the opportunity to learn how to drive (always under appropriate supervision) some of the farm equipment like tractors, pickup trucks, and the Gators. Kyler had no problem with any chore given and getting dirty was part of the fun. He interacted with all the center staff and summer temporary help with equal enthusiasm. Kyler was on his way to work at the farm after football practice when he passed into his next life.

Following are thoughts about Kyler offered by some of his farm friends.

―I first met Kyler when he was a kid working with Rick. I was commuting from Las Cruces, It must have been 2002 or 2004; I can‘t remember exactly. He was a scrawny, quirky kid. I remember how polite Kyler was. As the years went past, we all watched Kyler grow into a young man. His politeness and kindness were his endearing trademarks. He started playing football. My endearing memory of Kyler was attending the PV versus Aztec game, in Aztec, 2009. We spotted Rick in the visitor stands and migrated over. The score was already not looking good for the PV kids. Half time started. The players filed to the locker room. We chatted a bit with Rick. Then, the PV kids started coming out of the locker room for the second half. I rose from my seat walked down and to the side of the bleachers and found Kyler walking toward the field with his teammates; he in his face-shielded helmet (#22). What are you supposed to say? But there Kyler was, about ready to come out onto the field. I remember saying something in his face like ―you gonna let these guys kick your butts?!!!” Kyler started hitting his helmet; the spark ignited. Kyler made some plays. But it was a big time defeat for the PV kids if you were there. I have that image of Kyler coming onto the field seared into my memory forever. He was someone special, you could tell.” – Kevin Lombard

―Kyler was an intelligent, kind, and thoughtful young man; a person who always had a smile on his face. He worked hard and played hard. He was a joy to have around. We all miss him very much.” – Sue Stone

―I got to know Kyler through NMSU. He was a good worker/student. The things he did were always with a smile. My thoughts and prayers are with all the family. God Bless.” – Tom Jim

―We will never understand why Kyler was taken from us at such a young age. He was a good person, always pleasant to be around and was willing to help in any way he could. We miss him.” – Kenny Kohler:

―Kind, young, loving, energetic and respectful is how I knew Kyler. I enjoyed working with him. We learned from one another in many ways that I hold as precious memories. How he impacted me most is-on his last day at work as we were shutting off the sprinklers; I saw him standing in the water with his hands extended high in the air looking up and letting the water soak him, I walked over to him and he turned to me with a big smile and said, "It feels like this is the last time I will feel this water again”. I just stood by him for a while and then we took off to call it a day. One could take Kyler's act as a message saying-embrace and thank God daily for your life. The place where he stood and the tree stump on the NMSU facility always remind me of Kyler. I am thankful for the time given me to get to know Kyler and to have worked with him.” – Jonah P. Joe

“Kyler participated with me on many projects while he was employed with NMSU. He was always willing to do whatever he was asked to do with enthusiasm. He was especially handy to have around for heavy jobs such as changing pivot gear boxes. He could lift a gearbox with little effort when anyone else would struggle with the task. He was a budding mechanic and welder. Kyler enjoyed any equipment operation that was bestowed on him. He could always be trusted to do a job right. Kyler has been and will continue to be dearly missed at the NMSU ASC-Farmington.” – Curtis Owen

“When I think of Kyler, I‘m reminded of his deep stillness and warmth. These are rare qualities of young adults of our times when most are plugged into technology and not the people surrounding them. Upon greeting him in the morning with a smile, he would return the greeting with a smile. That gesture is how I knew of his calmness and caring capacity, for Kyler was a true human being of deep stillness and warmth.” – Margaret West

“Kyler was a fine young man of outstanding character with exceptional abilities. His kindness, pleasant personality, and terrific sense of humor brought light into the oftentimes dull, day to day work routine of the science center. Kyler will never be forgotten and I will miss him greatly this summer.” – Dan Smeal

“I wish I could have known you. We need more people in the world like you – people of kindness and optimism. Your life was brief. Still, you had a full life – with family who loved you, friends who respected you, and teammates who knew they could rely on you, both on the football grid and on the research farm where you spent so much time with your Grandpa and friends. Let us strive to remember you and your kind spirit, which still echoes in the lives of those who knew and loved you.” – Sam Allen

“My Grandson, Kyler Beaty was a young man of purpose, compassion, loyalty and integrity. I watched him grow from a little baby into an outstanding young man in just a short time period of 17 years. He was loved by all and made a lasting impression on those individuals who had the pleasure of meeting him. He came to work at the New Mexico State University Agricultural Science Center at Farmington, New Mexico as a summer laborer in 2009 and worked a short time in 2010. He loved the outdoors, always had a smile on his face, good do just about anything that was asked of him, and was never afraid to learn something new no matter the circumstance. He had a great talent to build things with his hands once he realized the tools and equipment he needed to complete the task. He loved God, his family, his friends and sports (especially football and hunting). There are a lot of things that bring back pleasant memories of this talented, compassionate and life loving young man, one is that he never said a cross word about anybody. If I could live my life over I would like to be how he was with people. I truly loved my Grandson, I miss him tremendously, but I know I will see him again.” – Rick Arnold

As Kyler himself said, “By the grace of God, I am who I am; a Congo cowboy with a Holister shirt and baggy pants”.

Mick O‘Neill – April 2011

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## Introduction

Serving the agricultural needs for the San Juan River basin of northwest New Mexico and the Four Corners region, the Agricultural Science Center at Farmington consists of 254 acres leased from the Navajo Nation in 1966. While the major irrigated cropland for northwestern New Mexico is in San Juan County, small parcels of irrigated lands are also found in the two adjoining counties, McKinley and Rio Arriba. These three counties have about 1,800 farms with 198,000 acres of irrigated and 11,000 acres of dry land farming. San Juan County ranks second in the state for irrigated cropland with 150,000 acres or 10% of the state total (Gore and Wilken, 1998).

Cash receipts from crop and livestock production in the three-county area is about $96,000,000 annually of which about 50% is from livestock sales and 50% is from crops. In 1997, San Juan County ranked eighth in cash receipts for all farm commodities and the three counties together produced 5.7% of the $1.9 billion cash receipts from all agricultural commodities in New Mexico (Gore and Wilken, 1998).

The Agricultural Science Center is located about seven miles southwest of Farmington on the high plateau of northwestern New Mexico. The Center is at an altitude of 5,640 ft above sea level (36º 4‘ N by 108º W) in a semi-arid environment with a mean annual precipitation of 8.19 in. The mean monthly maximum and minimum temperatures range from 40 and 19 ºF in January to 91 and 60 ºF in July. The average frost-free period is 163 days from May 4 to October 14 (Smeal et al. 2001). There are four soil orders within the Center ranging from sandy loam to loamy sand (59 – 83 % Sand) and having a pH of 7.8 (Anderson, 1970).

The Center is the only agricultural research facility in the state of New Mexico that is on the western side of the Continental Divide. River drainage is west into the Colorado River, which then continues west and south to the Saltan Sea and Pacific Ocean by way of the Gulf of California. Over two-thirds of the total surface water that exists in the state of New Mexico runs through the northwest corner of New Mexico (San Juan County). The Center receives water through the Navajo Indian Irrigation Project (NIIP). Total irrigated land serviced by NIIP comprises about 50% of the 150,000 acres of irrigated land in San Juan County and future development will expand NIIP to over 100,000 acres. Irrigated acreage in San Juan County is increasing and when all projects being planned are completed, acreage will climb from 150,000 to about 240,000 acres.

Of the 254 acres comprising the Agricultural Science Center, 170 acres are under cultivation. Over 100 crops have been grown on the Center since its inception in 1966. Many crops, which produce well in northwestern New Mexico, are not grown in the area because of market prices at the time of harvest, high transportation costs to a suitable market, personnel unfamiliar with production practices, etc. The Center currently receives water from NIIP to irrigate crops by sprinkler systems (center pivots, solid set, and side roll). Earlier, irrigation systems also included flood but that was impractical on the Center‘s sandy soils. Agricultural productivity within NIIP is carried out by the Navajo Agricultural Products Industry (NAPI) and is managed as a single farm. Close collaborative links are maintained with NAPI through varietal testing of potatoes, corn, small grains, beans, onions, chile, alfalfa, and other economically important crops.

Variety and agronomic crop research has included winter and spring wheat, winter and spring barley, oats, corn, alfalfa, and crambe. Dry bean variety and type trials, including row spacing and management for white mold control, have been conducted. Fertilizer-type/placement trials and herbicide-type/application trials have been carried out with potatoes, corn, cereal grain, and dry beans in various rotations. Alternative crops evaluated in the past have included soybeans, safflower, kenaf, licorice, buckwheat, sugarbeets, canola (rape), rye, triticale, sorghum, sunflower, amaranth, pasture and other minor acreage crops such as carrots for seed production. Agronomic work has also been conducted in no-till plots and clean-tilled areas as well as intercropping dry bean and soybean in spring wheat. Important areas of study have included leaching associated with herbicides and potential for contaminating drainage water, which affects future crop productivity and ground water draining into the San Juan basin.

Past areas of entomological study have included the control of corn ear worm, apple codling moth, and Russian wheat aphid. Weed research has included pre-plant, pre-emergence, and post-emergence applications of herbicides for grass and broadleaf control in alfalfa, corn, wheat, beans, potatoes, onion, carrot, and pumpkin. Water research has determined consumptive use indexes and efficient water application strategies on a number of crops including tomato, chile, potatoes, winter and spring grains, beans, corn, alfalfa, pasture and buffalo gourd. Turf research has included blue grass variety trials, and buffalo and blue grama evaluations for low-maintenance lawns. Horticultural crops evaluated in the past have included chile pepper, lettuce, tomato, green bean, onion, apple, pear, peach, nectarine, cherry, grape, cucumber, pea, pumpkin, winter and summer squash, and Christmas trees.

Research at the present time is being conducted on alfalfa, corn, dry beans, potatoes, onions, chile, pasture grass, winter wheat, and spring oats. Major emphasis at the present time is on variety and other adaptive or production research, weed control, crop fertility, irrigation and consumptive-use, herbicide persistence and leaching, and other varied areas of research. Water application research includes determining water use-production functions of the primary crops in the area. This project includes developing and evaluating formulas to predict water application and consumptive use of crops and turfgrass. An 8-acre subsurface drip irrigation system was installed during 2001, which allows the comparison of productivity and water use efficiencies of economically important crops under micro irrigation systems.

Since the mid-1960's, average county yields of alfalfa have increased from 3 to more than 5 tons/acre; corn has gone from 55 to 154 bu/acre and wheat from 35 to 110 bu/acre. Potatoes have become an increasingly important crop and production could be substantially increased if a proposed French fry plant is built. With new acreage being put into production each year, new research initiatives are needed primarily in the areas of high value crops, irrigation management, herbicide use, and soils.

Buildings on the Center include an office and laboratory building with six offices, a laboratory and a tissue culture laboratory, conference room, head house, and attached greenhouse partitioned into two bays, and a three-bedroom residence with attached garage. There are four metal buildings. The first building is 100 x 40 ft with a shop, small office, and restroom in a 40 x 40-ft section on the south end and a 60 x 40-ft area on the north end for machinery storage. The second building is 60' x 20' and is partitioned to form three small rooms. It is used for seed, fertilizer, and small equipment storage. The third building is a 20 x 60-ft open front machinery storage shed and the fourth building is a 20 x 30-ft chemical storage facility. Most of the machinery and equipment needed to carry out field, laboratory, and greenhouse research is available at the Center. Office, laboratory, greenhouse, and irrigated field plots are available to resident and visiting technical personnel.

Graduate students may participate in the program. Most research is towards adaptive or applied research programs. Small breeding programs, however, have contributed to the total program in the past. The Center also has a two-bedroom trailer-house with two baths. Anyone who uses this facility must furnish bed covers and linens. The trailer is furnished with four single-beds, a stove, a refrigerator, a table, and chairs.

Center personnel include 3 faculty, 3 professional and 5 support staff. Faculty are an agronomist, a pest management specialist, and an irrigation specialist. The 3 professional staff include the Farm Superintendent and 2 Research Specialists. The Center has 1 full-time Research Technicians, 1 full-time Research Assistant, a full-time Records Technician, 2 full-time field laborer/tractor drivers, and occasional field assistants.

### Literature Cited

Anderson, J.U. 1970. Soils of the San Juan Branch Agricultural Experiment Station. NMSU Ag. Exp. Stn. Res. Rpt. 180.

Gore, C.E. and W.W. Wilken. 1998. New Mexico Agricultural Statistics – 1998. United States Department of Agriculture and New Mexico Agricultural Statistics Service. Las Cruces, NM.

# Weather Conditions During 2010 at the NMSU Agricultural Science Center

A weather station was established at the NMSU Agricultural Science Center at Farmington, New Mexico, in January 1969. It was designated an official National Weather Service climatological observation site in 1978. Weather observations are made daily at 8:00 a.m.

Maximum and minimum U.S. Weather Service thermometers are housed in a regulation instrument shelter. In March of 2005, A Nimbus PL digital "bee hive" style thermometer was installed and replaced the mercury thermometers. A standard eight-inch rain gauge was installed in 1982. Wind movement in miles per day has been recorded at two heights since 1980. A 3-cup anemometer is set 6 inches above the rim of the evaporation pan, while a second anemometer is set at 2 meters above the soil surface. Evaporation was measured using a standard Class-A metal pan from 1972 through 2010. A maximum and minimum thermometer with a sensor probe buried 4 inches deep was installed in bare ground to record soil temperature in 1976.

A second weather station is located at the NMSU Agricultural Science Center. This weather station is one of about 200 located throughout the state of New Mexico and is managed by the New Mexico Climate Center at New Mexico State University main campus in Las Cruces. This weather station was established in 1985 and has an automated data collection system and can be viewed at (http://weather.nmsu.edu/).

During 2010, the temperature conditions were near normal compared to the 42 year average. The annual mean temperature of 52.3 ºF for 2010 was 0.4 ºF lower than the 42 year mean of 52.7 ºF (Table 5).The annual mean temperature was 2.8 ºF less than the highest year occurring in 2003 which had an annual mean temperature of 55.1 ºF. The annual mean temperature for 2010 was 2.3 ºF greater than the lowest year of 50.0 ºF occurring in 1975. The mean monthly temperatures in 2010 were lower than average for 7 months of the year. The month of January had a mean temperature of 26 ºF and was 4.2 ºF below the 42 year January mean of 30.2 ºF (Table 5).The month of December had a mean temperature of 38 ºF and was 6.6 ºF above the 42 year December mean of 31.4 ºF (Table 5). A monthly high temperature for the month of October was set when a temperature of 88 ºF was recorded. This broke the previous record high of 87 ºF set in 2003 (Table 8).

The 2010 growing season had 166 days of above freezing temperatures and was above the 42-year average of 161.7 days free of freezing temperatures (Table 3). The freeze-free period was from May 12 through October 26 (Table 3).

An above average 9.78 inches of precipitation was recorded in 2010. The wettest month was August which received 2.50 inches, over 2 times greater than the 42 year monthly average of 1.08 inches. January received the second highest amount of precipitation during the year when 1.34 inches of precipitation was recorded. May and June were especially dry when only 0.1 inches of precipitation were recorded in each month (Table 4).

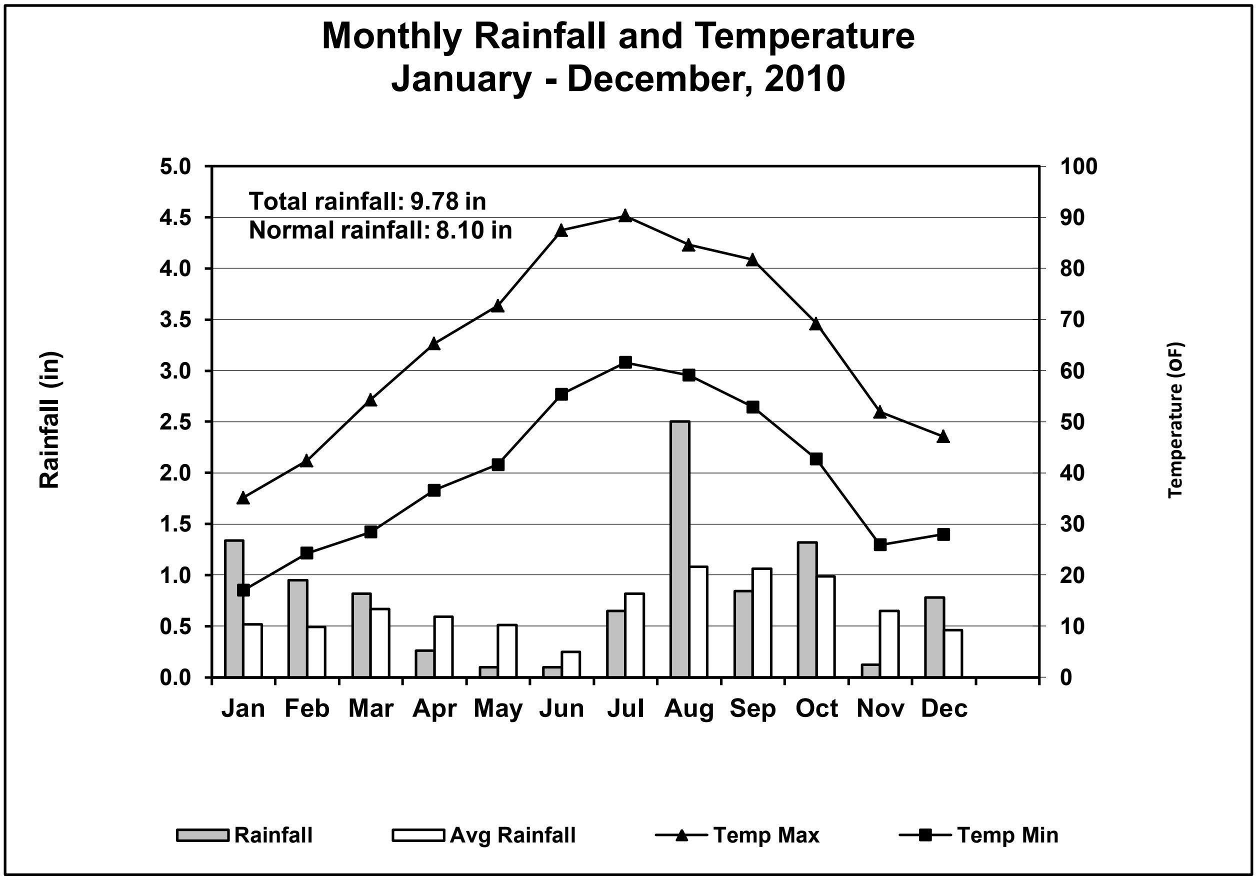
Monthly Rainfall and Temperature
January - December, 2010
Total rainfall: 9.78 in
Normal rainfall: 8.10 in
Rainfall (in)
Temperature (OF)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Rainfall
Avg Rainfall
Temp Max
Temp Min

**Figure 1. Monthly and average precipitation (in), monthly maximum and minimum temperatures (ºF); NMSU Agricultural Science Center at Farmington, NM, 2010.**

**Table 1. Mean daily climatological data; NMSU Agricultural Science Center at Farmington, NM. January through December 2010.**

| Month | Mean Temperature | | | Extreme Temp. | | Precipi- | Wind Speed | | Evapo- | Sunshine |
|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | Max | Min | tation | 18 in height | 2 m height | ration | |
| | (ºF) | (ºF) | (ºF) | (ºF) | (ºF) | (in) | (mi) | (mi) | (in) | (Langley) |
| January | 35.1 | 17.0 | 26.1 | 44.0 | 5.0 | 1.34 | 33 | 73 | | 232 |
| February | 42.4 | 24.3 | 33.4 | 50.0 | 12.0 | 0.95 | 59 | 100 | | 293 |
| March | 54.3 | 28.4 | 41.4 | 75.0 | 18.0 | 0.82 | 79 | 130 | | 451 |
| April | 65.3 | 36.6 | 51.0 | 78.0 | 21.0 | 0.26 | 82 | 154 | 8.35 | 553 |
| May | 72.7 | 41.6 | 57.2 | 90.0 | 26.0 | 0.1 | 30 | 125 | 10.88 | 677 |
| June | 87.5 | 55.4 | 71.5 | 98.0 | 44.0 | 0.1 | | 63 | 12.4 | 695 |
| July | 90.3 | 61.6 | 76.0 | 98.0 | 49.0 | 0.65 | | 94 | 12.25 | 624 |
| August | 84.6 | 59.1 | 71.9 | 94.0 | 53.0 | 2.5 | | 78 | 9.49 | 547 |
| September | 81.7 | 52.9 | 67.3 | 89.0 | 44.0 | 0.84 | | 79 | 8.58 | 501 |
| October | 69.2 | 42.7 | 56.0 | 88.0 | 24.0 | 1.32 | | 89 | 5.64 | 375 |
| November | 51.9 | 25.9 | 38.9 | 71.0 | 6.0 | 0.12 | | 108 | | 286 |
| December | 47.1 | 28.0 | 37.6 | 59 | 3 | 0.78 | | 90 | | 175 |
| **Total** | 782.1 | 473.5 | 627.8 | 934.0 | 305.0 | 9.78 | 282.1 | 1183.0 | 67.6 | 5409 |
| **Mean** | 65.2 | 39.5 | 52.3 | 77.8 | 25.4 | 0.8 | 23.5 | 98.6 | 9.7 | 451 |

<u>Freeze-Free Period</u>
Last Spring reading of 32 ºF or below: May 12 (27 ºF)
First Fall reading of 32 ºF or below: October 26 (27 ºF)
Number of freeze-free days: 166
<u>Killing Freeze-Free Period</u>
Last Spring reading of 28 ºF or below: May 12 (27 ºF)
First Fall reading killing freeze: October 26 (27 ºF)
First Fall reading killing freeze: October 26 (27 ºF)

**Table 2. Forty-two year average monthly weather conditions; NMSU Agriculture Science Center at Farmington, NM. 1969 – 2010.**

| Month | Precip- | Mean Temperature | | Extreme Temperature | | | |
|---|---|---|---|---|---|---|---|
| | tation | Maximum | Minimum | Maximum | Year Recorded | Minimum | Year Recorded |
| | (in) | (ºF) | (ºF) | (ºF) | | (ºF) | |
| January | 0.52 | 41 | 19 | 66 | 2000 | -18 | 1971 |
| February | 0.49 | 48 | 24 | 70 | 1986 | -14 | 1989 |
| March | 0.67 | 57 | 30 | 82 | 2004 | 3 | 2002 |
| April | 0.59 | 66 | 36 | 86 | 1992 | 16 | 1979 |
| May | 0.51 | 76 | 45 | 97 | 2000 | 23 | 1975 |
| June | 0.25 | 87 | 54 | 100 | 1981-1990-1994 | 32 | 1999 |
| July | 0.82 | 91 | 60 | 103 | 1989,90,03,05 | 43 | 1969 |
| August | 1.08 | 88 | 59 | 99 | 1969,70,83,02 | 41 | 1980 |
| September | 1.06 | 80 | 51 | 97 | 1995 | 28 | 1971-1999 |
| October | 0.99 | 68 | 40 | 88 | 2010 | 15 | 1989 |
| November | 0.65 | 53 | 28 | 75 | 1999-2001 | 1 | 1976 |
| December | 0.46 | 43 | 20 | 67 | 1999 | -16 | 1990 |
| **Total** | **8.10** | | | | | | |
| **Mean** | **0.68** | **66.4** | **38.8** | | | | |

**Table 3. Freeze dates and number of freeze-free days; NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| | Less than or equal to 32 ºF | | | Less than or equal to 28 ºF | | |
|---|---|---|---|---|---|---|
| Date | Last Spring Freeze (date) | First Fall Freeze (date) | Freeze-free Period (days) | Last Spring Killing Freeze (date) | First Fall Killing Freeze (date) | Killing Freeze-free Period (days) |
| 1969 | Apr 27 | Oct 05 | 161 | Apr 26 | Oct 06 | 163 |
| 1970 | May 02 | Oct 08 | 159 | May 01 | Oct 09 | 161 |
| 1971 | May 09 | **Sep 18*** | 132 | Apr 27 | **Sep 18*** | **144*** |
| 1972 | May 02 | Oct 30 | 181 | Apr 27 | Oct 31 | 187 |
| 1973 | May 02 | Oct 11 | 162 | May 02 | Oct 27 | 178 |
| 1974 | May 21 | Oct 30 | 162 | May 20 | Nov 04 | 168 |
| 1975 | May 08 | Oct 14 | 159 | May 07 | Oct 14 | 160 |
| 1976 | Apr 27 | Oct 07 | 164 | Apr 27 | Oct 19 | 175 |
| 1977 | Apr 21 | Oct 31 | **193**** | Apr 05 | Nov 02 | 211 |
| 1978 | May 06 | Oct 26 | 173 | May 06 | Nov 13 | 191 |
| 1979 | May 12 | Oct 21 | 162 | Apr 20 | Oct 22 | 185 |
| 1980 | May 26 | Oct 16 | 143 | **May 25**** | Oct 17 | 145 |
| 1981 | May 09 | Oct 16 | 160 | Apr 05 | Oct 17 | 194 |
| 1982 | May 06 | Oct 06 | 153 | Apr 21 | Oct 10 | 172 |

| Date | Less than or equal to 32 ºF | | | Less than or equal to 28 ºF | | |
|---|---|---|---|---|---|---|
| | Last Spring Freeze | First Fall Freeze | Freeze-free Period | Last Spring Killing Freeze | First Fall Killing Freeze | Killing Freeze-free Period |
| | (date) | (date) | (days) | (date) | (date) | (days) |
| 1983 | May 19 | Sep 21 | 125 | May 17 | Nov 09 | 176 |
| 1984 | May 08 | Oct 15 | 160 | May 08 | Oct 16 | 161 |
| 1985 | May 14 | Sep 30 | 139 | Apr 01 | Nov 01 | 214 |
| 1986 | Apr 27 | Oct 12 | 168 | Apr 27 | Oct 13 | 169 |
| 1987 | Apr 21 | Oct 19 | 181 | Apr 21 | Nov 11 | 204 |
| 1988 | May 07 | **Nov 12**** | 189 | Apr 11 | **Nov 16**** | **219**** |
| 1989 | Apr 30 | Oct 18 | 171 | Mar 21 | Oct 27 | **219**** |
| 1990 | **Apr 10*** | Oct 09 | 181 | Mar 31 | Oct 21 | 204 |
| 1991 | May 05 | Oct 28 | 176 | Apr 29 | Oct 29 | 182 |
| 1992 | Apr 21 | Oct 08 | 170 | **Mar 19*** | Oct 08 | 203 |
| 1993 | May 09 | Oct 19 | 163 | Apr 20 | Oct 27 | 190 |
| 1994 | Apr 30 | Oct 17 | 170 | Apr 08 | Oct 31 | 206 |
| 1995 | Apr 25 | Oct 06 | 164 | Apr 18 | Oct 06 | 171 |
| 1996 | Apr 30 | Sep 19 | 142 | Apr 29 | Oct 18 | 172 |
| 1997 | May 02 | Oct 13 | 163 | May 02 | Oct 13 | 163 |
| 1998 | May 15 | Oct 06 | 144 | Apr 19 | Oct 06 | 170 |
| 1999 | **Jun 05**** | Sep 28 | **115*** | Apr 16 | Sep 29 | 166 |
| 2000 | May 12 | Oct 14 | 154 | Apr 03 | Nov 02 | 212 |
| 2001 | Apr 23 | Oct 11 | 170 | Apr 13 | Oct 11 | 180 |
| 2002 | Apr 22 | Oct 04 | 165 | Apr 22 | Nov 04 | 196 |
| 2003 | May 11 | Oct 27 | 168 | Apr 08 | Oct 27 | 201 |
| 2004 | May 1 | Oct 23 | 174 | Mar 29 | Oct 30 | 214 |
| 2005 | Apr 22 | Oct 31 | 192 | Apr 21 | Nov 15 | 207 |
| 2006 | Apr 20 | Sep 23 | 155 | Apr 19 | Oct 22 | 183 |
| 2007 | May 07 | Oct 07 | 153 | Apr 19 | Oct 07 | 171 |
| 2008 | May 03 | Oct 12 | 162 | May 02 | Oct 12 | 163 |
| 2009 | April 27 | Sep 22 | 147 | Apr 16 | Oct 2 | 168 |
| 2010 | May 12 | Oct 26 | 166 | May 12 | Oct 26 | 166 |
| **Mean** | **May 3** | **Oct 12** | **161.7** | **Apr 21** | **Oct 21** | **183.0** |

* Earliest date (or shortest freeze-free period) of 42 years.
**Latest date (or longest freeze-free period) of 42 years.

**Table 4. Mean monthly precipitation (in); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 0.85 | 0.31 | 0.21 | 0.30 | 1.13 | ****1.00** | 0.69 | 0.47 | 2.07 | 2.88 | 0.38 | 0.29 | **10.58** |
| 1970 | 0.06 | 0.03 | 0.49 | 0.60 | 0.11 | 0.81 | 0.68 | ***0.02** | 2.48 | 0.48 | 0.46 | 0.20 | **6.42** |
| 1971 | 0.18 | 0.09 | 0.05 | 0.11 | 0.41 | ***0.00** | 0.31 | 1.72 | 1.06 | 1.15 | 0.77 | 0.16 | **6.01** |
| 1972 | 0.03 | ***trace** | 0.03 | ***0.00** | 0.02 | 0.18 | 0.04 | 1.34 | 0.57 | ****3.53** | 0.19 | 0.93 | **6.86** |
| 1973 | 0.28 | 0.17 | 1.82 | 1.54 | 0.65 | 0.95 | 0.27 | 0.61 | 1.49 | 0.35 | 0.30 | 0.37 | **8.80** |
| 1974 | 1.10 | 0.13 | 0.01 | 0.20 | 0.02 | 0.09 | 1.48 | 0.12 | 0.37 | 2.39 | 0.48 | 0.38 | **6.77** |
| 1975 | 0.11 | 0.61 | 1.52 | 0.78 | 0.35 | 0.13 | 0.84 | 0.24 | 0.80 | 0.14 | 0.22 | 0.20 | **5.94** |
| 1976 | 0.06 | 0.16 | ***0.00** | 0.10 | 0.41 | 0.09 | 0.62 | 0.80 | 1.31 | ***0.01** | 0.01 | ***trace** | ***3.57** |
| 1977 | 0.42 | ***trace** | ***0.00** | 0.01 | 0.29 | 0.04 | 1.01 | 1.41 | 0.38 | 0.30 | 0.62 | 0.63 | **5.15** |
| 1978 | 0.90 | 0.64 | 1.27 | 0.71 | 0.96 | ***0.00** | 0.07 | 0.18 | 1.55 | 1.46 | 2.24 | 0.59 | **10.57** |
| 1979 | 0.88 | 0.19 | 0.46 | 0.28 | 0.58 | 0.43 | 1.40 | 0.49 | ***0.08** | 1.37 | 0.97 | 0.73 | **7.86** |
| 1980 | 1.45 | 0.70 | 0.63 | 0.25 | 0.25 | 0.07 | 0.08 | 0.89 | 1.05 | 0.84 | 0.02 | ***trace** | **6.23** |
| 1981 | ***trace** | 0.30 | 1.76 | 0.21 | 1.05 | 0.16 | 1.34 | 0.35 | 0.69 | 0.89 | 0.36 | 0.03 | **7.14** |
| 1982 | 0.32 | 0.77 | 1.18 | 0.67 | 0.82 | ***0.00** | 1.27 | 2.78 | 1.50 | 0.16 | 0.92 | 0.76 | **11.15** |
| 1983 | 0.94 | 0.69 | 1.84 | 0.31 | 0.13 | 0.35 | 1.67 | 0.72 | 0.53 | 0.52 | 0.91 | 0.67 | **9.28** |
| 1984 | ***trace** | 0.12 | 0.54 | 1.00 | trace | 0.67 | 0.62 | 1.64 | 0.45 | 1.13 | 0.23 | 0.87 | **7.27** |
| 1985 | 0.39 | 0.13 | 1.74 | 1.76 | 0.29 | 0.01 | 1.38 | 0.43 | 1.31 | 1.21 | 0.52 | 0.22 | **9.39** |
| 1986 | 0.11 | 0.77 | 0.51 | 0.97 | 0.13 | 0.81 | ****4.10** | 0.93 | 2.18 | 0.65 | ****2.73** | 0.76 | ****14.65** |
| 1987 | 0.10 | 1.75 | 0.66 | trace | 0.68 | 0.02 | 0.28 | 1.17 | 0.27 | 1.07 | 1.65 | 0.59 | **8.24** |
| 1988 | 0.63 | 0.82 | 0.02 | 0.72 | 1.11 | 0.33 | 0.58 | 2.34 | 0.27 | 0.22 | 0.78 | 0.19 | **8.01** |
| 1989 | 1.19 | 0.56 | 0.06 | ***0.00** | trace | trace | 1.24 | 1.62 | 0.14 | 0.51 | ***0.00** | ***trace** | **5.32** |
| 1990 | 0.53 | 0.53 | 0.74 | 0.85 | 1.07 | 0.07 | 0.35 | 1.32 | 1.97 | 1.12 | 0.78 | 0.59 | **9.92** |
| 1991 | 0.59 | 0.26 | 0.67 | 0.01 | 0.27 | 0.69 | 0.35 | 0.58 | 1.38 | 0.38 | 2.07 | ****1.01** | **8.26** |
| 1992 | 0.15 | 0.18 | 0.74 | 0.25 | ****1.75** | 0.05 | 0.98 | 1.25 | 0.85 | 0.42 | 0.31 | 0.63 | **7.56** |
| 1993 | ****2.05** | 0.82 | 0.93 | 0.28 | 0.38 | 0.04 | ***0.03** | 2.06 | 0.84 | 1.25 | 0.47 | 0.15 | **9.30** |
| 1994 | 0.09 | 0.48 | 0.24 | 0.57 | 1.32 | 0.07 | 0.20 | 0.66 | 1.37 | 1.18 | 0.96 | 0.64 | **7.78** |
| 1995 | 0.57 | 0.14 | 1.45 | 1.28 | 0.9 | 0.03 | 0.23 | 1.88 | 2.04 | 0.10 | 0.14 | 0.39 | **9.15** |
| 1996 | 0.09 | 0.43 | 0.28 | 0.17 | ***0.00** | 0.64 | 0.24 | 1.07 | 0.63 | 2.21 | 0.72 | 0.22 | **6.70** |
| 1997 | 1.03 | 0.48 | 0.03 | ****2.88** | 0.82 | 0.62 | 1.28 | 1.12 | 2.68 | 0.43 | 0.67 | 0.80 | **12.84** |
| 1998 | 0.12 | 0.61 | 0.65 | 0.73 | 0.03 | 0.02 | 1.38 | 1.48 | 0.68 | 2.07 | 1.27 | 0.06 | **9.10** |
| 1999 | 0.14 | 0.05 | 0.13 | 1.21 | 1.26 | 0.44 | 2.51 | ****2.99** | 0.25 | ***0.01** | 0.06 | 0.12 | **9.17** |
| 2000 | 0.62 | 0.25 | ****2.05** | 0.21 | 0.03 | 0.12 | 0.80 | 1.22 | 0.50 | 2.16 | 0.78 | 0.22 | **8.96** |
| 2001 | 0.44 | 0.80 | 1.37 | 0.67 | 0.87 | 0.03 | 0.82 | 1.01 | 0.26 | 0.24 | 0.48 | 0.55 | **7.50** |
| 2002 | 0.04 | 0.04 | 0.17 | 0.37 | ***0.00** | ***0.00** | 0.42 | 0.32 | ****3.26** | 1.75 | 0.72 | 0.60 | **7.70** |
| 2003 | 0.08 | 1.29 | 0.49 | 0.02 | 0.01 | 0.15 | 0.11 | 1.24 | 0.87 | 0.72 | 1.03 | 0.31 | **6.32** |
| 2004 | 0.34 | 0.90 | ***0.00** | 2.50 | ***0.00** | 0.14 | 0.38 | 0.16 | 2.53 | 0.60 | 0.82 | 0.37 | **8.70** |
| 2005 | 1.09 | ****1.81** | 0.36 | 0.85 | 0.55 | 0.11 | 0.52 | 1.84 | 0.48 | 0.92 | 0.06 | 0.10 | **8.70** |
| 2006 | 0.39 | 0.05 | 0.71 | 0.58 | 0.09 | 0.24 | 1.90 | 0.79 | 1.38 | 1.90 | 0.06 | 0.73 | **8.80** |
| 2007 | 0.42 | 0.59 | 1.13 | 0.35 | 1.73 | 0.10 | 0.68 | 0.81 | 0.74 | 0.11 | 0.21 | 0.99 | **7.90** |
| 2008 | 1.21 | 0.74 | 0.14 | 0.03 | 0.25 | 0.13 | 0.63 | 0.53 | 0.28 | 0.76 | 0.61 | 0.96 | **6.30** |
| 2009 | 0.36 | 0.44 | 0.21 | 0.28 | 0.78 | 0.47 | 0.15 | 0.27 | 0.09 | 0.68 | 0.32 | 0.42 | **4.50** |
| 2010 | 1.34 | 0.95 | 0.82 | 0.26 | 0.10 | 0.10 | 0.65 | 2.50 | 0.84 | 1.32 | 0.12 | 0.78 | **9.78** |
| **Mean** | **0.52** | **0.49** | **0.67** | **0.59** | **0.51** | **0.25** | **0.82** | **1.08** | **1.06** | **0.99** | **0.65** | **0.46** | **8.10** |

* Lowest in column
** Highest in column

**Table 5. Summary of monthly average of the mean temperature* (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 34 | 35 | 37 | 52 | 63 | 67 | 76 | 76 | 69 | 50 | 40 | 34 | **52.8** |
| 1970 | 31 | 40 | 39 | 44 | 60 | 68 | 76 | 76 | 64 | 50 | 42 | 33 | **51.9** |
| 1971 | 30 | 34 | 43 | 50 | 58 | 71 | 77 | 74 | 64 | 52 | 40 | 30 | **51.9** |
| 1972 | 30 | 38 | 48 | 53 | 60 | 70 | 78 | 74 | 66 | 54 | 36 | 26 | **52.8** |
| 1973 | 22 | 35 | 39 | 45 | 59 | 68 | 75 | 75 | 63 | 55 | 44 | 30 | **50.8** |
| 1974 | 24 | 28 | 48 | 48 | 63 | 74 | 75 | 74 | 65 | 55 | 40 | 28 | **51.8** |
| 1975 | 26 | 34 | 40 | 46 | 56 | 66 | 74 | 72 | 64 | 54 | 38 | 30 | **50.0** |
| 1976 | 28 | 41 | 40 | 52 | 60 | 70 | 77 | 74 | 66 | 51 | 40 | 32 | **52.6** |
| 1977 | 25 | 37 | 39 | 54 | 59 | 74 | 76 | 75 | 68 | 56 | 43 | 36 | **53.5** |
| 1978 | 33 | 34 | 46 | 52 | 56 | 69 | 76 | 71 | 65 | 56 | 42 | 24 | **52.0** |
| 1979 | 24 | 32 | 40 | 50 | 58 | 67 | 74 | 72 | 69 | 56 | 35 | 32 | **50.8** |
| 1980 | 33 | 39 | 40 | 48 | 57 | 71 | 76 | 73 | 65 | 52 | 41 | 37 | **52.7** |
| 1981 | 30 | 37 | 41 | 55 | 59 | 71 | 74 | 72 | 65 | 51 | 44 | 34 | **52.8** |
| 1982 | 30 | 31 | 42 | 49 | 57 | 67 | 73 | 72 | 65 | 50 | 40 | 32 | **50.7** |
| 1983 | 31 | 36 | 42 | 45 | 56 | 66 | 74 | 75 | 68 | 54 | 41 | 34 | **51.8** |
| 1984 | 28 | 34 | 41 | 47 | 64 | 69 | 76 | 74 | 66 | 47 | 42 | 35 | **51.9** |
| 1985 | 30 | 32 | 41 | 53 | 61 | 71 | 76 | 74 | 62 | 54 | 40 | 31 | **52.1** |
| 1986 | 40 | 39 | 47 | 51 | 60 | 70 | 72 | 74 | 62 | 52 | 40 | 33 | **53.3** |
| 1987 | 29 | 36 | 39 | 53 | 59 | 70 | 73 | 71 | 65 | 56 | 39 | 29 | **51.6** |
| 1988 | 24 | 36 | 41 | 51 | 59 | 72 | 76 | 74 | 64 | 58 | 41 | 31 | **52.3** |
| 1989 | 27 | 35 | 49 | 57 | 63 | 70 | 78 | 72 | 69 | 55 | 41 | 31 | **53.9** |
| 1990 | 29 | 36 | 46 | 54 | 59 | 75 | 76 | 73 | 69 | 54 | 42 | 24 | **53.1** |
| 1991 | 25 | 37 | 41 | 49 | 59 | 68 | 75 | 74 | 66 | 56 | 38 | 29 | **51.4** |
| 1992 | 28 | 39 | 45 | 56 | 62 | 68 | 72 | 73 | 66 | 56 | 35 | 26 | **52.2** |
| 1993 | 35 | 38 | 44 | 51 | 61 | 69 | 74 | 71 | 64 | 52 | 38 | 32 | **52.4** |
| 1994 | 33 | 35 | 46 | 52 | 61 | 73 | 77 | 76 | 66 | 53 | 38 | 35 | **53.8** |
| 1995 | 33 | 44 | 44 | 48 | 57 | 67 | 74 | 76 | 67 | 53 | 44 | 35 | **53.5** |
| 1996 | 32 | 41 | 43 | 51 | 64 | 71 | 76 | 73 | 61 | 52 | 40 | 32 | **53.0** |
| 1997 | 29 | 36 | 46 | 47 | 61 | 70 | 74 | 73 | 68 | 52 | 41 | 31 | **52.3** |
| 1998 | 34 | 35 | 42 | 48 | 61 | 67 | 77 | 74 | 70 | 54 | 42 | 32 | **53.0** |
| 1999 | 35 | 39 | 48 | 49 | 58 | 68 | 74 | 71 | 63 | 54 | 45 | 30 | **52.8** |
| 2000 | 34 | 40 | 42 | 53 | 63 | 71 | 75 | 75 | 68 | 54 | 35 | 34 | **53.7** |
| 2001 | 31 | 37 | 45 | 54 | 63 | 71 | 77 | 74 | 70 | 57 | 45 | 31 | **54.6** |
| 2002 | 32 | 34 | 42 | 57 | 63 | 75 | 78 | 74 | 66 | 53 | 40 | 32 | **53.8** |
| 2003 | 38 | 36 | 44 | 51 | 63 | 71 | 81 | 77 | 66 | 59 | 41 | 34 | **55.1** |
| 2004 | 30 | 34 | 50 | 53 | 64 | 72 | 75 | 73 | 65 | 54 | 41 | 33 | **53.5** |
| 2005 | 38 | 40 | 43 | 52 | 62 | 69 | 79 | 73 | 68 | 56 | 43 | 32 | **54.6** |
| 2006 | 34 | 37 | 43 | 56 | 65 | 74 | 78 | 73 | 62 | 52 | 44 | 31 | **54.0** |
| 2007 | 28 | 37 | 47 | 52 | 61 | 72 | 78 | 76 | 68 | 55 | 44 | 30 | **53.7** |
| 2008 | 24 | 33 | 42 | 50 | 58 | 70 | 75 | 74 | 66 | 54 | 44 | 31 | **51.8** |
| 2009 | 32 | 38 | 45 | 49 | 64 | 68 | 77 | 73 | 67 | 50 | 43 | 27 | **52.8** |
| 2010 | 26 | 33 | 41 | 51 | 57 | 72 | 76 | 72 | 67 | 56 | 39 | 38 | **52.3** |
| **Mean** | **30.2** | **36.2** | **43.1** | **50.9** | **60.3** | **70.0** | **75.7** | **73.6** | **65.9** | **53.7** | **40.7** | **31.4** | **52.7** |

*The mean temperatures are the average of maximum and minimum temperatures for the month.

**Table 6. Summary of monthly average maximum temperature (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 42 | 46 | 50 | 69 | 78 | 81 | 91 | 90 | 83 | 62 | 51 | 45 | **65.7** |
| 1970 | 42 | 54 | 52 | 60 | 78 | 84 | 91 | 91 | 78 | 63 | 55 | 44 | **66.0** |
| 1971 | 43 | 48 | 59 | 66 | 74 | 87 | 93 | 87 | 80 | 65 | 51 | 39 | **66.0** |
| 1972 | 43 | 54 | 66 | 70 | 78 | 86 | 93 | 87 | 80 | 63 | 46 | 37 | **66.9** |
| 1973 | 32 | 42 | 50 | 59 | 74 | 84 | 90 | 90 | 79 | 70 | 57 | 42 | **64.1** |
| 1974 | 34 | 40 | 62 | 64 | 80 | 91 | 89 | 88 | 80 | 66 | 52 | 39 | **65.4** |
| 1975 | 37 | 44 | 52 | 60 | 71 | 85 | 89 | 88 | 79 | 70 | 53 | 42 | **64.2** |
| 1976 | 41 | 54 | 56 | 68 | 76 | 87 | 92 | 88 | 79 | 65 | 53 | 45 | **67.0** |
| 1977 | 34 | 51 | 53 | 69 | 74 | 90 | 90 | 89 | 81 | 71 | 54 | 47 | **66.9** |
| 1978 | 41 | 44 | 58 | 65 | 70 | 85 | 90 | 86 | 78 | 70 | 51 | 33 | **64.3** |
| 1979 | 31 | 42 | 52 | 65 | 72 | 84 | 90 | 86 | 84 | 71 | 46 | 43 | **63.8** |
| 1980 | 41 | 50 | 53 | 64 | 72 | 89 | 93 | 88 | 80 | 66 | 55 | 51 | **66.8** |
| 1981 | 49 | 51 | 53 | 70 | 74 | 88 | 90 | 88 | 80 | 65 | 58 | 46 | **67.7** |
| 1982 | 41 | 41 | 54 | 63 | 72 | 84 | 89 | 85 | 78 | 65 | 51 | 41 | **63.7** |
| 1983 | 40 | 46 | 53 | 59 | 72 | 82 | 90 | 89 | 83 | 68 | 52 | 43 | **64.8** |
| 1984 | 41 | 48 | 56 | 61 | 80 | 84 | 91 | 87 | 80 | 60 | 55 | 45 | **65.7** |
| 1985 | 41 | 44 | 55 | 67 | 75 | 88 | 91 | 89 | 76 | 67 | 51 | 43 | **65.6** |
| 1986 | 49 | 51 | 61 | 64 | 75 | 84 | 86 | 89 | 75 | 65 | 50 | 44 | **66.1** |
| 1987 | 40 | 47 | 52 | 68 | 74 | 87 | 90 | 86 | 80 | 71 | 51 | 40 | **65.5** |
| 1988 | 35 | 47 | 57 | 65 | 75 | 87 | 92 | 87 | 80 | 73 | 53 | 43 | **66.2** |
| 1989 | 38 | 45 | 63 | 73 | 79 | 86 | 93 | 87 | 84 | 69 | 56 | 45 | **68.2** |
| 1990 | 41 | 47 | 58 | 67 | 73 | 90 | 90 | 87 | 82 | 68 | 54 | 36 | **66.1** |
| 1991 | 35 | 49 | 53 | 65 | 75 | 84 | 90 | 88 | 80 | 71 | 49 | 37 | **64.7** |
| 1992 | 38 | 50 | 58 | 71 | 76 | 84 | 86 | 87 | 81 | 72 | 48 | 36 | **65.6** |
| 1993 | 44 | 48 | 59 | 67 | 76 | 86 | 91 | 85 | 79 | 66 | 50 | 43 | **66.2** |
| 1994 | 46 | 46 | 61 | 66 | 76 | 90 | 93 | 91 | 81 | 66 | 50 | 46 | **67.7** |
| 1995 | 42 | 58 | 58 | 61 | 71 | 83 | 91 | 90 | 81 | 69 | 59 | 47 | **67.5** |
| 1996 | 45 | 54 | 58 | 68 | 82 | 87 | 91 | 89 | 76 | 66 | 53 | 43 | **67.7** |
| 1997 | 39 | 48 | 63 | 61 | 77 | 86 | 90 | 87 | 82 | 67 | 54 | 42 | **66.3** |
| 1998 | 45 | 46 | 57 | 62 | 78 | 85 | 92 | 90 | 86 | 68 | 56 | 45 | **67.5** |
| 1999 | 50 | 54 | 64 | 63 | 73 | 86 | 89 | 84 | 80 | 73 | 63 | 44 | **68.6** |
| 2000 | 47 | 53 | 56 | 68 | 82 | 89 | 93 | 91 | 84 | 66 | 46 | 45 | **68.3** |
| 2001 | 41 | 48 | 57 | 68 | 79 | 89 | 92 | 88 | 85 | 72 | 59 | 43 | **68.4** |
| 2002 | 45 | 49 | 57 | 72 | 79 | 93 | 94 | 90 | 80 | 66 | 53 | 43 | **68.4** |
| 2003 | 51 | 48 | 56 | 67 | 79 | 88 | 97 | 91 | 82 | 74 | 52 | 46 | **69.3** |
| 2004 | 41 | 45 | 65 | 66 | 80 | 89 | 91 | 88 | 79 | 67 | 51 | 44 | **67.2** |
| 2005 | 48 | 49 | 56 | 67 | 78 | 86 | 96 | 88 | 83 | 69 | 57 | 45 | **68.4** |
| 2006 | 46 | 52 | 56 | 70 | 82 | 91 | 92 | 86 | 75 | 64 | 57 | 42 | **67.8** |
| 2007 | 38 | 48 | 61 | 66 | 74 | 88 | 93 | 90 | 82 | 69 | 59 | 39 | **67.3** |
| 2008 | 34 | 43 | 58 | 66 | 74 | 85 | 90 | 88 | 80 | 69 | 56 | 40 | **65.2** |
| 2009 | 42 | 51 | 59 | 64 | 78 | 81 | 92 | 88 | 80 | 63 | 55 | 37 | **65.8** |
| 2010 | 35 | 42 | 54 | 65 | 73 | 88 | 90 | 85 | 82 | 69 | 52 | 47 | **65.2** |
| **Mean** | **41.1** | **48.0** | **56.9** | **65.7** | **75.9** | **86.5** | **91.1** | **88.0** | **80.4** | **67.6** | **53.2** | **42.5** | **66.4** |

**Table 7. Summary of monthly average of the minimum temperature (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 25 | 24 | 24 | 35 | 48 | 51 | 61 | 62 | 55 | 39 | 30 | 22 | **39.7** |
| 1970 | 20 | 27 | 26 | 29 | 43 | 53 | 62 | 62 | 49 | 36 | 30 | 22 | **38.3** |
| 1971 | 16 | 20 | 26 | 33 | 42 | 54 | 61 | 60 | 48 | 38 | 28 | 21 | **37.3** |
| 1972 | 18 | 22 | 31 | 36 | 43 | 55 | 62 | 60 | 53 | 45 | 27 | 15 | **38.9** |
| 1973 | 12 | 26 | 29 | 32 | 44 | 52 | 60 | 60 | 48 | 40 | 31 | 19 | **37.8** |
| 1974 | 14 | 17 | 33 | 33 | 46 | 57 | 61 | 59 | 50 | 44 | 28 | 17 | **38.3** |
| 1975 | 14 | 23 | 28 | 31 | 40 | 48 | 60 | 57 | 50 | 39 | 24 | 19 | **36.1** |
| 1976 | 16 | 28 | 25 | 36 | 45 | 53 | 62 | 59 | 54 | 37 | 26 | 17 | **38.2** |
| 1977 | 15 | 22 | 25 | 39 | 44 | 59 | 62 | 61 | 55 | 42 | 31 | 26 | **40.1** |
| 1978 | 25 | 25 | 33 | 38 | 43 | 53 | 61 | 57 | 52 | 43 | 33 | 15 | **39.8** |
| 1979 | 16 | 22 | 28 | 34 | 44 | 50 | 58 | 57 | 53 | 40 | 25 | 20 | **37.3** |
| 1980 | 26 | 28 | 27 | 33 | 41 | 52 | 59 | 58 | 50 | 35 | 27 | 24 | **38.3** |
| 1981 | 20 | 23 | 29 | 39 | 44 | 54 | 58 | 56 | 50 | 37 | 30 | 22 | **38.5** |
| 1982 | 18 | 21 | 30 | 34 | 43 | 51 | 58 | 60 | 52 | 35 | 29 | 22 | **37.8** |
| 1983 | 21 | 26 | 31 | 31 | 41 | 51 | 58 | 61 | 52 | 41 | 29 | 24 | **38.8** |
| 1984 | 16 | 20 | 27 | 33 | 48 | 53 | 61 | 60 | 52 | 36 | 30 | 25 | **38.4** |
| 1985 | 20 | 19 | 32 | 38 | 46 | 54 | 61 | 59 | 48 | 41 | 29 | 19 | **38.8** |
| 1986 | 23 | 26 | 33 | 39 | 44 | 55 | 59 | 60 | 50 | 40 | 29 | 22 | **40.0** |
| 1987 | 18 | 25 | 26 | 39 | 45 | 53 | 57 | 57 | 49 | 40 | 28 | 19 | **38.0** |
| 1988 | 13 | 24 | 25 | 36 | 44 | 56 | 61 | 60 | 48 | 43 | 29 | 19 | **38.2** |
| 1989 | 16 | 24 | 34 | 40 | 47 | 54 | 63 | 58 | 54 | 40 | 26 | 16 | **39.3** |
| 1990 | 18 | 25 | 35 | 41 | 45 | 59 | 63 | 60 | 56 | 40 | 30 | 11 | **40.3** |
| 1991 | 16 | 25 | 30 | 34 | 44 | 53 | 59 | 59 | 51 | 40 | 27 | 21 | **38.3** |
| 1992 | 18 | 27 | 32 | 40 | 48 | 52 | 57 | 58 | 50 | 40 | 22 | 16 | **38.3** |
| 1993 | 26 | 28 | 30 | 36 | 45 | 52 | 57 | 58 | 48 | 38 | 25 | 20 | **38.6** |
| 1994 | 19 | 24 | 31 | 38 | 46 | 56 | 60 | 61 | 50 | 39 | 27 | 24 | **39.6** |
| 1995 | 24 | 29 | 31 | 35 | 43 | 50 | 58 | 61 | 52 | 37 | 29 | 23 | **39.3** |
| 1996 | 19 | 28 | 29 | 34 | 47 | 54 | 60 | 58 | 47 | 38 | 28 | 21 | **38.6** |
| 1997 | 19 | 24 | 28 | 32 | 46 | 54 | 59 | 59 | 54 | 37 | 28 | 20 | **38.3** |
| 1998 | 22 | 25 | 28 | 33 | 45 | 48 | 62 | 59 | 54 | 40 | 29 | 19 | **38.7** |
| 1999 | 21 | 24 | 31 | 34 | 43 | 50 | 59 | 57 | 46 | 36 | 28 | 15 | **37.0** |
| 2000 | 22 | 28 | 29 | 37 | 44 | 54 | 58 | 58 | 52 | 42 | 25 | 23 | **39.3** |
| 2001 | 21 | 26 | 32 | 40 | 47 | 54 | 63 | 59 | 54 | 42 | 32 | 19 | **40.8** |
| 2002 | 19 | 18 | 26 | 41 | 46 | 57 | 61 | 58 | 51 | 39 | 27 | 22 | **38.8** |
| 2003 | 25 | 24 | 31 | 35 | 47 | 53 | 64 | 62 | 50 | 44 | 29 | 22 | **40.5** |
| 2004 | 19 | 22 | 35 | 39 | 47 | 55 | 59 | 58 | 51 | 41 | 30 | 21 | **39.8** |
| 2005 | 28 | 31 | 30 | 37 | 47 | 52 | 62 | 59 | 54 | 43 | 29 | 19 | **40.9** |
| 2006 | 21 | 21 | 31 | 39 | 48 | 57 | 64 | 60 | 48 | 40 | 31 | 20 | **40.0** |
| 2007 | 17 | 26 | 32 | 38 | 48 | 56 | 62 | 62 | 53 | 40 | 28 | 20 | **40.2** |
| 2008 | 13 | 24 | 27 | 34 | 42 | 54 | 61 | 60 | 51 | 40 | 32 | 22 | **38.4** |
| 2009 | 22 | 25 | 31 | 34 | 49 | 54 | 62 | 58 | 53 | 36 | 30 | 16 | **39.2** |
| 2010 | 17 | 24 | 28 | 37 | 42 | 55 | 62 | 59 | 53 | 43 | 26 | 28 | **39.5** |
| **Mean** | **19.2** | **24.3** | **29.5** | **35.9** | **44.8** | **53.5** | **60.4** | **59.2** | **51.2** | **39.7** | **28.4** | **20.2** | 38.8 |

**Table 8. Highest temperatures (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 57 | 61 | 74 | 82 | 89 | 96 | 96 | **99** | 95 | 78 | 63 | 56 | **78.8** |
| 1970 | 56 | 65 | 65 | 72 | 86 | 98 | 98 | **99** | 90 | 76 | 64 | 61 | **77.5** |
| 1971 | 60 | 64 | 77 | 77 | 84 | 97 | 101 | 91 | 90 | 67 | 70 | 57 | **77.9** |
| 1972 | 61 | 66 | 76 | 78 | 86 | 94 | 100 | 98 | 89 | 82 | 57 | 52 | **78.3** |
| 1973 | 47 | 61 | 63 | 76 | 85 | 98 | 99 | 97 | 88 | 81 | 73 | 65 | **77.8** |
| 1974 | 45 | 60 | 72 | 75 | 93 | 99 | 95 | 94 | 93 | 83 | 64 | 56 | **77.4** |
| 1975 | 61 | 58 | 65 | 77 | 85 | 96 | 95 | 95 | 89 | 84 | 73 | 57 | **77.9** |
| 1976 | 54 | 68 | 71 | 77 | 86 | 96 | 100 | 93 | 94 | 78 | 70 | 55 | **78.5** |
| 1977 | 46 | 65 | 69 | 81 | 91 | 98 | 97 | 98 | 93 | 82 | 74 | 63 | **79.8** |
| 1978 | 53 | 59 | 79 | 77 | 88 | 95 | 95 | 94 | 90 | 83 | 67 | 47 | **77.3** |
| 1979 | 46 | 60 | 62 | 78 | 82 | 96 | 97 | 96 | 94 | 83 | 60 | 54 | **75.7** |
| 1980 | 55 | 64 | 67 | 81 | 86 | 99 | 97 | 97 | 88 | 84 | 73 | 63 | **79.5** |
| 1981 | 60 | 67 | 71 | 82 | 84 | **100** | 97 | 96 | 85 | 78 | 68 | 56 | **78.7** |
| 1982 | 60 | 64 | 64 | 75 | 75 | 93 | 97 | 95 | 91 | 79 | 64 | 53 | **75.8** |
| 1983 | 53 | 68 | 68 | 83 | 89 | 92 | 96 | **99** | 93 | 74 | 70 | 50 | **77.9** |
| 1984 | 51 | 60 | 68 | 79 | 93 | 94 | 95 | 93 | 89 | 75 | 68 | 54 | **76.6** |
| 1985 | 50 | 60 | 70 | 79 | 85 | 95 | 100 | 95 | 93 | 75 | 68 | 51 | **76.8** |
| 1986 | 64 | **70** | 75 | 79 | 85 | 94 | 96 | 96 | 88 | 75 | 63 | 55 | **78.3** |
| 1987 | 56 | 61 | 69 | 80 | 82 | 93 | 98 | 93 | 89 | 83 | 66 | 58 | **77.3** |
| 1988 | 49 | 62 | 77 | 78 | 87 | 99 | 96 | 93 | 93 | 83 | 70 | 56 | **78.6** |
| 1989 | 50 | 67 | 81 | 85 | 90 | 98 | **103** | 92 | 91 | 85 | 67 | 53 | **80.2** |
| 1990 | 56 | 64 | 74 | 80 | 86 | **100** | **103** | 94 | 93 | 79 | 69 | 55 | **79.4** |
| 1991 | 44 | 58 | 67 | 79 | 85 | 94 | 97 | 93 | 91 | 82 | 67 | 46 | **75.3** |
| 1992 | 52 | 58 | 67 | **86** | 85 | 92 | 95 | 95 | 89 | 83 | 61 | 49 | **76.0** |
| 1993 | 54 | 61 | 72 | 81 | 86 | 96 | 96 | 96 | 88 | 84 | 61 | 56 | **77.6** |
| 1994 | 58 | 63 | 74 | 81 | 90 | **100** | 98 | 97 | 89 | 80 | 70 | 55 | **79.6** |
| 1995 | 53 | 68 | 74 | 77 | 82 | 92 | 101 | 97 | **97** | 83 | 68 | 64 | **79.7** |
| 1996 | 56 | 65 | 71 | 82 | 90 | 93 | 96 | 96 | 90 | 83 | 66 | 57 | **78.8** |
| 1997 | 58 | 60 | 75 | 76 | 88 | 93 | 98 | 92 | 91 | 84 | 68 | 54 | **78.1** |
| 1998 | 56 | 62 | 77 | 80 | 87 | 99 | 100 | 95 | 90 | 85 | 67 | 60 | **79.8** |
| 1999 | 62 | 65 | 75 | 78 | 85 | 94 | 99 | 91 | 89 | 85 | **75** | **67** | **80.4** |
| 2000 | **66** | 66 | 70 | 85 | **97** | 94 | 97 | 97 | 93 | 83 | 57 | 55 | **80.0** |
| 2001 | 51 | 62 | 70 | 81 | 90 | 96 | 99 | 94 | 93 | 86 | **75** | 59 | **79.7** |
| 2002 | 59 | 63 | 74 | 81 | 95 | 98 | 100 | **99** | 90 | 77 | 63 | 55 | **79.5** |
| 2003 | 57 | 59 | 74 | 78 | 95 | 96 | **103** | 98 | 92 | **87** | 67 | 62 | **80.7** |
| 2004 | 51 | 62 | **82** | 78 | 89 | 96 | 99 | 97 | 91 | 78 | 67 | 60 | **79.2** |
| 2005 | 57 | 57 | 68 | 80 | 94 | 98 | **103** | 95 | 89 | 83 | 74 | 59 | **79.8** |
| 2006 | 57 | 62 | 71 | 85 | 92 | 99 | 100 | 92 | 87 | 83 | 69 | 54 | **79.3** |
| 2007 | 56 | 64 | 76 | 81 | 85 | 95 | 98 | 96 | 89 | 80 | 71 | 53 | **78.7** |
| 2008 | 51 | 54 | 70 | 79 | 89 | 93 | 94 | 97 | 87 | 81 | 74 | 53 | **76.9** |
| 2009 | 53 | 69 | 73 | 78 | 88 | 92 | 96 | 96 | 88 | 77 | 72 | 49 | **77.6** |
| 2010 | 44 | 50 | 75 | 78 | 90 | 98 | 98 | 94 | 89 | 88 | 71 | 59 | **77.8** |
| **Mean** | **54.4** | **62.4** | **71.7** | **79.4** | **87.6** | **95.9** | **98.0** | **95.3** | **90.5** | **80.9** | **67.7** | **56.0** | 78.3 |
| **Maximum** | **66** | **70** | **82** | **86** | **97** | **100** | **103** | **99** | **97** | **88** | **75** | **67** | |
| **Year** | **2000** | **1986** | **2004** | **1992** | **2000** | **1981** | **1989** | **1969** | **1995** | **2010** | **1999** | **1999** | |
| | | | | | | **1990** | **1990** | **1970** | | | **2001** | | |
| | | | | | | **1994** | **2003** | **1983** | | | | | |
| | | | | | | | **2005** | **2002** | | | | | |

**Table 9. Lowest temperatures (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969 | 9 | 12 | 13 | 27 | 37 | 44 | **43** | 52 | 46 | 26 | 14 | 7 | **27.5** |
| 1970 | 0 | 15 | 11 | 20 | 27 | 39 | 53 | 54 | 34 | 21 | 18 | 14 | **25.5** |
| 1971 | **-18** | 5 | 6 | 17 | 31 | 38 | 54 | 54 | **28** | 18 | 17 | 4 | **21.2** |
| 1972 | 2 | 2 | 14 | 24 | 30 | 47 | 56 | 54 | 37 | 22 | 15 | 2 | **25.4** |
| 1973 | 1 | 10 | 20 | 18 | 28 | 41 | 52 | 49 | 37 | 26 | 14 | 9 | **25.4** |
| 1974 | -11 | 1 | 20 | 18 | 28 | 38 | 53 | 52 | 33 | 30 | 14 | 1 | **23.1** |
| 1975 | -2 | 9 | 9 | 19 | **23** | 38 | 55 | 49 | 40 | 20 | 7 | 6 | **22.8** |
| 1976 | -4 | 12 | 11 | 23 | 34 | 38 | 54 | 52 | 42 | 22 | **1** | 9 | **24.5** |
| 1977 | -2 | 13 | 12 | 21 | 33 | 51 | 57 | 54 | 46 | 32 | 20 | 10 | **28.9** |
| 1978 | 12 | 0 | 20 | 26 | 31 | 45 | 51 | 46 | 32 | 31 | 18 | -9 | **25.3** |
| 1979 | -8 | 5 | 17 | **16** | 29 | 36 | 51 | 51 | 42 | 23 | 6 | 9 | **23.1** |
| 1980 | 14 | 18 | 13 | 18 | 27 | 36 | 53 | **41** | 37 | 17 | 12 | 11 | **24.8** |
| 1981 | 10 | 11 | 21 | 19 | 32 | 36 | 44 | 49 | 42 | 21 | 13 | 4 | **25.2** |
| 1982 | -1 | -3 | 19 | 22 | 30 | 38 | 47 | 54 | 38 | 21 | 17 | 6 | **24.0** |
| 1983 | 9 | 20 | 22 | 20 | 27 | 36 | 61 | 55 | 30 | 35 | 11 | 10 | **28.0** |
| 1984 | 2 | 11 | 14 | 18 | 27 | 40 | 53 | 54 | 39 | 23 | 15 | 13 | **25.8** |
| 1985 | 6 | -1 | 13 | 28 | 29 | 39 | 53 | 51 | 31 | 31 | 8 | 8 | **24.7** |
| 1986 | 8 | 8 | 19 | 23 | 33 | 42 | 53 | 52 | 40 | 28 | 16 | 8 | **27.5** |
| 1987 | 2 | 8 | 9 | 24 | 35 | 43 | 50 | 47 | 40 | 32 | 14 | 1 | **25.4** |
| 1988 | -2 | 16 | 9 | 21 | 30 | 38 | 54 | 54 | 33 | 36 | 12 | 1 | **25.2** |
| 1989 | 4 | **-14** | 14 | 29 | 36 | 41 | 55 | 48 | 36 | **15** | 9 | 3 | **23.0** |
| 1990 | 0 | 4 | 19 | 30 | 39 | 47 | 55 | 52 | 45 | 26 | 16 | **-16** | **26.4** |
| 1991 | -3 | 12 | 17 | 24 | 30 | 39 | 53 | 54 | 39 | 20 | 11 | 3 | **24.9** |
| 1992 | 10 | 17 | 20 | 30 | 40 | 41 | 47 | 48 | 37 | 28 | 7 | -2 | **26.9** |
| 1993 | 10 | 18 | 18 | 24 | 32 | 39 | 49 | 52 | 38 | 17 | 8 | 8 | **26.1** |
| 1994 | 7 | 4 | 12 | 26 | 35 | 46 | 50 | 57 | 39 | 26 | 8 | 11 | **26.8** |
| 1995 | 12 | 21 | 18 | 24 | 34 | 38 | 45 | 55 | 36 | 24 | 13 | 9 | **27.4** |
| 1996 | 6 | 12 | 16 | 20 | 39 | 41 | 54 | 52 | 29 | 16 | 19 | 3 | **25.6** |
| 1997 | -1 | 13 | 13 | 19 | 26 | 46 | 51 | 53 | 43 | 19 | 17 | 8 | **25.6** |
| 1998 | 12 | 15 | 13 | 25 | 31 | 40 | 59 | 52 | 46 | 27 | 16 | 3 | **28.3** |
| 1999 | 11 | 7 | 21 | 20 | 30 | **32** | 50 | 49 | **28** | 19 | 9 | 3 | **23.3** |
| 2000 | 1 | 14 | 17 | 28 | 29 | 44 | 52 | 52 | 33 | 32 | 10 | 11 | **26.9** |
| 2001 | 10 | 8 | 21 | 24 | 34 | 36 | 57 | 52 | 36 | 28 | 13 | 8 | **27.3** |
| 2002 | 3 | 6 | **3** | 27 | 35 | 48 | 56 | 50 | 39 | 30 | 19 | 8 | **27.0** |
| 2003 | 17 | 8 | 22 | 24 | 29 | 46 | 53 | 57 | 41 | 28 | 12 | 7 | **28.7** |
| 2004 | 8 | 6 | 21 | 32 | 32 | 44 | 52 | 51 | 35 | 26 | 8 | 4 | **26.6** |
| 2005 | 19 | 18 | 20 | 20 | 34 | 37 | 56 | 53 | 42 | 30 | 16 | -2 | **28.6** |
| 2006 | 10 | 11 | 17 | 27 | 35 | 48 | 56 | 49 | 31 | 24 | 4 | 5 | **26.4** |
| 2007 | 4 | 3 | 9 | 24 | 32 | 38 | 56 | 56 | 33 | 19 | 14 | 2 | **24.2** |
| 2008 | -7 | 4 | 17 | 21 | 27 | 40 | 54 | 53 | 41 | 22 | 13 | 7 | **24.3** |
| 2009 | 15 | 12 | 21 | 19 | 43 | 44 | 56 | 48 | 31 | 22 | 12 | 1 | **27.0** |
| 2010 | 5 | 12 | 18 | 21 | 26 | 44 | 49 | 53 | 44 | 24 | 6 | 3 | **25.4** |
| **Mean** | **4.3** | **9.1** | **15.7** | **22.9** | **31.6** | **41.0** | **52.7** | **51.7** | **37.4** | **24.7** | **12.4** | **5.0** | 25.7 |
| **Minimum** | **-18** | **-14** | **3** | **16** | **23** | **32** | **43** | **41** | **28** | **15** | **1** | **-16** | |
| **Years** | **1971** | **1989** | **2002** | **1979** | **1975** | **1999** | **1969** | **1980** | **1971** | **1989** | **1976** | **1990** | |
| | | | | | | | | | 1999 | | | | |

**Table 10. Number of days 32 ºF or below and 0 ºF in critical months; NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| | Number of Days 32 ºF or Below | | | | | | | | | | Number of Days 0 ºF or Below | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Sep** | **Oct** | **Nov** | **Dec** | **Total** | **Jan** | **Feb** | **Dec** | **Total** |
| 1969 | 22 | 26 | 25 | 7 | 0 | 0 | 0 | 7 | 22 | 29 | **138** | 0 | 0 | 0 | **0** |
| 1970 | 29 | 25 | 26 | 23 | 2 | 0 | 0 | 12 | 23 | 30 | **170** | 1 | 0 | 0 | **1** |
| 1971 | 29 | 27 | 22 | 13 | 1 | 0 | 2 | 8 | 26 | 27 | **155** | 4 | 0 | 0 | **4** |
| 1972 | 31 | 27 | 19 | 10 | 2 | 0 | 0 | 2 | 24 | 31 | **146** | 0 | 0 | 0 | **0** |
| 1973 | 31 | 26 | 25 | 17 | 1 | 0 | 0 | 5 | 16 | 28 | **149** | 0 | 0 | 0 | **0** |
| 1974 | 30 | 28 | 14 | 14 | 2 | 0 | 0 | 2 | 24 | 30 | **144** | 2 | 0 | 0 | **2** |
| 1975 | 29 | 27 | 24 | 15 | 3 | 0 | 0 | 6 | 25 | 30 | **159** | 2 | 0 | 0 | **2** |
| 1976 | 31 | 22 | 24 | 8 | 0 | 0 | 0 | 10 | 22 | 31 | **148** | 2 | 0 | 0 | **2** |
| 1977 | 31 | 28 | 26 | 8 | 0 | 0 | 0 | 1 | 20 | 30 | **144** | 3 | 0 | 0 | **3** |
| 1978 | 28 | 21 | 12 | 6 | 2 | 0 | 0 | 1 | 14 | 29 | **113** | 0 | 1 | 5 | **6** |
| 1979 | 29 | 27 | 25 | 11 | 3 | 0 | 0 | 5 | 24 | 31 | **155** | 3 | 1 | 0 | **4** |
| 1980 | 23 | 21 | 25 | 15 | 2 | 0 | 0 | 12 | 18 | 28 | **144** | 0 | 0 | 0 | **0** |
| 1981 | 29 | 26 | 24 | 3 | 1 | 0 | 0 | 11 | 19 | 31 | **144** | 0 | 0 | 0 | **0** |
| 1982 | 29 | 25 | 18 | 12 | 1 | 0 | 0 | 12 | 22 | 29 | **148** | 1 | 2 | 0 | **3** |
| 1983 | 31 | 25 | 18 | 15 | 6 | 0 | 1 | 0 | 18 | 26 | **140** | 0 | 0 | 0 | **0** |
| 1984 | 31 | 29 | 24 | 15 | 1 | 0 | 0 | 12 | 18 | 29 | **159** | 0 | 0 | 0 | **0** |
| 1985 | 31 | 25 | 16 | 5 | 1 | 0 | 1 | 2 | 19 | 30 | **130** | 0 | 1 | 0 | **1** |
| 1986 | 28 | 21 | 20 | 6 | 0 | 0 | 0 | 6 | 18 | 29 | **128** | 0 | 0 | 0 | **0** |
| 1987 | 28 | 25 | 24 | 10 | 0 | 0 | 0 | 3 | 22 | 31 | **143** | 0 | 0 | 0 | **0** |
| 1988 | 31 | 25 | 27 | 9 | 2 | 0 | 0 | 0 | 16 | 29 | **139** | 2 | 0 | 0 | **2** |
| 1989 | 31 | 24 | 13 | 5 | 0 | 0 | 0 | 6 | 27 | 31 | **137** | 0 | 2 | 0 | **2** |
| 1990 | 30 | 21 | 14 | 3 | 0 | 0 | 0 | 6 | 19 | 28 | **121** | 2 | 0 | 7 | **9** |
| 1991 | 31 | 22 | 20 | 11 | 2 | 0 | 0 | 4 | 23 | 31 | **144** | 2 | 0 | 0 | **2** |
| 1992 | 31 | 23 | 15 | 3 | 0 | 0 | 0 | 2 | 28 | 29 | **131** | 0 | 0 | 1 | **1** |
| 1993 | 28 | 22 | 24 | 11 | 3 | 0 | 0 | 9 | 25 | 31 | **153** | 0 | 0 | 0 | **0** |
| 1994 | 30 | 24 | 14 | 8 | 0 | 0 | 0 | 4 | 22 | 28 | **130** | 0 | 0 | 0 | **0** |
| 1995 | 28 | 18 | 15 | 15 | 0 | 0 | 0 | 7 | 23 | 28 | **134** | 0 | 0 | 0 | **0** |
| 1996 | 31 | 23 | 21 | 11 | 0 | 0 | 2 | 9 | 24 | 28 | **149** | 0 | 0 | 0 | **0** |
| 1997 | 29 | 27 | 23 | 16 | 1 | 0 | 0 | 11 | 22 | 31 | **160** | 1 | 0 | 0 | **1** |
| 1998 | 31 | 23 | 20 | 17 | 1 | 0 | 0 | 4 | 22 | 30 | **148** | 0 | 0 | 0 | **0** |
| 1999 | 30 | 26 | 19 | 12 | 4 | 1 | 2 | 8 | 24 | 30 | **156** | 0 | 0 | 0 | **0** |
| 2000 | 25 | 23 | 24 | 5 | 1 | 0 | 0 | 1 | 24 | 29 | **132** | 0 | 0 | 0 | **0** |
| 2001 | 31 | 23 | 13 | 6 | 0 | 0 | 0 | 2 | 13 | 29 | **117** | 0 | 0 | 0 | **0** |
| 2002 | 31 | 28 | 23 | 2 | 0 | 0 | 0 | 4 | 25 | 31 | **144** | 0 | 0 | 0 | **0** |
| 2003 | 30 | 22 | 21 | 9 | 3 | 0 | 0 | 2 | 18 | 29 | **134** | 0 | 0 | 0 | **0** |
| 2004 | 31 | 25 | 11 | 1 | 1 | 0 | 0 | 6 | 20 | 30 | **125** | 0 | 0 | 0 | **0** |
| 2005 | 27 | 17 | 21 | 8 | 0 | 0 | 0 | 1 | 19 | 30 | **123** | 0 | 0 | 1 | **1** |
| 2006 | 29 | 27 | 20 | 3 | 0 | 0 | 1 | 10 | 17 | 30 | **137** | 0 | 0 | 0 | **0** |
| 2007 | 31 | 22 | 14 | 4 | 1 | 0 | 0 | 5 | 23 | 28 | **128** | 0 | 0 | 0 | **0** |
| 2008 | 29 | 29 | 23 | 12 | 2 | 0 | 0 | 6 | 20 | 28 | **149** | 3 | 0 | 0 | **3** |
| 2009 | 30 | 25 | 20 | 14 | 0 | 0 | 1 | 10 | 17 | 31 | **148** | 0 | 0 | 0 | **0** |
| 2010 | 31 | 28 | 25 | 9 | 5 | 0 | 0 | 5 | 24 | 20 | **147** | 0 | 0 | 0 | **0** |
| **Mean** | **29.4** | **24.5** | **20.0** | **9.7** | **1.3** | **0** | **0.2** | **5.7** | **21.2** | **29.2** | **142** | **1** | **0.2** | **0.3** | **1.2** |
| **Total** | **1236** | **1028** | **851** | **407** | **54** | **1** | **10** | **239** | **889** | **1228** | **5943** | **28** | **7** | **14** | **49** |

**Table 11. Number of days 100 ºF or above and number of days 95 ºF or above in critical months; NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010.**

| | Number of Days 95 ºF or Above | | | | | | Number of Days 100 ºF or Above | | |
|---|---|---|---|---|---|---|---|---|---|
| **Year** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Total** | **Jun** | **Jul** | **Total** |
| 1969 | 0 | 1 | 3 | 5 | 1 | **10** | 0 | 0 | **0** |
| 1970 | 0 | 5 | 13 | 5 | 0 | **23** | 0 | 0 | **0** |
| 1971 | 0 | 5 | 11 | 0 | 0 | **16** | 0 | 2 | **2** |
| 1972 | 0 | 0 | 13 | 4 | 0 | **17** | 0 | 1 | **1** |
| 1973 | 0 | 5 | 6 | 6 | 0 | **17** | 0 | 0 | **0** |
| 1974 | 0 | 17 | 1 | 0 | 0 | **18** | 0 | 0 | **0** |
| 1975 | 0 | 1 | 1 | 3 | 0 | **5** | 0 | 0 | **0** |
| 1976 | 0 | 3 | 11 | 0 | 0 | **14** | 0 | 1 | **1** |
| 1977 | 0 | 3 | 6 | 3 | 0 | **12** | 0 | 0 | **0** |
| 1978 | 0 | 1 | 2 | 0 | 0 | **3** | 0 | 0 | **0** |
| 1979 | 0 | 1 | 9 | 3 | 0 | **13** | 0 | 0 | **0** |
| 1980 | 0 | 6 | 11 | 5 | 0 | **22** | 0 | 0 | **0** |
| 1981 | 0 | 5 | 5 | 1 | 0 | **11** | 0 | 0 | **0** |
| 1982 | 0 | 0 | 4 | 1 | 0 | **5** | 0 | 0 | **0** |
| 1983 | 0 | 0 | 3 | 1 | 0 | **4** | 0 | 0 | **0** |
| 1984 | 0 | 0 | 3 | 0 | 0 | **3** | 0 | 0 | **0** |
| 1985 | 0 | 3 | 12 | 1 | 0 | **16** | 0 | 0 | **0** |
| 1986 | 0 | 0 | 2 | 2 | 0 | **4** | 0 | 0 | **0** |
| 1987 | 0 | 0 | 2 | 0 | 0 | **2** | 0 | 0 | **0** |
| 1988 | 0 | 5 | 7 | 0 | 0 | **12** | 0 | 0 | **0** |
| 1989 | 0 | 2 | 16 | 0 | 0 | **18** | 0 | 5 | **5** |
| 1990 | 0 | 8 | 3 | 0 | 0 | **11** | 2 | 1 | **3** |
| 1991 | 0 | 0 | 3 | 0 | 0 | **3** | 0 | 0 | **0** |
| 1992 | 0 | 0 | 2 | 1 | 0 | **3** | 0 | 0 | **0** |
| 1993 | 0 | 4 | 3 | 2 | 0 | **9** | 0 | 0 | **0** |
| 1994 | 0 | 6 | 11 | 5 | 0 | **22** | 1 | 0 | **1** |
| 1995 | 0 | 0 | 12 | 6 | 1 | **19** | 0 | 3 | **3** |
| 1996 | 0 | 0 | 6 | 4 | 0 | **10** | 0 | 0 | **0** |
| 1997 | 0 | 0 | 4 | 0 | 0 | **4** | 0 | 0 | **0** |
| 1998 | 0 | 3 | 16 | 1 | 0 | **20** | 0 | 2 | **2** |
| 1999 | 0 | 0 | 2 | 0 | 0 | **2** | 0 | 0 | **0** |
| 2000 | 1 | 0 | 5 | 7 | 0 | **13** | 0 | 0 | **0** |
| 2001 | 0 | 3 | 10 | 0 | 0 | **13** | 0 | 0 | **0** |
| 2002 | 1 | 14 | 13 | 5 | 0 | **36** | 0 | 1 | **1** |
| 2003 | 1 | 2 | 26 | 7 | 0 | **36** | 0 | 9 | **9** |
| 2004 | 0 | 3 | 6 | 2 | 0 | **11** | 0 | 0 | **0** |
| 2005 | 0 | 2 | 22 | 1 | 0 | **25** | 0 | 7 | **7** |
| 2006 | 0 | 11 | 11 | 0 | 0 | **22** | 0 | 1 | **1** |
| 2007 | 0 | 3 | 12 | 3 | 0 | **18** | 0 | 0 | **0** |
| 2008 | 0 | 0 | 0 | 3 | 0 | **3** | 0 | 0 | **0** |
| 2009 | 0 | 0 | 7 | 1 | 0 | **8** | 0 | 0 | **0** |
| 2010 | 0 | 1 | 6 | 0 | 0 | **7** | 0 | 0 | **0** |
| **Mean** | **0.1** | **2.9** | **7.7** | **2.1** | **0.0** | **12.9** | **0.1** | **0.8** | **0.9** |
| **Total** | **3** | **123** | **324** | **88** | **2** | **540** | **3** | **33** | **36** |

**Table 12. Mean daily evaporation (inches per day); NMSU Agricultural Science Center at Farmington, NM. 1972 – 2010.**

| Year | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | - | - | - | 0.477 | 0.478 | 0.381 | 0.319 | 0.142 | - | **0.359** |
| 1973 | - | - | 0.347 | 0.370 | 0.372 | 0.344 | 0.319 | - | - | **0.350** |
| 1974 | - | - | 0.419 | 0.512 | 0.415 | 0.415 | 0.395 | 0.311 | - | **0.411** |
| 1975 | - | 0.206 | 0.299 | 0.401 | 0.396 | 0.403 | 0.270 | 0.242 | - | **0.317** |
| 1976 | - | 0.309 | 0.380 | 0.515 | 0.444 | 0.423 | 0.302 | 0.190 | - | **0.366** |
| 1977 | 0.226 | 0.304 | 0.396 | 0.498 | 0.423 | 0.394 | 0.317 | 0.213 | - | **0.346** |
| 1978 | - | 0.310 | 0.311 | 0.427 | 0.469 | 0.422 | 0.321 | 0.257 | - | **0.360** |
| 1979 | - | 0.278 | 0.278 | 0.362 | 0.354 | 0.342 | 0.317 | 0.229 | - | **0.309** |
| 1980 | - | 0.258 | 0.322 | 0.489 | 0.452 | 0.406 | 0.272 | 0.280 | - | **0.354** |
| 1981 | - | 0.254 | 0.297 | 0.470 | 0.388 | 0.363 | 0.255 | 0.165 | - | **0.313** |
| 1982 | - | 0.245 | 0.323 | 0.427 | 0.392 | 0.314 | 0.193 | 0.260 | - | **0.308** |
| 1983 | - | - | 0.328 | 0.384 | 0.404 | 0.357 | 0.291 | 0.203 | - | **0.328** |
| 1984 | - | 0.245 | 0.391 | 0.389 | 0.379 | 0.334 | 0.261 | 0.106 | - | **0.301** |
| 1985 | - | 0.212 | 0.282 | 0.409 | 0.409 | 0.374 | 0.233 | 0.141 | 0.155 | **0.277** |
| 1986 | - | 0.245 | 0.317 | 0.366 | 0.366 | 0.366 | 0.225 | 0.242 | 0.155 | **0.285** |
| 1987 | - | - | 0.277 | 0.383 | 0.393 | 0.335 | 0.274 | 0.101 | - | **0.294** |
| 1988 | - | 0.234 | 0.373 | 0.369 | 0.421 | 0.314 | 0.285 | 0.198 | 0.151 | **0.293** |
| 1989 | - | 0.330 | 0.393 | 0.418 | 0.446 | 0.356 | 0.312 | 0.219 | - | **0.353** |
| 1990 | - | 0.255 | 0.373 | 0.516 | 0.411 | 0.366 | 0.294 | 0.186 | - | **0.343** |
| 1991 | - | 0.299 | 0.377 | 0.366 | 0.411 | 0.358 | 0.284 | 0.238 | - | **0.333** |
| 1992 | - | 0.277 | 0.280 | 0.405 | 0.383 | 0.348 | 0.272 | 0.211 | - | **0.311** |
| 1993 | - | 0.322 | 0.339 | 0.465 | 0.477 | 0.328 | 0.304 | 0.180 | - | **0.345** |
| 1994 | - | 0.278 | 0.383 | 0.501 | 0.504 | 0.402 | 0.309 | 0.246 | - | **0.375** |
| 1995 | - | 0.249 | 0.315 | 0.424 | 0.445 | 0.375 | 0.324 | 0.241 | - | **0.339** |
| 1996 | - | 0.303 | 0.435 | 0.424 | 0.451 | 0.358 | 0.236 | 0.182 | - | **0.341** |
| 1997 | - | 0.246 | 0.301 | 0.395 | 0.399 | 0.309 | 0.259 | 0.187 | - | **0.299** |
| 1998 | - | 0.242 | 0.367 | 0.471 | 0.420 | 0.366 | 0.334 | 0.189 | - | **0.341** |
| 1999 | - | 0.277 | 0.347 | 0.437 | 0.379 | 0.280 | 0.274 | 0.240 | - | **0.319** |
| 2000 | - | 0.320 | 0.426 | 0.470 | 0.425 | 0.366 | 0.295 | 0.157 | - | **0.351** |
| 2001 | - | 0.281 | 0.378 | 0.465 | 0.405 | 0.352 | 0.361 | 0.235 | - | **0.354** |
| 2002 | - | 0.307 | 0.428 | 0.493 | 0.455 | 0.396 | 0.261 | 0.149 | - | **0.356** |
| 2003 | - | 0.274 | 0.374 | 0.493 | 0.504 | 0.397 | 0.311 | 0.212 | - | **0.366** |
| 2004 | - | 0.248 | 0.403 | 0.48 | 0.442 | 0.365 | 0.276 | 0.159 | - | **0.339** |
| 2005 | - | 0.272 | 0.362 | 0.420 | 0.490 | 0.338 | 0.277 | 0.162 | - | **0.332** |
| 2006 | - | 0.323 | 0.415 | 0.488 | 0.408 | 0.341 | 0.251 | 0.163 | - | **0.341** |
| 2007 | - | 0.266 | 0.315 | 0.447 | 0.416 | 0.360 | 0.289 | 0.211 | - | **0.329** |
| 2008 | - | 0.311 | 0.367 | 0.460 | 0.381 | 0.367 | 0.296 | 0.208 | - | **0.341** |
| 2009 | - | 0.277 | 0.285 | 0.336 | 0.430 | 0.362 | 0.261 | 0.169 | - | **0.303** |
| 2010 | | 0.278 | 0.351 | 0.413 | 0.395 | 0.306 | 0.286 | 0.182 | | **0.316** |
| **Mean** | **0.226** | **0.275** | **0.351** | **0.437** | **0.421** | **0.361** | **0.288** | **0.200** | **0.154** | **0.335** |
| **Years** | **1** | **34** | **38** | **39** | **39** | **39** | **39** | **38** | **3** | **39** |

**Table 13. Mean monthly evaporation (inches per month); NMSU Agricultural Science Center at Farmington, NM. 1972 – 2010.**

| Year | Apr | May | Jun | Jul | Aug | Sep | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1972 | - | - | 14.31 | 14.82 | 11.81 | 9.57 | 4.40 | **54.91** |
| 1973 | - | 10.76 | 11.10 | 11.53 | 10.66 | 9.57 | - | **53.62** |
| 1974 | - | 12.99 | 15.36 | 12.87 | 12.25 | 9.33 | 4.59 | **67.39** |
| 1975 | 6.18 | 9.27 | 12.03 | 12.28 | 12.49 | 8.10 | 7.50 | **67.85** |
| 1976 | 9.27 | 11.78 | 15.45 | 13.76 | 13.11 | 9.06 | 5.89 | **78.32** |
| 1977 | 9.12 | 12.28 | 14.94 | 13.11 | 12.21 | 9.51 | 6.60 | **77.77** |
| 1978 | 9.30 | 9.64 | 12.81 | 14.54 | 13.08 | 9.63 | 7.97 | **76.97** |
| 1979 | 8.34 | 8.62 | 10.86 | 10.97 | 10.60 | 9.51 | 7.10 | **66.00** |
| 1980 | 7.74 | 9.98 | 14.67 | 14.01 | 12.59 | 8.16 | 8.68 | **75.83** |
| 1981 | 7.62 | 9.21 | 14.10 | 12.03 | 11.25 | 7.65 | 5.12 | **66.98** |
| 1982 | 7.35 | 10.01 | 12.81 | 12.14 | 9.73 | 7.28 | 8.06 | **67.38** |
| 1983 | - | 8.85 | 11.51 | 12.51 | 11.06 | 8.72 | 6.35 | **59.00** |
| 1984 | 6.37 | 12.15 | 11.66 | 11.74 | 10.43 | 7.84 | 3.29 | **63.48** |
| 1985 | 6.35 | 8.74 | 12.27 | 12.68 | 11.61 | 6.99 | 4.44 | **63.08** |
| 1986 | 7.36 | 9.82 | 10.97 | 11.34 | 11.34 | 6.75 | - | **57.58** |
| 1987 | - | 6.64 | 11.47 | 12.19 | 10.39 | 8.23 | 3.12 | **52.04** |
| 1988 | - | 11.55 | 11.06 | 13.05 | 9.74 | 8.55 | 6.16 | **60.11** |
| 1989 | - | 12.18 | 12.54 | 13.83 | 11.04 | 9.37 | - | **58.96** |
| 1990 | 7.65 | 11.56 | 15.48 | 12.74 | 11.35 | 8.82 | 5.77 | **73.37** |
| 1991 | 8.68 | 11.68 | 10.99 | 12.77 | 11.11 | 8.53 | - | **63.76** |
| 1992 | 7.76 | 8.67 | 12.15 | 11.89 | 10.80 | 8.19 | 6.53 | **65.99** |
| 1993 | 9.66 | 10.52 | 13.94 | 14.78 | 10.17 | 9.11 | 5.57 | **73.75** |
| 1994 | 8.35 | 11.90 | 15.04 | 15.63 | 12.46 | 9.28 | 7.38 | **80.04** |
| 1995 | 7.48 | 9.78 | 12.72 | 13.81 | 11.63 | 9.74 | 7.48 | **72.64** |
| 1996 | 9.10 | 13.50 | 12.72 | 13.99 | 11.10 | 7.08 | 5.66 | **73.15** |
| 1997 | 7.37 | 9.33 | 11.84 | 12.36 | 9.59 | 7.78 | 5.80 | **64.07** |
| 1998 | 7.27 | 11.37 | 14.12 | 13.03 | 11.36 | 10.03 | 5.85 | **73.03** |
| 1999 | 8.31 | 10.75 | 13.12 | 11.75 | 8.68 | 8.21 | 7.45 | **68.27** |
| 2000 | 9.62 | 13.20 | 14.11 | 13.16 | 11.36 | 8.86 | 4.87 | **75.18** |
| 2001 | 8.45 | 11.35 | 13.92 | 11.75 | 10.93 | 10.59 | 7.29 | **74.28** |
| 2002 | 9.21 | 13.29 | 14.79 | 14.09 | 12.28 | 7.82 | 4.63 | **76.11** |
| 2003 | 8.22 | 11.58 | 14.80 | 15.63 | 12.32 | 9.33 | 6.58 | **78.46** |
| 2004 | 7.43 | 12.49 | 14.27 | 13.69 | 11.32 | 8.28 | 4.93 | **72.41** |
| 2005 | 8.17 | 11.21 | 12.59 | 15.20 | 10.47 | 8.30 | 5.03 | **70.97** |
| 2006 | 8.72 | 12.85 | 14.65 | 12.65 | 10.58 | 7.52 | 5.05 | **72.02** |
| 2007 | 7.97 | 9.78 | 13.41 | 12.90 | 11.15 | 8.68 | 6.54 | **70.40** |
| 2008 | 9.33 | 11.38 | 13.80 | 11.84 | 11.39 | 8.89 | 6.45 | **73.08** |
| 2009 | 8.33 | 8.86 | 10.08 | 13.34 | 11.24 | 7.83 | 5.26 | **64.94** |
| 2010 | 8.35 | 10.88 | 12.40 | 12.25 | 9.49 | 8.58 | 5.64 | **67.59** |
| **Mean** | **8.14** | **10.80** | **13.10** | **13.04** | **11.18** | **8.60** | **5.97** | **68.48** |
| **Years** | **34** | **38** | **39** | **39** | **39** | **39** | **38** | **39** |

**Table 14. Wind movement in miles per day (MPD) at 6 inch height above evaporation pan; NMSU Agricultural Science Center at Farmington, NM. 1980 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 inches above evaporation pan | | | | | | | | | | | | |
| 1980 | 64 | 66 | 100 | 97 | 80 | 57 | 44 | 41 | 27 | 30 | 23 | 14 | **53.6** |
| 1981 | 50 | 80 | 94 | 85 | 71 | 64 | 58 | 60 | 20 | 55 | 56 | 52 | **62.1** |
| 1982 | 69 | 36 | 63 | 89 | 78 | 42 | 59 | 75 | 77 | 86 | 77 | 89 | **70.0** |
| 1983 | 82 | 101 | 107 | 101 | 108 | 98 | 76 | 70 | 62 | 73 | 94 | 98 | **89.2** |
| 1984 | 63 | 101 | 104 | 114 | 78 | 94 | 66 | 61 | 70 | 71 | 99 | 67 | **82.3** |
| 1985 | 49 | 87 | 128 | 98 | 76 | 66 | 70 | 76 | 70 | 72 | 148 | 55 | **82.9** |
| 1986 | 53 | 61 | 72 | 95 | 78 | 64 | 52 | 66 | 60 | 45 | 50 | 45 | **61.8** |
| 1987 | 60 | 41 | 50 | 50 | 31 | 22 | 25 | 19 | 21 | 48 | 71 | 79 | **43.1** |
| 1988 | 76 | 73 | 99 | 88 | 99 | 81 | 75 | 71 | 75 | 64 | 82 | 82 | **80.4** |
| 1989 | 84 | 75 | 96 | 86 | 69 | 73 | 78 | 72 | 73 | 68 | 68 | 59 | **75.1** |
| 1990 | 78 | 97 | 90 | 91 | 91 | 84 | 82 | 82 | 76 | 72 | 71 | 83 | **83.1** |
| 1991 | 61 | 73 | 106 | 98 | 99 | 75 | 79 | 67 | 72 | 57 | 59 | 47 | **74.4** |
| 1992 | 64 | 66 | 80 | 76 | 72 | 74 | 66 | 70 | 62 | 58 | 68 | 66 | **68.5** |
| 1993 | 103 | 86 | 105 | 107 | 91 | 81 | 71 | 75 | 74 | 65 | 82 | 79 | **84.9** |
| 1994 | 81 | 96 | 83 | 94 | 71 | 61 | 72 | 72 | 63 | 58 | 84 | 59 | **74.5** |
| 1995 | 76 | 65 | 83 | 81 | 80 | 61 | 63 | 59 | 52 | 64 | 58 | 49 | **65.9** |
| 1996 | 92 | 79 | 88 | 93 | 72 | 73 | 72 | 60 | 44 | 51 | 53 | 71 | **70.7** |
| 1997 | 43 | 79 | 78 | 73 | 70 | 62 | 55 | 48 | 50 | 48 | 39 | 35 | **56.8** |
| 1998 | 59 | 75 | 83 | 81 | 66 | 72 | 70 | 66 | 62 | 78 | 66 | 59 | **69.5** |
| 1999 | 76 | 74 | 83 | 109 | 95 | 70 | 63 | 63 | 61 | 65 | 73 | 78 | **75.8** |
| 2000 | 83 | 88 | 93 | 93 | 85 | 80 | 66 | 64 | 62 | 63 | 60 | 57 | **74.5** |
| 2001 | 65 | 74 | 72 | 91 | 83 | 77 | 64 | 67 | 74 | 74 | 65 | 75 | **73.4** |
| 2002 | 74 | 90 | 104 | 83 | 59 | 64 | 69 | 55 | 62 | 50 | 56 | 49 | **67.9** |
| 2003 | 36 | 58 | 60 | 68 | 70 | 70 | 56 | 60 | 56 | 50 | 56 | 62 | **58.5** |
| 2004 | 36 | 56 | 61 | 65 | 53 | 54 | 54 | 46 | 48 | 44 | 52 | 29 | **49.8** |
| 2005 | 52 | 54 | 72 | 71 | 50 | 50 | 49 | 43 | 44 | 44 | 46 | 39 | **51.2** |
| 2006 | 52 | 51 | 61 | 66 | 57 | 61 | 53 | 47 | 43 | 44 | 37 | 48 | **51.7** |
| 2007 | 40 | 53 | 47 | 62 | 50 | - | - | 41 | 51 | 62 | 38 | 54 | **41.5** |
| 2008 | 48 | 69 | 81 | 92 | 82 | 65 | 50 | 35 | 31 | 60 | 65 | 69 | **62.3** |
| 2009 | 41 | 57 | 77 | 80 | 52 | 44 | 48 | 43 | 47 | 54 | 49 | 66 | **54.8** |
| 2010 | 33 | 59 | 79 | 82 | - | - | - | - | - | - | - | - | |
| **Mean (MPD)** | **62.7** | **71.6** | **83.8** | **85.8** | **73.9** | **66.9** | **62.2** | **59.1** | **56.3** | **59.1** | **64.8** | **60.5** | **67.3** |
| **Mean (MPH)** | **2.6** | **3.0** | **3.5** | **3.6** | **3.1** | **2.8** | **2.6** | **2.5** | **2.3** | **2.5** | **2.7** | **2.5** | **2.8** |

**Table 15. Wind movement in miles per day (MPD) at two meter height above ground; NMSU Agricultural Science Center at Farmington, NM. 1980 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 meters above ground | | | | | | | | | | | | |
| 1980 | - | - | - | - | 134 | 132 | 116 | 96 | 82 | 78 | 80 | 84 | |
| 1981 | 112 | 124 | 141 | 124 | 102 | 81 | 62 | 82 | 71 | 81 | 76 | 58 | **100.3** |
| 1982 | 88 | 63 | 97 | 127 | 100 | 122 | 103 | 91 | 99 | 95 | 86 | 99 | **92.8** |
| 1983 | 111 | 139 | 147 | 154 | 141 | 120 | 116 | 102 | 113 | 107 | 130 | 136 | **97.5** |
| 1984 | 64 | 115 | 93 | 136 | 88 | 96 | 52 | 46 | 49 | 44 | 136 | 110 | **126.3** |
| 1985 | 95 | 127 | 183 | 155 | 142 | 136 | 136 | 133 | 125 | 127 | 72 | 117 | **85.7** |
| 1986 | 113 | 129 | 145 | 179 | 154 | 139 | 128 | 134 | 128 | 118 | 116 | 99 | **129.0** |
| 1987 | 139 | 131 | 143 | 158 | 139 | 126 | 122 | 119 | 132 | 108 | 123 | 117 | **131.9** |
| 1988 | 121 | 122 | 163 | 148 | 166 | 138 | 132 | 126 | 120 | 91 | 98 | 98 | **129.7** |
| 1989 | 97 | 133 | 151 | 147 | 132 | 123 | 126 | 120 | 125 | 115 | 112 | 104 | **126.8** |
| 1990 | 125 | 152 | 146 | 170 | 165 | 154 | 141 | 136 | 127 | 135 | 127 | 130 | **123.8** |
| 1991 | 101 | 120 | 190 | 191 | 167 | 138 | 140 | 119 | 129 | 111 | 109 | 85 | **142.2** |
| 1992 | 117 | 119 | 137 | 142 | 133 | 137 | 118 | 118 | 111 | 110 | 113 | 106 | **133.4** |
| 1993 | 164 | 139 | 153 | 171 | 144 | 86 | 57 | 80 | 103 | 87 | 92 | - | **121.6** |
| 1994 | 130 | 156 | 144 | 166 | 135 | 130 | 136 | 127 | 120 | 119 | 154 | 115 | **115.8** |
| 1995 | 137 | 129 | 147 | 176 | 185 | 137 | 128 | 118 | 115 | 137 | 129 | 100 | **136.0** |
| 1996 | 171 | 145 | 161 | 182 | 149 | 140 | 127 | 119 | 112 | 134 | 119 | 147 | **136.5** |
| 1997 | 106 | 149 | 146 | 153 | 137 | 113 | 112 | 101 | 105 | 115 | 118 | 110 | **142.3** |
| 1998 | 100 | 133 | 145 | 144 | 112 | 120 | 111 | 100 | 105 | 131 | 111 | 106 | **122.1** |
| 1999 | 143 | 142 | 145 | 186 | 196 | 92 | 85 | 100 | 107 | 98 | 93 | 126 | **118.2** |
| 2000 | 132 | 141 | 149 | 158 | 144 | 135 | 108 | 104 | 108 | 110 | 113 | 109 | **126.1** |
| 2001 | 116 | 127 | 173 | 147 | 141 | 128 | 106 | 108 | 121 | 125 | 110 | 132 | **125.9** |
| 2002 | 117 | 144 | 163 | 134 | 126 | 115 | 114 | 96 | 108 | 90 | 110 | 107 | **127.8** |
| 2003 | 98 | 134 | 143 | 139 | 134 | 128 | 106 | 107 | 113 | 103 | 116 | 129 | **118.7** |
| 2004 | 93 | 121 | 135 | 134 | 120 | 114 | 112 | 99 | 100 | 102 | 119 | 87 | **120.8** |
| 2005 | 107 | 111 | 146 | 153 | 117 | 116 | 111 | 94 | 98 | 98 | 119 | 113 | **111.3** |
| 2006 | 131 | 140 | 139 | 143 | 126 | 127 | 106 | 95 | 103 | 104 | 122 | 106 | **120.2** |
| 2007 | 96 | 131 | 121 | 147 | 122 | 129 | 109 | 89 | 96 | 117 | 103 | 128 | **115.7** |
| 2008 | 106 | 125 | 142 | 165 | 144 | 128 | 101 | 95 | 94 | 108 | 121 | 133 | **121.8** |
| 2009 | 100 | 119 | 144 | 157 | 108 | 96 | 96 | 88 | 94 | 106 | 87 | 145 | **111.7** |
| 2010 | 73 | 100 | 130 | 154 | 125 | 63 | 94 | 78 | 79 | 89 | 108 | 90 | **98.6** |
| **Mean (MPD)** | **113.4** | **128.7** | **145.4** | **154.7** | **136.4** | **120.6** | **110.0** | **103.9** | **106.2** | **106.2** | **110.4** | **110.9** | **120.9** |
| **Mean (MPH)** | **4.7** | **5.4** | **6.1** | **6.4** | **5.7** | **5.0** | **4.6** | **4.3** | **4.4** | **4.4** | **4.6** | **4.6** | **5.0** |

**Table 16. Mean daily solar radiation (Langleys); NMSU Agricultural Science Center at Farmington, NM. 1977 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 204 | 305 | 386 | 552 | 438 | 530 | 501 | 464 | 396 | 360 | - | - | 4,136 | **413.6** |
| 1978 | 157 | 168 | 334 | 459 | 490 | 586 | 641 | 491 | 401 | 292 | 185 | 166 | 4,370 | **364.2** |
| 1979 | 166 | 261 | 302 | 423 | 445 | 527 | 489 | 477 | 459 | 267 | 165 | 155 | 4,136 | **344.7** |
| 1980 | 141 | 192 | 300 | 429 | 459 | 529 | 595 | 501 | 436 | 342 | 280 | 145 | 4,349 | **362.4** |
| 1981 | 190 | 296 | 292 | 473 | 499 | 607 | 550 | 489 | 422 | 314 | 248 | 200 | 4,580 | **381.7** |
| 1982 | 129 | 207 | 369 | 536 | 594 | 707 | 651 | 565 | 470 | 393 | 227 | 208 | 5,052 | **421.0** |
| 1983 | 188 | 294 | 345 | 518 | 654 | 734 | 793 | 725 | 583 | 332 | 230 | 176 | 5,575 | **464.6** |
| 1984 | 250 | 345 | 486 | 540 | 688 | 494 | 736 | 744 | 595 | 317 | 226 | 188 | 5,606 | **467.2** |
| 1985 | 242 | - | - | 499 | 618 | 816 | 843 | 801 | 557 | 410 | 256 | 184 | 6,274 | **522.8** |
| 1986 | 243 | 304 | 505 | 584 | 837 | 736 | 1,028 | 1,223 | 918 | 513 | 282 | 205 | 7,381 | **615.1** |
| 1987 | 229 | 289 | 506 | 566 | 551 | 665 | 638 | 542 | 483 | 352 | 246 | 197 | 5,264 | **438.7** |
| 1988 | 220 | 305 | 474 | 496 | 626 | 623 | 621 | 555 | 486 | 470 | 251 | 216 | 5,344 | **445.3** |
| 1989 | 224 | 280 | 419 | 550 | 628 | 633 | 619 | 570 | 498 | 361 | 277 | 219 | 5,278 | **439.8** |
| 1990 | 222 | 282 | 316 | 479 | 593 | 662 | 620 | 541 | 462 | 361 | 234 | 203 | 4,975 | **414.6** |
| 1991 | 212 | 309 | 356 | 554 | 651 | 556 | 613 | 537 | 450 | 340 | 249 | 146 | 4,973 | **414.4** |
| 1992 | 189 | 268 | 358 | 509 | 530 | 616 | 560 | 501 | 451 | 324 | 238 | 167 | 4,711 | **392.6** |
| 1993 | 160 | 230 | 374 | 514 | 532 | 599 | 614 | 464 | 456 | 331 | 240 | 187 | 4,702 | **391.8** |
| 1994 | 223 | 262 | 371 | 439 | 482 | 564 | 555 | 496 | 411 | 300 | 225 | 178 | 4,506 | **375.5** |
| 1995 | 189 | 288 | 358 | 438 | 481 | 552 | 520 | 459 | 373 | 324 | 212 | 157 | 4,351 | **362.6** |
| 1996 | 240 | 309 | 463 | 580 | 651 | 609 | 676 | 604 | 458 | 357 | 250 | 226 | 5,423 | **451.9** |
| 1997 | 215 | 314 | 516 | 513 | 613 | 657 | 640 | 567 | 491 | 390 | 267 | 220 | 5,403 | **450.3** |
| 1998 | 236 | 260 | 443 | 563 | 661 | 725 | 604 | 565 | 506 | 331 | 266 | 244 | 5,404 | **450.3** |
| 1999 | 263 | 363 | 458 | 527 | 624 | 702 | 584 | 515 | 505 | 438 | 320 | 241 | 5,540 | **461.7** |
| 2000 | 251 | 305 | 399 | 581 | 689 | 696 | 673 | 579 | 479 | 325 | 255 | 213 | 5,445 | **453.8** |
| 2001 | 241 | 322 | 424 | 508 | 672 | 766 | 633 | 580 | 541 | 396 | 286 | 248 | 5,617 | **468.1** |
| 2002 | 251 | 383 | 492 | 593 | 710 | 742 | 663 | 601 | 479 | 372 | 294 | 219 | 5,799 | **483.3** |
| 2003 | 249 | 315 | 452 | 596 | 640 | 719 | 692 | 604 | 510 | 401 | 200 | 203 | 5,581 | **465.1** |
| 2004 | 186 | 264 | 418 | 451 | 656 | 703 | 646 | 531 | 468 | 346 | 214 | 201 | 5,084 | **423.7** |
| 2005 | 206 | 272 | 402 | 526 | 624 | 639 | 664 | 539 | 442 | 347 | 277 | 232 | 5,170 | **430.8** |
| 2006 | 258 | 362 | 375 | 539 | 644 | 616 | 533 | 472 | 426 | 308 | 249 | 188 | 4,970 | **414.2** |
| 2007 | 228 | 284 | 396 | 539 | 562 | 676 | 535 | 455 | 407 | 406 | 310 | 220 | 5,018 | **418.2** |
| 2008 | 287 | 341 | 514 | 617 | 673 | 729 | 641 | 587 | 504 | 405 | 286 | 223 | 5,807 | **483.9** |
| 2009 | 262 | 352 | 431 | 541 | 608 | 589 | 637 | 581 | 473 | 358 | 276 | 200 | 5,308 | **442.3** |
| 2010 | 232 | 293 | 451 | 553 | 677 | 695 | 624 | 547 | 501 | 375 | 286 | 175 | 5,409 | **450.8** |
| **Mean** | 217.1 | 291.6 | 408.6 | 523.1 | 602.9 | 647.0 | 636.2 | 572.7 | 485.2 | 360.5 | 251.7 | 198.5 | 5,159 | **432.9** |

**Table 17. Forty-two year total monthly Growing Degree Days* (May thru Sept. and first fall freeze); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2010. (Automatic weather station data from http://weather.nmsu.edu/).**

| Year | May | Jun | Jul | Aug | Sep | May - Sep | Ist Freeze Date | Total to 1st Frost (32 ºF) |
|---|---|---|---|---|---|---|---|---|
| 1969 | 434 | 510 | 729 | 744 | 570 | **2,987** | **Oct 05** | **3,017** |
| 1970 | 434 | 555 | 744 | 744 | 420 | **2,897** | **Oct 08** | **2,949** |
| 1971 | 372 | 600 | 729 | 713 | 450 | **2,864** | **Sep 18** | **2,684** |
| 1972 | 434 | 615 | 744 | 713 | 495 | **3,001** | **Oct 30** | **3,201** |
| 1973 | 372 | 640 | 713 | 713 | 435 | **2,873** | **Oct 11** | **2,990** |
| 1974 | 465 | 645 | 729 | 698 | 450 | **2,987** | **Oct 30** | **3,227** |
| 1975 | 326 | 525 | 713 | 667 | 435 | **2,666** | **Oct 14** | **2,806** |
| 1976 | 403 | 585 | 744 | 698 | 495 | **2,925** | **Oct 07** | **2,978** |
| 1977 | 372 | 675 | 744 | 729 | 540 | **3,060** | **Oct 31** | **3,386** |
| 1978 | 310 | 570 | 729 | 667 | 450 | **2,726** | **Sep 20** | **2,576** |
| 1979 | 341 | 510 | 682 | 667 | 555 | **2,755** | **Oct 22** | **2,986** |
| 1980 | 341 | 570 | 698 | 682 | 450 | **2,741** | **Oct 16** | **2,869** |
| 1981 | 372 | 600 | 682 | 651 | 450 | **2,755** | **Oct 16** | **2,875** |
| 1982 | 341 | 525 | 682 | 698 | 450 | **2,696** | **Oct 06** | **2,741** |
| 1983 | 341 | 495 | 682 | 729 | 525 | **2,772** | **Sep 21** | **2,615** |
| 1984 | 465 | 555 | 729 | 713 | 480 | **2,942** | **Oct 15** | **3,017** |
| 1985 | 397 | 600 | 710 | 692 | 416 | **2,815** | **Sep 30** | **2,926** |
| 1986 | 377 | 574 | 661 | 693 | 395 | **2,700** | **Oct 12** | **2,790** |
| 1987 | 366 | 592 | 674 | 646 | 473 | **2,751** | **Oct 19** | **2,873** |
| 1988 | 396 | 607 | 722 | 697 | 476 | **2,898** | **Nov 12** | **2,981** |
| 1989 | 468 | 565 | 731 | 670 | 540 | **2,974** | **Oct 18** | **3,131** |
| 1990 | 378 | 635 | 729 | 673 | 532 | **2,947** | **Oct 09** | **3,029** |
| 1991 | 409 | 557 | 704 | 701 | 471 | **2,842** | **Oct 28** | **3,153** |
| 1992 | 385 | 536 | 630 | 639 | 484 | **2,674** | **Oct 08** | **2,763** |
| 1993 | 416 | 538 | 652 | 615 | 454 | **2,675** | **Oct 19** | **2,854** |
| 1994 | 426 | 628 | 729 | 746 | 495 | **3,024** | **Oct 17** | **3,169** |
| 1995 | 330 | 516 | 676 | 729 | 494 | **2,745** | **Oct 06** | **2,782** |
| 1996 | 477 | 612 | 730 | 695 | 410 | **2,924** | **Sep 19** | **2,785** |
| 1997 | 441 | 563 | 685 | 670 | 568 | **2,927** | **Oct 13** | **3,081** |
| 1998 | 417 | 499 | 746 | 716 | 560 | **2,938** | **Oct 06** | **2,984** |
| 1999 | 364 | 554 | 710 | 655 | 451 | **2,734** | **Sep 28** | **2,702** |
| 2000 | 479 | 640 | 665 | 663 | 536 | **2,983** | **Oct 14** | **3,117** |
| 2001 | 465 | 591 | 751 | 691 | 578 | **3,076** | **Oct 11** | **3,214** |
| 2002 | 446 | 625 | 739 | 674 | 486 | **2,973** | **Oct 04** | **3,004** |
| 2003 | 453 | 586 | 763 | 730 | 485 | **3,018** | **Oct 27** | **3,329** |
| 2004 | 456 | 588 | 688 | 667 | 452 | **2,851** | **Oct 23** | **3,057** |
| 2005 | 428 | 555 | 745 | 683 | 542 | **2,953** | **Oct 31** | **3,228** |
| 2006 | 477 | 631 | 743 | 674 | 395 | **2,920** | **Sep 23** | **2,826** |
| 2007 | 388 | 581 | 711 | 720 | 509 | **2,909** | **Oct 07** | **2,981** |
| 2008 | 370 | 570 | 720 | 691 | 501 | **2,852** | **Oct 12** | **2,980** |
| 2009 | 450 | 515 | 738 | 660 | 515 | **2,878** | **Sep 22** | **2,753** |
| 2010 | 373 | 584 | 728 | 662 | 519 | **2,866** | **Oct 26** | **3,139** |
| **Mean** | **404** | **577** | **713** | **690** | **485** | **2,869** | **Oct 12** | **2,965** |
| **Accum-mulation** | **404** | **981** | **1,694** | **2,384** | **2,869** | | | |

*Growing Degree Days = $(Temp_{(max)} + Temp_{(min)})/2 - Temp_{(base)}$ $Temp_{(max)}$ = 86 ºF at temperatures ≥ 86 ºF; $Temp_{(min)}$ = 50 ºF at temperatures ≤50 ºF; $Temp_{(base)}$ = 50 ºF
There is very little growth at temperatures above 86 ºF and below 50 ºF,

**Table 18. Mean soil temperature (ºF) 4 inches below soil surface; NMSU Agricultural Science Center at Farmington, NM. September 1976 to December 2010.**

| Month | Mean High | Mean Low | Mean* | Extreme High | Extreme Low |
|---|---|---|---|---|---|
| January | 34.9 | 30.8 | 32.9 | 40.9 | 25.0 |
| February | 42.1 | 34.3 | 38.2 | 52.5 | 29.4 |
| March | 54.4 | 40.5 | 47.5 | 64.3 | 34.0 |
| April | 66.2 | 49.1 | 57.7 | 77.1 | 39.6 |
| May | 78.2 | 59.4 | 68.8 | 88.2 | 48.3 |
| June | 89.1 | 70.1 | 79.6 | 96.5 | 62.1 |
| July | 95.6 | 75.8 | 85.7 | 101.2 | 68.7 |
| August | 92.8 | 73.5 | 83.2 | 98.9 | 66.2 |
| September | 83.4 | 65.3 | 74.4 | 93.2 | 55.7 |
| October | 66.7 | 51.5 | 59.1 | 78.9 | 41.2 |
| November | 48.7 | 39.0 | 43.9 | 59.5 | 31.6 |
| December | 36.4 | 31.6 | 34.0 | 45.4 | 25.6 |
| **Mean** | **65.4** | **51.8** | **58.6** | **74.7** | **43.9** |

*Mean between high and low.

**Table 19. Mean high soil temperatures (ºF) four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | - | - | - | - | - | - | - | - | 88.9 | 69.2 | 56.8 | 38.8 | **63.4** |
| 1977 | 31.8 | 49.8 | 56.2 | 79.1 | 88.3 | 106.6 | 109.7 | 102.9 | 92.6 | 74.1 | 53.3 | 42.6 | **73.9** |
| 1978 | 37.0 | 42.8 | 53.7 | 75.5 | 82.0 | 100.7 | 106.0 | 102.2 | 91.2 | 73.3 | 53.9 | 36.3 | **71.2** |
| 1979 | 35.7 | 40.8 | 53.9 | 68.4 | 81.6 | 92.2 | 99.2 | 98.4 | 93.4 | 75.0 | 49.8 | 38.9 | **68.9** |
| 1980 | 46.2 | 52.5 | 59.8 | 68.4 | 80.8 | 94.2 | 102.3 | 96.8 | 85.3 | 70.0 | 54.8 | 49.0 | **71.7** |
| 1981 | 47.6 | 49.9 | 57.6 | 73.9 | 79.3 | 88.5 | 92.8 | 89.7 | 81.2 | 65.6 | 52.0 | 38.1 | **68.0** |
| 1982 | 33.9 | 38.9 | 51.0 | 62.7 | 78.5 | 89.4 | 96.0 | 94.0 | 82.8 | 67.7 | 50.1 | 39.6 | **65.4** |
| 1983 | 34.9 | 44.8 | 51.4 | 59.8 | 73.8 | 81.4 | 90.5 | 92.7 | 82.6 | 66.0 | 47.4 | 37.1 | **63.5** |
| 1984 | 32.5 | 38.5 | 52.4 | 59.3 | 77.0 | 84.7 | 92.6 | 94.7 | 85.6 | 59.6 | 51.1 | 38.7 | **63.9** |
| 1985 | 35.5 | 39.9 | 54.1 | 65.2 | 81.4 | 93.3 | 100.4 | 96.2 | 83.3 | 69.5 | 49.6 | 37.0 | **67.1** |
| 1986 | 41.6 | 47.1 | 58.6 | 64.3 | 77.9 | 88.9 | 92.4 | 95.9 | 78.9 | 63.1 | 45.9 | 37.0 | **66.0** |
| 1987 | 32.2 | 41.9 | 47.1 | 62.4 | 77.0 | 88.6 | 93.7 | 91.5 | 82.4 | 70.9 | 50.9 | 40.9 | **65.0** |
| 1988 | 34.6 | 42.7 | 57.1 | 66.3 | 77.3 | 89.2 | 94.0 | 92.5 | 82.6 | 71.0 | 50.2 | 34.4 | **66.0** |
| 1989 | 31.1 | 38.7 | 57.2 | 67.8 | 77.3 | 86.6 | 94.6 | 90.6 | 82.3 | 67.8 | 49.7 | 37.0 | **65.1** |
| 1990 | 34.5 | 39.5 | 55.5 | 65.8 | 75.4 | 87.1 | 91.3 | 88.6 | 83.0 | 67.5 | 49.8 | 34.8 | **64.4** |
| 1991 | 33.5 | 42.1 | 51.9 | 66.1 | 76.6 | 86.4 | 95.3 | 95.3 | 85.6 | 70.1 | 46.4 | 37.6 | **65.6** |
| 1992 | 34.8 | 43.8 | 55.3 | 68.5 | 77.5 | 86.1 | 90.4 | 90.9 | 83.3 | 70.9 | 44.4 | 31.4 | **64.8** |
| 1993 | 36.8 | 42.4 | 53.7 | 66.0 | 78.9 | 85.9 | 94.8 | 88.4 | 80.2 | 64.2 | 42.5 | 33.7 | **64.0** |
| 1994 | 34.7 | 38.3 | 57.4 | 65.8 | 76.6 | 89.7 | 94.5 | 94.1 | 84.3 | 63.2 | 42.5 | 33.9 | **64.6** |
| 1995 | 34.5 | 48.9 | 55.9 | 60.9 | 69.5 | 83.7 | 91.0 | 92.3 | - | 63.9 | 51.7 | 39.9 | **64.7** |
| 1996 | 36.1 | 46.9 | 56.6 | 68.3 | 83.5 | 89.4 | 94.6 | 86.4 | 78.5 | 64.3 | 53.1 | 34.9 | **61.9** |
| 1997 | 33.6 | 41.3 | 54.8 | 58.3 | 73.0 | - | - | 91.0 | 83.8 | 65.5 | 47.4 | 32.6 | **63.9** |
| 1998 | 33.6 | 40.6 | 51.1 | 62.2 | 80.4 | 89.2 | 95.6 | 92.0 | 85.3 | 65.0 | 46.5 | 34.8 | **64.7** |
| 1999 | 35.6 | 42.5 | 56.1 | 61.9 | 71.2 | 87.0 | 90.7 | 85.0 | 78.7 | 65.1 | 50.5 | 35.2 | **63.3** |
| 2000 | 36.5 | 43.8 | 51.7 | 67.1 | 79.0 | 87.8 | 92.4 | 90.4 | 80.0 | 62.4 | 38.1 | 34.5 | **63.6** |
| 2001 | 29.9 | 37.3 | 51.4 | 64.9 | 78.0 | 88.0 | 92.5 | 89.7 | 83.7 | 66.8 | 52.1 | 34.1 | **64.0** |
| 2002 | 32.4 | 37.6 | 52.3 | 69.5 | 79.1 | 90.7 | 95.5 | 90.5 | 80.1 | 63.3 | 46.0 | 34.6 | **64.3** |
| 2003 | 37.5 | 41.3 | 52.0 | 66.0 | 75.9 | 86.8 | 96.1 | 95.1 | 81.4 | 68.8 | 46.2 | 35.9 | **65.3** |
| 2004 | 31.4 | 35.5 | 60.3 | 65.8 | 80.6 | 85.8 | 91.6 | 92.5 | 81.2 | 64.3 | 46.5 | 32.3 | **64.0** |
| 2005 | 38.5 | 43.8 | 54.9 | 68.6 | 81.9 | 88.8 | 101.2 | 92.6 | 81.6 | 63.2 | 47.6 | 35.6 | **66.5** |
| 2006 | 37.1 | 44.1 | 53.9 | 71.9 | 82.6 | 93.8 | 96.3 | 92.4 | 78.6 | 62.2 | 50.9 | 33.4 | **66.4** |
| 2007 | 29.8 | 40.4 | 57.2 | 68.2 | 80.4 | 91.6 | 101.1 | 98.9 | 87.8 | 67.1 | 53.5 | 33.4 | **66.9** |
| 2008 | 29.9 | 34.7 | 53.3 | 64.1 | 74.9 | 88.4 | 96.6 | 93.0 | 84.2 | 66.0 | 49.3 | 35.3 | **64.1** |
| 2009 | 32.3 | 39.8 | 54.3 | 63.3 | 78.9 | 84.0 | 97.5 | 93.2 | 84.7 | 62.1 | 45.8 | 29.4 | **63.8** |
| 2010 | 28.3 | 37.9 | 49.5 | 63.2 | 73.0 | 85.2 | 92.0 | 85.6 | 76.8 | 65.6 | 45.6 | 40.2 | **61.9** |
| **Mean** | **34.9** | **42.1** | **54.4** | **66.2** | **78.2** | **89.1** | **95.6** | **92.8** | **83.4** | **66.7** | **48.7** | **36.4** | 65.4 |

**Table 20. Mean low soil temperature (ºF) four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | - | - | - | - | - | - | - | - | 66.5 | 51.1 | 39.9 | 23.6 | **45.3** |
| 1977 | 21.6 | 30.0 | 35.8 | 52.1 | 59.8 | 78.4 | 80.2 | 78.2 | 70.8 | 53.4 | 39.4 | 32.0 | **52.6** |
| 1978 | 33.7 | 36.1 | 40.2 | 55.3 | 60.0 | 75.2 | 81.3 | 77.8 | 68.7 | 57.7 | 45.1 | 33.8 | **55.4** |
| 1979 | 33.7 | 35.9 | 42.5 | 52.0 | 62.0 | 72.1 | 78.6 | 77.7 | 72.7 | 54.4 | 41.2 | 35.6 | **54.9** |
| 1980 | 39.9 | 42.4 | 44.2 | 52.1 | 61.1 | 72.1 | 77.5 | 76.1 | 67.3 | 53.9 | 43.7 | 39.1 | **55.8** |
| 1981 | 37.0 | 37.0 | 42.6 | 54.6 | 59.8 | 70.5 | 75.3 | 75.2 | 67.1 | 53.4 | 42.7 | 33.0 | **54.0** |
| 1982 | 29.6 | 33.6 | 40.0 | 48.0 | 60.1 | 72.5 | 78.2 | 74.5 | 67.6 | 51.4 | 41.6 | 36.6 | **52.8** |
| 1983 | 32.7 | 37.9 | 42.4 | 47.1 | 57.6 | 65.6 | 71.2 | 73.6 | 67.6 | 51.5 | 40.3 | 34.0 | **51.8** |
| 1984 | 31.1 | 33.3 | 37.7 | 43.8 | 59.6 | 66.7 | 74.7 | 71.0 | 64.7 | 44.4 | 38.2 | 33.6 | **49.9** |
| 1985 | 32.1 | 31.2 | 40.9 | 48.1 | 56.0 | 68.4 | 72.3 | 70.4 | 58.9 | 47.9 | 37.1 | 31.2 | **49.5** |
| 1986 | 33.5 | 36.4 | 42.7 | 47.8 | 57.8 | 67.1 | 67.7 | 71.6 | 57.8 | 47.1 | 38.2 | 34.6 | **50.2** |
| 1987 | 31.2 | 35.1 | 37.0 | 48.4 | 61.7 | 72.9 | 77.2 | 75.0 | 68.3 | 56.8 | 42.7 | 38.5 | **53.7** |
| 1988 | 33.8 | 37.8 | 43.3 | 49.6 | 56.9 | 67.7 | 75.6 | 70.5 | 64.1 | 55.1 | 40.4 | 32.1 | **52.2** |
| 1989 | 27.4 | 34.1 | 43.8 | 53.7 | 61.8 | 68.7 | 74.2 | 71.7 | 66.9 | 52.9 | 38.3 | 28.9 | **51.9** |
| 1990 | 27.9 | 31.7 | 40.9 | 50.7 | 56.9 | 71.2 | 76.3 | 71.7 | 66.6 | 50.8 | 41.4 | 33.2 | **51.6** |
| 1991 | 30.6 | 35.2 | 40.7 | 49.4 | 59.4 | 67.7 | 76.4 | 75.6 | 65.9 | 57.1 | 39.5 | 36.4 | **52.8** |
| 1992 | 33.3 | 37.6 | 45.0 | 55.2 | 63.2 | 69.5 | 73.7 | 74.6 | 64.8 | 57.1 | 35.5 | 29.7 | **53.3** |
| 1993 | 33.8 | 36.1 | 40.7 | 47.0 | 59.1 | 68.6 | 74.2 | 68.7 | 57.7 | 46.7 | 32.6 | 28.5 | **49.5** |
| 1994 | 28.5 | 30.7 | 40.3 | 48.1 | 57.3 | 70.5 | 74.5 | 74.6 | 60.3 | 47.0 | 35.1 | 31.0 | **49.8** |
| 1995 | 31.8 | 35.4 | 41.4 | 45.2 | 52.2 | 66.6 | 73.5 | 74.9 | - | 48.7 | 39.2 | 31.5 | **50.5** |
| 1996 | 28.2 | 36.5 | 40.4 | 49.4 | 63.4 | 67.7 | 74.1 | 64.9 | 60.5 | 48.7 | 37.4 | 32.0 | **50.3** |
| 1997 | 31.3 | 34.8 | 42.4 | 46.6 | 59.8 | - | - | 73.4 | 66.1 | 49.7 | 36.7 | 28.9 | **47.0** |
| 1998 | 30.6 | 33.4 | 37.5 | 45.1 | 61.5 | 69.7 | 76.3 | 73.8 | 69.1 | 51.7 | 37.4 | 30.9 | **51.4** |
| 1999 | 31.8 | 33.8 | 44.0 | 46.9 | 55.5 | 71.2 | 76.5 | 70.8 | 66.1 | 55.5 | 43.6 | 30.8 | **52.2** |
| 2000 | 32.1 | 36.9 | 40.4 | 50.9 | 63.9 | 72.6 | 76.2 | 76.8 | 67.0 | 51.4 | 34.1 | 31.9 | **52.9** |
| 2001 | 28.7 | 32.5 | 41.0 | 48.7 | 59.6 | 70.3 | 76.3 | 73.1 | 69.2 | 55.1 | 43.2 | 28.5 | **52.2** |
| 2002 | 28.6 | 31.0 | 36.2 | 52.3 | 60.6 | 72.4 | 77.0 | 73.3 | 62.9 | 47.8 | 35.9 | 31.9 | **50.8** |
| 2003 | 31.6 | 34.0 | 39.4 | 48.6 | 59.9 | 69.8 | 78.0 | 75.5 | 63.3 | 53.6 | 37.8 | 30.5 | **51.8** |
| 2004 | 28.3 | 30.1 | 43.0 | 48.2 | 61.3 | 71.1 | 74.5 | 73.5 | 61.5 | 48.0 | 36.1 | 27.3 | **50.2** |
| 2005 | 33.7 | 35.3 | 37.8 | 47.2 | 58.0 | 67.6 | 75.2 | 71.0 | 66.6 | 50.2 | 38.6 | 26.0 | **50.6** |
| 2006 | 29.0 | 31.5 | 37.4 | 48.1 | 61.1 | 70.1 | 74.0 | 72.1 | 57.5 | 46.1 | 37.4 | 27.8 | **49.3** |
| 2007 | 26.0 | 32.5 | 40.3 | 47.3 | 57.5 | 69.7 | 77.5 | 76.0 | 65.3 | 49.9 | 40.6 | 29.3 | **51.0** |
| 2008 | 27.6 | 30.9 | 38.2 | 45.8 | 56.7 | 68.1 | 74.2 | 72.9 | 65.5 | 49.4 | 38.1 | 32.4 | **50.0** |
| 2009 | 31.2 | 33.8 | 40.5 | 45.7 | 61.3 | 68.9 | 80.8 | 75.3 | 71.2 | 52.0 | 37.8 | 25.6 | **52.0** |
| 2010 | 26.1 | 33.1 | 37.4 | 49.3 | 57.9 | 73.2 | 78.8 | 72.5 | 65.6 | 54.7 | 38.2 | 35.5 | **51.9** |
| **Mean** | **30.8** | **34.3** | **40.5** | **49.1** | **59.4** | **70.1** | **75.8** | **73.5** | **65.3** | **51.5** | **39.0** | **31.6** | **51.8** |

**Table 21. Soil high temperature (ºF) extremes, four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | - | - | - | - | - | - | - | - | 107 | 80 | 64 | 46 | **74.3** |
| 1977 | 44 | 57 | 68 | 95 | 106 | 117 | 117 | 112 | 103 | 90 | 67 | 53 | **85.8** |
| 1978 | 45 | 51 | 60 | 88 | 95 | 108 | 112 | 110 | 105 | 86 | 68 | 45 | **81.1** |
| 1979 | 40 | 53 | 64 | 80 | 91 | 101 | 107 | 107 | 100 | 89 | 63 | 44 | **78.3** |
| 1980 | 38 | 62 | 65 | 79 | 89 | 104 | 106 | 106 | 92 | 84 | 65 | 55 | **78.8** |
| 1981 | 52 | 61 | 69 | 86 | 88 | 95 | 98 | 95 | 88 | 76 | 58 | 45 | **75.9** |
| 1982 | 44 | 53 | 57 | 78 | 88 | 99 | 102 | 99 | 94 | 78 | 56 | 47 | **74.6** |
| 1983 | 39 | 53 | 60 | 71 | 88 | 91 | 97 | 97 | 92 | 74 | 64 | 43 | **72.4** |
| 1984 | 37 | 45 | 62 | 68 | 91 | 92 | 97 | 102 | 94 | 76 | 61 | 47 | **72.7** |
| 1985 | 45 | 54 | 63 | 76 | 90 | 100 | 108 | 101 | 103 | 77 | 66 | 49 | **77.7** |
| 1986 | 50 | 59 | 70 | 78 | 86 | 97 | 101 | 102 | 96 | 72 | 54 | 44 | **75.8** |
| 1987 | 37 | 54 | 56 | 77 | 87 | 93 | 99 | 97 | 96 | 80 | 63 | 49 | **74.0** |
| 1988 | 36 | 57 | 68 | 75 | 88 | 99 | 98 | 97 | 91 | 79 | 66 | 43 | **74.8** |
| 1989 | 35 | 57 | 69 | 76 | 85 | 94 | 100 | 98 | 90 | 80 | 59 | 44 | **73.9** |
| 1990 | 44 | 55 | 66 | 75 | 84 | 95 | 97 | 94 | 92 | 78 | 61 | 45 | **73.8** |
| 1991 | 37 | 50 | 61 | 76 | 86 | 94 | 100 | 99 | 95 | 85 | 60 | 42 | **73.8** |
| 1992 | 38 | 53 | 60 | 79 | 85 | 95 | 96 | 98 | 88 | 82 | 53 | 37 | **72.0** |
| 1993 | 42 | 52 | 67 | 77 | 89 | 92 | 99 | 100 | 88 | 77 | 53 | 42 | **73.2** |
| 1994 | 45 | 52 | 65 | 80 | 86 | 95 | 98 | 99 | 92 | 75 | 57 | 43 | **73.9** |
| 1995 | 41 | 60 | 65 | 72 | 79 | 90 | 98 | 99 | - | 70 | 60 | 50 | **71.3** |
| 1996 | 42 | 55 | 65 | 77 | 91 | 96 | 100 | 92 | 91 | 78 | 54 | 48 | **74.1** |
| 1997 | 45 | 49 | 64 | 69 | 84 | - | - | 95 | 91 | 81 | 57 | 47 | **68.2** |
| 1998 | 39 | 48 | 64 | 74 | 90 | 98 | 102 | 96 | 90 | 79 | 54 | 49 | **73.6** |
| 1999 | 44 | 50 | 65 | 72 | 80 | 95 | 99 | 92 | 86 | 73 | 57 | 48 | **71.8** |
| 2000 | 47 | 49 | 64 | 78 | 89 | 92 | 95 | 94 | 86 | 76 | 50 | 42 | **71.8** |
| 2001 | 32 | 47 | 63 | 78 | 86 | 93 | 100 | 96 | 90 | 83 | 62 | 47 | **73.1** |
| 2002 | 39 | 48 | 67 | 75 | 90 | 95 | 99 | 97 | 90 | 75 | 56 | 45 | **73.0** |
| 2003 | 45 | 49 | 63 | 74 | 90 | 91 | 100 | 99 | 95 | 79 | 59 | 45 | **74.1** |
| 2004 | 35 | 50 | 73 | 79 | 85 | 90 | 101 | 98 | 94 | 78 | 57 | 42 | **73.5** |
| 2005 | 45 | 50 | 64 | 79 | 93 | 99 | 106 | 103 | 89 | 76 | 59 | 46 | **75.8** |
| 2006 | 46 | 56 | 64 | 81 | 91 | 99 | 103 | 98 | 92 | 78 | 60 | 42 | **75.8** |
| 2007 | 34 | 52 | 68 | 82 | 88 | 102 | 105 | 102 | 100 | 79 | 63 | 45 | **76.7** |
| 2008 | 32 | 47 | 63 | 72 | 87 | 99 | 100 | 100 | 93 | 82 | 63 | 46 | **73.7** |
| 2009 | 44 | 53 | 65 | 74 | 86 | 94 | 101 | 99 | 94 | 76 | 58 | 40 | **73.7** |
| 2010 | 33 | 43 | 60 | 71 | 87 | 90 | 97 | 91 | 82 | 80 | 57 | 44 | **69.6** |
| **Mean** | **40.9** | **52.5** | **64.3** | **77.1** | **88.2** | **96.5** | **101.2** | **98.9** | **93.2** | **78.9** | **59.5** | **45.4** | **74.7** |

**Table 22. Soil low temperature (ºF) extremes, four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2010.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | - | - | - | - | - | - | - | - | 53 | 39 | 36 | - | **36.5** |
| 1977 | 6 | 22 | 24 | 32 | 52 | 73 | 70 | 73 | 62 | 43 | 31 | 6 | **42.3** |
| 1978 | 31 | 34 | 37 | 49 | 44 | 68 | 75 | 70 | 52 | 44 | 38 | 31 | **47.4** |
| 1979 | 19 | 30 | 38 | 39 | 49 | 62 | 70 | 69 | 68 | 44 | 32 | 19 | **45.9** |
| 1980 | 36 | 38 | 40 | 40 | 54 | 63 | 72 | 68 | 61 | 41 | 37 | 36 | **48.8** |
| 1981 | 33 | 31 | 39 | 40 | 52 | 56 | 67 | 71 | 62 | 43 | 36 | 33 | **46.5** |
| 1982 | 22 | 29 | 35 | 43 | 47 | 63 | 72 | 68 | 57 | 40 | 37 | 22 | **45.3** |
| 1983 | 26 | 34 | 38 | 39 | 47 | 60 | 64 | 65 | 58 | 49 | 33 | 26 | **45.3** |
| 1984 | 23 | 32 | 32 | 38 | 42 | 56 | 69 | 65 | 53 | 34 | 30 | 23 | **42.0** |
| 1985 | 29 | 22 | 35 | 37 | 45 | 60 | 66 | 64 | 47 | 41 | 31 | 29 | **41.8** |
| 1986 | 29 | 29 | 35 | 37 | 49 | 62 | 60 | 62 | 48 | 37 | 31 | 29 | **42.7** |
| 1987 | 28 | 32 | 31 | 36 | 41 | 65 | 75 | 71 | 61 | 50 | 38 | 28 | **47.1** |
| 1988 | 32 | 34 | 38 | 44 | 45 | 53 | 68 | 66 | 56 | 49 | 31 | 32 | **45.2** |
| 1989 | 20 | 33 | 35 | 45 | 53 | 65 | 63 | 65 | 60 | 38 | 30 | 20 | **44.3** |
| 1990 | 23 | 26 | 33 | 43 | 47 | 59 | 71 | 63 | 55 | 42 | 35 | 23 | **43.8** |
| 1991 | 23 | 25 | 37 | 43 | 50 | 56 | 71 | 68 | 58 | 40 | 35 | 23 | **45.0** |
| 1992 | 28 | 35 | 40 | 46 | 54 | 62 | 66 | 62 | 59 | 50 | 27 | 28 | **46.3** |
| 1993 | 30 | 34 | 36 | 39 | 45 | 63 | 71 | 57 | 49 | 34 | 26 | 30 | **42.2** |
| 1994 | 24 | 20 | 33 | 38 | 51 | 64 | 70 | 65 | 53 | 37 | 26 | 24 | **42.3** |
| 1995 | 28 | 29 | 34 | 38 | 45 | 59 | 62 | 66 | - | 42 | 31 | 28 | **41.3** |
| 1996 | 22 | 26 | 32 | 41 | 54 | 58 | 58 | 57 | 44 | 37 | 35 | 22 | **41.3** |
| 1997 | 27 | 33 | 34 | 38 | 46 | - | - | 68 | 57 | 35 | 32 | 27 | **39.2** |
| 1998 | 22 | 31 | 31 | 37 | 54 | 64 | 68 | 65 | 63 | 41 | 33 | 22 | **44.4** |
| 1999 | 30 | 29 | 37 | 40 | 42 | 63 | 72 | 67 | 56 | 48 | 32 | 30 | **45.1** |
| 2000 | 25 | 32 | 35 | 40 | 57 | 64 | 71 | 68 | 58 | 44 | 30 | 25 | **46.0** |
| 2001 | 24 | 25 | 35 | 41 | 46 | 62 | 69 | 66 | 63 | 46 | 27 | 24 | **44.0** |
| 2002 | 23 | 25 | 28 | 41 | 51 | 69 | 72 | 66 | 51 | 39 | 32 | 30 | **43.9** |
| 2003 | 27 | 30 | 33 | 40 | 50 | 65 | 73 | 70 | 54 | 45 | 26 | 24 | **44.8** |
| 2004 | 22 | 24 | 32 | 41 | 49 | 63 | 69 | 69 | 48 | 37 | 26 | 16 | **41.3** |
| 2005 | 31 | 31 | 35 | 35 | 44 | 60 | 69 | 64 | 56 | 44 | 27 | 12 | **42.3** |
| 2006 | 24 | 28 | 31 | 39 | 52 | 63 | 63 | 67 | 42 | 35 | 31 | 21 | **41.3** |
| 2007 | 19 | 28 | 30 | 36 | 44 | 61 | 71 | 64 | 50 | 40 | 30 | 19 | **41.0** |
| 2008 | 16 | 29 | 33 | 37 | 48 | 58 | 65 | 70 | 58 | 40 | 31 | 29 | **42.8** |
| 2009 | 29 | 29 | 31 | 35 | 51 | 64 | 73 | 71 | 62 | 35 | 32 | 16 | **44.0** |
| 2010 | 20 | 31 | 29 | 38 | 42 | 66 | 73 | 61 | 59 | 38 | 30 | 26 | **42.8** |
| **Mean** | **25.0** | **29.4** | **34.0** | **39.6** | **48.3** | **62.1** | **68.7** | **66.2** | **55.7** | **41.2** | **31.6** | **25.6** | **43.9** |

## Adaptive Field Crops Research in Northwestern New Mexico

Field crop acreage in northwestern New Mexico is irrigated either by surface or sprinkler systems. Nearly all agricultural lands are irrigated because the average annual precipitation is approximately eight inches. Most farmland in northwestern New Mexico is located in San Juan County along three river valleys (Animas, La Plata, and San Juan) or part of the Navajo Indian Irrigation Project (NIIP), which is located on a high mesa south of Farmington. NIIP is irrigated by water from Navajo Lake located on the San Juan River.

Approximately 30% of all lands in New Mexico, which are irrigated with surface water, lie within San Juan County. The irrigated 150,000 crop acreage in the county is surface irrigated. With the continued construction of NIIP, irrigated acreage in San Juan County is growing each year and should reach approximately 240,000 acres when the 110,000-acre Navajo Agricultural Products Industry (NAPI) project is completed.

San Juan County produces over 65% of the state‘s potato crop and 75% of the state‘s dry bean crop. It is one of the top four counties in winter wheat, alfalfa, and corn grain production (New Mexico Agricultural Statistics, 2002). Historically, it has been an apple producing area and remains one of the top five counties in apple production.

The New Mexico State University Agricultural Science Center at Farmington and the Cooperative Extension Service, in San Juan County, have been and will continue to be the major field crop research and dissemination sources in northwestern New Mexico and the Four Corners region. The Agricultural Science Center at Farmington has furnished adaptive research information that has contributed to increased crop productivity and profitability, in the area. Extension agents, in all four states bordering the region, have used research results published by faculty and staff from the Agricultural Science Center, for dissemination and education.

The agricultural industry in northwestern New Mexico is critical to San Juan County and the rest of the state. As newly irrigated cropland is developed for the area each year, the demand for information on the adaptation of new crops for the area will increase. The search for new varieties and hybrids, of currently important crops, will also be important. Adaptive crop research has made and will continue to make a significant contribution to the success of agriculture in the state, region, and nation. This project is designed to evaluate varieties and hybrids of field crops for production in northwestern New Mexico. This includes the evaluation of cultural practices, such as crop variety selection, planting dates, plant population and soil fertility.

## Alfalfa – New Mexico 2007-Planted Alfalfa Variety Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Margaret M. West**

### Abstract

The 2007 Alfalfa Variety Trial is part of a statewide testing program to help determine which entries will perform best in the area they are tested. This trial was coordinated through the Plant and Environmental Sciences Department at New Mexico State University's (NMSU) main campus in Las Cruces, NM. The trial consisted of 24 varieties (Table 23) from public varieties, private seed companies and NMSU. Mean seasonal total yield for this trial in 2010 was 10.23 ton/acre (Table 24). The highest yielding entry of 11.29 ton/acre was Mountaineer 2.0, a check entry from Croplan Genetics. The lowest yielding entry of 8.82 ton/acre was NM Common, a Public check entry. There were no significant differences in yield at the 95% probability level between the top yielding entry and the next 15 top yielding entries within this trial. The first cut yielded the highest with a mean of 4.03 ton/acre, while the fourth cutting was the lowest yielding cut with a mean of 1.18 ton/acre (Table 24).

The highest yielding entries, over a three year period from 2008 through 2010, were Mountaineer 2.0, a check entry from Croplan Genetics, and 54V09 entered by Pioneer HiBred International with an average yield of 10.28 and 10.15 ton/acre, respectively. The lowest yielding entry over a three year period was NM Common, a check entry, with an average of 7.76 ton/acre. The average yield over a three year period of all entries was 8.99 ton/acre (Table 25).

### Introduction

The Alfalfa Variety Trial is a statewide testing program to help determine which entries will perform best in the area they are tested. This trial was coordinated through the Plant and Environmental Sciences Department at New Mexico State University's (NMSU) main campus in Las Cruces. The results are compiled at NMSU and distributed to all cooperating growers and seed companies.

### Objectives

- Test alfalfa varieties for forage yield and yield components.
- Relate alfalfa productivity at the Agricultural Science Center at Farmington with productivity at other sites in the state.

### Materials and methods

The 2007-Planted Alfalfa Variety Trial was planted at the Agriculture Science Center at Farmington on August 20, 2007. The trial consisted of 24 varieties (Table 23) from public varieties, private seed companies and NMSU. The trial at Farmington was established in a randomized block design with four replications. Individual plots were six 8-inch rows by 16 ft long (64 $ft^2$). Planting rate was 20 lb/acre. The planter used was a Kincaid 6-row cone seeder equipped with discs that closed the seed trench directly after the seeds were dropped in the small furrow opening at a depth of about 0.25 inches.

**Table 23. Procedures for the 2007-Planted Alfalfa Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Twenty-Four |
| Check Entries: | Dona Ana, Archer II, Wilson, NM Common, African Common, Ranger, Mountaineer 2.0 and Legend |
| Planting Date: | August 20, 2007 |
| Planting Rate: | 20 lb/acre |
| Plot Design: | Complete randomized block with four replications |
| Plot Size: | Six 8-inch rows, 16 ft long |
| Cutting Date: | Four cutting dates: June 3, July 13, August 18 and October 13, 2010 |
| Fertilization: | Pre-plant Fertilizer applied on March 23, 2010 at 200 lb of 5-26-30 e.g. N 10 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre |
| Herbicide: | Raptor applied at 0.4 pints/acre on March 17, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Solid set pipe, watered as needed; generally 4 to 5 hours 3 times per week; 33.7 inches applied including precipitation |
| Results and Discussion: | Yield and other characteristics are presented in Table 24 and Table 25. |

Dry fertilizer was applied pre-plant on March 23, 2010 at the rate of N 10 lb/acre, $P_2O_5$ 52 lb/acre and $K_2O$ 60 lb/acre.

The plot area was chemically treated with the herbicide Raptor at a rate of 0.4 pints per acre on March 17, 2010 using a tractor mounted spray rig.

During the 2010 growing season, there were four cutting dates; June 3, July 13, August 18, and October 13, 2010. The plots were cut with an Almaco forage harvester equipped with an electronic scale to weigh the green weight of each plot as it was cut. At cutting, samples were taken from each plot to determine dry matter percent.

**Results and discussion**

Yield results for the 2010 growing season of the 2007-Planted Alfalfa Variety Trial are presented in Table 24.

Yield for each cut, along with the seasonal total yield, are shown for each entry as dry ton/acre. 2010 was the third year to obtain harvest data from this trial as it was planted in August of 2007.

2010 mean seasonal total yield for this trial was 10.23 ton/acre (Table 24). The highest yielding entry of 11.29 ton/acre was Mountaineer 2.0, a check entry from Croplan Genetics. The lowest yielding entry of 8.82 ton/acre was NM Common, a Public check entry. There were no significant differences in yield at the 95% probability level between the top yielding entry and the next 15 top yielding entries within this trial. The first cut yielded the highest with a mean of 4.03 ton/acre, while the fourth cutting was the lowest yielding cut with a mean of 1.18 ton/acre (Table 24).

The highest yielding entries, over a three year period from 2008 through 2010, were Mountaineer 2.0, a check entry from Croplan Genetics, and 54V09 entered by Pioneer HiBred International with an average yield of 10.28 and 10.15 ton/acre, respectively. The lowest yielding entry over a three year period was NM Common, a check entry, with an average of 7.76 ton/acre. The average yield over a three year period of all entries was 8.99 ton/acre (Table 25).

Alfalfa samples from the 2009 harvest were taken to the N.A.P.I. lab for forage analysis. *Guide to Forage Measurements* is presented in Table 29. Results show two cuts from the growing season of 2009, the variety with the highest Relative Feed Value (RFV), of 162.3, on the first cut was Archer II, a check entry from America's Alfalfa. The mean RFV of 149.9 for the first cut for all entries (Table 26) is slightly less than the RFV of 151 recommended as the minimum value for forage to be used for prime dairy (Table 29). The variety with the highest Relative Feed Value (RFV), of 168.6, on the second cut was WL343HQ, an entry from W-L Research. The mean RFV of 148.7 for the second cut for all entries (Table 27) is slightly less than the RFV 151 recommended as the minimum value for forage to be used for prime dairy (Table 29).The variety with the highest Relative Feed Value (RFV), of 158.18, from the average of the first two cuts was Medalist from Intermountain Farmers Association (Table 28).

**Table 24. Forage yield of the 2007-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| | | Yield dry ton/acre | | | | |
|---|---|---|---|---|---|---|
| **Variety** | **Company** | **Cut-1** | **Cut-2** | **Cut-3** | **Cut-4** | **Total** |
| Mountaineer 2.0 | Croplan Genetics (Check) | 4.77 | 3.16 | 2.14 | 1.23 | 11.29 |
| Masterpiece | JR Simplot Co | 4.40 | 3.10 | 2.32 | 1.21 | 11.03 |
| 54V09 | Pioneer HiBred Int'l | 4.88 | 2.89 | 2.08 | 1.06 | 10.91 |
| Legend | Arkansas Valley Seed Co. (Check) | 4.49 | 3.25 | 2.15 | 0.97 | 10.86 |
| PGI459 | Producer's Choice Seed | 4.17 | 3.25 | 2.13 | 1.29 | 10.84 |
| FSG 528SF | Allied Seed, LLC | 4.13 | 3.03 | 2.31 | 1.25 | 10.71 |
| A-5225 | Cal/West Seeds | 4.40 | 3.09 | 1.95 | 1.22 | 10.66 |
| Grandstand | W.F.S. | 4.46 | 2.98 | 2.00 | 1.14 | 10.58 |
| CW 95026 | Producer's Choice Seed | 4.11 | 2.93 | 2.22 | 1.24 | 10.50 |
| Integra 8400 | Wilbur-Ellis Co | 4.48 | 3.05 | 1.75 | 1.20 | 10.49 |
| AmeriStand 444NT | America's Alfalfa | 4.10 | 3.16 | 1.98 | 1.22 | 10.47 |
| Wilson | Public (Check) | 3.79 | 3.06 | 2.23 | 1.32 | 10.40 |
| NM0306 | NMSU | 3.90 | 3.04 | 2.07 | 1.37 | 10.38 |

| | | Yield dry ton/acre | | | | |
|---|---|---|---|---|---|---|
| **Variety** | **Company** | **Cut-1** | **Cut-2** | **Cut-3** | **Cut-4** | **Total** |
| Archer III | America's Alfalfa | 4.16 | 2.99 | 1.95 | 1.22 | 10.32 |
| Dona Ana | Public (Check) | 4.10 | 2.90 | 1.99 | 1.28 | 10.27 |
| Ranger | Public (Check) | 4.38 | 2.90 | 1.98 | 0.87 | 10.14 |
| Medalist | Intermountain Farmers Association | 4.15 | 3.01 | 1.82 | 1.02 | 10.00 |
| AmeriStand 407TQ | America's Alfalfa | 3.81 | 2.95 | 2.02 | 1.10 | 9.89 |
| NM0307 | NMSU | 3.34 | 2.94 | 2.09 | 1.30 | 9.68 |
| Archer II | America's Alfalfa (Check) | 4.05 | 2.71 | 1.79 | 0.95 | 9.50 |
| WL343HQ | W-L Research | 3.55 | 2.99 | 1.83 | 1.09 | 9.47 |
| African Common | Public (Check) | 3.25 | 2.81 | 2.00 | 1.29 | 9.34 |
| NM0313 | NMSU | 3.19 | 2.60 | 1.89 | 1.37 | 9.04 |
| NM Common | Public (Check) | 2.78 | 2.69 | 2.14 | 1.22 | 8.82 |
| **Mean** | | **4.03** | **2.98** | **2.04** | **1.18** | **10.23** |
| LSD (0.05) | | 0.73 | 0.51 | 0.37 | 0.19 | 1.15 |
| CV (%) | | 12.8 | 12.2 | 12.9 | 11.9 | 8.0 |
| P Value | | <0.0001 | 0.7149 | 0.1583 | <0.0001 | 0.0019 |
| Significance | | *** | ns | ns | *** | ** |

Yield data may be different than that presented in other publications due to a difference in statistical analysis methods.

**Table 25. Three Year Forage yield of the 2007-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2008-2010.**

| | | Yield dry ton/acre | | | |
|---|---|---|---|---|---|
| **Variety** | **Company** | **2008** | **2009** | **2010** | **3 year** |
| Mountaineer 2.0 | Croplan Genetics (Check) | 9.12 | 10.41 | 11.29 | 10.28 |
| 54V09 | Pioneer HiBred Int'l | 9.12 | 10.42 | 10.91 | 10.15 |
| Masterpiece | JR Simplot Co | 8.32 | 10.40 | 11.03 | 9.92 |
| FSG 528SF | Allied Seed, LLC | 7.73 | 10.56 | 10.71 | 9.67 |
| CW 95026 | Producer's Choice Seed | 7.88 | 9.90 | 10.50 | 9.43 |
| Wilson | Public (Check) | 8.51 | 9.24 | 10.40 | 9.38 |
| PGI459 | Producer's Choice Seed | 7.70 | 9.60 | 10.84 | 9.38 |
| NM0306 | NMSU | 7.68 | 9.78 | 10.38 | 9.28 |
| A-5225 | Cal/West Seeds | 7.09 | 9.65 | 10.66 | 9.13 |
| Grandstand | W.F.S. | 7.45 | 9.12 | 10.58 | 9.05 |
| AmeriStand 407TQ | America's Alfalfa | 8.02 | 9.19 | 9.89 | 9.03 |
| Ranger | Public (Check) | 7.50 | 9.41 | 10.14 | 9.02 |
| Dona Ana | Public (Check) | 6.98 | 9.53 | 10.27 | 8.93 |
| African Common | Public (Check) | 7.80 | 9.43 | 9.34 | 8.86 |
| AmeriStand 444NT | America's Alfalfa | 6.53 | 9.36 | 10.47 | 8.79 |

| | | Yield dry ton/acre | | | |
|---|---|---|---|---|---|
| **Variety** | **Company** | **2008** | **2009** | **2010** | **3 year** |
| Integra 8400 | Wilbur-Ellis Co | 6.78 | 8.97 | 10.49 | 8.75 |
| Archer II | America's Alfalfa (Check) | 6.52 | 9.58 | 9.50 | 8.54 |
| Medalist | Intermountain Farmers Association | 6.49 | 9.02 | 10.00 | 8.51 |
| Legend | Arkansas Valley Seed Co. (Check) | 5.45 | 9.14 | 10.86 | 8.48 |
| NM0307 | NMSU | 6.29 | 9.40 | 9.68 | 8.46 |
| WL343HQ | W-L Research | 7.39 | 8.44 | 9.47 | 8.43 |
| NM0313 | NMSU | 7.35 | 8.71 | 9.04 | 8.37 |
| Archer III | America's Alfalfa | 5.65 | 8.83 | 10.32 | 8.26 |
| NM Common | Public (Check) | 6.26 | 8.19 | 8.82 | 7.76 |
| **Mean** | | **7.32** | **9.43** | **10.2** | **8.99** |
| LSD (0.05) | | 2.3 | 0.2 | 1.15 | 1.16 |
| CV (%) | | 21.8 | 6.9 | 8.0 | 9.14 |
| P Value | | 0.1 | <0.0001 | 0.0 | 0.005 |
| Significance | | ns | *** | ** | ** |

Yield data may be different than that presented in other publications due to a difference in statistical analysis methods.

**Table 26. First Cutting Relative Feed Value and other attributes of the 2007-Planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2009.**

| | | Cut 1 | | | | | |
|---|---|---|---|---|---|---|---|
| **Variety** | **Company** | **Protein** | **ADF** | **NDF** | **DDM** | **DMI** | **RFV** |
| Archer II | America's Alfalfa (Check) | 20.3 | 34.1 | 35.8 | 62.3 | 3.4 | 162.3 |
| Medalist | Intermountain Farmers Association | 19.4 | 34.5 | 36.8 | 62.1 | 3.3 | 158.4 |
| Archer III | America's Alfalfa | 18.8 | 34.9 | 36.8 | 61.7 | 3.3 | 158.3 |
| Integra 8400 | Wilbur-Ellis Co | 19.1 | 35.1 | 37.1 | 61.5 | 3.3 | 156.1 |
| 54V09 | Pioneer HiBred Int'l | 19.7 | 35.3 | 37.0 | 61.4 | 3.3 | 155.9 |
| NM0307 | NMSU | 19.7 | 34.8 | 37.2 | 61.8 | 3.2 | 155.9 |
| NM Common | Public (Check) | 19.3 | 34.8 | 38.0 | 61.8 | 3.2 | 155.7 |
| Masterpiece | JR Simplot Co | 19.4 | 34.5 | 37.6 | 62.0 | 3.2 | 155.7 |
| NM0313 | NMSU | 19.0 | 35.4 | 36.7 | 61.3 | 3.3 | 155.5 |
| Legend | Arkansas Valley Seed Co. (Check) | 19.3 | 35.7 | 37.8 | 61.1 | 3.2 | 151.9 |
| Wilson | Public (Check) | 18.0 | 35.3 | 38.0 | 61.4 | 3.2 | 151.5 |
| AmeriStand 444NT | America's Alfalfa | 18.6 | 35.8 | 37.8 | 61.0 | 3.2 | 151.2 |
| Grandstand | W.F.S. | 18.1 | 34.9 | 38.1 | 61.7 | 3.2 | 150.9 |
| Dona Ana | Public (Check) | 17.8 | 35.3 | 38.4 | 61.4 | 3.1 | 150.1 |
| African Common | Public (Check) | 17.5 | 35.4 | 38.7 | 61.3 | 3.1 | 149.5 |
| Ranger | Public (Check) | 18.2 | 35.4 | 38.4 | 61.3 | 3.1 | 149.5 |

| | | Cut 1 | | | | | |
|---|---|---|---|---|---|---|---|
| **Variety** | **Company** | **Protein** | **ADF** | **NDF** | **DDM** | **DMI** | **RFV** |
| FSG 528SF | Allied Seed, LLC | 17.9 | 35.3 | 38.9 | 61.4 | 3.1 | 147.9 |
| Mountaineer 2.0 | Croplan Genetics (Check) | 17.7 | 35.4 | 39.6 | 61.3 | 3.1 | 145.5 |
| AmeriStand 407TQ | America's Alfalfa | 17.3 | 36.6 | 39.9 | 60.4 | 3.1 | 144.1 |
| PGI459 | Producer's Choice Seed | 17.5 | 36.7 | 40.0 | 60.3 | 3.1 | 143.4 |
| WL343HQ | W-L Research | 17.1 | 36.4 | 40.5 | 60.5 | 3.0 | 141.9 |
| CW500 | Producer's Choice Seed | 17.5 | 36.6 | 41.2 | 60.4 | 2.9 | 136.9 |
| NM0306 | NMSU | 17.1 | 37.5 | 41.6 | 59.7 | 2.9 | 135.1 |
| A-5225 | Cal/West Seeds | 16.9 | 38.1 | 41.8 | 59.2 | 2.9 | 133.7 |
| **Mean** | | **18.4** | **35.6** | **38.5** | **61.2** | **3.2** | **149.9** |
| LSD (0.05) | | 3.7 | 3.8 | 5.9 | 3.0 | 0.5 | 29.0 |
| CV (%) | | 14.3 | 7.7 | 10.8 | 3.5 | 10.9 | 13.7 |
| P Value | | 0.94 | 0.97 | 0.90 | 0.97 | 0.93 | 0.95 |

**Table 27. Second Cutting Relative Feed Value and other attributes of the 2007-Planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| | | Cut 2 | | | | | |
|---|---|---|---|---|---|---|---|
| **Variety** | **Company** | **Protein** | **ADF** | **NDF** | **DDM** | **DMI** | **RFV** |
| WL343HQ | W-L Research | 22.5 | 31.8 | 35.4 | 64.1 | 3.4 | 168.6 |
| Legend | Arkansas Valley Seed Co. (Check) | 22.5 | 33.6 | 35.6 | 62.8 | 3.4 | 164.3 |
| A-5225 | Cal/West Seeds | 22.0 | 33.8 | 36.2 | 62.6 | 3.3 | 160.6 |
| Integra 8400 | Wilbur-Ellis Co | 20.9 | 34.5 | 36.9 | 62.0 | 3.3 | 158.8 |
| Medalist | Intermountain Farmers Association | 21.4 | 34.4 | 36.8 | 62.1 | 3.3 | 157.9 |
| AmeriStand 444NT | America's Alfalfa | 21.2 | 34.4 | 37.0 | 62.1 | 3.3 | 157.3 |
| AmeriStand 407TQ | America's Alfalfa | 20.8 | 35.3 | 37.4 | 61.4 | 3.3 | 155.4 |
| Archer III | America's Alfalfa | 21.6 | 35.2 | 37.7 | 61.5 | 3.2 | 152.9 |
| Grandstand | W.F.S. | 20.9 | 35.6 | 38.2 | 61.2 | 3.2 | 150.7 |
| NM Common | Public (Check) | 20.6 | 35.9 | 37.8 | 60.9 | 3.2 | 150.4 |
| CW500 | Producer's Choice Seed | 20.6 | 32.7 | 39.4 | 63.4 | 3.0 | 150.1 |
| Mountaineer 2.0 | Croplan Genetics (Check) | 21.4 | 35.4 | 38.4 | 61.3 | 3.1 | 149.3 |
| Archer II | America's Alfalfa (Check) | 21.2 | 34.3 | 38.1 | 62.1 | 3.2 | 146.9 |
| Ranger | Public (Check) | 21.4 | 35.1 | 39.2 | 61.6 | 3.1 | 146.5 |
| Wilson | Public (Check) | 20.3 | 35.4 | 39.4 | 61.3 | 3.1 | 145.6 |
| PGI459 | Producer's Choice Seed | 20.2 | 35.7 | 39.5 | 61.1 | 3.0 | 144.2 |
| Masterpiece | JR Simplot Co | 20.8 | 35.8 | 39.6 | 61.0 | 3.0 | 143.8 |
| 54V09 | Pioneer HiBred Int'l | 19.8 | 36.4 | 40.0 | 60.6 | 3.0 | 143.0 |
| NM0313 | NMSU | 19.1 | 36.2 | 40.0 | 60.7 | 3.0 | 142.2 |

| | | Cut 2 | | | | | |
|---|---|---|---|---|---|---|---|
| Variety | Company | Protein | ADF | NDF | DDM | DMI | RFV |
| FSG 528SF | Allied Seed, LLC | 19.5 | 36.0 | 41.4 | 60.9 | 2.9 | 139.8 |
| Dona Ana | Public (Check) | 20.2 | 36.9 | 40.5 | 60.2 | 3.0 | 139.1 |
| NM0307 | NMSU | 19.9 | 36.8 | 40.9 | 60.2 | 2.9 | 137.7 |
| NM0306 | NMSU | 19.8 | 37.0 | 40.7 | 60.1 | 3.0 | 137.5 |
| African Common | Public (Check) | 17.4 | 39.5 | 43.7 | 58.2 | 2.8 | 125.5 |
| **Mean** | | **20.7** | **35.3** | **38.7** | **61.4** | **3.1** | **148.7** |
| LSD (0.05) | | 2.7 | 3.7 | 4.5 | 2.9 | 0.4 | 23.1 |
| CV (%) | | 9.1 | 7.5 | 8.3 | 3.4 | 8.1 | 11.0 |
| P Value | | 0.13 | 0.16 | 0.09 | 0.16 | 0.13 | 0.13 |
| Significant | | ns | ns | ns | ns | ns | ns |

**Table 28. Averaged Relative Feed Value of the 2007-Planted Alfalfa Variety Trial for two cuttings; NMSU Agriculture Science Center at Farmington, NM. 2009.**

| | | Relative Food Value | | | | |
|---|---|---|---|---|---|---|
| Variety | Company | Cut 1 | Cut 2 | Cut 3 | Cut 4 | Average |
| Medalist | Intermountain Farmers Association | 158.43 | 157.93 | | | 158.18 |
| Legend | Arkansas Valley Seed Co. (Check) | 151.87 | 164.29 | | | 158.08 |
| Integra 8400 | Wilbur-Ellis Co | 156.10 | 158.77 | | | 157.44 |
| Archer III | America's Alfalfa | 158.30 | 152.90 | | | 155.60 |
| WL343HQ | W-L Research | 141.95 | 168.60 | | | 155.28 |
| Archer II | America's Alfalfa (Check) | 162.35 | 146.85 | | | 154.60 |
| AmeriStand 444NT | America's Alfalfa | 151.18 | 157.28 | | | 154.23 |
| NM Common | Public (Check) | 155.72 | 150.42 | | | 153.07 |
| Grandstand | W.F.S. | 150.89 | 150.72 | | | 150.80 |
| AmeriStand 407TQ | America's Alfalfa | 144.09 | 155.39 | | | 149.74 |
| Masterpiece | JR Simplot Co | 155.67 | 143.81 | | | 149.74 |
| 54V09 | Pioneer HiBred Int'l | 155.93 | 142.95 | | | 149.44 |
| NM0313 | NMSU | 155.48 | 142.17 | | | 148.82 |
| Wilson | Public (Check) | 151.48 | 145.65 | | | 148.57 |
| Ranger | Public (Check) | 149.47 | 146.47 | | | 147.97 |
| Mountaineer 2.0 | Croplan Genetics (Check) | 145.53 | 149.27 | | | 147.40 |
| A-5225 | Cal/West Seeds | 133.73 | 160.62 | | | 147.18 |
| NM0307 | NMSU | 155.87 | 137.73 | | | 146.80 |
| Dona Ana | Public (Check) | 150.14 | 139.09 | | | 144.62 |
| FSG 528SF | Allied Seed, LLC | 147.90 | 139.78 | | | 143.84 |

| Variety | Company | Cut 1 | Cut 2 | Cut 3 | Cut 4 | Average |
|---|---|---|---|---|---|---|
| | | Relative Food Value | | | | |
| PGI459 | Producer's Choice Seed | 143.42 | 144.18 | | | 143.80 |
| CW 500 | Producer's Choice Seed | 136.87 | 150.09 | | | 143.48 |
| African Common | Public (Check) | 149.55 | 125.46 | | | 137.51 |
| NM0306 | NMSU | 135.06 | 137.46 | | | 136.26 |
| **Mean** | | **149.87** | **148.66** | | | **149.27** |

**Table 29. Guide to forage measurements: http://www.agrigro.com/research/alfalfa.html.**

| Uses | ADF | NDF | DDM | DMI | RFV |
|---|---|---|---|---|---|
| | Analysis Calculations | | | | |
| | — % DM — | | | — % Body Weight — | |
| **Prime dairy,** fresh and high producers | < 31 | < 40 | > 65 | > 3.0 | > 151 |
| **Good dairy**, young heifers, excellent for backgrounding | 31-35 | 40-46 | 62-65 | 2.6-3.0 | 125-151 |
| **Good Beef**, older heifers, marginal For dairy cows | 36-40 | 47-53 | 58-61 | 2.2-3.5 | 103-124 |
| **Maintenance** for beef or dry dairy cows | 41-42 | 54-60 | 56-57 | 2.0-2.2 | 87-102 |
| **Poor Quality***  | 43-45 | 61-65 | 53-55 | 1.8-1.9 | 75-86 |

*Requires supplementation with higher quality (energy) feeds as well as possibly other nutrients for most animals. This quality hay could be fed to dry beef cows under some circumstances.

**Guide to Forage Measurements:**

- Acid Detergent Fiber (ADF) — least digestible parts of the plant, lower ADF is desired
- Neutral Detergent Fiber (NDF) — gives bulk to the diet and limits intake, low NDF is usually desired
- Digestable Dry Matter (DDM) — estimates the percentage of forage that is digestible. It is calculated from ADF using the equation: DDM (%) = 88.9 - [ADF (%) x 0.779]
- Dry Matter Intake (DMI) — estimates the maximum amount of forage dry matter a cow will eat. It is expressed as a percent of body weight and is calculated from NDF using the equation: DMI = 120 ÷ NDF
- Relative Feed Value (RFV) — combines digestibility and intake into one number to evaluate the quality of hay. RFV = [DDM x DMI] ÷ 1.29

Relationships among several estimators of alfalfa quality and suggested livestock uses as determined by the University of Nebraska-Lincoln

## Alfalfa – New Mexico 2009-Planted Alfalfa Variety Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Margaret M. West**

### Abstract

The 2009 Alfalfa Variety Trial is part of a statewide testing program to help determine which entries will perform best in the area they are tested. This trial was coordinated through the Plant and Environmental Sciences Department at New Mexico State University's (NMSU) main campus in Las Cruces, NM. The trial consisted of 24 varieties (Table 30) from public varieties and private seed companies. Mean seasonal total yield for this trial in 2010 was 8.93 ton/acre (Table 31). The highest yielding entry of 9.57 ton/acre was Lahontan, a public check entry. The lowest yielding entry of 8.26 ton/acre was Maxi-Graze GT from Croplan Genetics. There were no significant differences in seasonal total yield at the 95% probability level between entries within this trial. The first cut yielded the highest with a mean of 3.06 ton/acre, while the fourth cutting was the lowest yielding with a mean of 1.15 ton/acre (Table 31).

### Introduction

The Alfalfa Variety Trial is a statewide testing program to help determine which entries will perform best in the area they are tested. This trial was coordinated through the Plant and Environmental Sciences Department at New Mexico State University's (NMSU) main campus in Las Cruces. The results are compiled at NMSU and distributed to all cooperating growers and seed companies.

### Objectives

- Test alfalfa varieties for forage yield and yield components.
- Relate alfalfa productivity at the Agricultural Science Center at Farmington with productivity at other sites in the state.

### Materials and methods

The 2009-Planted Alfalfa Variety Trial was planted at the Agriculture Science Center at Farmington on August 26, 2009. The trial consisted of 24 varieties (Table 30) from public varieties and private seed companies. The trial at Farmington was established in a randomized block design with four replications. Individual plots were six 8-inch rows by 16 ft long (64 $ft^2$). Planting rate was 20 lb/acre. The planter used was a Kincaid 6-row cone seeder equipped with discs that closed the seed trench directly after the seeds were dropped in the small furrow opening at a depth of about 0.25 inches.

**Table 30. Procedures for the 2009-Planted Alfalfa Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Twenty-Four |
| Check Entries: | Dona Ana, Wilson, NM Common, African Common, Ranger, Mountaineer 2.0 and Lahontan |
| Planting Date: | August 26, 2009 |
| Planting Rate: | 20 lb/acre |
| Plot Design: | Complete randomized block with four replications |
| Plot Size: | Six 8-inch rows, 16 ft long |
| Cutting Date: | Four cutting dates: June 4, July 14, August 24 and October 14, 2010 |
| Fertilization: | Dry fertilizer applied on March 23, 2010 at 200 lb of 5-26-30 e.g. N 10 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre |
| Herbicide: | Raptor applied at 0.4 pints/acre on March 17, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Solid set pipe, watered as needed; generally 2 hours 3 times per week; 52.8 inches applied including precipitation |
| Results and Discussion: | Yield and other characteristics are presented in Table 31 |

Dry fertilizer was applied pre-plant on March 23, 2010 at the rate of N 10 lb/acre, $P_2O_5$ 52 lb/acre and $K_2O$ 60 lb/acre.

The plot area was chemically treated with the herbicide Raptor at a rate of 0.4 pints per acre on March 17, 2010 using a tractor mounted spray rig.

During the 2010 growing season, there were four cutting dates; June 4, July 14, August 24, and October 14, 2010. The plots were cut with an Almaco forage harvester equipped with an electronic scale to weigh the green weight of each plot as it was cut. At cutting, samples were taken from each plot to determine dry matter percent.

**Results and discussion**

Yield results for the 2010 growing season of the 2009-Planted Alfalfa Variety Trial are presented in Table 31.

Yield for each cut, along with the seasonal total yield, are shown for each entry as dry ton/acre. 2010 was the first year to obtain harvest data from this trial as it was planted in August of 2009.

Mean seasonal total yield for this trial in 2010 was 8.93 ton/acre (Table 31). The highest yielding entry of 9.57 ton/acre was Lahontan, a public check entry. The lowest yielding entry of 8.26 ton/acre was Maxi-Graze GT from Croplan Genetics. There were no significant differences in seasonal total yield at the 95% probability level between entries within this trial. The first cut yielded the highest with a mean of 3.06 ton/acre, while the fourth cutting was the lowest yielding with a mean of 1.15 ton/acre (Table 31).

**Table 31. Forage yield of the 2009-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| | | Yield dry ton/acre | | | | |
|---|---|---|---|---|---|---|
| **Variety** | **Company** | **Cut-1** | **Cut-2** | **Cut-3** | **Cut-4** | **Total** |
| Lahontan | Check | 3.44 | 3.17 | 1.82 | 1.15 | 9.57 |
| Mountaineer 2.0 | Croplan Genetics | 3.29 | 3.12 | 1.70 | 1.29 | 9.41 |
| Dura 843 | Croplan Genetics | 3.13 | 3.18 | 1.83 | 1.25 | 9.39 |
| 4S417 | Mycogen Seed | 3.42 | 3.12 | 1.75 | 0.98 | 9.27 |
| HybriForce 2400 | Dairyland Seed | 3.39 | 2.98 | 1.86 | 1.02 | 9.25 |
| Artesian Sunrise | Croplan Genetics | 3.16 | 3.00 | 1.68 | 1.37 | 9.21 |
| African Common | Roswell Seed | 2.78 | 3.09 | 1.82 | 1.48 | 9.17 |
| WL363HQ | W-L Research | 3.17 | 3.00 | 1.63 | 1.28 | 9.08 |
| SW6330 | S&W Seed | 2.97 | 2.95 | 1.70 | 1.41 | 9.04 |
| Dona Ana | Roswell Seed | 2.93 | 2.93 | 1.83 | 1.30 | 9.00 |
| NM Common | Roswell Seed | 2.83 | 3.07 | 1.66 | 1.41 | 8.97 |
| SW435 | S&W Seed | 3.00 | 3.16 | 1.76 | 1.05 | 8.96 |
| LegenDairy 5.0 | Croplan Genetics | 3.12 | 3.08 | 1.69 | 1.06 | 8.95 |
| WL440HQ | W-L Research | 3.01 | 2.96 | 1.66 | 1.29 | 8.92 |
| HybriForce 2420/wet | Dairyland Seed | 3.26 | 2.93 | 1.74 | 0.93 | 8.86 |
| Velvet | Producers Choice Seeds | 2.99 | 2.94 | 1.77 | 1.10 | 8.80 |
| Wilson | Roswell Seed | 2.68 | 2.82 | 1.81 | 1.45 | 8.75 |
| Malone | Roswell Seed | 2.71 | 3.06 | 1.58 | 1.40 | 8.75 |
| Ranger | Check | 3.19 | 2.87 | 1.73 | 0.94 | 8.72 |
| 63Q105 | Syngenta Seeds | 2.95 | 2.75 | 1.96 | 0.97 | 8.63 |
| Rugged | Producers Choice Seeds | 3.29 | 2.67 | 1.73 | 0.88 | 8.57 |
| AmeriStand 201+Z | America's Alfalfa | 2.93 | 2.90 | 1.79 | 0.89 | 8.51 |
| 6422Q | Syngenta Seeds | 2.92 | 2.85 | 1.46 | 1.15 | 8.38 |
| Maxi-Graze GT | Croplan Genetics | 2.98 | 2.84 | 1.76 | 0.69 | 8.26 |
| **Mean** | | **3.06** | **2.98** | **1.74** | **1.15** | **8.93** |
| LSD (0.05) | | 0.04 | 0.36 | 0.42 | 0.25 | 0.78 |
| CV (%) | | 10.90 | 8.70 | 17.50 | 15.40 | 6.24 |
| P Value | | 0.04 | 0.45 | 0.99 | <0.0001 | 0.14 |
| Significance | | * | ns | ns | *** | ns |

Yield data may be different than that presented in other publications due to a difference in statistical analysis methods.

## Alfalfa – Penatron and Thoro-Gro Treated Alfalfa Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Wes Richens**

### Abstract

The Penatron and Thoro-Gro treated Alfalfa Trial is a collaborated effort between New Mexico State University Agriculture Science Center at Farmington and S.C.A.L.E. Ag Services represented by Wes Richens. The purpose of the experiment was to see how Penatron and Thoro-Gro applied at different rates on the soil and crop would affect alfalfa yield compared with a check entry of the same variety. Penatron and Thoro-Gro are both natural crop enhancers that when applied to the soil and/or crop may increase production. Penatron, a product from Maz-Zee S.A. International, is an organic liquid soil conditioner. Thoro-Gro, a product from S.C.A.L.E. Ag Services, is ~~a~~ spore based (Dormant Live Liquid Bio-Stimulant) made from a fermented bio mass and other natural accruing growth enhancers".

Treatments of Penatron and Thoro-Gro were each applied to the alfalfa plots with a 35 gallon tractor mounted spray rig. Each product was applied at a one and two (split) application schedule. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on May 25, 2010. Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on June 9, 2010. Penatron was applied again to the split application plots at a rate of one gallon per acre on June 16, 2010. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 21, 2010 (Table 32).

A delay in delivery of the Thoro-Gro resulted in only the Penetron being applied before the first cut. Mean yield of the five treatments of this trial was a total of 6.03 ton/acre for cuts 2, 3, & 4. The Penetron split application treatment had the top yield of 6.34 ton/acre and was an increase of 0.39 tons over the untreated entry which ranked fourth in yield at 5.95 ton/acre for cuts 2, 3, & 4. There were no significant differences in yield at the 95% probability level between the five treatments (Table 33). All treatments except the Thoro-Gro split application yielded higher than the check entry for cuts 2, 3, & 4. The Thoro-Gro split application was 0.14 ton/acre less than the check entry for cuts 2, 3, & 4 at 5.81 ton/acre (Table 33).

### Introduction

The Penatron and Thoro-Gro treated Alfalfa Trial is a collaborated effort between New Mexico State University Agriculture Science Center at Farmington and S.C.A.L.E. Ag Services represented by Wes Richens. The purpose of the experiment was to see how Penatron and Thoro-Gro applied at different rates on the soil and crop would affect alfalfa yield compared with a check entry of the same variety. Penatron and Thoro-Gro are both natural crop enhancers that when applied to the soil and/or crop may increase production. Penatron, a product from Maz-Zee S.A. International, is an organic liquid soil conditioner. Thoro-Gro, a product from S.C.A.L.E. Ag Services, is ~~a~~ spore based (Dormant Live Liquid Bio-Stimulant) made from a fermented bio mass and other natural accruing growth enhancers".

## Objectives

- Compare Penatron and Thoro-Gro products applied at various rates to a single alfalfa variety with a check of the same variety to determine any benefit in yield from the soil and crop treatments.

## Materials and methods

The alfalfa variety Legend from Arkansas Valley Seed Co. was planted as outside border rows for the 2009-Planted Alfalfa Variety Trial. These border rows were used to conduct the Penatron and Thoro-Gro treated Alfalfa Trial The alfalfa was planted at the Agriculture Science Center at Farmington on August 26, 2009. The trial at Farmington was established in a randomized block design with four replications. Individual plots were six 8-inch rows by 16 ft long (64 $ft^2$). Planting rate was 20 lb/acre. The planter used was a Kincaid 6-row cone seeder equipped with discs that closed the seed trench directly after the seeds were dropped in the small furrow opening at a depth of about 0.25 inches.

Treatments of Penatron and Thoro-Gro were each applied to the alfalfa plots with a 35 gallon tractor mounted spray rig. Each product was applied at a one and two (split) application schedule. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on May 25, 2010. Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on June 9, 2010. Penatron was applied again to the split application plots at a rate of one gallon per acre on June 16, 2010. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 21, 2010.

**Table 32. Procedures for the Penatron and Thoro-Gro Treatment Alfalfa Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Treatments: | Five;<br>(1) Penetron applied once at a rate of 1 gallon per acre, 05/25/2010<br>(2) Penetron applied twice at a rate of 1 gallon per acre at each application, 05/25/2010, 06/16/2010.<br>(3) Thoro-Gro applied once at the rate of 0.1 gallon per acre, 06/09/2010.<br>(4) Thoro-Gro applied twice at the rate of 0.1 gallon per acre at each application 06/09/2010, 06/21/2010.<br>(5) a check plot |
| Planting Date: | August 26, 2009 |
| Planting Rate: | 20 lb/acre |
| Plot Design: | Complete randomized block with four replications |
| Plot Size: | Six 8-inch rows, 16 ft long |
| Harvest Date: | Four cutting dates: |

| Operation | Procedure |
|---|---|
| | 06/04/2010, 07/14/2010, 08/24/2010, 10/14/2010. |
| Fertilization: | Dry fertilizer applied on March 23, 2010 at 200 lb of 5-26-30 e.g. N 10 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre |
| Herbicide: | Raptor applied at 0.4 pints/acre on March 17, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Solid set pipe, watered as needed; generally 2 hours 3 times per week; 52.8 inches applied including precipitation |
| Results and Discussion: | Yield and other characteristics are presented in Table 33. |

Dry fertilizer was applied pre-plant on March 23, 2010 at the rate of N 10 lb/acre, $P_2O_5$ 52 lb/acre and $K_2O$ 60 lb/acre.

The plot area was chemically treated with the herbicide Raptor at a rate of 0.4 pints per acre on March 17, 2010 using a tractor mounted spray rig.

During the 2010 growing season, there were four cutting dates; June 4, July 14, August 24, and October 14, 2010. The plots were cut with an Almaco forage harvester equipped with an electronic scale to weigh the green weight of each plot as it was cut. At cutting, samples were taken from each plot to determine dry matter percent

**Results and discussion**

A delay in delivery of the Thoro-Gro resulted in only the Penetron being applied before the first cut. Mean yield of the five treatments of this trial was a total of 6.03 ton/acre for cuts 2, 3, & 4. The Penetron split application treatment had the top yield of 6.34 ton/acre and was an increase of 0.39 tons over the untreated entry which ranked fourth in yield at 5.95 ton/acre for cuts 2, 3, & 4. There were no significant differences in yield at the 95% probability level between the five treatments (Table 33). All treatments except the Thoro-Gro split application yielded higher than the check entry for cuts 2, 3, & 4. The Thoro-Gro split application was 0.14 ton/acre less than the check entry for cuts 2, 3, & 4 at 5.81 ton/acre.

**Table 33. Forage yield of the Penatron and Thoro-Gro Alfalfa Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Treatment | # Appli-cations | Total Product Applied | Yield dry ton/acre Cut-1 | Cut 2 | Cut-3 | Cut-4 | Total 4 cuts | Total Cuts2-3-4 |
|---|---|---|---|---|---|---|---|---|
| Penatron | 2 | 2 gal/a | 2.54* | 3.06 | 1.94 | 1.34 | 8.87 | 6.34 |
| Thorogro | 1 | 0.1 gal/a | 2.64 | 2.92 | 1.93 | 1.26 | 8.75 | 6.11 |
| Penatron | 1 | 1 gal/a | 2.50* | 2.85 | 1.94 | 1.16 | 8.45 | 5.95 |
| Check | 0 | 0 | 2.55 | 2.72 | 1.92 | 1.31 | 8.50 | 5.95 |
| Thorogro | 2 | 0.2 gal/a | 2.72 | 2.73 | 1.91 | 1.17 | 8.53 | 5.81 |
| **Mean** | | | **2.59** | **2.86** | **1.93** | **1.25** | **8.62** | **6.03** |
| LSD (0.05) | | | 0.44 | 0.32 | 0.38 | 0.19 | 0.60 | 1.66 |
| CV (%) | | | 11.00 | 7.20 | 12.80 | 10.10 | 4.50 | 15.70 |
| P Value | | | 0.81 | 0.18 | 1.00 | 0.22 | 0.51 | 0.24 |
| Significance | | | ns | ns | ns | ns | ns | ns |

* Only Penetron was applied to alfalfa plots for the first cut due to a delay in delivery of the Thoro-Gro

## Canola – 2010 Winter Canola Variety Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Margaret M. West**

### Abstract

The Winter Canola Variety Trial is a testing program to help determine which entries will perform best in the area they are tested. Canola is a potential oil seed crop for Northwestern New Mexico. The trial was compiled by Kansas State University and grown at various locations in the U.S. The trial consisted of 42 entries of canola from public and private sources. The trial was planted September 3, 2009 and harvested July 29, 2010 (Table 34). Mean yield of this trial was 2,988.7 lb/acre. The highest yielding entry, at 4,458.5 lb/acre was Sitro. The lowest yielding entry at 1,669.9 lb/acre was ARC00024-2. There were no significant differences in yield between the top yielding variety and the next five varieties. The moisture content averaged 7.9 % for the 42 entries. The average test weight was 39.3 lb/bu. The average plant height was 42.7 inches. The entry KS3254 had the tallest height of 46.7 inches. The shortest entry was DKW41-10 at 32.7 inches (Table 35). The mean 50 % flowering date was April 27.

### Introduction

The Winter Canola Variety Trial is a testing program to help determine which entries will perform best in the area they are tested. The trial was compiled at Kansas State University and grown at various locations in the U.S.

### Objectives

- Test winter canola varieties and hybrids on grain yield and yield components.
- Relate winter canola productivity at the Agricultural Science Center at Farmington with productivity at other sites that grow winter canola.

### Materials and methods

The Winter Canola Variety Trial was planted at the Agriculture Science Center at Farmington, on September 3, 2009 (Table 34). The trial consisted of 42 entries of winter canola from public and private sources. The trial at Farmington was established in a randomized block design with three replications. Individual plots were six 10-in rows by 20 ft long. Planting rate was 5 lb/acre. The planter used was a Kincaid 6-row cone seeder equipped with discs that closed the seed trench directly after the seeds were dropped in the small furrow opening.

**Table 34. Procedures for the Winter Canola Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2009-2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Forty-two |
| Planting Date: | September 3, 2009 |
| Planting Rate: | 5 lb/acre |
| Plot Design: | Randomized block with three replications |
| Plot Size: | Six 10-in rows, 20 ft long |
| Harvest Date: | July 29, 2010 |
| Fertilization: | N 115 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre |
| Herbicide: | None, hand weeded |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Center pivot, watered as needed from September 4 through October 20, 2009; and April 16 through July 11, 2010. 26 inches irrigation water applied and 5.1 inches of precipitation for a total of 31.1 inches total water |
| Results and Discussion: | Yield and other characteristics are presented in Table 35 |

Dry fertilizer was applied prior to planting and land preparation on August 28, 2009 at the rate of N 10 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre. During the growing season, 105 lb/acre of liquid nitrogen fertilizer was applied through the irrigation water for a seasonal total N 115 lb/acre (including the dry fertilizer).

The plot area was not treated with any herbicide. Hand weeding was done in March to control mustard.

This trial was grown under a center pivot irrigation system and was watered from September 4 through October 20, 2009; and April 16 through July 11, 2010. Twenty-six inches irrigation water was applied and 5.1 inches of precipitation fell from September 2009 through June 2010 for a total of 31.1 inches total water.

Plots were harvested on July 29, 2010 using a John Deere 3300 combine equipped with a special gathering box and weigh scale. Samples were taken for yield, moisture content and bushel weight.

### Results and discussion

The plot area was not treated with any herbicide. Hand weeding was done in March to control mustard.

Yield results and other data collected in this trial are presented in Table 35. Yields of all entries were adjusted to a uniform 10% moisture content.

Mean yield of this trial was 2,988.7 lb/acre (Table 35). The highest yielding entry, at 4,458.5 lb/acre, was Sitro. The lowest yielding entry at 1,669.9 lb/acre, was ARC00024-2. There were no significant differences in yield between the top yielding variety and the next five varieties. The moisture content averaged 7.9 % for the 42 entries. The average test weight was 39.3 lb/bu. The average plant height was 42.7 inches (Table 35). KS3254 had the tallest height of 46.7 inches. The shortest entry was DKW41-10 at 32.7 inches (Table 35). The mean 50 % flowering date was April 27.

**Table 35. Yield and other characteristics for the Winter Canola Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2009-2010.**

| Variety or Selection | Yield (lb/acre) | Moisture Content (%) | Test Weight (lb/bu) | Plant Height (in) | 50 % Flower (date) | Fall Plant Stand (%) | Winter Kill (%) |
|---|---|---|---|---|---|---|---|
| Sitro | 4,458.5 | 6.0 | 44.4 | 43.3 | 27-Apr | 97.0 | 0.0 |
| Safran | 4,118.2 | 9.3 | 39.2 | 44.7 | 28-Apr | 95.3 | 0.0 |
| Hybrisurf | 3,861.9 | 10.7 | 38.8 | 42.7 | 27-Apr | 97.0 | 0.0 |
| KS4475 | 3,856.6 | 6.7 | 45.8 | 42.3 | 30-Apr | 97.0 | 0.0 |
| KS4158 | 3,569.7 | 6.8 | 41.0 | 43.3 | 27-Apr | 97.0 | 0.0 |
| KS3254 | 3,558.8 | 7.4 | 43.2 | 46.7 | 30-Apr | 97.0 | 0.0 |
| BSX-7019 | 3,513.1 | 8.0 | 42.0 | 44.7 | 30-Apr | 97.0 | 0.0 |
| Visby | 3,439.2 | 6.5 | 43.1 | 45.0 | 26-Apr | 96.0 | 0.0 |
| Dynastie | 3,429.6 | 6.5 | 40.1 | 42.3 | 26-Apr | 97.0 | 0.0 |
| MH06E10 | 3,428.9 | 10.4 | 41.2 | 42.0 | 27-Apr | 96.3 | 0.0 |
| CHHE96 | 3,420.8 | 9.2 | 38.6 | 44.3 | 27-Apr | 98.0 | 0.0 |
| Virginia | 3,407.8 | 8.7 | 38.3 | 41.3 | 27-Apr | 96.3 | 0.0 |
| Flash | 3,190.6 | 9.3 | 37.4 | 44.0 | 27-Apr | 97.0 | 0.0 |
| Kadore | 3,181.1 | 8.3 | 39.7 | 43.0 | 30-Apr | 93.7 | 0.0 |
| AAMU-33-07 | 3,157.2 | 6.3 | 40.4 | 44.7 | 26-Apr | 95.3 | 0.0 |
| KS4426 | 3,119.2 | 6.2 | 41.5 | 42.0 | 28-Apr | 93.3 | 0.0 |
| Hybristar | 3,105.0 | 7.9 | 38.1 | 41.7 | 26-Apr | 93.7 | 0.0 |
| BSX-7127 | 3,085.3 | 6.9 | 41.3 | 43.3 | 30-Apr | 96.0 | 0.0 |
| MH905492 | 3,064.6 | 8.6 | 37.5 | 39.7 | 27-Apr | 96.3 | 0.0 |
| BSX-501 | 3,055.3 | 8.3 | 37.7 | 45.7 | 30-Apr | 98.0 | 0.0 |
| MH06E11 | 3,028.4 | 7.5 | 40.0 | 41.3 | 27-Apr | 97.0 | 0.0 |
| KS3132 | 2,957.7 | 7.0 | 40.0 | 41.0 | 28-Apr | 97.0 | 0.0 |
| ARC00005-2 | 2,956.2 | 8.3 | 41.0 | 41.7 | 30-Apr | 94.3 | 0.0 |
| BSX-7341 | 2,937.4 | 6.7 | 39.3 | 45.7 | 27-Apr | 96.0 | 0.0 |
| DKW47-15 | 2,867.9 | 9.6 | 36.1 | 41.7 | 27-Apr | 95.3 | 0.0 |
| BSX-6271 | 2,863.4 | 7.2 | 38.6 | 43.7 | 27-Apr | 98.0 | 0.0 |
| MH06E4 | 2,827.1 | 12.0 | 36.0 | 44.7 | 27-Apr | 94.3 | 0.0 |
| Dimension | 2,799.8 | 6.8 | 40.6 | 42.7 | 26-Apr | 96.0 | 0.0 |
| Kiowa | 2,764.0 | 6.4 | 41.2 | 44.7 | 28-Apr | 98.0 | 0.0 |
| ARC2189-2 | 2,627.7 | 8.0 | 39.2 | 46.3 | 30-Apr | 96.0 | 0.0 |
| HyClass154W | 2,581.4 | 9.4 | 35.4 | 41.3 | 27-Apr | 97.0 | 0.0 |

| Variety or Selection | Yield (lb/acre) | Moisture Content (%) | Test Weight (lb/bu) | Plant Height (in) | 50 % Flower (date) | Fall Plant Stand (%) | Winter Kill (%) |
|---|---|---|---|---|---|---|---|
| BSX-7228 | 2,573.6 | 9.2 | 33.6 | 42.0 | 26-Apr | 98.0 | 0.0 |
| Wichita | 2,541.4 | 7.0 | 37.9 | 40.0 | 28-Apr | 98.0 | 0.0 |
| Baldur | 2,492.7 | 9.8 | 38.4 | 45.0 | 26-Apr | 96.0 | 0.0 |
| Sumner | 2,469.3 | 6.7 | 38.2 | 40.0 | 26-Apr | 96.3 | 0.0 |
| HyClass115W | 2,451.9 | 6.7 | 41.0 | 39.0 | 28-Apr | 97.0 | 0.0 |
| ARC99009-1 | 2,422.9 | 7.9 | 37.3 | 44.0 | 28-Apr | 96.0 | 0.0 |
| DKW46-15 | 2,351.1 | 6.7 | 40.6 | 43.0 | 28-Apr | 96.0 | 0.0 |
| HyClass110W | 2,252.9 | 7.4 | 36.7 | 39.3 | 27-Apr | 93.7 | 0.0 |
| AAMU-18-07 | 2,131.8 | 6.2 | 36.5 | 41.3 | 18-Apr | 96.0 | 0.0 |
| DKW41-10 | 1,935.2 | 11.2 | 36.2 | 32.7 | 26-Apr | 97.0 | 0.0 |
| ARC00024-2 | 1,669.9 | 8.1 | 37.0 | 46.0 | 10-May | 98.0 | 0.0 |
| **Mean** | **2,988.7** | **7.9** | **39.3** | **42.7** | **27-Apr** | **96.3** | **0.0** |
| LSD .05 | 936.1 | 4.8 | 6.8 | 5.9 | 2.7 | 3.2 | |
| CV % | 19.2 | 36.9 | 10.6 | 8.5 | 0.0 | 2.0 | |
| P | <.0001 | 0.8102 | 0.3777 | 0.0821 | <.001 | 0.1725 | |
| significant | *** | ns | ns | ns | *** | ns | |

Yields adjusted to 10 % moisture

# Corn – Early Season Corn Hybrid and Variety Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Margaret M. West**

## Abstract

The Early Season Corn Hybrid and Variety Trial is part of a statewide entry fee program. Seed companies wishing to test their hybrids pay an entry fee to help with the cost of running the test. Hybrids in this test should be in the maturity range of less than 107 days. Eight hybrids of early season corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 and harvested December 1, 2010. Mean yield of this trial was 253.05 bu/acre. The highest yielding entry, at 281.17 bu/acre was the hybrid PO751HR from Pioneer Hi-Bred International. The top yielding entry was not significantly different from the next two highest entries at the 95% probability level. The lowest yielding hybrid, at 236.12 bu/acre was Dekalb DKC50-35(VT3) from Monsanto. The test weights averaged 58.3 lb/bu (Table 37).

## Introduction

The Early Season Corn Hybrid and Variety Trial is part of a statewide entry fee program. Seed companies wishing to test their hybrids pay an entry fee to help with the cost of running the test. Hybrids in this test should be in the maturity range of less than 107 days.

## Objectives

- Test early season corn varieties and hybrids with a maturation period of less than 107 days for grain yield and yield components.

- Relate early season corn productivity at the Agricultural Science Center at Farmington with productivity at other sites within New Mexico.

## Materials and methods

Eight hybrids of early season corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 (Table 36). Plots were planted using cone seeders that fit on John Deere 71 flex planters. Individual plots were four 34-inch rows by 20 feet long. Planting rate was approximately 35,000 seeds/acre and all hybrids were planted at the same rate.

**Table 36. Procedures for the Early Season Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Eight |
| Planting Date: | May 12, 2010 |
| Planting Rate: | 35,000 seeds per acre (46 seeds per 20 ft row) |
| Plot Design: | Randomized block with four replications |
| Plot Size: | Four 34-in rows by 20 ft long |
| Harvest Date: | December 1, 2010 |
| Fertilization: | N 240 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre, |
| Herbicide: | 1.2 qt/acre of Guardsman Max & 2 oz Clarity applied on May 20, 2010; 1 qt/acre Prowl $H_2O$ & 5 oz/acre Status applied on June 9, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Center pivot, watered as needed from May 14 through September 27, 2010; Irrigation water applied: 30.6 inches Total water received including precipitation: 34.8 inches. |
| Results and Discussion: | Yield and other characteristics are presented in Table 37. |

Dry fertilizer was applied prior to planting on March 23, 2010 at the rate of N 10 lb, $P_2O_5$ 52 lb and $K_2O$ 60 lb. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 230 lb/acre. Total nitrogen received was 240 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.2 qt/acre) and 2 oz Clarity to prevent weed infestation. The active ingredients of Guardsman Max are dimethenamid-P (0.5 lb ai/acre) and Atrazine (1 lb ai/acre). The active ingredient of Clarity is Dicamba (0.06 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 8 days after planting on May 20, 2010. Irrigation water was applied immediately after planting and also after the herbicide application. The plot area was also chemically treated with the herbicide Status (5 oz/acre) and Prowl $H_2O$ (1 qt/acre) to prevent weed infestation. The active ingredients of Status are diflufenzopyr(0.04 lb ai/acre) and dicamba(0.09 lb ai/acre). The active ingredient of Prowl $H_2O$ is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 9, 2010. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 14 through September 27, 2010. During the growing season, 34.8 inches of irrigation water and precipitation was received.

The plots were harvested December 1, 2010 using a small John Deere 3300 combine equipped with a special gathering box and weighing scale. Samples were taken from the center two rows of the plot for yield, moisture content, and bushel weight, number of plants per acre, plant height, and ear height. Data was taken from four replications.

The previous crop grown on this plot was sunflower that was harvested in October, 2009.

**Results and discussion**

Yield results and other data collected from this trial are presented in Table 37. Yields of all hybrids were adjusted to a uniform 15.5% moisture content and a 56 lb/bu. The 15.5% moisture content is the level that corn can be stored to eliminate danger of spoilage and spontaneous combustion

Mean yield of this trial (Table 37) was 253.05 bu/acre. The highest yielding entry, at 281.17 bu/acre, was the hybrid PO751HR from Pioneer Hi-Bred International. The top yielding entry was not significantly different from the next two highest entries at the 95% probability level. The lowest yielding hybrid, at 236.12 bu/acre was Dekalb DKC50-35(VT3) from Monsanto. The test weights averaged 58.3 lb/bu (Table 37).

Stand counts at the end of the growing season averaged 32,957 plants/acre (Table 37). The plant heights averaged 116 inches (9.67 feet) and ranged from 108 to 123 inches. The moisture content of the grain at harvest averaged 13.1 % and ranged from 12.1 % to 13.8 % (Table 37).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl $H_2O$ application was very good with very few weeds present at the end of the growing season. No hand weeding was needed.

**Table 37. Grain yield and other attributes of the Early Season Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Hybrid or Selection | Source | Grain Yield (bu/acre) | Test Weight (lb/bu) | Moisture Content (%) | Plant Height (in) | Ear Height (in) | Days to Silk (# days) | Lodge (%) | Plant Pop. (#/acre) | Relative Maturity (Days) |
|---|---|---|---|---|---|---|---|---|---|---|
| PO751HR | Pioneer | 281.17 | 57.6 | 13.2 | 119 | 53 | 83 | 0 | 32,100 | 107 |
| 36V75 | Pioneer | 267.32 | 56.6 | 13.3 | 116 | 49 | 81 | 0 | 32,723 | 102 |
| 1023S | Triumph | 263.56 | 57.8 | 13.8 | 122 | 56 | 83 | 0 | 33,035 | 109 |
| PO541HR | Pioneer | 248.85 | 59.2 | 13.6 | 123 | 53 | 84 | 0 | 33,554 | 105 |
| 3212X | Triumph | 244.53 | 58.8 | 13.7 | 115 | 53 | 79 | 0 | 30,230 | 103 |
| DEKALB DKC50-66 | Monsanto | 243.87 | 59.4 | 12.5 | 113 | 50 | 74 | 0 | 35,424 | 100 |
| DEKALB DKC52-59 (VT3) | Monsanto | 238.96 | 57.7 | 12.1 | 111 | 52 | 80 | 0 | 32,827 | 102 |
| DEKALB DKC50-35 (VT3) | Monsanto | 236.12 | 59.2 | 12.9 | 108 | 43 | 75 | 0 | 33,762 | 100 |

| Hybrid or Selection | Source | Grain Yield (bu/acre) | Test Weight (lb/bu) | Moisture Content (%) | Plant Height (in) | Ear Height (in) | Days to Silk (# days) | Lodge (%) | Plant Pop. (#/acre) | Relative Maturity (Days) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | | **253.05** | **58.3** | **13.1** | **116** | **51** | **80** | **0** | **32,957** | **103.5** |
| LSD (0.05) | | 26.31 | 0.73 | 0.58 | 4.58 | 4.89 | 1.61 | | 2210.00 | |
| CV (%) | | 7.07 | 0.85 | 3.00 | 2.69 | 6.54 | 1.37 | | 4.56 | |
| P Value | | 0.0194 | <.0001 | <0.0001 | <.0001 | 0.0008 | <0.0001 | | 0.0073 | |
| significant | | * | *** | *** | *** | *** | *** | | ** | |

Yields adjusted to 15.5% moisture and 56 lb/bu.

## Corn – Full Season Corn Hybrid and Variety Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Margaret M. West**

### Abstract

The Full Season Corn Hybrid and Variety Trial is part of a statewide entry fee program in which seed companies wishing to test their hybrids pay an entry fee, to help with the cost of running the test. Hybrids in this test should be in the maturity range of greater than 107 days. Three hybrids of full season corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 and harvested December 1, 2010 (Table 38). Mean yield of this trial was 258.78 bu/acre. The highest yielding entry at 269.87 bu/acre was hybrid Dekalb DKC54-16(VT3) from Monsanto. There were no significant differences in yield at the 95% probability level between the three entries. The lowest yielding hybrid at 247.06 bu/acre was Dekalb DKC55-24(VT3) from Monsanto. The test weights averaged 59.2 lb/bu and ranged from a low of 58.8 lb/bu to a high of 59.4 lb/bu (Table 39). Plant populations at the end of the growing season averaged 32,616 plant/acre (Table 39). The plant heights averaged 108.8 inches (9.1 feet) and ranged from 105.8 to 111.0 inches (Table 39). The moisture content of the grain at harvest averaged 13.2 % and ranged from 12.7 % to 13.6 % (Table 39)

The weed control from the Guardsman Max and Clarity along with the Status and Prowl $H_2O$ application was very good with very few weeds present at the end of the growing season. No hand weeding was needed.

### Introduction

The Full Season Corn Hybrid and Variety Trial is part of a statewide entry fee program in which seed companies wishing to test their hybrids pay an entry fee to help with the cost of running the test. Hybrids in this test should be in the maturity range of greater than 107 days.

### Objectives

- Test full season corn varieties and hybrids with a maturation period greater than 107 days for grain yield and yield components.
- Relate full season corn productivity at the Agricultural Science Center at Farmington with productivity at other sites within New Mexico.

### Materials and methods

Three hybrids of full season corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 (Table 38). Plots were planted using cone seeders that fit on John Deere 71 flex planters. Individual plots were four 34-in rows by 20 ft long. Planting rate was approximately 35,000 seeds/acre and all hybrids were planted at the same rate.

**Table 38. Procedures for the Full Season Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Three |
| Planting Date: | May 12, 2010 |
| Planting Rate: | 35,000 seeds/acre (46 seeds/20 ft row) |
| Plot Design: | Randomized block with three replications |
| Plot Size: | Four 34-in rows by 20 ft long |
| Harvest Date: | December 1, 2010 |
| Fertilization: | N 240 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre, |
| Herbicide: | 1.2 qt/acre of Guardsman Max & 2 oz Clarity applied on May 20, 2010; 1 qt/acre Prowl $H_2O$ & 5 oz/acre Status applied on June 9, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Center pivot, watered as needed from May 14 through September 27, 2010; Irrigation water applied: 30.6 inches Total water received including precipitation: 34.8 inches. |
| Results and Discussion: | Yield and other characteristics are presented in Table 39. |

Dry fertilizer was applied prior to planting on March 23, 2010 at the rate of N 10 lb, $P_2O_5$ 52 lb and $K_2O$ 60 lb. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 230 lb/acre. Total nitrogen received was 240 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.2 qt/acre) and 2 oz Clarity to prevent weed infestation. The active ingredients of Guardsman Max are dimethenamid-P (0.5 lb ai/acre) and Atrazine (1 lb ai/acre). The active ingredient of Clarity is Dicamba (0.06 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 8 days after planting on May 20, 2010. Irrigation water was applied immediately after planting and also after the herbicide application. The plot area was also chemically treated with the herbicide Status (5 oz/acre) and Prowl $H_2O$ (1 qt/acre) to prevent weed infestation. The active ingredients of Status are diflufenzopyr (0.04 lb ai/acre) and dicamba(0.09 lb ai/acre). The active ingredient of Prowl $H_2O$ is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 9, 2010. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 14 through September 27, 2010. During the growing season, 34.8 inches of irrigation water and precipitation was received.

The plots were harvested December 1, 2010 using a small John Deere 3300 combine equipped with a special gathering box and weighing scale. Samples were taken from the center two rows of the plot for yield, moisture content, and bushel weight, number of plants per acre, plant height, and ear height. Data was taken from four replications.

The previous crop grown on this plot was sunflower that was harvested in October, 2009.

**Results and discussion**

Yield results and other data collected from this trial are presented in Table 39. Yields of all hybrids were adjusted to a uniform 15.5% moisture content and a 56 lb/bu. The 15.5% moisture content is the level that corn can be stored to eliminate danger of spoilage and spontaneous combustion

Mean yield of this trial was 258.78 bu/acre. The highest yielding entry at 269.87 bu/acre was hybrid Dekalb DKC54-16(VT3) from Monsanto. There were no significant differences in yield at the 95% probability level between the three entries. The lowest yielding hybrid at 247.06 bu/acre was Dekalb DKC55-24(VT3) from Monsanto. The test weights, averaged 59.2 lb/bu and ranged from a low of 58.8 lb/bu to a high of 59.4 lb/bu (Table 39). Plant populations at the end of the growing season averaged 32,616 plant/acre. The plant heights averaged 108.8 inches (9.1 feet) and ranged from 105.8 to 111.0 inches. The moisture content of the grain at harvest averaged 13.2 % and ranged from 12.7 % to 13.6 % (Table 39).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl $H_2O$ application was very good with very few weeds present at the end of the growing season. No hand weeding was needed.

**Table 39. Grain yield and other attributes of the Full Season Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Hybrid or Selection | Source | Grain Yield (bu/acre) | Test Weight (lb/bu) | Moisture Content (%) | Plant Height (in) | Ear Height (in) | Days to Silk (# days) | Lodge (%) | Plant Pop. (#/acre) | Relative Maturity (Days) |
|---|---|---|---|---|---|---|---|---|---|---|
| DEKALB DKC54-16 (VT3) | Monsanto | 269.87 | 59.4 | 13.3 | 109.5 | 48.0 | 77 | 0 | 33,655 | 104 |
| DEKALB DKC59-88 (VT3) | Monsanto | 259.42 | 58.8 | 13.6 | 111.0 | 45.8 | 82 | 0 | 30,954 | 109 |
| DEKALB DKC55-24 (VT3) | Monsanto | 247.06 | 59.3 | 12.7 | 105.8 | 48.8 | 83 | 0 | 33,239 | 105 |
| **Mean** | | **258.78** | **59.2** | **13.2** | **108.8** | **47.5** | **80** | **0** | **32,616** | **106** |
| LSD (0.05) | | 40.92 | 1.0 | 0.7 | 2.6 | 4.5 | 1 | | 3,970 | |
| CV (%) | | 9.1 | 0.9 | 2.9 | 1.4 | 5.5 | 0.5 | | 7.0 | |
| P Value | | 0.4444 | 0.3775 | 0.0300 | 0.0066 | 0.3075 | <0.0001 | | 0.2767 | |
| significant | | ns | ns | * | ** | ns | *** | | ns | |

## Corn – Forage Corn Hybrid and Variety Trial

**Mick O'Neil, Curtis Owen, Ken Kohler, and Margaret M. West**

### Abstract

The Forage Corn Hybrid and Variety Trial is part of a statewide entry fee program in which seed companies wishing to test their hybrids pay an entry fee to help with the cost of running the test. Three hybrids of forage corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 and harvested September 20, 2010 (Table 40). The highest yielding entry during the 2010 growing season was Dekalb DKC59-35 (VT3) from Monsanto with a total yield of 13.74 dry ton/acre. The lowest yielding entries in the 2010 growing season was Dekalb DKC52-59 (VT3) from Monsanto with a total yield of 12.93 dry ton/acre. The mean yield of all 3 entries in the 2010 growing season was 13.46 dry ton/acre (Table 41). The mean moisture content at harvest was 53.6% wet weight. The mean plant height was 110 inches. The mean days to 50% silk was 79 days. The mean plants/acre was 32,708 (Table 41). Dekalb DKC59-35 (VT3) from Monsanto had the highest production of milk per acre with 40,841 lb milk/acre. The mean of all 3 entries of milk production per acre was 39,686 lb milk/acre (Table 42).

### Introduction

The Forage Corn Hybrid and Variety Trial is part of a statewide entry fee program in which seed companies wishing to test their hybrids pay an entry fee to help with the cost of running the test.

### Objectives

- Test forage corn varieties and hybrids for forage yield and yield components.
- Relate forage corn productivity at the Agricultural Science Center at Farmington with productivity at other sites within New Mexico.

### Materials and methods

Three hybrids of forage corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 (Table 40). Plots were planted using cone seeders that fit on John Deere 71 flex planters. Individual plots were four 34 in rows by 20 ft long. Planting rate was approximately 35,000 seeds/acre and all hybrids were planted at the same rate.

**Table 40. Procedures for the Forage Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Three |
| Planting Date: | May 12, 2010 |
| Planting Rate: | 35,000 seeds/acre (46 seeds/20 ft row) |
| Plot Design: | Randomized block with four replications |
| Plot Size: | Four 34 in rows by 20 ft long |
| Harvest Date: | September 20, 2010 |
| Fertilization: | N 240 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre, |
| Herbicide: | 1.2 qt/acre of Guardsman Max & 2 oz Clarity applied on May 20, 2010; 1 qt/acre Prowl $H_2O$ & 5 oz/acre Status applied on June 9, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Center pivot, watered as needed from May 14 through September 27, 2010; Irrigation water applied: 30.6 inches Total water received including precipitation: 34.8 inches. |
| Results and Discussion: | Yield and other characteristics are presented in Table 41. |

Dry fertilizer was applied prior to planting on March 23, 2010 at the rate of N 10 lb, $P_2O_5$ 52 lb and $K_2O$ 60 lb. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 230 lb/acre. Total nitrogen received was 240 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.2 qt/acre) and 2 oz Clarity to prevent weed infestation. The active ingredients of Guardsman Max are dimetnenamid-P (0.5 lb ai/acre) and Atrazine (1 lb ai/acre). The active ingredient of Clarity is Dicamba (0.06 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 8 days after planting on May 20, 2010. Irrigation water was applied immediately after planting and also after the herbicide application. The plot area was also chemically treated with the herbicide Status (5 oz/acre) and Prowl $H_2O$ (1 qt/acre) to prevent weed infestation. The active ingredients of Status are diflufenzopyr(0.04 lb ai/acre) and dicamba(0.09 lb ai/acre). The active ingredient of Prowl $H_2O$ is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 9, 2010. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 14 through September 16, 2010. During the growing season, 29.6 inches of irrigation water and precipitation was received.

The plots were harvested for forage September 20, 2010 via hand harvesting 10 feet of 1 row within the plot by cutting the plants with a machete. The plants were counted and weighed and a single plant was run through a shredder and sacked to determine moisture content. This was accomplished by weighing each sample before and after oven drying. The samples were then sent to The University of Wisconsin Laboratory for chemical analysis.

The previous crop grown on this plot was sunflower that was harvested in October, 2009.

**Results and discussion**

Yield results and other data collected in this trial are presented in Table 41. Chemical analysis data for forage quality is presented in Table 42.

The highest yielding entry during the 2010 growing season was Dekalb DKC59-35 (VT3) from Monsanto with a total yield of 13.74 dry ton/acre. The lowest yielding entries in the 2010 growing season was Dekalb DKC52-59 (VT3) from Monsanto with a total yield of 12.93 dry ton/acre. The mean yield of all 3 entries in the 2010 growing season was 13.46 dry ton/acre (Table 41). The mean moisture content at harvest was 53.6% wet weight. The mean plant height was 110 inches. The mean days to 50% silk was 79 days. The mean plants/acre was 32,708 (Table 41). Dekalb DKC59-35 (VT3) from Monsanto had the highest production of milk per acre with 40,841 lb milk/acre. The mean of all 3 entries of milk production per acre was 39,686 lb milk/acre (Table 42).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl $H_2O$ application was very good with very few weeds present at the end of the growing season. No hand weeding was needed.

**Table 41. Forage yield (dry and green) and other attributes of the Forage Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Hybrid or Selection | Source | Forage Dry (ton/acre) | Forage Wet (ton/acre) | Wet Weight (%) | Plant Pop. (plants/acre) | Plant Height (in) | Ear Height (in) | Silk Date # days | Relative Maturity #days |
|---|---|---|---|---|---|---|---|---|---|
| DEKALB DKC59-35 (VT3) | Monsanto | 13.74 | 31.56 | 56.3 | 30,784 | 115.5 | 50.3 | 83 | 109 |
| DEKALB DKC54-16 (VT3) | Monsanto | 13.72 | 28.05 | 51.1 | 33,478 | 110.3 | 48.8 | 76 | 104 |
| DEKALB DKC52-59 (VT3) | Monsanto | 12.93 | 27.82 | 53.4 | 33,863 | 104.3 | 46.5 | 80 | 102 |
| **Mean** | | **13.46** | **29.15** | **53.6** | **32,708** | **110.0** | **48.5** | **79** | **105** |
| LSD (0.05) | | 2.8 | 6.6 | 4.9 | 9,796 | 7.9 | 7.4 | 3.5 | |
| CV (%) | | 12.1 | 13.1 | 5.3 | 17.3 | 4.1 | 8.8 | 2.5 | |
| P Value | | 0.7508 | 0.3545 | 0.1061 | 0.7174 | 0.0357 | 0.4996 | 0.0066 | |
| significant | | ns | ns | ns | ns | * | ns | ** | |

**Table 42. Chemical analysis for forage quality done at the University of Wisconsin on the Forage Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Hybrid or Selection | Source | Forage Dry (ton/acre) | CP (%) | NDF (%) | NDFD 48hr (%) | Starch (%) | Ash (%) | Fat DM (%) | Milk/ ton (lb/ton) | Milk/ acre (lb/acre) |
|---|---|---|---|---|---|---|---|---|---|---|
| DEKALB DKC59-35 (VT3) | Monsanto | 13.74 | 7.9 | 37.1 | 62.4 | 35.7 | 4.1 | 2.5 | 2,971 | 40,841 |
| DEKALB DKC54-16 (VT3) | Monsanto | 13.72 | 7.2 | 33.8 | 61.7 | 40.9 | 3.8 | 2.8 | 2,961 | 40,503 |
| DEKALB DKC52-59 (VT3) | Monsanto | 12.93 | 7.3 | 34.3 | 59.8 | 40.5 | 3.7 | 2.7 | 2,911 | 37,714 |
| **Mean** | | **13.46** | **7.5** | **35.1** | **61.3** | **39.0** | **3.9** | **2.7** | **2,948** | **39,686** |
| LSD (0.05) | | 2.8 | 0.7 | 4.5 | 3.4 | 6.1 | 1.0 | 0.6 | 121 | 8,414 |
| CV (%) | | 12.1 | 5.5 | 7.4 | 3.2 | 9.1 | 14.4 | 11.8 | 2.4 | 12.3 |
| P Value | | 0.7508 | .088 | 0.231 | 0.241 | 0.1468 | 0.770 | 0.125 | 0.476 | 0.630 |
| significant | | ns | ns | ns | ns | ns | ns | ns | ns | ns |

# Corn – Penatron and Thoro-Gro Treated Corn Hybrid Trial

**Mick O'Neill, Curtis Owen, Ken Kohler, and Wes Richens**

## Abstract

The Penatron and Thoro-Gro treated Corn Hybrid Trial is a collaborated effort between New Mexico State University Agriculture Science Center at Farmington and S.C.A.L.E. Ag Services represented by Wes Richens. The purpose of the experiment was to see how Penatron and Thoro-Gro applied at different rates on the soil and crop would affect corn yield compared with a check entry of the same hybrid. Penatron and Thoro-Gro are both natural crop enhancers that when applied to the soil and/or crop may increase production. Penatron, a product from Maz-Zee S.A. International, is an organic liquid soil conditioner. Thoro-Gro, a product from S.C.A.L.E. Ag Services, is ~~a~~ spore based (Dormant Live Liquid Bio-Stimulant) made from a fermented bio mass and other natural accruing growth enhancers".

Treatments of Penatron and Thoro-Gro were each applied to the corn plots with a 35 gallon tractor mounted spray rig. Each product was applied at a one and two (split) application schedule. Penatron was applied to the single application plots and to the split application plots, at a rate of one gallon per acre, on May 25, 2010. Thoro-Gro was applied to the single application plots and to the split application plots, at a rate of 0.1 gallon per acre, on June 9, 2010. Penatron was applied again to the split application plots, at a rate of one gallon per acre, on June 16, 2010. Thoro-Gro was applied again to the split application plots, at a rate of 0.1 gallon per acre, on June 22, 2010. Mean yield of the five treatments of this trial was 242.22 bu/acre (Table 44). The Penetron split application treatment was the top producer yielding 255.97 bu/acre and was an increase of 13.2 bushels over the untreated entry which ranked second in yield at 242.85 Bu/acre. There were no significant differences in yield at the 95% probability level between the five treatments. The test weights, averaged 57.6 lb/bu and the moisture content averaged 12.4 % Plant populations at the end of the growing season averaged 27,983 plants/acre. The plant heights averaged 104 inches and the ear heights averaged 45 inches (Table 44).

## Introduction

The Penatron and Thoro-Gro treated Corn Hybrid Trial is a collaborated effort between New Mexico State University Agriculture Science Center at Farmington and S.C.A.L.E. Ag Services represented by Wes Richens. The purpose of the experiment was to see how Penatron and Thoro-Gro applied at different rates on the soil and crop would affect corn yield compared with a check entry of the same hybrid. Penatron and Thoro-Gro are both natural crop enhancers that when applied to the soil and/or crop may increase production. Penatron, a product from Maz-Zee S.A. International, is an organic liquid soil conditioner. Thoro-Gro, a product from S.C.A.L.E. Ag Services, is ~~a~~ spore based (Dormant Live Liquid Bio-Stimulant) made from a fermented bio mass and other natural accruing growth enhancers".

## Objectives

- Compare Penatron and Thoro-Gro products applied at various rates to a single corn hybrid with a check of the same hybrid to determine any benefit in yield from the soil and crop treatments.

## Materials and methods

The corn hybrid Dekalb DKC52-59 (VT3) from Monsanto was planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 12, 2010 (Table 43). Plots were planted with a pair of John Deere 71 flex planters. Individual plots were four 34 in rows by 20 ft long. Planting rate was approximately 30,000 seeds/acre.

Treatments of Penatron and Thoro-Gro were each applied to the corn plots with a 35 gallon tractor mounted spray rig. Each product was applied at a one and two (split) application schedule. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on May 25, 2010. Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on June 9, 2010. Penatron was applied again to the split application plots at a rate of one gallon per acre on June 16, 2010. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 22, 2010.

**Table 43. Procedures for the Penatron and Thoro-Gro Treatment Corn Hybrid Trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Treatments: | Five;<br>(1) Penetron applied once at a rate of 1 gallon per acre, on 05/25/2010.<br>(2) Penetron applied twice at a rate of 1 gallon per acre at each application, on 06/16/2010.<br>(3) Thoro-Gro applied once at the rate of 0.1 gallon per acre, o 06/09/2010.<br>(4) Thoro-Gro applied twice at the rate of 0.1 gallon per acre at each application, 06/22/2010<br>(5) a check plot |
| Planting Date: | May 12, 2010 |
| Planting Rate: | 30,000 seeds/acre (46 seeds/20 ft row) |
| Plot Design: | Randomized block with four replications |
| Plot Size: | Four 34 in rows by 20 ft long |
| Harvest Date: | December 1, 2010 |
| Fertilization: | N 240 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre, |
| Herbicide: | 1.2 qt/acre of Guardsman Max & 2 oz Clarity applied on |

| Operation | Procedure |
|---|---|
| | May 20, 2010; 1 qt/acre Prowl $H_2O$ & 5 oz/acre Status applied on June 9, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Center pivot, watered as needed from May 14 through September 27, 2010; Irrigation water applied: 30.6 inches Total water received including precipitation: 34.8 inches. |
| Results and Discussion: | Yield and other characteristics are presented in Table 44. |

Dry fertilizer was applied prior to planting on March 23, 2010 at the rate of N 10 lb, $P_2O_5$ 52 lb and $K_2O$ 60 lb. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 230 lb/acre. Total nitrogen received was 240 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.2 qt/acre) and 2 oz Clarity to prevent weed infestation. The active ingredients of Guardsman Max are dimethenamid-P (0.5 lb ai/acre) and Atrazine (1 lb ai/acre). The active ingredient of Clarity is Dicamba (0.06 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 8 days after planting on May 20, 2010. Irrigation water was applied immediately after planting and also after the herbicide application. The plot area was also chemically treated with the herbicide Status (5 oz/acre) and Prowl $H_2O$ (1 qt/acre) to prevent weed infestation. The active ingredients of Status are diflufenzopyr(0.04 lb ai/acre) and dicamba (0.09 lb ai/acre). The active ingredient of Prowl $H_2O$ is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 9, 2010. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 14 through September 27, 2010. During the growing season, 34.8 inches of irrigation water and precipitation was received.

The plots were harvested December 1, 2010 using a small John Deere 3300 combine equipped with a special gathering box and weighing scale. Samples were taken from the center two rows of the plot for yield, moisture content, and bushel weight, number of plants per acre, plant height, and ear height. Data was taken from four replications.

The previous crop grown on this plot was sunflower that was harvested in October, 2009.

### Results and discussion

Mean yield of the five treatments of this trial was 242.22 bu/acre.The Penetron split application treatment was the top producer yielding 255.97 bu/acre and was an increase of 13.1 bushels over the untreated entry which ranked second in yield at 242.85 bu/acre. There were no significant differences in yield at the 95% probability level between the five treatments. The test weights, averaged 57.6 lb/bu and the moisture content averaged 12.4 % (Table 44). Plant populations at the end of the growing season averaged 27,983 plants/acre (Table 44). The plant heights averaged 104 inches and the ear heights averaged 45 inches (Table 44).

**Table 44. Grain yield and other attributes of the Penatron and Thoro-Gro Treated Corn Hybrid Trial; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Treatment | # Applica-tions | Total Product applied | Grain Yield (bu/acre) | Test Weight (lb/bu) | Moisture Content (%) | Plant Height (in) | Ear Height (in) | Days to Silk (# days) | Plant Pop. (#/acre) | Relative Maturity (Days) |
|---|---|---|---|---|---|---|---|---|---|---|
| Penetron | 2 | 2 gal/a | 255.97 | 57.9 | 12.3 | 104 | 46 | 77.5 | 28,877 | 102 |
| check | 0 | 0 | 242.85 | 57.5 | 12.5 | 102 | 43 | 78.5 | 27,942 | 102 |
| Thoro-Gro | 1 | 0.1 gal/a | 241.72 | 57.5 | 12.2 | 105 | 45 | 78.8 | 26,591 | 102 |
| Thoro-Gro | 2 | 0.2 gal/a | 238.57 | 57.9 | 12.4 | 106 | 47 | 77.8 | 29,500 | 102 |
| Penetron | 1 | 1 gal/a | 231.98 | 57.5 | 12.5 | 103 | 44 | 78.0 | 27,007 | 102 |
| **Mean** | | | **242.22** | **57.6** | **12.4** | **104** | **45** | **78.1** | **27,983** | **102** |
| LSD (0.05) | | | 26.41 | 0.4 | 0.4 | 4 | 6 | 1.3 | 2,177 | |
| CV (%) | | | 7.07 | 0.5 | 2.3 | 3 | 9 | 1.1 | 5 | |
| P Value | | | 0.4239 | 0.0948 | 0.4690 | 0.3145 | 0.7380 | 0.2393 | 0.0625 | |
| Significance | | | ns | ns | ns | ns | ns | ns | ns | |

# Winter Wheat – Southern Regional Winter Wheat Performance Nursery

**Mick O'Neill, Curtis Owen, Ken Kohler, and Margaret M. West**

## Abstract

The Southern Regional Performance Nursery is a winter wheat trial grown collaboratively in various southern and western states and the results compiled by the University of Nebraska at Lincoln and distributed to all cooperators growing this nursery. Forty-eight entries were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on September 15, 2009 and harvested August 10, 2010 (Table 45). Mean yield of this trial was 39.1 bu/acre (Table 46). The highest yielding entry at 59.6 bu/acre was a Colorado State University selection CO050337-2. The top yielding entry was not significantly different in yield from the next ten highest yielding entries at the 95% probability level. The lowest yielding entry at 17.7 bu/acre was T168, an entry from Trio. The tallest entry in this trial at 30.5 inches was Kharkof, a check variety. The shortest entry in height at 17.8 inches was HV9W04-1594R from Westbred Haven. The moisture content of all the entries ranged from 10.2 to 13.3%. Bushel weights ranged from 50.8 to 56.0 lb/bu (Table 46).

## Introduction

The Southern Regional Performance Nursery is a winter wheat trial grown collaboratively in various southern and western states and the results compiled by the University of Nebraska at Lincoln and distributed to all cooperators growing this nursery.

## Objectives

- Test winter wheat varieties and hybrids on grain yield and yield components.
- Relate winter wheat productivity at the Agricultural Science Center at Farmington with productivity at other sites in the country.

## Materials and methods

The Southern Regional Performance Nursery was planted at the Agriculture Science Center at Farmington on September 15, 2009 (Table 45). The nursery consisted of 48 winter wheat entries from university breeding programs in Colorado, Kansas, Oklahoma, Texas, Nebraska, and private seed companies. The trial at Farmington was established in a randomized block design with four replications. Individual plots were six 10-inch rows by 20 ft long. Planting rate was 100 lb/acre. The planter used was a Kincaid 6-row cone seeder equipped with discs that closed the seed trench directly after the seeds were dropped in the small furrow opening.

**Table 45. Procedures for the Southern Regional Winter Wheat Performance Nursery; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operation | Procedure |
|---|---|
| Number of Entries: | Forty-eight |
| Check Entries: | TAM-107, Scout 66, Kharkof, Fuller |
| Planting Date: | September 15, 2009 |
| Planting Rate: | 100 lb/acre |
| Plot Design: | Randomized block with four replications |
| Plot Size: | Six 10-in rows, 20 ft long |
| Harvest Date: | August 10, 2010 |
| Fertilization: | N 135 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre |
| Herbicide: | Lo Vol 6 Ester weed killer 0.5 pt/acre applied on April 8, 2010 |
| Insecticide: | None |
| Soil Type: | Doak fine sandy loam |
| Irrigation: | Center pivot, watered as needed, 25 in of irrigation water and 5.1 in of precipitation for total received water of 30.1 in. |
| Results and Discussion: | Yield and other characteristics are presented in Table 46. |

Dry fertilizer was applied prior to planting and land preparation at the rate of N 10 lb/acre, $P_2O_5$ 52 lb/acre, $K_2O$ 60 lb/acre on August 28, 2009. During the growing season, 125 lb of liquid nitrogen fertilizer was applied through the irrigation water for a seasonal total N 135 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Lo Vol 6 Ester weed killer at the rate of 0.5 pt/acre to help prevent weed infestation. The active ingredient of Lo Vol 6 Ester weed killer is 2,4-Dichlorophenoxyacetic acid (0.35 lb ai/acre. A pull behind sprayer was used to apply the herbicide post-emergence on April 8, 2010.

This trial was grown under a center pivot irrigation system and was watered from September 16 through October 20, 2009 and from April 16 through July 11, 2010. During the growing season, 25 inches of water was applied along with 5.1 inches of precipitation for a total amount of received water of 30.1 inches.

Plots were harvested on August 10, 2010 using a small John Deere 3300 combine equipped with a special gathering box and weigh scale. Samples were taken for yield, moisture content, bushel weight, and plant height.

**Results and discussion**

The weed control from the Lo Vol 6 Ester weed killer was poor. Some hand weeding was necessary.

Yield results and other data collected in this trial are presented in Table 46. Yields of all entries were adjusted to a uniform 14% moisture content and a 60-lb bushel.

Mean yield of this trial was 39.1 bu/acre (Table 46). The highest yielding entry at 59.6 bu/acre was a Colorado State University selection CO050337-2. The top yielding entry was not significantly different in yield from the next ten highest yielding entries at the 95% probability level. The lowest yielding entry at 17.7 bu/acre was T168, an entry from Trio. The tallest entry in this trial at 30.5 inches was Kharkof, a check variety. The shortest entry in height at 17.8 inches was HV9W04-1594R from Westbred Haven. The moisture content of all the entries ranged from 10.2 to 13.3% (Table 46). Bushel weights ranged from 50.8 to 56.0 lb/bu (Table 46).

**Table 46. Winter wheat grain yield and other characteristics of the Southern Regional Performance Nursery; NMSU Agriculture Science Center at Farmington, NM. 2010.**

| Variety or Selection | Source | Putative Market Class | Grain Yield (bu/acre) | Grain Yield (kg/ha) | Moisture Content (%) | Test Wt (lb/bu) | Plant Ht (in) | Heading Date (date) |
|---|---|---|---|---|---|---|---|---|
| CO050337-2 | CSU | HRW | 59.6 | 3,578.2 | 11.1 | 55.7 | 24.8 | 21-May |
| CO050303-2 | CSU | HRW | 56.2 | 3,372.7 | 11.4 | 55.1 | 24.0 | 21-May |
| KS06O3A~50-3 | KSU-Manhattan | HRW | 54.1 | 3,245.7 | 12.4 | 53.4 | 27.0 | 17-May |
| TX05A001822 | TAMU | HRW | 53.9 | 3,235.0 | 11.4 | 54.7 | 21.8 | 18-May |
| TX06A001386 | TAMU | HRW | 53.5 | 3,212.3 | 12.4 | 55.1 | 23.3 | 18-May |
| CO050322 | CSU | HRW | 52.3 | 3,135.1 | 11.6 | 54.7 | 24.0 | 21-May |
| OK05526 | OSU | HRW | 51.7 | 3,102.2 | 11.5 | 53.4 | 24.3 | 17-May |
| KS010990M~8 | KSU-Manhattan | HRW | 49.5 | 2,970.5 | 11.8 | 54.4 | 21.8 | 19-May |
| T167 | Trio | HRW | 49.5 | 2,969.2 | 12.1 | 53.1 | 20.8 | 18-May |
| BC01007-7 | AGRIPRO NORTH | HRW | 47.5 | 2,848.4 | 11.1 | 53.3 | 21.8 | 21-May |
| OK07209 | OSU | HRW | 47.3 | 2,839.6 | 12.7 | 54.5 | 22.0 | 21-May |
| KS011327M~2 | KSU-Manhattan | HRW | 45.5 | 2,732.0 | 10.9 | 54.4 | 23.8 | 13-May |
| OK07231 | OSU | HRW | 43.4 | 2,603.7 | 10.6 | 53.5 | 21.5 | 21-May |
| KS06O3A~58-2 | KSU-Manhattan | HRW | 42.8 | 2,570.0 | 13.0 | 52.8 | 26.0 | 19-May |
| OK05212 | OSU | HRW | 42.5 | 2,547.1 | 10.2 | 52.9 | 21.3 | 20-May |
| KS08HW176-4 | KSU-HAYS | HWW | 42.2 | 2,533.8 | 11.0 | 56.0 | 23.0 | 20-May |
| Kharkof | check | HRW | 42.1 | 2,526.4 | 11.5 | 53.7 | 30.5 | 24-May |
| NI08708 | UNL | HRW | 41.8 | 2,505.6 | 12.7 | 52.6 | 22.8 | 20-May |
| CO04499 | CSU | HRW | 40.9 | 2,452.5 | 11.5 | 54.6 | 21.0 | 17-May |
| CO050270 | CSU | HRW | 40.7 | 2,442.0 | 11.6 | 53.8 | 20.8 | 12-May |
| BC01131-24 | AGRIPRO NORTH | HRW | 40.4 | 2,425.7 | 12.2 | 53.1 | 20.5 | 21-May |
| TX05V7269 | TAMU | HRW | 39.6 | 2,373.4 | 11.2 | 54.0 | 24.3 | 20-May |
| OK05511 | OSU | HRW | 39.6 | 2,373.2 | 10.9 | 54.4 | 21.8 | 20-May |
| NI07703 | UNL | HRW | 39.1 | 2,344.3 | 11.3 | 52.8 | 21.0 | 18-May |
| OK05204 | OSU | HRW | 38.7 | 2,323.5 | 10.7 | 54.1 | 21.8 | 21-May |
| KS07HW52-5 | KSU-HAYS | HWW | 38.0 | 2,279.0 | 11.8 | 55.5 | 19.0 | 17-May |

| Variety or Selection | Source | Putative Market Class | Grain Yield (bu/acre) | Grain Yield (kg/ha) | Moisture Content (%) | Test Wt (lb/bu) | Plant Ht (in) | Heading Date (date) |
|---|---|---|---|---|---|---|---|---|
| Scout 66 | check | HRW | 37.1 | 2,226.9 | 11.8 | 53.9 | 25.3 | 15-May |
| 00X0100-51 | AGRIPRO NORTH | HRW | 37.0 | 2,219.4 | 10.9 | 53.6 | 21.5 | 18-May |
| CO04393 | CSU | HRW | 36.9 | 4,017.4 | 10.3 | 54.5 | 19.0 | 19-May |
| NE07444 | UNL | HRW | 36.5 | 3,786.7 | 11.5 | 53.2 | 25.3 | 18-May |
| TAM-107 | check | HRW | 36.0 | 3,644.0 | 12.9 | 52.8 | 21.0 | 17-May |
| TX06A001132 | TAMU | HRW | 35.2 | 3,632.0 | 10.9 | 53.5 | 23.8 | 21-May |
| TX06A001263 | TAMU | HRW | 34.7 | 3,606.5 | 10.2 | 54.3 | 21.3 | 16-May |
| BC01139-1 | AGRIPRO NORTH | HRW | 34.6 | 3,519.8 | 11.3 | 52.4 | 24.3 | 21-May |
| HV9W06-1046 | WestBred Haven | HRW | 32.6 | 3,482.9 | 10.8 | 54.2 | 18.8 | 18-May |
| NE06545 | UNL | HRW | 32.1 | 3,335.1 | 10.8 | 54.0 | 24.5 | 10-May |
| BC01138-5 | AGRIPRO South | HRW | 31.7 | 3,333.6 | 11.4 | 53.4 | 22.3 | 20-May |
| HV9W06-262 | WestBred Haven | HRW | 30.4 | 3,198.0 | 10.5 | 54.6 | 20.8 | 19-May |
| HV9W06-509 | WestBred Haven | HRW | 30.3 | 3,188.1 | 10.9 | 54.1 | 21.0 | 14-May |
| Fuller | check | HRW | 30.0 | 3,067.3 | 11.0 | 54.0 | 25.0 | 15-May |
| T150-1 | Trio | HRW | 29.3 | 2,923.3 | 12.8 | 50.8 | 20.8 | 18-May |
| HV9W04-1594R | WestBred Haven | HRW | 29.1 | 2,885.5 | 10.4 | 53.5 | 17.8 | 17-May |
| TX05V7259 | TAMU | HRW | 29.1 | 2,859.7 | 13.3 | 52.5 | 20.0 | 17-May |
| TX05A001188 | TAMU | HRW | 28.5 | 2,844.8 | 11.4 | 53.9 | 22.5 | 17-May |
| TX06A001281 | TAMU | HRW | 26.1 | 2,836.4 | 12.3 | 51.6 | 21.5 | 12-May |
| AP06T3621 | AGRIPRO South | HRW | 25.3 | 2,813.1 | 12.3 | 52.0 | 21.8 | 19-May |
| T166 | Trio | HRW | 24.5 | 2,753.5 | 10.7 | 53.7 | 19.0 | 16-May |
| T168 | Trio | HRW | 17.7 | 2,741.7 | 12.6 | 53.6 | 19.5 | 15-May |
| **Mean** | | | **39.1** | **2,723.4** | **11.5** | **53.7** | **22.3** | **18-May** |
| CV (%) | | | 25.4 | | 13.3 | 2.0 | 11.6 | 0.0 |
| LSD .05% | | | 13.9 | | 2.1 | 1.5 | 3.6 | 2.6 |
| P Value | | | <.0001 | | 0.3 | <.0001 | <.0001 | <.0001 |
| significant | | | *** | | ns | *** | *** | *** |

Yields adjusted to 14% moisture content and 60 lb/bu

# Pest Control in Crops Grown in Northwestern New Mexico

**Funds provided by the USDA through the Hatch Program and the State of New Mexico through general appropriations, and various chemical companies.**

Weeds cause more total crop losses than any other agricultural pest (Lorenzi and Jeffery, 1987). Weeds reduce crop yields and quality, harbor insects and plant diseases, and cause irrigation and harvesting problems (Anonymous, 1986; Chandler et al. 1984; Lorenzi, and Jeffery, 1987), by reducing the total value of agricultural products by 10 to15% in the United States (Lorenzi and Jeffery, 1987). Estimated average losses during 1975-1979 in the potential production of field corn, potatoes, and onion ranged from 7 to 16% in the Mountain States Region (which includes New Mexico) (Chandler et al. 1984). San Juan County ranks 1$^{st}$ in potato production, 2$^{nd}$ in alfalfa production and 4$^{th}$ in corn production (USDA and New Mexico Agric. Stat. Service, 1998). An estimated 90% of all tillage operations are for weed control (Anonymous, 1986). Herbicides can reduce the number of tillage operations necessary, and can be used where cultivation is not possible, such as within crop rows or in solid-seeded crops. With increasing fuel and labor costs, herbicides are often more economical than other methods of weed control.

Many herbicides are approved for use on agronomic crops grown on medium and fine-textured, high organic soils. Little information, however, is available regarding their effectiveness and safety on low-organic, coarse-textured soils that are common to northwestern New Mexico.

Insect infestations reduce the yield and quality of crops, increase the cost of production and harvesting, and may transmit disease among plants. Insecticides are the primary method of control of insect pests because they are very effective, allow rapid control, and can be used as needed. Without insecticides, crop production would drop and estimated 30% (National Academy of Sciences, 1969).

There is growing concern about toxic pesticide residues in the soil and in agricultural products, and an interest in new chemicals and methods that minimize toxic residues while effectively controlling pest. This has led to an increasing interest in pyrethroid insecticides, which have low mammalian toxicity. Synthetic pyrethroid insecticides are being developed to improve upon the activity or stability of the insecticidal properties (National Academy of Sciences. 1969). These new insecticides require field-testing to simulate performance under actual conditions. There is also evidence that sub-lethal levels of some pyrethroids can reduce crop damage by adversely affecting the feeding behavior of insects. In 1984 alone, there were almost 100 new insecticides (Richardson, 1986).

The Environmental Protection Agency (EPA) has become more stringent with regard to research data required for pesticide approval. Thus, it has become critical that State Agricultural Science Centers work closely with commercial companies developing new pesticides in order to obtain the research data required by EPA. This cooperation will benefit the Agricultural Industry of the state and assist EPA pesticide registration.

Before 1980, the use of herbicides in northwestern New Mexico was limited. Most growers were still using 2,4-D in corn for broadleaf weed control while annual grasses were left in check. In alfalfa, burning winter annual mustard and downy brome with propane was not uncommon. A herbicide field-screening program has provided essential information on the activity of new and old herbicides on crops grown in northwestern New Mexico.

Previous insecticide research at the Science Center has included control of corn earworm in sweet corn and Russian wheat aphid in winter wheat. The Russian wheat aphid was first reported in the United States in 1986 and now infests 100% of the small grain acreage in New Mexico, causing an estimated $13,765,500 in economic losses in 1988 (Peairs et al. 1989).

As new land on the Navajo Indian Irrigation Project comes under cultivation, weed and insect problems are varied and may change with each successive crop. It is only through continued research that the demand for reliable information on the use of pesticides in northwestern New Mexico can be met.

The author wishes to express his sincere appreciation to the following companies for providing technical assistance, products, and/or financial assistance: Bayer CropSciences, BASF, DuPont Crop Protection, Monsanto, Dow AgroSciences Navajo Agricultural Products Industry, Pioneer Hi-Bred, and Southwest Seed.

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# BASF, Broadleaf Weed Control in Field Corn with Preemergence Followed by Sequential Late Postemergence Herbicides

Richard N. Arnold

## Introduction

Many herbicides can be used in sequential treatments. These trials are preemergence herbicides followed by sequential late postemergence treatments. If weeds escape the preemergence treatment, a late postemergence treatment may then be used to assist in weed control.

## Objectives

- Determine herbicide efficacy of selected herbicides for control of annual broadleaf weeds in field corn.
- Determine corn tolerance and yield to applied selected herbicides

## Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO751HR) and annual broadleaf weeds to preemergence followed by sequential late postemergence herbicides. Soils were a Doak silt loam with a pH of 7.4 and an organic matter content of less than 0.5 percent. Soils were fertilized according to New Mexico State University recommendations based on soil tests. The experimental design was a randomized complete block with four replications. Individual plots were 4, 30 inch rows 30 feet long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Field corn was planted with flexi-planters equipped with disk openers on May 10. Preemergence herbicides were applied on May 12 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soil had a maximum and minimum temperature of 70 and 54 degrees F. Late postemergence treatments were applied on June 28, when field corn was 12 to 14 inch in height and weeds averaged 6 inch in height. Air temperature maximum and minimum during late postemergence applications was 91 and 60 degrees F. Black nightshade, redroot and prostrate pigweed infestations were heavy and common lambsquarters and Russian thistle infestations were moderate throughout the experimental area. Preemergence treatments were rated visually for crop injury on June 10 and weed control on June 10 and July 7. Sequential late postemergence treatments were rated visually for weed control on July 7. Stand counts were made on June 10 by counting individual plants per 10 ft of the third row of each plot. Field corn was harvested on November 19, by combining the center two rows of each plot using a John Deere 3300 combine equipped with a load cell. Results obtained were subjected to analysis of variance at P=0.05.

## Results and discussion

***Weed Control and Injury Evaluations***: Crop injury evaluations and stand counts are given in (Table 47). Weed control evaluations are given in (Table 47 and Table 48). There was no crop injury and there were no significant differences among treatments for stand count (Table 47). On June 10 all treatments except the check gave excellent control of redroot and prostrate pigweed, black nightshade and common lambsquarters Russian thistle control was poor with Integrity applied preemergence at 13 oz/A (Table 47 and Table 48). On July 7, when Status and Roundup powermax plus a nonionic surfactant plus ammonium sulfate were added as a late postemergence at 2.5 plus 22 plus 10 oz/A plus 5 lb/A applied to Integrity applied preemergence at 10 oz/A, Russian thistle control increased approximately 22 percent, respectively. (Table 48).

***Crop Yields:*** Yields are given in (Table 48). Yields were 177 to 207 bu/A higher in the treated plots as compared to the weedy check.

**Table 47. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 10, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | Stand Count No. | Crop Injury[a] % | Weed Control[a,b] Amare % | Amabl | Solni | Saskr | Cheal |
|---|---|---|---|---|---|---|---|---|
| Integrity | 10 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Lumax | 64 | 23 | 0 | 100 | 100 | 100 | 100 | 100 |
| Corvus | 3.3 | 23 | 0 | 100 | 100 | 100 | 100 | 100 |
| Balance flex+atrazine | 3+32 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Sharpen+harness xtra | 2+48 | 23 | 0 | 100 | 100 | 100 | 100 | 100 |
| Harness xtra | 48 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Integrity | 13 | 23 | 0 | 100 | 100 | 100 | 73 | 100 |
| Corvus | 5.6 | 23 | 0 | 100 | 100 | 100 | 100 | 100 |
| Balance flexx | 5 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Weedy check | | 23 | 0 | 0 | 0 | 0 | 0 | 0 |
| LSD 0.05 | | ns | | 1 | 1 | 1 | 1 | 1 |

[a] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[b] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

**Table 48. Control of annual broadleaf weeds with preemergence followed by sequential late postemergence herbicides in field corn on July 7, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments[a] | Rate (oz/A) | Weed Control[c,d] Amare | Amabl | Solni | Saskr | Cheal | Yield (bu/A) |
|---|---|---|---|---|---|---|---|
| | | % | | | | | |
| Integrity/roundup powermax[b] | 10/22 | 100 | 100 | 100 | 100 | 100 | 262 |
| Lumax/ roundup powermax[b] | 64/22 | 100 | 100 | 100 | 100 | 100 | 258 |
| Corvus/roundup powermax[b] | 3.3/22 | 100 | 100 | 100 | 100 | 100 | 279 |
| Balance flex+atrazine/ roundup powermax[b] | 3+32/22 | 100 | 100 | 100 | 100 | 100 | 267 |
| Sharpen+harness xtra/ roundup powermax[b] | 2+48/22 | 100 | 100 | 100 | 100 | 100 | 264 |
| Harness xtra/roundup powermax[b] | 48/22 | 100 | 100 | 100 | 100 | 100 | 279 |
| Integrity/status+roundup powermax[b] | 10/2.5+22 | 100 | 100 | 100 | 100 | 100 | 276 |
| Integrity | 13 | 100 | 100 | 100 | 78 | 100 | 262 |
| Corvus | 5.6 | 100 | 100 | 100 | 100 | 100 | 260 |
| Balance flexx | 5.0 | 100 | 100 | 100 | 100 | 100 | 249 |
| Lumax | 64 | 100 | 100 | 100 | 100 | 100 | 257 |
| Weedy check | | 0 | 0 | 0 | 0 | 0 | 72 |
| LSD 0.05 | | 1 | 1 | 1 | 1 | 1 | 33 |

[a] First treatment applied preemergence then a slash followed by a sequential late postemergence treatment.
[b] Treatments applied with either or both a nonionic surfactant and ammonium sulfate at 10 oz and 5 lb/A.
[c] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[d] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

## Bayer CropScience, Broadleaf Weed Control in Field Corn with Early and Late Postemergence Treatments

**Richard N. Arnold**

### Introduction

Postemergence herbicides are most effective if applied when the weeds and field corn are small. If weeds are not controlled, weeds then become difficult to control with corn growth being restricted. This trial was to examine the efficacy of postemergence herbicides applied to corn in the 5$^{th}$ and 7$^{th}$ leaf stage and to weeds less than 4 inch and greater than 4 inch in height, and to evaluate their effect on crop injury and field corn yields.

### Objectives

- Determine herbicide efficacy of selected herbicides for control of annual broadleaf weeds in field corn.
- Determine corn tolerance and yield to applied selected herbicides

### Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO751HR) and annual broadleaf weeds to early postemergence and late postemergence herbicides. Soils were a Doak silt loam with a pH of 7.4 and an organic matter content of less than 0.5 percent. Soils were fertilized according to New Mexico State University recommendations based on soil tests. The experimental design was a randomized complete block with three replications. Individual plots were 4, 30 inch rows 30 feet long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Field corn was planted with flexi-planters equipped with disk openers on May 10. Approximately 35 inches of sprinkler water were applied during the growing season. Early postemergence treatments were applied on May 28, when field corn was in the 5$^{th}$ leaf stage and weeds were small (<4 inch). The late postemergence treatments were applied on June 28, when field corn was in the 7$^{th}$ leaf stage and weeds were greater than 4 inches tall. Air temperature maximum and minimum during early and late postemergence applications were 94 and 57, and 91 and 60 ºF.

Black nightshade, redroot and prostrate pigweed infestations were heavy and common lambsquarters infestations and Russian thistle infestations were moderate throughout the experimental area. Early and late postemergence treatments were evaluated for crop injury on June 28 and weed control June 28 and July 7. Stand counts were made on June 28 by counting individual plants per 10 feet of the third row of each plot. Field corn was harvested on November 19, by combining the center two rows of each plot using a John Deere 3300 combine equipped with a load cell. Results obtained were subjected to analysis of variance at P=0.05.

## Results and discussion

***Weed Control and Injury Evaluations:*** Weed control and crop injury evaluations and stand counts are given in (Table 49). There was no crop injury from any of the treatments. On June 28, Ignite 280 at 22 oz/A in combination with either Capreno, Atrazine, Laudis at 2, and 32 oz/A and either ammonium sulfate or coron at 5 lb/A and 128 oz/A gave excellent control of redroot and prostrate pigweed, black nightshade, Russian thistle, and common lambsquarters (Table 49). On July 7, the sequential postemergence treatment of Ignite plus ammonium sulfate increased Russian thistle control approximately 33 percent (Table 49).

***Crop Yields:*** Yields are given in (Table 49). Yields were 189 to 159 bu/A higher in the herbicide treated plots as compared to the check.

**Table 49. Control of annual broadleaf weeds with preemergence, herbicides in field corn on June 28 and July 7, 2010; NMSU Agricultural Science Center at Farmington, New Mexico. 2010.**

| Treatments | Rate | Stand Count | Crop Injury[a] | Weed Control[a,b,c] Amare | Amabl | Solni | Saskr | Cheal | Yield |
|---|---|---|---|---|---|---|---|---|---|
| | (oz/A) | No. | % | % | | | | | (Bu/A) |
| Ignite 280+ammonium sulfate | 22+5 lb/A | 23 | 0 | 78 | 81 | 73 | 65 | 78 | 236 |
| Ignite 280+ammonium sulfate | 29+5 lb/A | 24 | 0 | 83 | 91 | 93 | 95 | 86 | 259 |
| Ignite 280+ ammonium sulfate | 36+5 lb/A | 24 | 0 | 83 | 90 | 96 | 92 | 73 | 243 |
| Ignite 280+ammonium sulfate/Ignite 280+ ammonium sulfate[a] | 22 +5 lb/A 22+5 lb/A | 23 | 0 | 93/97 | 92/96 | 88/96 | 63/96 | 94/95 | 261 |
| Ignite 280+coron | 22+128 | 23 | 0 | 94 | 95 | 63 | 66 | 86 | 252 |
| Ignite 280+urea ammonium nitrate solution | 22+64 | 23 | 0 | 95 | 93 | 96 | 26 | 71 | 245 |
| Ignite 280+capreno+ atrazine+ ammonium sulfate | 22+2+32 +5 lb/A | 25 | 0 | 100 | 100 | 100 | 100 | 100 | 266 |
| Ignite 280+laudis+ atrazine+coron | 22+2+32 +128 | 24 | 0 | 100 | 100 | 100 | 100 | 100 | 266 |
| Ignite 280+laudis+ atrazine+ammonium sulfate | 22+2+32 +5 lb/A | 23 | 0 | 100 | 100 | 100 | 100 | 100 | 256 |

| Treatments | Rate | Stand Count | Crop Injury[a] | Weed Control[a,b,c] Amare | Amab l | Solni | Saskr | Cheal | Yield |
|---|---|---|---|---|---|---|---|---|---|
| | (oz/A) | No. | % | % | | | | | (Bu/A) |
| Ignite 280+laudis+ atrazine+coron+ ammonium sulfate | 22+2+32 + 128+5 lb/A | 24 | 0 | 100 | 100 | 100 | 100 | 100 | 258 |
| Roundup powermax+ ammonium sulfate | 22+5 lb/A | 24 | 0 | 98 | 98 | 93 | 58 | 96 | 247 |
| Roundup powermax+ignite 280+ammonium sulfate | 22+22+5 lb/A | 24 | 0 | 93 | 97 | 99 | 92 | 51 | 255 |
| Roundup powermax+ignite 280+coron | 22+22+1 28 | 23 | 0 | 98 | 98 | 99 | 78 | 88 | 246 |
| Ignite 280+ N-PACT | 22+128 | 24 | 0 | 90 | 94 | 97 | 93 | 73 | 243 |
| Cadet+roundup powermax+ nonionic surfactant | 0.5+22 | 25 | 0 | 60 | 90 | 55 | 78 | 48 | 239 |
| Weedy check | | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 77 |
| LSD 0.05 | | ns | | 4 | 3 | 5 | 4 | 3 | 29 |

[a] First treatment applied early postemergence and evaluated on June 28, then a slash followed by a sequential late postemergence and evaluated on July 7.
[b] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[c] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

# Bayer CropScience and DuPont Crop Protection, Broadleaf Weed Control in Field Corn with Preemergence Followed by Sequential Postemergence Herbicides

Richard N. Arnold

## Introduction

Many herbicides can be used in sequential treatments. These trials are preemergence herbicides followed by sequential postemergence treatments. If weeds escape the preemergence treatment, a postemergence treatment may then be used to assist in weed control.

## Objectives

- Determine herbicide efficacy of selected herbicides for control of annual broadleaf weeds in field corn.
- Determine corn tolerance and yield to applied selected herbicides

## Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO751HR) and annual broadleaf weeds to preemergence, preemergence followed by sequential postemergence herbicides. Soils were a Doak silt loam with a pH of 7.4 and an organic matter content of less than 0.5 percent. Soils were fertilized according to New Mexico State University recommendations based on soil tests. The experimental design was a randomized complete block with three replications. Individual plots were 4, 30 inch rows 30 feet long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Field corn was planted with flexi-planters equipped with disk openers on May 10. Preemergence herbicides were applied on May 12 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soil had a maximum and minimum temperature of 70 and 54 degrees F. Postemergence treatments were applied on June 1, when field corn was in the $2^{rd}$ to $3^{rd}$ leaf stage and weeds were small (<2 inch). The other postemergence treatments were applied on June 9, when field corn was in the $4^{th}$ to $5^{th}$ leaf stage and weeds were less than 4 inch tall. Air temperature maximum and minimum postemergence applications for June 1 and June 8 were 85, 52 and 91, 60 degrees F. Black nightshade, redroot and prostrate pigweed infestations were heavy and common lambsquarters and Russian thistle infestations were moderate throughout the experimental area. Preemergence treatments were evaluated for weed control on June 8 and 28. Postemergence treatments were evaluated on June 28. Crop injury was evaluated on June 8 for preemergence treatments and on June 28 postemergence treatments. Stand counts were made on June 8 by counting individual plants per 10 feet of the third row of each plot. Field corn was harvested on November 19, by combining the center two rows of each plot using a John Deere 3300 combine equipped with a load cell. Results obtained were subjected to analysis of variance at P=0.05.

## Results and discussion

***Weed Control and Injury Evaluations:*** Weed control evaluations are given in (Table 50 and Table 51). Crop injury evaluations and stand counts are given in (Table 50). There was no crop injury from any of the treatments (Table 50). On June 8, all preemergence treatments gave excellent control of redroot and prostrate pigweed, black nightshade, Russian thistle and common lambsquarters (Table 50).

***Crop Yields:*** Yields are given in (Table 51). Yields were 166 to 189 bu/A higher in the herbicide treated plots as compared to the check.

**Table 50. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 8, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate | Stand Count | Crop Injury[a] | Weed Control[a,b] | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Amare | Amabl | Solni | Saskr | Cheal |
| | (oz/A) | No. | % | % | | | | |
| Corvus+atrazine | 5.6+32 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Balance flex+atrazine | 6+32 | 23 | 0 | 100 | 100 | 100 | 100 | 100 |
| Corvus | 3 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Balance flexx | 6 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| Balance flexx | 3 | 24 | | 100 | 100 | 100 | 100 | 100 |
| DPX E9636+DPXYI671-010 | 0.669+0.446 | 25 | | 100 | 100 | 100 | 98 | 100 |
| DPX E9636+DPXYI671-010 | 0.801+0.53 | 24 | 0 | 100 | 100 | 100 | 100 | 100 |
| DPX E9636+DPXYI671-010 | 1+0.66 | 23 | 0 | 100 | 100 | 100 | 98 | 100 |
| Weedy check | | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| LSD 0.05 | | ns | | 1 | 1 | 1 | 1 | 1 |

[a] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[b] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

**Table 51. Control of annual broadleaf weeds with preemergence followed by sequential postemergence herbicides in field corn on June 28, 2010; NMSU Agricultural Science Cener at Farmington, NM. 2010.**

| Treatments[a] | Rate (oz/A) | Amare | Amabl | Solni | Saskr | Cheal | Yield (bu/A) |
|---|---|---|---|---|---|---|---|
| | | Weed Control[g,h] — % | | | | | |
| Corvus+atrazine | 5.6+32 | 100 | 100 | 100 | 100 | 100 | 258 |
| Balance flex+atrazine | 6+32 | 100 | 100 | 100 | 100 | 100 | 252 |
| Corvus+atrazine[b] | 5.6+32 | 100 | 100 | 100 | 100 | 100 | 256 |
| Balance flex+atrazine[b] | 6+32 | 99 | 100 | 100 | 99 | 100 | 256 |
| Capreno+roundup powermax[b,d] | 3+11 | 100 | 100 | 100 | 73 | 100 | 253 |
| Capreno+roundup powermax[c,d] | 3+11 | 100 | 100 | 100 | 66 | 100 | 251 |
| Corvus/laudis+roundup powermax[c,e] | 3/3+11 | 100 | 100 | 100 | 100 | 100 | 256 |
| Balance flex/ laudis+roundup powermax[c,e] | 6/3+11 | 100 | 100 | 100 | 100 | 100 | 259 |
| Corvus/ignite 280+laudis[c] | 3/22+2 | 100 | 100 | 100 | 100 | 100 | 252 |
| Balance flex/ ignite 280+laudis[c] | 2/22+2 | 100 | 100 | 100 | 100 | 100 | 252 |
| Balance flex/capreno+roundup powermax[c,d] | 3/3+11 | 100 | 100 | 100 | 100 | 100 | 258 |
| DPX E9636+DPXYI671-010/ roundup powermax[c,f] | 0.669+ 0.446/22 | 98 | 100 | 100 | 98 | 100 | 247 |
| DPX E9636+DPXYI671-010/ roundup powermax[c,f] | 0.801+0.53/22 | 99 | 100 | 100 | 99 | 100 | 248 |
| DPX E9636+DPXYI671-010/ roundup powermax[c,f] | 1+0.66/22 | 99 | 100 | 100 | 98 | 100 | 268 |
| Resolve Q+roundup powermax[c,f] | 1.25+22 | 100 | 100 | 100 | 46 | 100 | 245 |
| Weedy check | | 0 | 0 | 0 | 0 | 0 | 79 |
| LSD 0.05 | | 1 | 1 | 1 | 2 | 1 | 26 |

[a] First treatment applied preemergence then a slash followed by a sequential late postemergence treatment.
[b] Treatments applied postemergence on June 1.
[c] Treatments applied postemergence on June 8.
[d] Treatments applied with a crop oil concentrate at 16 oz/A.
[e] Treatments applied with a methylated seed oil at 16 oz/a.
[f] Treatments applied with ammonium sulfate at 2 lb/A.
[g] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[h] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

## Microbial Energy, Inc. and True Green Organics, Microbial use in Field Corn Production

Richard N. Arnold

### Introduction

Microbes to increase production in crops is gaining acceptance as an agronomic practice. The idea is to use less fertilizer (nitrogen) and let the microbes work with the soil to increase yields.

### Objectives

- Determine if microbes will indeed increase or hold production yields without the full rate of nitrogen applied to field corn.

### Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO751HR) and microbes using less nitrogen applied for holding or increasing yields. Soils were a Doak silt loam with a pH of 7.4 and an organic matter content of less than 0.5 percent. All plots were fertilized with a starter fertilizer consisting of 100 lb/A 11-52-0 in combination with 100 lb/A of 0-0-60 on May 1. Starter fertilizer was then disk into the soil at a depth of approximately 4 inches. The remaining ammonium nitrate solution (32-0-0) was applied at increments of 30 lb N/A (90 lb N/A) until June 15. This made an application of approximately 100 lb N/A applied for the growing season instead of 200 lb N/A which is normally used on these soils and in this area. Individual plots were 4, 30 inch rows 30 feet long. The experimental design was a randomized complete block with three replications. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Field corn was planted with flexi-planters equipped with disk openers on May 10. Preemergence treatments were applied on May 17 and immediately incorporated with 0.75 inch of sprinkler applied water. Approximately 35 inches of sprinkler water were applied during the growing season. Soil temperature maximum and minimum during application was 69 and 56 degrees F. Postemergence treatments were applied on June 8. Air temperature maximum and minimum during postemergence applications was 94 and 60 degrees F. Bicep Lite II max was applied preemergence on May 12 at 55 oz/A followed by a postemergence treatment of status and prowl $H_2O$ applied at 3 plus 32 oz/A on June 8. Field corn was harvested on November 22, by combining the center two rows of each plot using a John Deere 3300 combine equipped with a load cell. Results obtained were subjected to analysis of variance at P=0.05.

### Results and discussion

***Crop Yields:*** Yields are given in (Table 52). There were no significant treatments for yield (Table 52). Research should continue in the microbial realm for maximum crop production using microbes in combination with reduced fertilizer nitrogen for maximum crop production.

**Table 52. Yield of field corn from microbes applied either preemergence of preemergence followed by a sequential postemergence treatment, on November 22, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments[a] | Rate (oz/A) | Crop Yield (bu/A) |
|---|---|---|
| Microbial energy | 256 | 221 |
| Microbial energy | 512 | 230 |
| Microbial energy | 768 | 239 |
| Microbial energy | 1024 | 234 |
| Microbial energy/microbial energy | 128/128 | 200 |
| Microbial energy/microbial energy | 256/256 | 221 |
| Microbial energy/microbial energy | 384/384 | 217 |
| Microbial energy/microbial energy | 512/512 | 225 |
| Quantum VS+inoculaid light | 16+16 | 194 |
| Quantum VS+inoculaid light | 32+32 | 227 |
| Quantum VS+inoculaid light | 128+32 | 225 |
| Quantum VS+inoculaid light/quantum VS+inoculaid light | 8+8/8+8 | 220 |
| Quantum VS+inoculaid light/quantum VS+inoculaid light | 16+16/16+16 | 234 |
| Quantum VS+inoculaid light/quantum VS+inoculaid light | 64+64/64+16 | 226 |
| Quantum VS+inoculaid light/quantum VS+inoculaid light | 64+8/64+8 | 224 |
| Untreated check | | 233 |
| LSD 0.05 | | ns |

[a] First treatment applied preemergence then a slash followed by a postemergence treatment.

# Bayer CropSciences, Broadleaf Weed Control in Grain Sorghum with Preemergence Followed by Sequential Early and Late Postemergence Herbicides

Richard N. Arnold

## Introduction

Postemergence herbicides are most effective if applied when the weeds and grain sorghum are small. If weeds are not controlled, weeds then become difficult to control with grain sorghum growth being restricted. This trial was to examine the efficacy of preemergence followed by sequential early and late postemergence herbicides applied grain sorghum and weeds, and to evaluate their effect on crop injury and grain sorghum yields.

## Objectives

- Determine herbicide efficacy of selected herbicides for control of annual broadleaf weeds in grain sorghum.
- Determine grain sorghum tolerance and yield to applied herbicides.

## Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of grain sorghum (Pioneer, DKS 53-67) and annual broadleaf weeds to preemergence followed by sequential early and late postemergence herbicides. Soils were a Doak silt loam with a pH of 7.4 and an organic matter content of less than 0.5 percent. Soils were fertilized according to New Mexico State University recommendations based on soil tests. The experimental design was a randomized complete block with three replications. Individual plots were 4, 30 inch rows 30 feet long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Grain sorghum was planted with flexi-planters equipped with disk openers on May 28. Preemergence treatments were applied on June 1 and immediately incorporated with 0.75 inch of sprinkler applied water. Soil temperature maximum and minimum temperature during application were 81 and 65 degrees F. Approximately 35 inches of sprinkler water were applied during the growing season. Early postemergence treatments were applied on June 30 when grain sorghum was in the V5 stage and weeds were less than 4 inches in height. Late postemergence treatments were applied on July 7 when grain sorghum was in stage 3 and weeds were less than 7 inches in height. Air temperatures for early and late postemergence applications were 89, 60 and 83, 54 degrees F. Black nightshade, redroot and prostrate pigweed infestations were heavy, common lambsquarters infestations and Russian thistle infestations were moderate throughout the experimental area. Preemergence treatments were evaluated for crop injury and weed control on July 1. Early and late post emergence treatments were evaluated for crop injury and weed control on July 22. Grain sorghum was harvested on November 16, by combining the center two rows of each plot using a John Deere 3300 combine equipped with a load cell. Results obtained were subjected to analysis of variance at P=0.05.

## Results and discussion

***Weed Control and Injury Evaluations:*** Weed control and crop injury evaluations are given in (Table 53 and Table 54). There were no crop injury symptoms from any of the treatments for both rating periods. On July 1, the preemergence treatment of Roundup weathermax plus Sharpen plus ammonium sulfate at 16+2 oz/A plus 2.8 lb/A gave poor control of redroot and prostrate pigweed, black nightshade, Russian thistle and common lambsquarters (Table 53). On July 22, the pre-emergence treatment of Roundup weathermax plus Sharpen plus ammonium sulfate at 16+2 oz/A plus 2.8 lb/A and the late postemergence treatment of Aim plus 2,4-D amine plus a nonionic surfactant and ammonium sulfate at 1 plus 6 plus 6 oz/A plus 1 lb/A gave poor control of redroot and prostrate pigweed, black nightshade, Russian thistle and common lambsquarters (Table 54).

***Crop Yields:*** Yields are given in (Table 54). Yields were 16 to 163 bu/A higher in the herbicide treated plots as compared to the weedy check.

**Table 53. Control of annual broadleaf weeds with preemergence herbicides in grain sorghum on July 1, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | Crop Injury[b] % | Weed Control[b] % Amare | Amabl | Solni | Saskr | Cheal |
|---|---|---|---|---|---|---|---|
| Roundup weathermax+sharpen[a] | 16+2 | 0 | 30 | 35 | 45 | 33 | 55 |
| Guardsman max | 48 | 0 | 100 | 100 | 100 | 100 | 100 |
| Weedy check | | 0 | 0 | 0 | 0 | 0 | 0 |
| LSD 0.05 | | | 6 | 6 | 5 | 12 | 5 |

[a] Treatment applied with ammonium sulfate at 2.8 lb/A.
[b] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

**Table 54. Control of annual broadleaf weeds with preemergence followed by early and late postemergence herbicides in grain sorghum on July 22, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments[a] | Rate (oz/A) | Crop Injury[f] % | Amare | Amabl | Solni | Saskr | Cheal | Yield (bu/A) |
|---|---|---|---|---|---|---|---|---|
| | | | Weed Control[f,g] % | | | | | |
| Roundup weathermax+sharpen[d] | 16+2 | 0 | 25 | 31 | 41 | 30 | 41 | 28 |
| Huskie+atrazine[b,d] | 13+16 | 0 | 100 | 100 | 100 | 100 | 100 | 161 |
| Huskie+atrazine[b,d] | 16+16 | 0 | 100 | 100 | 100 | 100 | 100 | 163 |
| Huskie+atrazine+2,4-D ester[b,d] | 13+16+ 4 | 0 | 100 | 100 | 100 | 100 | 100 | 175 |
| Huskie+atrazine+ banvel[b,d] | 13+16+ 4 | 0 | 100 | 100 | 100 | 100 | 100 | 147 |
| Atrazine+buctril[b] | 16+16 | 0 | 100 | 100 | 100 | 100 | 100 | 159 |
| Aim+2,4-D amine[b,e] | 1+6 | 0 | 98 | 98 | 92 | 86 | 90 | 71 |
| Huskie+atrazine[b,d]/Huskie +atrazine[c,d] | 13+16/ 13+16 | 0 | 100 | 100 | 100 | 100 | 100 | 159 |
| Huskie+atrazine[c,d] | 13+16 | 0 | 100 | 100 | 100 | 100 | 100 | 164 |
| Huskie+atrazine[c,d] | 16+16 | 0 | 100 | 100 | 100 | 100 | 100 | 151 |
| Huskie+atrazine+2,4-D ester[c,d] | 13+16+ 4 | 0 | 100 | 100 | 100 | 100 | 100 | 134 |
| Huskie+atrazine+banvel[c,d] | 13+16+ 4 | 0 | 100 | 100 | 100 | 100 | 100 | 133 |
| Atrazine+buctril[c] | 16+16 | 0 | 90 | 90 | 95 | 93 | 93 | 126 |
| Aim+2,4-D amine[c,e] | 1+6+6 | 0 | 21 | 25 | 28 | 36 | 28 | 51 |
| Guardsman max/huskie[c,d] | 48/13 | 0 | 100 | 100 | 100 | 100 | 100 | 163 |
| Weedy check | | | 0 | 0 | 0 | 0 | 0 | 12 |
| LSD 0.05 | | | 2 | 2 | 3 | 3 | 3 | 33 |

[a] First treatment applied preemergence then a slash followed by a postemergence treatment.
[b] Treatments applied early postemergence on June 30.
[c] Treatments applied late postemergence on July 6.
[d] Treatments applied with ammonium sulfate at 1 lb/A.
[e] Treatments applied with a nonionic surfactant at 6 oz/A.
[f] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[g] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

## Dow AgroSciences, Tansymustard Control in Winter Wheat.

Richard N. Arnold

### Introduction

Tansymustard is a troublesome weed in winter wheat. If not controlled they can decrease wheat yields and interfere with harvest operations. Field trials were conducted to evaluate the control of tansymustard by selected herbicides in winter wheat.

### Objectives

- Determine herbicide efficacy of selected herbicides for control of Jim Hill mustard in winter wheat.
- Determine tolerance and yield of winter wheat to applied selected herbicides

### Materials and methods

A field experiment was conducted in 2010 on a Wall sandy loam with less than 0.5 percent organic matter at Farmington, New Mexico, to evaluate the response of winter wheat and tansymustard to postemergence herbicides. The experimental design was a randomized complete block with three replications. Individual plots were 10 feet wide by 30 feet long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Winter wheat (var. Jagaline) was planted on 18 inch rows at 100 lb/A with a Massey Ferguson grain drill on September 14. Eighteen inch row spacing‘s were used to ensure tansymustard pressure. Treatments were applied on March 23, prior to winter wheat Feekes 6 growth stage. Air temperature maximum and minimum during treatment application was 59 to 25 degrees F. Other postemergence treatments were applied on April 26 after winter wheat was approximately at the Feekes 9 growth stage. Air temperature maximum and minimum during treatment application was 69 to 40 degrees F. On March 23 and April 26 tansymustard heights were less than 4 and greater than 8 inch in height. Tansymustard infestation was heavy with approximately 40 to 50 plants per square yard. Crop injury and weed control evaluations were made on April 26 and May 26. Winter wheat was harvested with a John Deere 3300 combine equipped with a load cell on August 10. Results obtained were subjected to analysis of variance at P=0.05.

### Results and discussion

***Weed Control and Injury Evaluations:*** Results of crop injury and weed control evaluations are given in (Table 55 and Table 56). Harmony GT XP plus 2,4-D LV6 plus urea ammonium nitrate at 0.6 plus 4 plus 1152 oz/A had the highest in injury rating of 5 (Table 55 and Table 56). On April 26, all treatments except the weedy check, Puma and Axial applied at 10.5 and 16.4 oz/A gave excellent control of tansymustard (Table 55). On May 26, BASF 8100H and Banvel plus Harmony GT XP plus a nonionic surfactant applied late postemergence at 2.2 and 2 oz/A plus 5 oz/A gave poor control of tansymustard (Table 56).

***Yield:*** Results of yield are given in (Table 56). Yields were 18 to 42 bu/A higher in the herbicide treated plots as compared to the weedy check.

**Table 55. Control of tansymustard in Jagaline winter wheat on April 26, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | Crop Injury[h] —%— | Weed Control[h,i] DESPI —%— |
|---|---|---|---|
| BASF 8100H+harmony GT XP[a] | 4.4+0.3 | 0 | 100 |
| Banvel+harmony GT XP[a] | 4+0.3 | 0 | 99 |
| Proxsulam+cloquintocet[a,g] | 6.75 | 0 | 98 |
| Proxsulam+cloquintocet[a,b,g] | 6.75 | 0 | 100 |
| Proxsulam+cloquintocet[a,c,g] | 6.75 | 0 | 99 |
| Osprey[a,b] | 4.76 | 0 | 100 |
| Puma | 10.5 | 0 | 72 |
| Axial | 16.4 | 0 | 83 |
| Harmony GT XP+2,4-D ester[a] | 0.6+6 | 0 | 100 |
| Harmony GT XP+2,4-D ester[d] | 0.6+6 | 0 | 100 |
| Harmony GT XP+2,4-D ester[e] | 0.6+4 | 0 | 100 |
| Harmony GT XP+2,4-D ester[f] | 0.6+4 | 5 | 100 |
| Weedy check | | 0 | 0 |
| LSD 0.05 | | | 7 |

[a] Treatments applied with a nonionic surfactant at 5 oz/A.
[b] Treatment applied with ammonium sulfate at 1.5 lb/A.
[c] Treatment applied with a crop oil concentrate at 16 oz/A.
[d] Treatments applied urea ammonium nitrate solution, 32-0-0 at 384 oz/A.
[e] Treatments applied urea ammonium nitrate solution, 32-0-0 at 768 oz/A.
[f] Treatments applied urea ammonium nitrate solution, 32-0-0 at 1152 oz/A.
[g] Proxsulam+cloquintocet is a package mix.
[h] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[i] DESPI equal tansymustard.

**Table 56. Control of tansymustard in Jagaline winter wheat on May 26, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate | Crop Injury[h] | Weed Control[h,i] DESPI | Yield |
|---|---|---|---|---|
| | (oz/A) | —%— | —%— | (bu/A) |
| BASF 8199H+harmony GT XP[a] | 4.4+0.3 | 0 | 95 | 64 |
| Banvel+harmony GT XP[a] | 4+0.3 | 0 | 92 | 62 |
| BASF 8100H+harmony GT XP[a,j] | 2.2+0.6 | 0 | 63 | 52 |
| Banvel+harmony GT XP[a,j] | 2+0.6 | 0 | 68 | 49 |
| Proxsulam+cloquintocet[a,g] | 6.75 | 0 | 98 | 69 |
| Proxsulam+cloquintocet[a,b,g] | 6.75 | 0 | 99 | 68 |
| Proxsulam+cloquintocet[a,c,g] | 6.75 | 0 | 93 | 66 |
| Osprey[a,b] | 4.76 | 0 | 95 | 62 |
| Puma | 10.5 | 0 | 33 | 49 |
| Axial | 16.4 | 0 | 30 | 51 |
| Harmony GT XP+2,4-D ester[a] | 0.6+6 | 0 | 100 | 68 |
| Harmony GT XP+2,4-D ester[d] | 0.6+6 | 0 | 99 | 70 |
| Harmony GT XP+2,4-D ester[e] | 0.6+4 | 0 | 100 | 73 |
| Harmony GT XP+2,4-D ester[f] | 0.6+4 | 5 | 96 | 66 |
| Weedy check | | 0 | 0 | 31 |
| LSD 0.05 | | | 3 | 10 |

[a] Treatments applied with a nonionic surfactant at 5 oz/A.
[b] Treatment applied with ammonium sulfate at 1.5 lb/A.
[c] Treatment applied with a crop oil concentrate at 16 oz/A.
[d] Treatments applied urea ammonium nitrate solution, 32-0-0 at 384 oz/A.
[e] Treatments applied urea ammonium nitrate solution, 32-0-0 at 768 oz/A.
[f] Treatments applied urea ammonium nitrate solution, 32-0-0 at 1152 oz/A.
[g] Proxsulam+cloquintocet is a package mix.
[h] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[I] DESPI = tansymustard.
[j] Treatments applied on April 26.

## DuPont Crop Protection, Cool Season Native and Non-Native Grass Response to MAT-28

**Richard N. Arnold**

### Introduction

In the San Juan Oil and Gas Producing Basin on northwest New Mexico, it is estimated that approximately 20,000 to 30,000 acres of disturbed lands created by oil and natural gas drilling will need to be re-vegetated during the next 10 years. Most herbicides used today injure grass seedlings during germination followed by future replanting. A field trial was conducted to determine MAT-28 injury to seedlings and permanent grass stands.

### Objectives

- Determine stand establishment and yield to selected non-native and native cool season grasses.

### Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of selected non-native and native cool season grasses to MAT-28. Soils were a Doak silt loam with a pH of 7.5 and an organic matter content of less than 0.5 percent. Soils were fertilized according to New Mexico State University recommendations based on soil tests. The experimental design was a split plot with rangeland grasses as whole plots and herbicide treatments as sub plots. Individual plots were 6 feet wide by 30 feet long. San Luis Slender Wheatgrass, Manchar Smoothbrome Grass, Rimrock Indian Ricegrass, Hy Crest Crested Wheatgrass, Oahe Intermediate Wheatgrass, Lune Pubescent Wheatgrass, Potomac Orchardgrass, and Fawn Tall Fescue were planted on August 18, 2009 at 8, 8, 6, 8, 10, 9, 5, and 15 lb pls/A (pure live seed). Mat 28 was applied preemergence at 4 oz/A on August 25, 2009 and immediately water in with 0.75 inch of sprinkler applied water. All other treatments were applied postemergence with a nonionic surfactant at 13 oz/A on April 22, 2010. Preemergence treatment soil maximum and minimum were 94 and 72 degrees F. Air temperature maximum and minimum for the postemergence treatments were 52 and 35 degrees F. Grass stand establishment ratings were made on July 7 and plots were harvested for yield on July 8. Results obtained were subjected to analysis of variance at P=0.05.

### Results and discussion

***Stand Establishment Evaluations:*** All grasses showed good to excellent tolerance to MAT 28 applied postemergence at 1 and 2 oz/A (Table 57). All grasses, except Hy Crest Crested Wheatgrass and Fawn Tall Fescue, showed excellent tolerance to MAT 28 plus Telar XP applied postemergence at 2.0 plus 0.5 oz/A. MAT 28 plus Escort XP applied postemergence at 2.0 plus 0.33 oz/A reduced Manchar Smooth Bromegrass and Fawn Tall Fescue stands to 56 and 57 percent, respectively. MAT 28 applied preemergence at 4.0 oz/A severely reduced stands of San Luis Slender Wheatgrass, Manchar Smooth Bromegrass, and Fawn Tall Fescue (Table 57).

***Grass Yield:*** Grass yields are given in (Table 58). The untreated treatment and MAT 28 applied preemergence at 4.0 oz/A had approximately 20 to 40 percent weeds when harvested (Table 58). Oahe Intermediate Wheatgrass, Fawn Tall Fescue and Luna Pubescent Wheatgrass were the highest yielding grass (Table 58).

**Table 57. Percent stand establishment ratings of grasses to MAT 28 alone or in combination, on July 7, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | Stand establishment ratings[d] (%) SLSW | MSM | RIR | HCCW | OIW | LPW | POG | FTF | Treatment means herbicides[c] |
|---|---|---|---|---|---|---|---|---|---|---|
| MAT-28[a] | 1.0 | 97 | 94 | 100 | 85 | 100 | 100 | 100 | 100 | 96[a] |
| MAT-28[a] | 2.0 | 95 | 95 | 100 | 83 | 97 | 97 | 100 | 100 | 95[b] |
| MAT-28[a] | 4.0 | 68 | 73 | 93 | 77 | 95 | 93 | 97 | 97 | 86[e] |
| MAT-28+telar[a] | 2.0+0.5 | 99 | 97 | 95 | 70 | 100 | 100 | 100 | 73 | 92[c] |
| MAT-28+ escort XP[a] | 2.0+0.33 | 95 | 56 | 97 | 83 | 90 | 100 | 100 | 57 | 89[d] |
| MAT-28[b] | 4.0 | 5 | 47 | 65 | 80 | 90 | 87 | 95 | 20 | 61[f] |
| Milestone[a] | 7.0 | 95 | 100 | 57 | 67 | 100 | 97 | 100 | 100 | 89[d] |
| Untreated | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100[a] |
| Treatment means grass[c] | | 81[c] | 87[b] | 88[b] | 80[c] | 96[a] | 96[a] | 99[a] | 81[c] | |

[a] Treatments applied with a nonionic surfactant at 22 oz/A.
[b] Treatment applied preemergence on August 25, 2009.
[c] Means followed by the same letter are not significantly different as determined by the LSD test at 0.05.
[d] SLSW = San Luis Slender Wheatgrass, MSM= Manchar Smooth Bromegrass, RIR = Rimrock Indian Ricegrass, HCCW = Hy Crested Crested Wheatgrass, OIW = Oahe Intermediate Wheatgrass, LPW = Luna Pubescent Wheatgrass, POG = Potomac Orchardgrass, and FTF = Fawn Tall Fescue.

**Table 58. Yield of grasses to MAT 28 alone or in combination on July 8, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | SLSW | MSM | RIR | HCCW | OIW | LPW | POG | FTF | Treatment means herbicides[c] |
|---|---|---|---|---|---|---|---|---|---|---|
| MAT-28 [a] | 1.0 | 21.6 | 22.1 | 27.9 | 25.4 | 67.6 | 34.8 | 25.2 | 46.9 | 34[d] |
| MAT-28 [a] | 2.0 | 18.0 | 28.6 | 26.1 | 24.8 | 62.1 | 29.3 | 27.4 | 43.3 | 32[d,e] |
| MAT-28 [a] | 4.0 | 19.4 | 23.7 | 23.6 | 21.3 | 60.6 | 27.2 | 36.9 | 42.5 | 32[d,e] |
| MAT-28+telar [a] | 2.0+0.5 | 26.0 | 48.0 | 29.5 | 24.6 | 82.8 | 37 | 40.1 | 37.8 | 41[b] |
| MAT-28+ escort XP [a] | 2.0+0.33 | 28.7 | 42.4 | 26.5 | 28.6 | 43.3 | 52.6 | 38.9 | 34.4 | 37[c] |
| MAT-28 [b] | 4.0 | 16.9 | 14.9 | 31.9 | 34.8 | 50.1 | 32.9 | 21.5 | 38.3 | 30[e] |
| Milestone [a] | 7.0 | 14.6 | 47.8 | 18.6 | 23.8 | 87.9 | 52.0 | 42.0 | 60.5 | 42[b] |
| Untreated | | 38.4 | 48.2 | 27.9 | 45.4 | 87.9 | 43.7 | 31.9 | 36.3 | 45[a] |
| Treatment means grass [c] | | 23[f] | 34[d] | 27[e] | 29[e] | 66[a] | 39[c] | 33[d] | 43[b] | |

[a] Treatments applied with a nonionic surfactant at 22 oz/A.
[b] Treatment applied preemergence on August 25, 2009.
[c] Means followed by the same letter are not significantly different as determined by the LSD test at 0.05.
[d] SLSW – San Luis Slender Wheatgrass, OIW – Oahe-intermediate Wheatgrass, LPW – Luna Pubescent Wheatgrass, POG = Potomac Orchardgrass, and FTF = Fawn Tall Fescue.

## Dow AgroSciences, Cool Season Native Grass Response to Milestone

**Richard N. Arnold**

### Introduction

In the San Juan Oil and Gas Producing Basin on northwest New Mexico, it is estimated that approximately 20,000 to 30,000 acres of disturbed lands created by oil and natural gas drilling will need to be re-vegetated during the next 10 years. Most herbicides used today injure grass seedlings during germination followed by future replanting. A field trial was conducted to determine timing of Milestone injury to seedlings.

### Objectives

- Determine stand establishment and yield to selected non-native and native cool season grasses.

### Materials and methods

In 2010, a field experiment was conducted at Farmington, New Mexico to evaluate the response of selected non-native and native cool season grasses to Milestone. Soils were a Doak silt loam with a pH of 7.5 and an organic matter content of less than 0.5 percent. Soils were fertilized according to New Mexico State University recommendations based on soil tests. The experimental design was a split-split plot with rangeland grasses as whole plots, timing as sub plots and herbicide treatments as sub-sub plots. Individual plot were 6 feet wide by 30 feet long. San Luis Slender Wheatgrass and Arriba Western Wheatgrass were planted on May 3, at 8 and 10 lb pls/A (pure live seed). Milestone was applied on November 17, 2009, February 16, March 1 and April 8, 2010 at 3, 7 and 14 oz/A. Soil maximum and minimum from November 2009, February, March and April 2010 were 36-34, 37-32, 43-35, and 58-41 degrees F. Grass stand establishment ratings were made on July 29 and plots were harvested for yield on October 5. Results obtained were subjected to analysis of variance at P=0.05.

### Results and discussion

***Stand Establishment Evaluations:*** Stand establishment ratings are given in (Table 59). Milestone applied at 7 and 14 oz/A on April 8 resulted in severe crop injury to both grasses. Milestone at 14 oz/A applied at 14 oz/A on April 8 virtually had no seedlings emergence of either grass (Table 59).

***Grass Yield:*** Grass yields are given in (Table 60). Milestone at 7 and 14 oz/A applied on April 8, had a decrease in yield of 32.7 and 23.5, 40.1 and 34.5 lb/plot when compared to the overall average of 50 and 43 lb/plot for Arriba Western Wheatgrass and San Luis Slender Wheatgrass (Table 60).

**Table 59. Percent stand establishment ratings of grasses to Milestone applied at different timings, on July 29, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| | | | % Stand establishment [a] | |
|---|---|---|---|---|
| Treatments | Rate (oz/A) | Timing Month | AWWG | SLSW |
| | | | ———%——— | |
| Milestone | 3.0 | November 17, 09 | 100 | 100 |
| | | February 16, 10 | 100 | 100 |
| | | March 1, 10 | 100 | 100 |
| | | April 8-10 | 100 | 100 |
| Milestone | 7.0 | November 17, 09 | 100 | 100 |
| | | February 16, 10 | 100 | 100 |
| | | March 1, 10 | 100 | 100 |
| | | April 8-10 | 47 | 22 |
| Milestone | 14.0 | November 17, 09 | 100 | 100 |
| | | February 16, 10 | 100 | 100 |
| | | March 1, 10 | 100 | 100 |
| | | April 8-10 | 2 | 2 |
| Untreated | | November 17, 09 | 100 | 100 |
| | | February 16, 10 | 100 | 100 |
| | | March 1, 10 | 100 | 100 |
| | | April 8-10 | 100 | 100 |
| Mean LSD for timing at 0.05[b] | | November 17, 09 | 100[a] | |
| | | February 16, 10 | 100[a] | |
| | | March 1, 10 | 100[a] | |
| | | April 8-10 | 59[b] | |
| Mean LSD for treatment at 0.05[b] | | Milestone 3.0 oz/A | 100[a] | |
| | | Milestone 7.0 oz/A | 83[b] | |
| | | Milestone 14.0 oz/A | 76[c] | |
| | | Untreated | 100[a] | |

[a] AWWG = Arriba Western Wheatgrass and SLSW = San Luis Slender Wheatgrass.

[b] Means followed by the same letter are not significantly different as determined by the LSD test at 0.05.

**Table 60. Yield of grass to Milestone, on October 5, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | Timing Month | Yield AWWG (lb/plot [a]) | Yield SLSW (lb/plot [a]) |
|---|---|---|---|---|
| Milestone | 3.0 | November 17, 09 | 55.1 | 48.0 |
| | | February 16, 10 | 55.7 | 48.1 |
| | | March 1, 10 | 56.4 | 49.0 |
| | | April 8-10 | 53.3 | 33.4 |
| Milestone | 7.0 | November 17, 09 | 51.4 | 52.0 |
| | | February 16, 10 | 64.2 | 51.3 |
| | | March 1, 10 | 70.2 | 48.5 |
| | | April 8-10 | 17.3 | 19.5 |
| Milestone | 14.0 | November 17, 09 | 48.7 | 52.7 |
| | | February 16, 10 | 55.9 | 47.0 |
| | | March 1, 10 | 58.0 | 43.6 |
| | | April 8-10 | 9.9 | 8.5 |
| Untreated | | November 17, 09 | 56.0 | 48.8 |
| | | February 16, 10 | 54.0 | 52.4 |
| | | March 1, 10 | 51.0 | 47.9 |
| | | April 8-10 | 54.1 | 48.4 |
| Mean LSD for timing at 0.05b | | November 17, 09 | 51.6a | |
| | | February 16, 10 | 53.6a | |
| | | March 1, 10 | 53.1a | |
| | | April 8-10 | 30.5b | |
| Mean LSD for treatment at 0.05b | | Milestone 3.0 oz/A | 49.9a | |
| | | Milestone 7.0 oz/A | 46.8b | |
| | | Milestone 14.0 oz/A | 40.5c | |
| | | Untreated | 51.6a | |

[a] AWWG = Arriba Western Wheatgrass and SLSW = San Luis Slender Wheatgrass.
[b] Means followed by the same letter are not significantly different as determined by the LSD test at 0.05.

# NAPI, A Demonstration of Broadleaf Weed Control in Field Pumpkins with preemergence herbicides on the Navajo Agricultural Products Industry Farm

Richard N. Arnold

## Introduction

Field pumpkin acreage on the Navajo Agricultural Products Industry (NAPI) farm was approximately 2,500 acres. These fields are irrigated by center pivot irrigation. Weeds like redroot and prostrate pigweed, Russian thistle, common lambsquarters, and black nightshade are troublesome weeds that if left uncontrolled can cause yield reductions and harvesting problems.

## Objectives

- Determine herbicide efficacy of selected herbicides for control of broadleaf weeds in field pumpkins.

## Materials and methods

In 2010, a broadleaf weed control demonstration plot was done on NAPI field 8-46B. Demonstration plots were 24 feet wide by 100 feet long. All treatments were applied preemergence on May 19 approximately 4 days after planting. Treatments were incorporated on May 20 by applying 0.5 inch of center pivot applied irrigation. Soil temperature maximum and minimum during application was 71 to 60 degrees F. These fields were then evaluated by Mr. Leon Notah on June 14.

## Results and discussion

***Weed Control and Injury Evaluations:*** No injury was observed from any of the treatments. All treatments except the check gave good to excellent control of redroot and prostrate pigweed (Table 61). Sandea at 0.75 oz/A and Sonalan HFP alone or in combination with Sandea applied at 48 and 48 plus 0.75 oz/A gave poor control of black nightshade. Russian thistle control was poor with Dual mag, Outlook, Sandea and the combination of Sandea plus Sonalan HFP applied at 16, 13, 0.75 and 0.75+48 oz/A. All treatments except the check gave good to excellent control of redroot and prostrate pigweed (Table 61). Sonolan HFP applied at 48 oz/A, and Sandea applied at 0.75 oz/A alone or in combination with Sonolan at 48 oz/A gave poor control of black nightshade and Russian thistle. Dual mag and Outlook applied at 16 and 13 oz/A gave poor control of Russian thistle (Table 61).

**Table 61. Broadleaf weed control in field pumpkins on NAPI field 8-46B, June 14, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate (oz/A) | Weed Control [a,b] | | | | |
|---|---|---|---|---|---|---|
| | | Amare | Amabl | Solni | Saskr | Cheal |
| Dual mag | 16 | 100 | 96 | 85 | 55 | 100 |
| Outlook | 13 | 100 | 98 | 92 | 55 | 100 |
| Sonalan HFP | 48 | 90 | 88 | 75 | 80 | 88 |
| Dual mag+sonalan HFP | 16+48 | 98 | 100 | 90 | 82 | 98 |
| Outlook+sonalan HFP | 13+48 | 100 | 100 | 88 | 80 | 98 |
| Sandea | 0.75 | 98 | 92 | 75 | 60 | 85 |
| Sandea+sonalan HFP | 0.75+48 | 96 | 88 | 72 | 55 | 98 |
| Sandea+dual mag | 0.75+16 | 100 | 100 | 86 | 85 | 98 |
| Sandea+outlook | 0.75+13 | 100 | 100 | 88 | 86 | 98 |
| Weedy check | | 0 | 0 | 0 | 0 | 0 |

[a] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[b] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

## NAPI, A Demonstration of Broadleaf Weed Control in Dry Beans with preemergence herbicides on the Navajo Agricultural Products Industry Farm

Richard N. Arnold

### Introduction

Dry bean acreage on the Navajo Agricultural Products Industry (NAPI) farm was approximately 12,500 acres. These fields are irrigated by center pivot irrigation. Weeds like redroot and prostrate pigweed, Russian thistle, common lambsquarters, and black nightshade are troublesome weeds that if left uncontrolled can cause yield reductions and harvesting problems.

### Objectives

- Determine herbicide efficacy of selected herbicides for control of broadleaf weeds in dry beans.

### Materials and methods

In 2010, a broadleaf weed control demonstration plot was done on NAPI field 2-12. Demonstration plots were 24 feet wide by 100 feet long. All treatments were applied preemergence on June 3 approximately 3 days after planting. Treatments were incorporated on May June 4 by applying 0.5 inch of center pivot applied irrigation. Soil temperature maximum and minimum during application was 81 to 67 degrees F.

### Results and discussion

***Weed Control and Injury Evaluations:*** No injury was observed from any of the treatments. All treatments, except the check, gave excellent control of redroot and prostrate pigweed, black nightshade, and common lambsquarters (Table 62). Russian thistle control was poor with Dual mag and Outlook applied at 21 oz/A.

**Table 62. Broadleaf weed control in dry beans on NAPI field 2-12, June 29, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Treatments | Rate | Weed Control [a,b] | | | | |
|---|---|---|---|---|---|---|
| | (oz/A) | Amare | Amabl | Solni | Saskr | Cheal |
| Dual mag | 21 | 100 | 100 | 96 | 55 | 100 |
| Outlook | 21 | 100 | 100 | 98 | 55 | 100 |
| Valor | 1.5 | 100 | 100 | 98 | 98 | 100 |
| Dual mag+valor | 16+0.75 | 100 | 100 | 100 | 100 | 100 |
| Outlook+valor | 16+0.75 | 100 | 100 | 100 | 100 | 100 |
| Weedy check | | 0 | 0 | 0 | 0 | 0 |

[a] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[b] Amare = redroot pigweed, Amabl = prostrate pigweed, Solni = black nightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

## Microirrigation for Small Farm Plots, Landscapes, and Soil Revegetation Species

**Funds provided by the USDA through the Hatch Program, the State of New Mexico through general appropriations, and the U.S. Bureau of Reclamation's Water Conservation Field Services Program.**

The populations of western U.S. cities have increased dramatically over the past 50 years but available fresh water to supply the rising demand of these populations has remained relatively constant or has decreased. For example, in San Juan County, NM, projected dependable fresh surface water supplies are fully (or overly) appropriated (Lansford, et al., 1988; Belin, et al., 2002) and new, major water storage projects are not planned for the region in the future (Engelbert and Scheuring, 1984). Until San Juan and Animas river water rights issues and legal adjudication proceedings are settled, the quantity of water available for future industrial and urban development, or for sustaining agriculture along these river valleys, is uncertain. While the effects of global warming on future water supplies for the county are also uncertain, most climate change models indicate probable water shortages during late summer due to accelerated snowpack melt earlier in the year from the Rocky Mountains of southwestern Colorado (Strzepek, 1998; Service, 2004; Guido, 2008; Powers, 2009; Clow, 2010) the primary source of the county's fresh water.

In an effort to insure water availability for essential needs, most water purveyors in northern New Mexico have developed water management plans that include incentives, such as increasing-block water rate structures, water use restrictions and/or penalties for water waste, and rebates on purchases of water saving devices, including rain catchment systems. Since outdoor water use can represent up to 60% of total residential water use during summer in some of these municipalities (Vickers, 2001), cash rewards have also been offered for removal of high water-use landscape plants, such as turf and exotic trees. In response, many homeowners and businesses are converting their sprinkler-irrigated grass lawns to drip-irrigated landscapes consisting of native plants or other drought tolerant species suitable to the arid or semi-arid environments of the region.

Due in part to economic necessity and food safety and/or quality concerns, there has been a resurgence of home (or small farm) gardens in northern New Mexico to provide fresh vegetables for the domestic table and for sale at increasing numbers of local farmers markets. In the Four Corners region, for example, in just the last 5 to 10 years, the number of fresh-air markets that sell locally grown produce has increased from just one in Farmington to at least six (two in Farmington and one each in Aztec, Bloomfield, Shiprock, and Durango, CO). The demand for fresh, vine-ripened vegetables and fruits by local restaurants and grocery stores has also increased in the region. Produce sales at farmers markets or to customers elsewhere represent a significant source of supplemental income for many local growers but this production would not be possible in this semi-arid region without supplemental irrigation. In the event of water use limitations, or where expensive domestic water must be used to irrigate landscapes or vegetable gardens, water conserving techniques, such as drip irrigation and efficient irrigation scheduling needs to be implemented in order to minimize water use while sustaining acceptable plant quality, optimum yields and/or economic returns. Compared with sprinkler or flood irrigation, microirrigation has the potential to produce greater yields and/or higher quality of horticultural crops (Bernstein and Francois, 1972; Sammis, 1980; Camp, 1998) on less amounts of water. As water becomes more limited and expensive, drip irrigation will undoubtedly increase in diversified landscapes and on small farms or urban gardens where high value vegetables are produced.

One water conserving measure receiving increased attention throughout the western U.S. is the use of catchment systems that collect and store precipitation runoff from roofs or other hard surfaces. In New Mexico, the City of Albuquerque (2009) began offering rebates for installation of rainwater catchment systems on existing buildings and Santa Fe County (2010) now requires installation of rainwater catchment systems on new residential buildings. If late summer water shortages occur because of accelerated snow melt as predicted by the climate models, the ability to store and use rainwater for irrigating could help mitigate the adverse effects of these shortages on plant growth and yields during a critical time of fruit set and development. Because of the limited capacity and low head (pressure) provided by above-ground storage tanks of typical rainwater catch systems, drip irrigation represents an ideal, efficient way of distributing the water to individual plants within a landscape or vegetable garden. Choosing suitable drip components that function adequately under these low heads (typically less than 10 feet or 4 psi) is problematic, however, since the flow rates specified by the manufacturers of drip tape, drip tubing or plug-in emitters have been measured under higher pressures (10 to 20 psi). It has been observed that some drip emitters, in fact, provide no water flow at all under low pressures and the flow rates of others appear to be far less than specified. While it might be assumed that water application uniformity, and hence overall efficiency, of a microirrigation system would be adversely affected when operated under lower than expected pressures (Smajstria et. al., 1997), this cannot be concluded with certainty since adequate studies designed to identify the functionality of various drip components at low pressures have not been conducted.

Overgrazing and removal of native plants and other vegetation when establishing housing developments, industrial complexes, well sites, and agricultural fields in central and northern New Mexico have left many soils bare and exposed to the erosive forces of water and wind. As a consequence, precious topsoil has been carried away in runoff or dust and sand storms. Major crop losses have occurred on the Navajo Indian Irrigation Project and other farming areas of northwestern New Mexico because of sandblasting damage inflicted to plants by windblown sand, especially in the spring. Onion, small grain, pinto bean, corn, and chile pepper establishment in particular has been adversely impacted. Health concerns due to the potential transport of fertilizers, pesticides (Majewski and Capel, 1996) and disease carrying organisms, such as *Coccidioides immitis* (Arenofsky, 2010) in this windblown sand have also been of great concern to the populace of the Southwest.

One way to reduce wind erosion and dampen its damaging effect on crops is to establish (or reestablish) windbreaks, or natural vegetation buffers, to replace the vegetation that was initially removed or disturbed upwind of the cropped field. In a semi-arid region like northwestern New Mexico, however, water availability is a major limiting factor to the establishment of even native plants, particularly on disturbed soils that have lost their structure and water holding capabilities. Consequently, revegetating these soils may be very difficult, if not impossible, without some supplemental irrigation.

Efficient irrigation scheduling requires accurate estimates of crop water requirements, or evapotranspiration (ET), during each stage of the crops growth cycle. Other factors not being limiting, the ET requirements of a given species are related to climatic factors and the growth stage or size of the plant. Since these factors vary from year to year and from place to place, crop ET measurements taken during a particular time period at one location (usually a research site) may not be useful in providing accurate estimates of the same crop's ET at a different location, particularly if the weather (and/or growing season) at the site of interest is significantly different than that of the research site. By correlating measured ET to a calculated reference ET ($ET_{REF}$), formulated with weather data from the research site, crop coefficients ($ET/ET_{REF}$) have been developed to help provide more accurate estimates of actual crop ET at any site where local weather parameters are available. In New Mexico, a network of remote, automated weather stations provides the data necessary to calculate $ET_{REF}$ at various locations. These weather data are downloaded daily to a central computer at the New Mexico Climate Center (NMSU main campus) and are available online (along with the $ET_{REF}$ calculations) at http://weather.nmsu.edu. Locally calibrated crop coefficient ($K_C$) values and irrigation scheduling spreadsheets for many agricultural crops and some turfgrasses are also available at this web site. Additional $K_C$s for most vegetable and agricultural crops can be found in the United Nations Food and Agriculture FAO-56 publication: http://www.fao.org/docrep/X0490E/x0490e00.htm#Contents. These are somewhat general in nature and have not been locally calibrated.

Most published $K_C$ values were formulated using measured ET from non-stressed vegetable and agronomic crops whose growth and production potential was not limited by water or other stress factors. The effects on crop growth of ET values lower than those predicted by the $K_C$ are not as well publicized. An understanding of the relationships between ET and crop growth (crop production functions) will become much more important as water available for irrigation becomes more limited. In landscapes, irrigating at a level to satisfy maximum plant ET is not necessary since plant quality, rather than plant growth rate or production (yield) potential, is the factor of primary concern. Therefore, in the interest of water conservation, it's more desirable to provide ET at the minimum level required for acceptable quality of the plant rather than at the plant's maximum ET potential.

In past experiments conducted at NMSU's Agricultural Science Center at Farmington (ASCF), measured ET and irrigation data were used to formulate water production functions and $K_C$s for sprinkler irrigated alfalfa, corn, potatoes, small grains, pinto beans, chile peppers, tomatoes, turfgrass, and other crops. These experiments are continuing, in an effort to identify the yield/water relations and consumptive use requirements of other plant species at the site, including drip irrigated garden vegetables and landscape plants. This report summarizes the progress of these studies for 2010.

***Climate Data and Reference ET***

In addition to weather data recorded manually from the National Weather Service station and summarized in the first section of this annual report, an automated Campbell Scientific, Inc. Model CR10 weather station has been operating at the ASCF since 1985 (Figure 2). Climatological data, including air temperature, relative humidity, solar radiation, wind speed and direction, and precipitation are recorded by this station and hourly readings, as well as daily summaries, are available from the NMCC website (http://weather.nmsu.edu/). These data were used to calculate $ET_{REF}$ using a modified FAO-24 Penman equation (PET), a standardized Penman-Monteith (P-M) grass reference equation ($ET_{OS}$), and a P-M alfalfa referenced ($ET_{RS}$) equation (Allen, et al. 1998). The P-M equations, which are also referred to as $ET_{SHORT}$ (grass) and $ET_{TALL}$ (alfalfa) are considered the standard methods for developing crop coefficients for narrow-leaf and broad-leaf plants, respectively, by the American Society of Agricultural and Biological Engineers (ASABE), American Society of Civil Engineers (ASCE), and the Irrigation Association (IA). The use of these standards should help mitigate the problems that have been encountered in KC transferability caused by the use of different empirical methods used to derive $ET_{REF}$ at various research sites in the past.

In 2010, cumulative $ET_{RS}$, PET, and $ET_{OS}$ at the Farmington ASC research site totaled 83, 76, and 60 inches, respectively (Figure 3). During most of the active growing season (April 15 to September 15), daily $ET_{RS}$, PET, and $ET_{OS}$ averaged 0.35, 0.32, and 0.26 inch, respectively (Figure 4).

**Figure 2. Automated New Mexico Climate Center (NMCC) weather station; NMSU Agricultural Science Center at Farmington, NM. Winter 2009.**

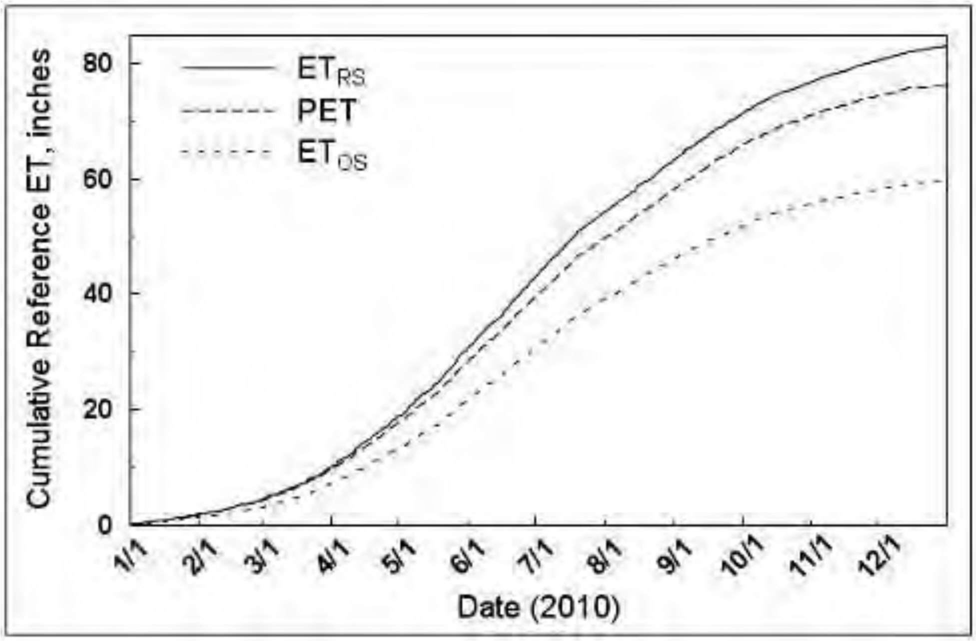


**Figure 3.** **Cumulative, 2010 FAO-56 Penman-Monteith standardized reference ET based on alfalfa ($ET_{RS}$) and grass ($ET_{OS}$) as compared to the FAO-24 modified Penman method (PET); NMSU Agricultural Science Center at Farmington, NM. 2010.**

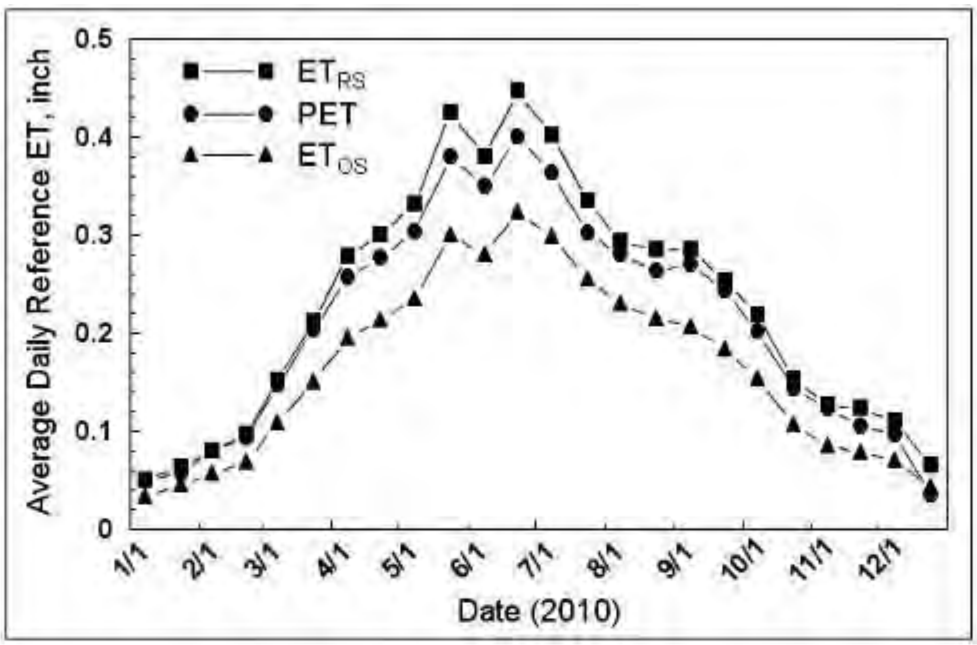


**Figure 4.** **Average daily 2010 FAO-56 Penman-Monteith standardized reference ET based on alfalfa ($ET_{RS}$) and grass ($ET_{OS}$) as compared to the FAO-24 modified Penman method (PET). Note: each point on the graph represents the daily average from half-month periods during the year; NMSU Agricultural Science Center at Farmington, NM. 2010.**

## Xeriscape Demonstration Garden

**Dan Smeal**

### Abstract

A plant demonstration garden, which exhibits more than 100, mostly native, xeric-adapted plant species that have potential for use in urban xeric landscapes, was maintained for the eighth year at the science center. The garden is split into four differentially drip-irrigated quadrants to evaluate the growth and quality of each species at varying levels of water application. From 2004 through 2007, the quadrants were irrigated once per week at rates equal to zero, 20, 40, and 60% of $ET_{RS}$ with corrections for canopy area. In 2008 and 2009, the plants were irrigated weekly from about May 1 through September with water volumes of zero, 4, 8, and 12 gallons per week (gpw) at the no, low, medium, and high treatment levels, respectively. Total annual rainfall from 2004 through 2009 averaged 7.56 inches. In 2010, water application levels were decreased to about 3.0, 5.5, and 8.0 gpw per plant in the low, medium, and high irrigation treatments, respectively and total water applied per plant from May 1 to October 15 were 0, 84.1, 133.6, and 176.3 in the no, low, medium, and high treatments, respectively. Total annual precipitation in 2010 was 9.8 inches. Most species exhibited acceptable plant quality when irrigated at the low and medium irrigation levels. A list of all species is presented in this report and on the Agricultural Science Center's web site (http://farmingtonsc.nmsu.edu) information and plant photographs are also included on the web site and relative water requirements of each species are available in the ASCF 2007 Annual Report.

### Introduction

Because of ever-increasing demand on the limited water resources of the west, many municipalities in the region are imposing limits or placing restrictions on the volume of water that can be used for irrigating landscapes. Research studies and surveys have suggested that up to 70% of the water now used for landscape irrigation, which now accounts for about 50% of all domestic water use in urban areas of the southwest U.S. during the summer months, could potentially be saved by increasing irrigation efficiencies and by replacing landscapes consisting of imported turfgrass and non-native flowers and trees, with species more suited to the natural, semiarid environment. Irrigation evaluations conducted at the ASCF from 2004 through 2010, in fact, indicate that a well-designed xeriscape (60% canopy cover) can be maintained with less than 20% of the water required for maintaining acceptable quality of a non-native cool season turfgrass lawn.

Water savings are not achieved through plant selection alone. Irrigation system efficiencies must be maximized and irrigation schedules modified to compensate for the lower water requirements (or ET) of the selected species. To accomplish an efficient irrigation schedule, the irrigator must: (1) know the output of his irrigation system, (2) have knowledge of the water holding characteristics of the soil, and (3) have ET estimates for the plants in the landscape. This demonstration/research project was implemented to exhibit drought-tolerant plant species that may be suitable for northern New Mexico landscapes and to quantify the water required to maintain acceptable quality of these species.

## Objectives

- Establish and maintain a xeric plant demonstration/research garden to serve as an educational exhibit of various drought-tolerant plant species that may be suitable for local landscapes.
- Evaluate the growth and quality of xeric adapted plant species at various levels of microirrigation and quantify the levels of water required to maintain satisfactory aesthetic quality of each species.
- Develop crop coefficients and irrigation scheduling recommendations for xeric landscapes based on plant quality/irrigation relationships observed for various species in a xeric plant demonstration/research garden.

## Materials and methods

A plot area 160 feet long by 80 feet wide (12,800 $ft^2$ or 0.3 acres) was prepared for planting in early spring, 2002. The plot area was disked, spring tooth harrowed, rototilled, and spike-tooth harrowed in mid-April. After consulting various native plant and xeriscaping references, suitable plants were chosen for inclusion in the garden. Plants were obtained from different sources and were planted on various dates between April 25 and September 5, 2002. Additional plants were added to the garden in 2009 and 2010. Specific planting methods, number of plants, and sources of specimens were presented in the 2002 Annual Progress Report (April 2003) and can be accessed through the ASC-Farmington web site (http://farmingtonsc.nmsu.edu). The plot was split into four equal quadrants of 40 feet by 80 feet each. A minimum of four specimens of each species was obtained so that at least one individual of each could be planted in each of the four quadrants (Figure 5). During the summer of 2003, a 3-zone, drip irrigation system was installed in the garden and was used from 2004 through 2010 to provide different irrigation treatments to each of three quadrants. Plants in the fourth quadrant received only ambient precipitation.

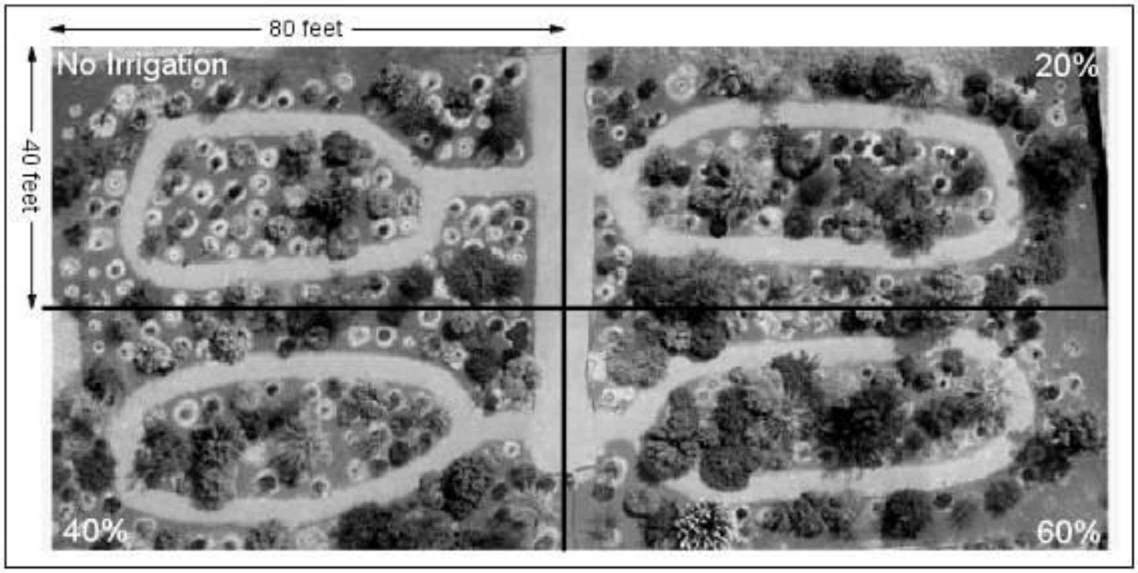


**Figure 5. Overhead view of the xeric plant demonstration/research garden showing the four irrigation treatment (% of $ET_{RS}$) quadrants; NMSU Agricultural Science Center at Farmington, NM. 2010.**

Drip irrigation components in each zone consisted of a main shut off (ball) valve, a main pressure regulator, in-line main filter, 1-inch polyethylene pipe (PE) main line, ½-inch PE laterals (Figure 6, left), Xeribird-8 multi-outlet, pressure-compensating emitter manifolds (Figure 6, right), 1-gal/hour emitters, and ¼-inch PE distribution tubing. Enclosed basins with raised dikes were formed around each plant to hold irrigation water or precipitation. During 2003, ovular, 3-foot wide pathways were formed in each garden quadrant using gray crusher fines over weed barrier and a 10-foot wide, gray crusher-fine pathway separated the north and south halves of the garden (Figure 5). In February and March, 2004, red, crushed lava rock was spread to a depth of about 2 inches in the open areas between plants but outside of the basin dikes to provide weed-inhibiting mulch.

***Weed Control***

Weeds not inhibited by the mulch were controlled by hand-hoeing or spot treating with a spray bottle containing a 2%-glyphosate solution.

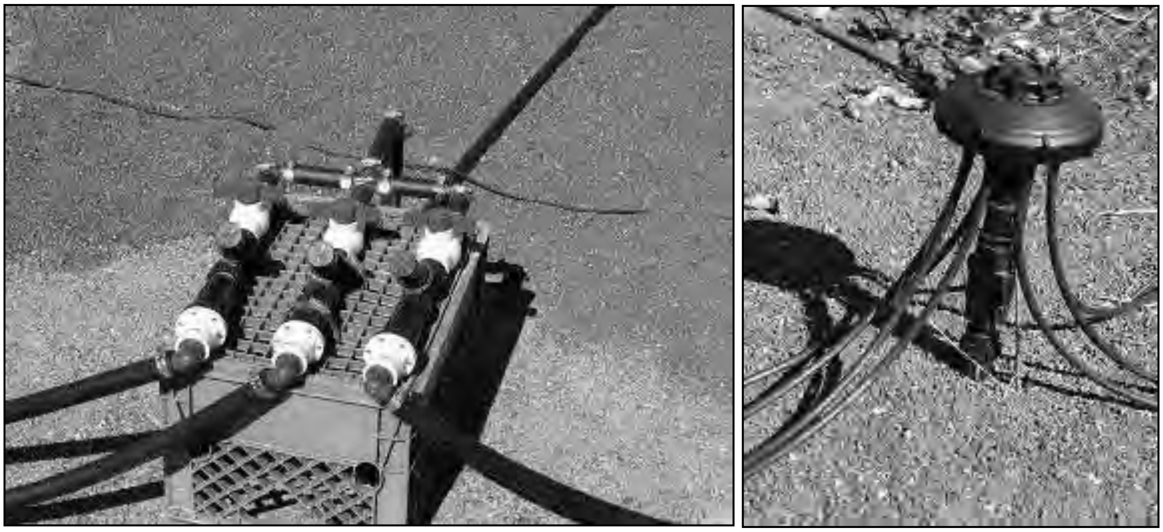

**Figure 6. Photos of the ball valves, filters, pressure regulators, and 1-inch mainline (left) and the 8-outlet distribution manifolds (right) used for irrigating the xeric plant demonstration garden; NMSU Agricultural Science Center at Farmington, NM. 2010.**

***Irrigations***

During establishment (2002 and early 2003) the plants were irrigated with between 1 and 3 gallons of water per week. Irrigation frequency and amount (within the 1- to 3-gallon range) varied with plant size, age and atmospheric demand. Generally, newly planted, specimens from 2 to 3 inch pots were irrigated every other day with about 1 quart of water per application during the first few weeks. As the plants became established and new growth was evident, irrigation frequency was reduced to once or twice per week and irrigation volume increased to between 1 and 3 gallons per application.

Beginning in late 2003, irrigations were scheduled in the respective irrigation treatments to replace 0, 20, 40, and 60% of reference $ET_{RS}$ over a given canopy area about every 7 to 10 days. Equation 1 was used to convert inches of $ET_{RS}$ to gallons of water per plant (gpp) for weekly irrigations.

$$I = ET_{RS} \times K_L \times 0.623 \times A_C \quad (1)$$

Where:

| | |
|---|---|
| I | = irrigation (gallons per plant [gpp]) |
| $ET_{RS}$ | = reference ET ($ET_{TALL}$) from the NMCC website (inches per week) |
| $K_L$ | = landscape coefficient (0.0, 0.2, 0.4, or 0.6 for respective treatment) |
| 0.62 | = (constant) gallons of water to cover 1 $ft^2$ to a depth of 1 inch |
| $A_C$ | = plant canopy area ($ft^2$) |

Since all plants within a given quadrant received the same amount of water, a gross average canopy area (AC), representing the mean of all plants within the quadrant, was used for irrigation scheduling. Since the canopy shape of most plants was roughly circular, AC in square feet was calculated from measured plant diameter in feet (D) using the ‗area of a circle' formula (Equation 2).

AC = D2 x 0.785 ........................................................................................... (2)

Irrigation runtimes were adjusted to apply the appropriate irrigation treatment volume using Equation 3.

Runtime (minutes) = I x FR x 60 .................................................................... (3)

Where:

I = irrigation (gpp)

FR = flow rate of emitter (all emitters had a 1 gph flow rate)

60 = minutes/hour

Plant characteristics for aesthetic appeal (including growth rate and form, flowering and fruiting, color, odor, overall shape and appearance, etc.) were observed throughout the growing season. Several photographs were also taken for archiving and to assist in the evaluations. Aerial photos were taken to evaluate the relationship between actual plant canopy area and irrigation.

## Results and discussion

Reference ET ($ET_{RS}$) totaled 56.0 inches between May 1 and October 15, 2010 (Table 63). Total seasonal irrigation applied to the plants at the zero, low, medium, and high treatment levels during this time period were 0, 84.1, 133.6, and 176.3 gallons per plant, respectively, and precipitation totaled 4.55 inches (Table 63).

**Table 63. Dates and amounts of irrigation applied to four irrigation treatments and monthly precipitation in the xeric plant demonstration garden; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| | $ET_{RS}$ | Irrigation (gal/plant/week) | | | | Monthly Precipitation | |
|---|---|---|---|---|---|---|---|
| Date | (in) | High (8) | Medium (5.5) | Low (3) | None (0) | Date | (in) |
| 5/10 | 3.18† | 2.00 | 2.00 | 2.00 | 0 | Jan | 1.34 |
| 5/14 | 1.20 | 8.00 | 6.00 | 4.00 | 0 | Feb | 0.95 |
| 5/21 | 2.27 | 8.00 | 5.50 | 3.00 | 0 | Mar | 0.82 |
| 5/28 | 3.38 | 4.08 | 2.52 | 2.33 | 0 | Apr | 0.26 |
| 5/30 | 0.99 | 1.33 | 1.33 | 1.33 | 0 | May | 0.10 |
| 6/4 | 1.85 | 8.00 | 5.50 | 3.00 | 0 | June | 0.10 |
| 6/7 | 1.26 | 2.17 | 2.17 | 2.17 | 0 | July | 0.65 |
| 6/11 | 1.77 | 8.00 | 5.50 | 3.00 | 0 | Aug | 2.50 |
| 6/18 | 2.50 | 8.00 | 5.50 | 3.00 | 0 | Sep | 0.84 |
| 6/25 | 3.25 | 8.00 | 5.50 | 3.00 | 0 | Oct | 1.32 |
| 7/1 | 2.51 | 4.08 | 4.08 | 4.08 | 0 | Nov | 0.12 |

| Date | $ET_{RS}$ (in) | Irrigation (gal/plant/week) High (8) | Medium (5.5) | Low (3) | None (0) | Monthly Precipitation Date | (in) |
|---|---|---|---|---|---|---|---|
| 7/2 | 0.40 | 8.00 | 5.50 | 3.00 | 0 | Dec | 0.78 |
| 7/9 | 2.87 | 8.00 | 5.50 | 3.00 | 0 | | |
| 7/13 | 1.53 | 3.00 | 3.00 | 3.00 | 0 | | |
| 7/16 | 1.22 | 8.00 | 5.50 | 3.00 | 0 | | |
| 7/20 | 1.71 | 2.00 | 8.00 | 8.00 | 0 | | |
| 7/22 | 0.68 | 8.00 | 5.50 | 3.00 | 0 | | |
| 7/29 | 2.16 | 7.08 | 0.00 | 0.00 | 0 | | |
| 7/30 | 0.31 | 0.92 | 5.50 | 3.00 | 0 | | |
| 8/6 | 1.76 | 8.00 | 5.50 | 3.00 | 0 | | |
| 8/13 | 2.06 | 5.75 | 5.50 | 3.00 | 0 | | |
| 8/16 | 1.06 | 2.25 | 0.00 | 0.00 | 0 | | |
| 8/26 | 2.83 | 8.00 | 5.50 | 3.00 | 0 | | |
| 9/3 | 2.33 | 5.50 | 5.50 | 3.17 | 0 | | |
| 9/10 | 2.12 | 2.67 | 0.00 | 0.00 | 0 | | |
| 9/15 | 1.28 | 8.00 | 5.50 | 3.00 | 0 | | |
| 9/22 | 2.04 | 5.50 | 5.50 | 3.00 | 0 | | |
| 10/1 | 2.00 | 8.00 | 5.50 | 3.00 | 0 | | |
| 10/8 | 1.74 | 8.00 | 5.50 | 3.50 | 0 | | |
| 10/15 | 1.32 | 8.00 | 5.50 | 2.50 | 0 | | |
| **Total** | **55.6** | **176.33** | **133.6** | **84.081** | **0** | | **9.8** |

†$ET_{RS}$ from May 1 thru May 9.

A complete listing of the plants in the Xeriscape demonstration garden is shown in Table 64. Suggested landscape coefficients ($K_L$) for scheduling irrigations on each species, based on quality observations at each irrigation level, are shown in the 2007 Annual Report which is available from the ASC-Farmington website; http://farmingtonsc.nmsu.edu. Photographs and brief descriptions of the plants can also be viewed by clicking on the Xeriscape links from the website.

**Table 64. List of species planted and surviving in the xeric plant demonstration garden. NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Species Name | Common Name | 2010 Inventory† No | Low | Med | Hi |
|---|---|---|---|---|---|
| *Achillea millefolium* | white yarrow | | | x | x |
| *Achnatherum hymenoides* | indian ricegrass | x | | x | |
| *Agastache foeniculum* | blue giant hyssop | | x | | x |
| *Agastache ruprestris* | licorice hyssop | | x | x | x |
| *Agave utahensis* | Utah agave | x | x | x | x |
| *Agropyron smithii* | western wheatgrass | | x | x | x |
| *Amelanchier utahensis* | Utah serviceberry | x | x | x | x |

| Species Name | Common Name | —— 2010 Inventory† —— | | | |
|---|---|---|---|---|---|
| | | No | Low | Med | Hi |
| *Anemopsis californica* | yerba mansa | | x | | x |
| *Angropogon gerardii* | big bluestem | new | new | new | new |
| *Aquilegia sp.* | columbine | 09 | 09 | 09 | 09 |
| *Armeria maritima* | seathrift | | | | |
| *Artemisia abrotanum* | southernwood | | x | x | x |
| *Artemisia frigida* | fringed sagewort | x | x | x | x |
| *Artemisia ludoviciana* | prairie sagewort | x | x | x | x |
| *Artemisia nova* | black sage | | | x | x |
| *Artemisia tridentata* | big sagebrush | x | x | x | x |
| *Asclepias tuberosa* | butterfly weed | | | x | |
| *Atriplex confertifolia* | shadscale saltbush | | | | |
| *Berberis fremontii* | Fremont barberry | x | x | x | x |
| *Berlandiera lyrata* | chocolate flower | x | x | x | x |
| *Brickellia californica* | California bricklebush | x | x | x | x |
| *Buddleja davidii* | butterfly bush | x | x | x | x |
| *Caesalpinia gilliesii* | bird of paradise bush | | x | x | |
| *Callirhoe involucrata* | wine cups | x | x | x | |
| *Calylophus berlandieri* | Berlandieri sundrops | | x | x | x |
| *Campsis radicans* | trumpet vine | | | x | x |
| *Caragana arborescens* | Siberian peashrub | x | x | x | x |
| *Caryopteris clandonensis* | blue mist spirea | x | x | x | x |
| *Centranthus ruber* | Jupiter‘s beard | | | x | x |
| *Cerastium tomentosum* | snow in summer | | x | x | x |
| *Cercocarpus ledifolius* | curlleaf mountain mahogany | x | x | x | x |
| *Cercocarpus montanus* | true mountain mahogany | x | x | | x |
| *Chamaebatiaria millefolium* | fernbush | x | x | x | x |
| *Chilopsis linearis* | Desert willow | x | x | x | x |
| *Chrysanthemum sp.* | Crete white | | | | |
| *Chrysothamnus nauseosus* | rubber rabbitbrush | x | x | x | x |
| *Coreopsis lanceolata* | lanceleaf coreopsis | | x | x | x |
| *Cowania mexicana* | cliffrose | x | x | | x |
| *Cylindropuntia imbricata* | tree cholla | x | x | x | |
| *Datura metaloides* | sacred datura | | x | x | x |
| *Delosperma cooperi* | purple iceplant | 10 | 10 | x | 10 |
| *Delosperma nubigenum* | yellow iceplant | | | | |
| *Echinacea purpurea* | purple coneflower | | | | x |
| *Engelmannia pinnatifida* | Engelmann's daisy | 10 | 10 | 10 | 10 |
| *Ephedra viridis* | Mormon tea | | | | |
| *Erigonum umbellatum* | sulfur flower buckwheat | 10 | 10 | 10 | 10 |
| *Eriogonum jamesii* | James‘ buckwheat | x | x | x | x |
| *Euphorbia myrsinites* | yellow euphorbia | x | | x | x |
| *Fallugia paradoxa* | Apache plume | x | x | x | x |

| Species Name | Common Name | —— 2010 Inventory† —— | | | |
|---|---|---|---|---|---|
| | | No | Low | Med | Hi |
| *Fendlera rupicola* | cliff fendler bush | 09 | 09 | 09 | 09 |
| *Festuca glauca* | blue fescue | | x | x | x |
| *Forestiera neomexicana* | New Mexico olive | x | x | x | x |
| *Gaillardia aristata* | blanket flower | | x | x | x |
| *Gaura lindheimeri* | gaura | | | | |
| *Gypsophilia repens* | creeping baby's breath | 10 | 10 | 10 | 10 |
| *Helianthemum nummularium* | sunrose | | x | x | x |
| *Helianthus maximiliani* | Maximilian sunflower | x | x | x | x |
| *Helichrysum angustifolium* | curry plant | | x | x | |
| *Hesperaloe parviflora* | red yucca | x | x | x | x |
| *Heuchera sanguinea* | coral bells | | | x | x |
| *Hylotelephium telephium* | autumn joy sedum | | x | x | x |
| *Hyssopus officinalis* | hyssop | 10 | 10 | 10 | 10 |
| *Ipomopsis aggregata* | scarlet gilia | | | x | |
| *Juniperus scopulorum* | Rocky Mountain juniper | x | x | x | x |
| *Kniphofia uvaria* | red-hot poker | | x | x | |
| *Koelreuteria paniculata* | goldenrain tree) | x | x | x | x |
| *Krascheninnikovia lanata* | winterfat | x | x | x | x |
| *Lavandula angustifolia* | English lavender | 10 | 10 | 10 | 10 |
| *Liatris punctata* | dotted gayfeather | x | | x | |
| *Limonium sp.* | statice | 09 | 09 | 09 | 09 |
| *Linum perenne* | perennial blueflax | | x | x | x |
| *Lychnis chalcedonica* | Maltese cross | | | | |
| *Lycium pallidum* | pale wolfberry | x | x | x | x |
| *Malus sp.* | flowering crabapple | x | x | Np | Np |
| *Melampodium leucanthum* | blackfoot daisy | | | | |
| *Mirabilis multiflora* | giant four o‘clock | | x | x | x |
| *Nassella tenuissima* | threadgrass | | x | x | x |
| *Nolina microcarpa* | beargrass | x | x | x | x |
| *Oenothera caespitosa* | tufted evening primrose | x | x | | |
| *Oenothera missouriensis* | Ozark sundrops | | x | x | |
| *Oenothera organensis* | Organ Mountain evening primrose | x | x | | x |
| *Oenothera speciosa* | Mexican evening primrose | | | x | |
| *Parthenium incanum* | mariola | x | x | x | x |
| *Penstemon “abuelitas”* | abuelita penstemon | x | x | | |
| *Penstemon ambiguus* | bush penstemon | x | x | x | x |
| *Penstemon angustifolia* | narrow-leaf beardtongue | x | x | x | x |
| *Penstemon barbatus* | scarlet bugler penstemon | x | x | x | x |
| *Penstemon clutei* | Sunset Crater beardtongue | x | x | x | x |
| *Penstemon eatonii* | firecracker penstemon | | x | | |
| *Penstemon palmeri* | Palmer penstemon | x | x | x | x |
| *Penstemon pinifolius* | pineleaf penstemon | | x | x | x |

| Species Name | Common Name | —— 2010 Inventory† —— | | | |
|---|---|---|---|---|---|
| | | No | Low | Med | Hi |
| *Penstemon pseudospectabilis* | desert penstemon | Np | Np | Np | x |
| *Penstemon strictus* | Rocky Mountain penstemon | | x | x | x |
| *Penstemon superbus* | superb beardtongue | 10 | 10 | 10 | 10 |
| *Peraphyllum ramosissimum* | squaw apple | x | x | | x |
| *Perovskia atriplicifolia* | Russian sage | x | x | x | x |
| *Pinus nigra* | black pine | x | x | x | x |
| *Potentilla fruticosa* | native potentilla | | x | x | x |
| *Potentilla thurberii* | red cinquefoil | | | x | x |
| *Prosopis pubescens* | screwbean mesquite | x | x | x | |
| *Prunus besseyi* | western sandcherry | x | x | x | x |
| *Prunus domestica „Stanley"* | Stanley dwarf prune | x | x | Np | Np |
| *Prunus tomentosa* | Nanking cherry | 10 | 10 | 10 | 10 |
| *Psorothamnus scoparius* | broom dalea | 10 | 10 | 10 | 10 |
| *Ratibida columnifera* | prairie coneflower | x | | | x |
| *Rhus trilobata* | three-leaf sumac | x | x | x | x |
| *Rhus trilobata pilosissima* | pubescent squawbush | x | x | x | x |
| *Ribes aureum* | golden currant | x | x | x | x |
| *Robinia neomexicana* | New Mexico locust | x | x | x | x |
| *Rosa woodsii* | Woods' rose | 10 | 10 | 10 | 10 |
| *Rosmarinus officianalis* | upright rosemary | | x | x | |
| *Salvia greggii* | cherry sage | | x | | x |
| *Salvia greggii* var. ‗Navajo Purple' | cherry sage ' Navajo purple' | | | | |
| *Salvia penstemonoides* | big red sage | 09 | 09 | 09 | 09 |
| *Salvia pinguifolia* | rock sage | x | x | x | x |
| *Sedum spurium* | dragon's blood sedum | | x | x | x |
| *Spartium junceum* | Spanish broom | | x | x | x |
| *Sphaeralcea ambigua* | desert globemallow | x | x | x | |
| *Sporobolus wrightii* | giant sacaton | x | x | x | x |
| *Stachys byzantina* | lamb's ear | | x | x | x |
| *Stanleya pinnata* | prince's plume | | | | |
| *Syringa vulgaris* | lilac | 10 | 10 | 10 | 10 |
| *Teucrium arogrium* | Greek germander | | | x | x |
| *Verbena macdougalii* | western spike verbena | | x | | x |
| *Yucca baccata* | banana yucca | x | x | | x |
| *Yucca elata* | soaptree yucca | x | x | x | |
| *Zauschneria californica* | hummingbird trumpet | | | | x |
| *Zinnia grandiflora* | desert zinnia | x | x | x | x |

†'x' indicates the plant is alive in the respective quadrant (No, Low, Medium, or High Irrigation); blank spaces indicate lack of survival; 09 and 10 indicate new plantings in 2009 and 2010, respectively; Np - species was never planted in that quadrant (donations).

# Evaluation of Drip Irrigation Emitters at Low Water Pressure

Dan Smeal

## Abstract

Collecting rainwater from rooftops for use in irrigating gardens or landscapes has been receiving increased attention in New Mexico, in recent years. While drip irrigation represents an efficient method of distributing this collected rainwater to plants, it is uncertain which drip components (e.g. emitters) will function satisfactorily at the low, gravity pressures provided by rain barrel systems. This study was implemented to evaluate the performance of selected drip irrigation point source emitters and three drip lines at water pressures less than those specified or recommended by the drip component manufacturer or dealer. Flow rates were measured from 17 different models of point source emitters in two separate tests and from three models of drip line with built in emitters in the latter test. A low water pressure of about 2.5 psi was maintained during the tests from an elevated water barrel. Application uniformity (AU) for each emitter model was calculated by subtracting the coefficient of variability (standard deviation ÷ the mean of replication flow rate measurements [cv]) from 1.0. Measured flow rates of all emitters were lower than the manufacturer's specified flow rates but AU values greater than 0.85 were exhibited by about 1/3 of the emitters in the tests.

## Introduction

Rainwater catchment systems that collect and store precipitation runoff from roofs or other hard surfaces are becoming more popular in New Mexico now that guidelines have been prepared by the Office of the State Engineer (2009). The City of Albuquerque (2009) began offering rebates for installation of rainwater catchment systems on existing buildings and Santa Fe County (2010) now requires installation of rainwater catchment systems on new residential buildings. Drip irrigation represents an ideal, efficient way of distributing harvested rainwater from elevated tanks to plants within a landscape or vegetable garden. Choosing suitable drip components that function adequately under the low heads (typically less than 10 feet or 4 psi) provided the tanks is problematic, however, since the flow rates specified by the manufacturers of drip tape, drip tubing or plug-in emitters have been measured under higher pressures (10 to 20 psi). It has been observed that some drip emitters, in fact, provide no water flow at all under low pressures and the flow rates of others appear to be far less than specified. While it might be assumed that water application uniformity, and hence overall efficiency, of a microirrigation system would be adversely affected when operated under lower than expected pressures (Smajstria et. al., 1997), this cannot be concluded with certainty since adequate studies designed to identify the functionality of various drip components at low pressures have not been conducted. This study was implemented to evaluate the effects of low pressures on the output and application efficiency of various microirrigation components so that intelligent recommendations can be provided to the increasing number of gardeners and small-plot farmers that want to use rainwater catchment systems.

**Objective**

- Evaluate the water flow rate and application uniformity of selected point source and line source drip emitters at pressures lower than those specified or recommended by the manufacturers.

**Materials and methods**

Two separate studies were undertaken during 2010 to evaluate the flow rates and application uniformities of various drip emitters at low pressures. The water source for the studies was an elevated water tank in which the water level was maintained at a height of approximately 6 feet above the drip lines with a pressurized water line and float valve. The first evaluation was conducted between June 16 and June 24, 2010. Point source drip emitter flow rates were measured from two, 107-foot long, ½-inch (nominal) polyethylene (PE) drip lines. The actual inside diameter (ID) of one line was 0.700 inch (Set 1) and the ID of the other was 0.620 inch (Set 2). Seventeen different models of emitters (Table 65) were spaced 18 inches apart in four replications along each line: Rep. 1; 0 to 25.5 ft, Rep. 2; 25.5 to 51 ft, Rep. 3; 51 to 76.5 ft, and Rep. 4; 76.5 to 102 ft away from a 6-foot long section of ¾-PE that delivered water to the drip line from the source. The lines, which were evaluated separately, were hung near ground level from a wire mesh fence at the study site and slope was near zero from the beginning to end of the drip line. After the line was filled and pressured up, a small glass beaker was used to catch water from emitters for a timed period (usually between 1 to 4 minutes). Water was poured from the beaker into a small graduated cylinder for measurement in milliliters (ml). Flow rate in ml per second was converted to gallons per hour (gph) using an appropriate conversion factor (ml/sec x 0.95).

The second evaluation was performed in August 2010 and consisted of 9, 51 foot long drip lines. Four of the lines were ½ inch (nominal) PE, two each of those described above with the same point source emitters (Table 65). The other five lines had built-in emitters (line source). Four of these lines were drip tubing: two were ½ inch brown-colored PC (0.700 inch ID) with a 12-inch emitter spacing and the other two were ½-inch nominal (0.620 inch ID) black colored with a 24 inch emitter spacing. The remaining line was a 0.625 inch ID drip tape (John Deere Ro-Drip) with an emitter spacing of 8 inches (Table 65). All lines were connected by a ¾-inch header (no footer) and were run simultaneously during the evaluation. There were two replications of 17 different models of emitters in each of the point source drip lines (Rep. 1; 0 to 25.5 ft, and Rep. 2; 25.5 to 51 ft from the header). The lines were laid out at a line spacing of about 3 ft on level, rototilled and harrowed ground. Small depressions were dug into the soil under each point source emitter and under selected line source emitters at various distances from the header to collect water from the emitters without disturbing the drip lines. The water source, water measurement procedures, and flow rate determinations were as previously described for evaluation 1. Application uniformity (AU) for each model emitter was inferred by calculating a coefficient of uniformity value (*cv*), or standard deviation ÷ mean flow rate of all replications, and then subtracting *cv* from unity (1 - *cv*) so that decimal values closest to 1 indicate best AU.

***Statistical Analyses***

A two-way analysis of variance (ANOVA) procedure (CoStat 6, 2001) with lateral length and pipe ID as main factor and sub factor, respectively, was used to determine significant effects of these two factors on the flow rate of each point source emitter model. Replications (4 per 100-foot lateral and 2 per 50-foot lateral [replicated twice]) were the different sections of each PE lateral. If emitter flow rates appeared to decrease with increased distance (i.e. between reps) from headers, regression procedures were used to determine if the relationship was significant. A simple mean and *cv* was calculated from several emitter flow measurements along the line source drip lines and where appropriate, regression analyses was used to describe potential linear relations between emitter flow rate and emitter distance from header.

**Table 65. Drip emitter (or drip line) models included in the low-pressure (2.5 psi) evaluation with manufacturer specified flow rates and recommended minimum operating water pressures. NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Emitter Model (or Part Number) | Manufacturer's Specified Flow Rate (gph) | Manufacturer's Recommended Pressure (psi) | |
|---|---|---|---|
| | | Working[a] | Minimum |
| D001 | 1.0 | 25 (PC) | 7 |
| D002 | 2.0 | 25 (PC) | 7 |
| D004 | 3.3 | 25 (PC) | 7 |
| D006 | 1.0 | 25 (PC) | 8 |
| D012 | 1.0 | 20 (NC) | 10 |
| D013 | 2.0 | 20 (NC) | 10 |
| D021 | 1.0 | 20 (NC) | 10 |
| D022 | 2.0 | 20 (NC) | 10 |
| D023 | 4.0 | 20 (NC) | 10 |
| D031 | 0 - 10.0 | n.s. | 10 |
| D076 | 1.0 | 30 (PC) | 10 |
| D077 | 2.0 | 30 (PC) | 10 |
| D078 | 4.0 | 30 (PC) | 10 |
| D080 | 1.0 | 25 - 30 (PC) | 7 |
| PC-10-SP-B | 1.0 | 25 (PC) | 15 |
| PC-20-SP-B | 2.0 | 25 (PC) | 15 |
| PC-40-SP-B | 4.0 | 25 (PC) | 15 |
| DL053 | 1.0 | 45 (PC) | 10 |
| DL079 | 1.0 | n.s. (PC) | n.s. |
| T015 | 0.27 (40 gph/100 ft) | 10 (n.s.) | n.s. |

[a]PC indicates a pressure compensating emitter; NC indicates a non-pressure compensating emitter. n.s. - pressure not specified.

**Results and discussion**

No significant difference (Tukey's Honestly Significance Difference Test at 0.05 significance level) was found between measured flow rates at the two different PE pipe IDs for all emitters except model D012 (Table 66). With the exception of this emitter, the flow rate measurements from the 0.610 inch ID PE and 0.700 inch ID PE were combined in the calculation of average flow rates for each emitter. There was a significant difference between average flow rates for each emitter measured from the different lateral lengths. The mean flow rates from the 50 foot laterals were 1.90 times (Emitter D076) to 5.56 times (Emitter D080) greater than those of the same emitter from the 100 foot laterals. In all cases but one (Emitter D076 on the 50 foot lateral), measured flow rate was less than the manufacturer's specified flow rate (MSFR) at the recommended pressure for each emitter. Average flow rates of the point source emitters ranged from a low of 0.063 gph for emitter D021 (100-foot lateral) to a high of 3.13 gph for emitter D078 (50-foot lateral), 6.3% and 78.2%, respectively, of the MSFR (Table 66.). Emitter D012 exhibited the greatest AU (1 - *cv*) from both the 100-foot lateral (0.700 inch ID) and 50-foot lateral (both IDs combined) of 0.983 and 0.957, respectively. Other emitters exhibiting AUs of greater than 0.85 included; D001, D004, D006, D013, and RB2 from the 100-foot laterals, and D006, D013, and D023 from the 50-foot laterals. Only emitters D006, D012 (0.700" ID), and D013 had AUs greater than 0.85 from both lateral lengths (Table 66).

**Table 66. Average measured flow rates[a], application uniformities, and % of manufacturer's specified flow rates (MSFR) for 17 different point source emitter models at low pressure (2.5 psi) installed at 18-inch spacings in 100-foot laterals and 50-foot laterals. NMSU Agricultural Science Center, Farmington, NM. 2010.**

| Emitter | 100-ft. Laterals | | | 50-ft. Laterals | | |
|---|---|---|---|---|---|---|
| | Flow Rate (gph) | Application Uniformity (1 - *cv*) | MSFR (%) | Flow Rate (gph) | Application Uniformity (1 - *cv*) | MSFR (%) |
| D001 | 0.236 | 0.864 | 23.6 | 0.661 | 0.688 | 66.1 |
| D002 | 0.529[b] | 0.558[b] | 26.5[b] | 1.027[b] | 0.581[b] | 51.4[b] |
| D004 | 0.098 | 0.865 | 3.0 | 0.314 | 0.693 | 9.5 |
| D006 | 0.228 | 0.878 | 22.8 | 0.519 | 0.940 | 51.9 |
| D012[c] | 0.121/0.070 | 0.983/0.838 | 12.1/7.0 | 0.336 | 0.957 | 33.6 |
| D013 | 0.370 | 0.889 | 18.5 | 0.723 | 0.871 | 36.2 |
| D021 | 0.063 | 0.726 | 6.3 | 0.195 | 0.659 | 19.5 |
| D022 | 0.106 | 0.552 | 5.3 | 0.477 | 0.569 | 23.9 |
| D023 | 0.380 | 0.834 | 9.5 | 0.991 | 0.913 | 24.8 |
| D076 | 0.650 | 0.558 | 65.0 | 1.236 | 0.616 | 123.6 |
| D077 | 0.549 | 0.499 | 27.5 | 1.428 | 0.568 | 71.4 |
| D078 | 1.315 | 0.631 | 32.9 | 3.129 | 0.774 | 78.2 |
| D080 | 0.163[d] | 0.348[d] | 16.3[d] | 0.906 | 0.554 | 90.6 |
| RB-1 | 0.286 | 0.766 | 28.6 | 0.933 | 0.730 | 93.3 |
| RB-2 | 0.457 | 0.875 | 22.9 | 0.915 | 0.798 | 45.8 |

| Emitter | 100-ft. Laterals | | | 50-ft. Laterals | | |
|---|---|---|---|---|---|---|
| | Flow Rate (gph) | Application Uniformity (1 - *cv*) | MSFR (%) | Flow Rate (gph) | Application Uniformity (1 - *cv*) | MSFR (%) |
| RB-4 | 0.514 | 0.599 | 12.9 | 1.119[e] | 0.731[e] | 28.0[e] |
| D031 | Adjustable emitter - see Figure 7. | | | | | |

[a] Except as indicated, each flow rate value represents the average of 8 measurements (4 reps from 0.620 inch ID and 4 reps from 0.700 inch ID PE).
[b] Average includes one zero from clogged nozzle.
[c] Flow rates from the 0.700 inch ID PE and 0.620 inch ID PE, respectively, which were significantly different.
[d] Average includes 2 zeros from clogged nozzles.
[e] Average of 6 measurements. Water from two emitters was streaming upward and could not be measured.

Emitter D031 is an adjustable emitter that has a variable MSFR of between 1 and 10 gph. Flow adjustment is accomplished by turning the head of the emitter. Turning counter clockwise increases flow rate as it clicks into different stop points. There are about 20 to 25 stop points or clicks. Under the low pressure conditions of this study, flow rates of emitter D031 increased slightly, from 0.4 to 0.9 gph, between 10 and 20 counter clockwise clicks when they were installed in the 100-foot long laterals (Figure 7). When installed in the 50-foot long laterals, emitter flow rate ranged from 0.4 to 3.2 gph between 5 and 22 counter clockwise clicks.

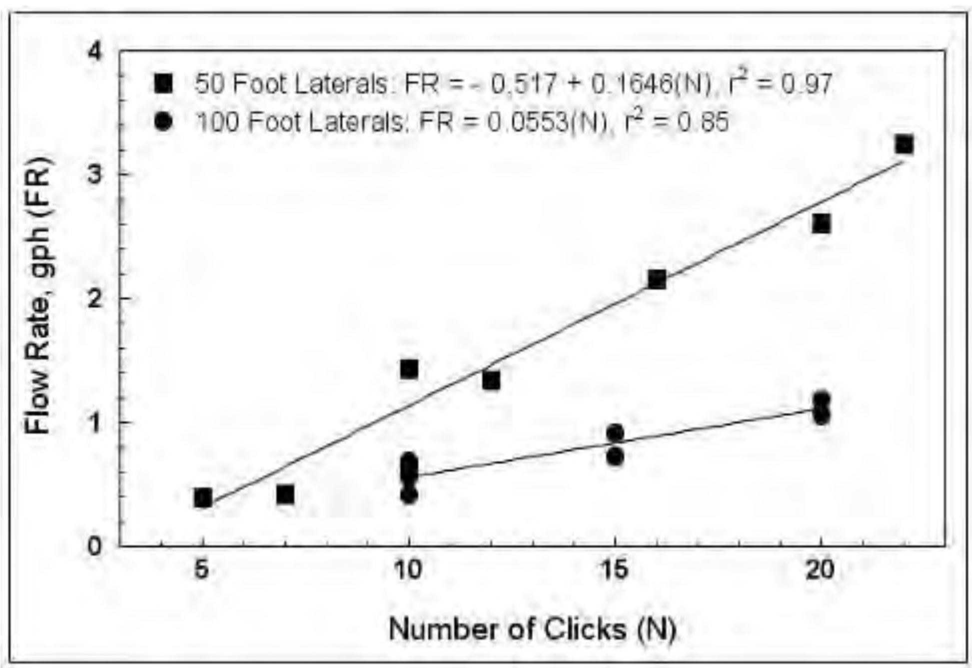


**Figure 7. Measured flow rates from adjustable emitter model D031 open to various clicks from 50-foot and 100-foot laterals at low pressure (2.5 psi); NMSU Agricultural Science Center at Farmington. 2010.**

Average line source flow rates ranged from 0.034 and 0.104 gph per emitter from a 100 and 50 foot lateral of drip tape (8-inch emitter spacing), respectively, to 0.497 gph per emitter for the brown ½-inch drip tubing with a 12 inch emitter spacing (Table 67). The 50-foot lateral, per emitter flow rates were 38.5% and 49.7% of the MSFR for these drip lines. The drip tape (50-foot lateral) and black ½ inch PE tubing (24-inch emitter spacing) had very high AUs of 0.958 and 0.940, respectively (Table 67). The 0.887 AU of the 100-foot drip tape lateral was also quite high. Emitters in the first 32.5 feet of the brown tubing had a very high AU of 0.969 but the two much higher flow rates of 0.761 and 0.940 gph measured from emitters 39.8 and 45.5 feet away from the header, respectively, lowered the overall AU of this tubing to 0.551 (Table 67). Similar results were found from an earlier evaluation of the drip tubings in which the flow rates and AUs averaged 0.361 gph and 0.947 for the black tubing and 0.466 gph and 0.553 for the brown tubing, respectively.

**Table 67. Measured flow rates from line source emitters on a 50-foot drip tape lateral and two 50-foot drip tubing laterals at selected distances from the water source at a head of approximately 6 feet (2.6 psi) along with mean flow rates, standard deviations and application uniformities (1- *cv*); NMSU Agricultural Science Center at Farmington, NM. 2010.**

| 5/8-inch Drip Tape (J.D. Ro-Drip) 8-inch emitter spacing | | | | Drip Tubing (Brown ½") 12-inch emitter spacing | | Drip Tubing (Black ½") 24-inch emitter spacing | |
|---|---|---|---|---|---|---|---|
| — 100-ft. Lateral — | | — 50-ft. Lateral — | | — 50-ft. Lateral — | | — 50-ft. Lateral — | |
| Distance (feet) | Flow Rate (gph) | Distance (feet) | Flow Rate (gph) | Distance (feet) | Flow Rate (gph) | Distance (feet) | Flow Rate (gph) |
| 13.3 | 0.038 | 5.3 | 0.101 | 9.8 | 0.380 | 9.2 | 0.291 |
| 26.7 | 0.037 | 19.3 | 0.110 | 14.5 | 0.365 | 10.3 | 0.340 |
| 40.0 | 0.039 | 28.0 | 0.100 | 19.8 | 0.391 | 20.3 | 0.336 |
| 53.4 | 0.032 | 42.7 | 0.105 | 22.5 | 0.377 | 23.2 | 0.307 |
| 66.7 | 0.029 | | | 29.8 | 0.370 | 30.3 | 0.292 |
| 80.1 | 0.029 | | | 32.5 | 0.395 | 35.2 | 0.311 |
| 93.4 | 0.036 | | | 39.8 | 0.761 | 40.3 | 0.330 |
| 106.8 | 0.035 | | | 45.5 | 0.940 | 45.2 | 0.312 |
| **Mean** | **0.034** | | **0.104** | | **0.497** | | **0.315** |
| **Std. Dev.** | **0.004** | | **0.004** | | **0.223** | | **0.019** |
| **1 - *cv*** | **0.887** | | **0.958** | | **0.551** | | **0.940** |
| **% MSFR** | **12.9** | | **38.5** | | **49.7** | | **31.5** |

## Summary and Conclusions

The low pressure (2.5 psi) flow rate characteristics of the drip emitters evaluated in this preliminary study varied substantially between emitters. In all emitters except one, there was no significant difference between flow rates measured from a given emitter installed in laterals of different PE pipe diameters but there was a significant difference between flow rates measured from the same model emitter installed in different lateral lengths. Flow rates from emitters installed in 50-foot laterals were generally 2 to 3 times more than those measured from the 100-foot laterals. Application uniformity (AU) did not seem to be affected by lateral length or lateral ID. Six point source emitter models installed in the 100-foot laterals had AU values greater than 0.85 while only four (three being the same) had AU values greater than 0.85 in the 50-foot laterals. The 5/8 inch drip tape and black ½-inch drip tubing exhibited AUs greater than 0.85. Generally, flow rates ranged from about 10 to 30% and 25 to 90% of the manufacturer's specified flow rate at the recommended pressure when installed in the 100-foot and 50-foot laterals, respectively. Results suggest that while using shorter laterals in a low pressure system will reduce runtimes, AUs may not be improved.

# Drip Irrigation Requirements of Xeric Adapted Shrubs and Small Trees Suitable for Landscapes, Wind-Breaks, and Soil Reclamation in Northwestern New Mexico

Dan Smeal

## Introduction

Overgrazing and/or removal of native plants and other vegetation when establishing housing developments, industrial complexes, well sites, and agricultural fields in central and northern New Mexico has left many soils bare and exposed to the erosive forces of water and wind. As a consequence, precious topsoil has been carried away in runoff or dust and sand storms. Major crop losses have occurred on the Navajo Indian Irrigation Project and other farming areas of northwestern New Mexico because of sandblasting damage inflicted to plants by windblown sand, especially in the spring. Onion, small grain, pinto bean, corn, and chile pepper establishment in particular has been adversely impacted. Health concerns due to the potential transport of fertilizers, pesticides (Majewski and Capel, 1996) and disease carrying organisms such as *Coccidioides immitis* (Arenofsky, 2010) in this windblown sand have also been of great concern to the populace of the Southwest.

One way to reduce wind erosion and dampen its damaging effect on crops is to establish (or reestablish) windbreaks, or natural vegetation buffers, to replace the vegetation that was initially removed or disturbed upwind of the cropped field. In a semi-arid region like northwestern New Mexico, however, water availability is a major limiting factor to the establishment of even native plants, particularly on disturbed soils that have lost their structure and water holding capabilities. Consequently, revegetating these soils may be very difficult, if not impossible, without some supplemental irrigation. The purpose of this study is to evaluate the effects of limited irrigation, applied with a microirrigation system, on the establishment and growth of various native, or other drought tolerant, woody species on a bare soil area of the ASCF that has been particularly affected by wind erosion.

## Objective

- Evaluate the establishment and growth potential of selected plant species that have potential for use in landscapes, soil remediation, or windbreaks under variable levels of drip irrigation.

## Materials and methods

Fourteen different species of shrubs and trees were obtained for planting in April 2009 from the New Mexico State Forestry Conservation Seedling Program (Table 68). Nine of the species were bare root while five were rooted in a potting mixture in small cone (1-inch diameter at top) pots. On April 7 and 8, prior to planting, 16 rows of ½-inch (0.6-inch ID) PE hose were laid out from south to north at a spacing of 8 feet. Thirty, 1-gph emitters were inserted into each PE lateral at a spacing of 8 feet. The drip lines were connected by ¾-inch PE headers which were connected to filters and 20-psi pressure reducers before being connected to high pressure (70 psi), 3-inch, aluminum mainlines. A 20-hour preplant irrigation was applied on April 9 to provide a workable soil for transplanting. On April 13 and 14, twelve of the species were planted in two separate sections in ten blocks of four individuals of six species (40 individuals per species) per section (Figure 8). The two potentially larger species (black pine and bur oak) were planted at a 12-foot spacing in three separate rows west of the two main sections on April 15 and 16 (Figure 8).

**Table 68. Species of xeric-adapted shrubs or small trees planted in Spring 2009 in an experimental plot to determine their drip irrigation requirements†; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Species (common name) | Species (common name) |
|---|---|
| *Amelanchier spp.* (serviceberry) - B | *Chamaebatiaria millefolium* (fernbush) - P |
| *Chilopsis linearis* (willow-leaf catalpa) - P | *Fallugia paradoxa* (Apache plume) - P |
| *Forestiera neomexicana* (New Mexico forestiera) - B | *Pinus nigra* (black pine) - P |
| *Prunus besseyi* (western sandcherry) - B | *Prunus tomentosa* (Nanking cherry) - B |
| *Quercus gambelii* (gambel oak) - P | *Quercus macrocarpa* (bur oak) - B |
| *Rhus trilobata* (3-leaf sumac) - B | *Rosa woodsii* (woods rose) - B |
| *Shepherdia argentea* (buffaloberry) - B | *Syringa vulgaris* (lilac) - B |

†B = bareroot; P = potted

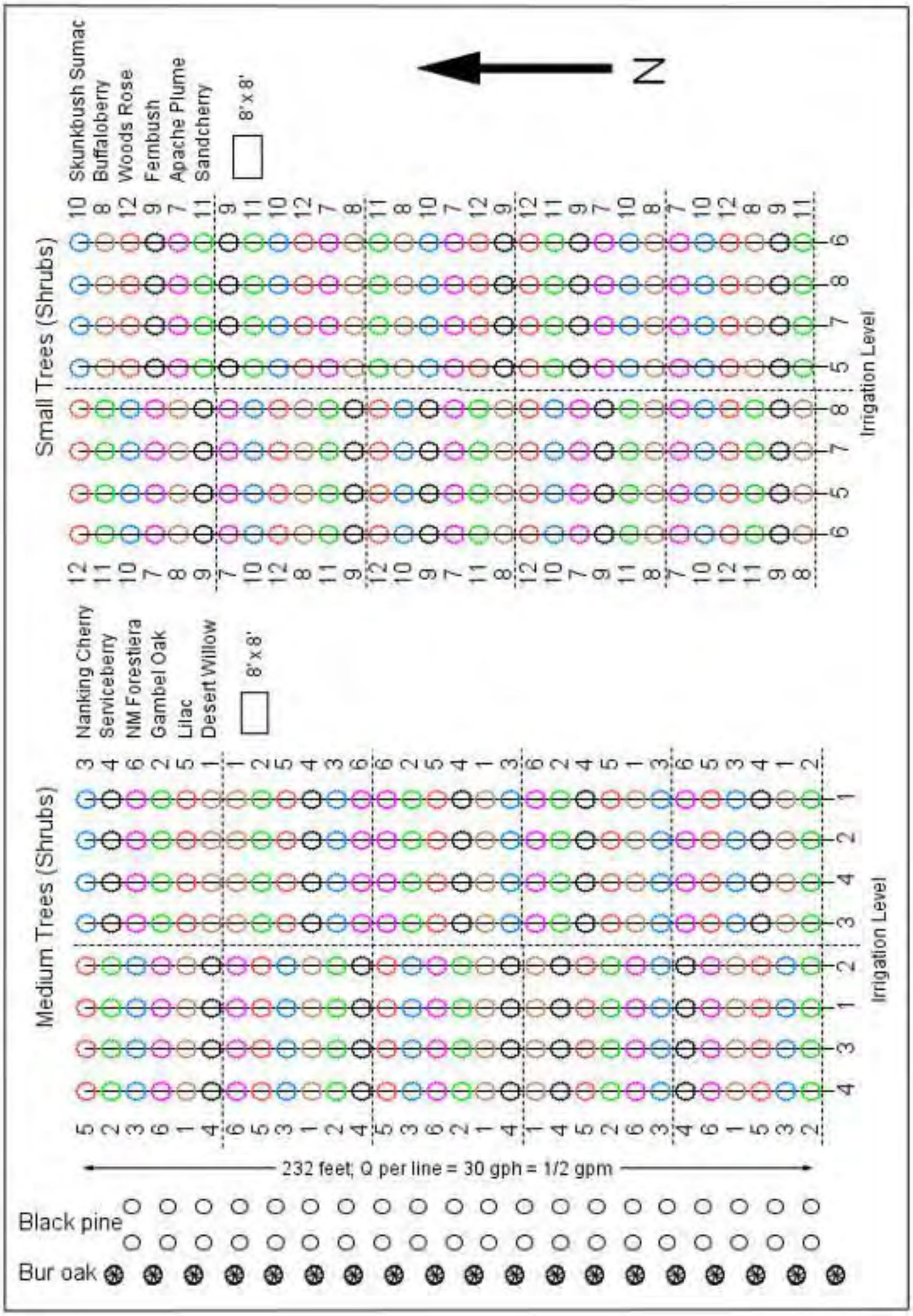


**Figure 8.** **Plot diagram for the study designed to evaluate the drip irrigation requirements of trees and shrubs; NMSU Agricultural Science Center at Farmington. 2010.**

## Results and discussion

### *Irrigation*

Drip irrigations were scheduled on an approximate weekly basis beginning on May 10. Each plant was irrigated with the same volume of water from May 10 through June 24 (Table 69). Different irrigation treatments were initiated to all plants except the bur oaks and black pines on July 1. Water volumes to apply to each treatment level were calculated using Equation 1.

$$I = ETR \times TF \times 0.623 \times CA \quad (1)$$

Where:

| | |
|---|---|
| I | = irrigation (gallons per plant [gpp]) |
| $ET_R$ | = cumulative reference ET ($ET_{TALL}$) since last irrigation (inches) |
| TF | = treatment factor (0.0, 0.2, 0.4, or 0.6 for respective treatment) |
| 0.623 | = conversion factor (in / $ft^2$ to gallons) |
| CA | = plant canopy area ($ft^2$) |

Total irrigation volume applied per plant during the season ranged from 22.6 to 69.8 gallons at the low and high irrigation treatments, respectively (Table 69). An additional 9.8 inches of precipitation occurred during 2010.

**Table 69. Record of drip irrigations for drought-tolerant trees and shrubs at four different irrigation treatments; NMSU Agricultural Science Center at Farmington. 2010.**

| Date | Bur Oak | Black Pine | Large Trees (west plot) | | | | Small Trees (east plot) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All | All | No | Low | Med | High | No | Low | Med | High |
| | (gallons per plant) | | | | | | | | | |
| 5/10 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| 5/20 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| 5/28 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 |
| 6/4 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| 6/11 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| 6/17 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| 6/24 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| 7/1 | 2.9 | 2.9 | 0.0 | 2.9 | 2.9 | 3.6 | 0.0 | 2.9 | 3.7 | 5.7 |
| 7/8 | 1.3 | 1.3 | 0.0 | 1.8 | 3.5 | 5.3 | 0.0 | 1.8 | 3.5 | 5.3 |
| 7/15 | 2.5 | 1.0 | 0.0 | 0.8 | 1.7 | 2.5 | 0.0 | 1.7 | 3.3 | 5.0 |
| 7/22 | 3.4 | 1.8 | 0.0 | 1.8 | 3.4 | 6.9 | 0.0 | 1.8 | 3.4 | 6.9 |
| 7/29 | 2.0 | 1.0 | 0.0 | 2.0 | 2.5 | 2.8 | 0.0 | 2.0 | 2.5 | 2.8 |
| 8/5 | 2.0 | 1.0 | 0.0 | 2.0 | 3.0 | 4.0 | 0.0 | 2.0 | 3.0 | 4.0 |
| 8/27 | 2.9 | 2.9 | 0.0 | 2.9 | 4.4 | 6.1 | 0.0 | 2.9 | 4.4 | 6.1 |

| Date | Bur Oak | Black Pine | — Large Trees (west plot) — | | | | — Small Trees (east plot) — | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All | All | No | Low | Med | High | No | Low | Med | High |
| | | | | | (gallons per plant) | | | | | |
| 9/3 | 2.1 | 2.1 | 0.0 | 2.0 | 3.5 | 4.8 | 0.0 | 2.0 | 3.5 | 4.8 |
| 9/15 | 2.5 | 1.5 | 0.0 | 2.5 | 4.1 | 6.5 | 0.0 | 2.5 | 4.1 | 6.5 |
| **Totals** | **44.2** | **38.1** | **22.6** | **41.3** | **51.6** | **65.1** | **22.6** | **42.1** | **54.0** | **69.8** |

***Plant Survival***

Inventories for plant survival ratings were taken periodically during the 2010 growing season. On the initial inventory conducted April 17, apparent plant survival, evidenced by budding, emergence of new growth from ground, leaf emergence, etc., ranged from 77.5% for the sand cherry to 100% for the NM forestiera, black pine, bur oak, woods rose, and lilac (Table 70). Desert willow (willow-leafed catalpa) and gambel oak had not yet broken dormancy.

**Table 70. Evidence of plant survival (% of plants budding, leaf emergence, etc.) on April 5, 2010 for fourteen shrub and tree seedlings; NMSU Agricultural Science Center at Farmington. 2010.**

| Species | Evidence of Survival (%)[a] | Species | Evidence of Survival (%)[a] |
|---|---|---|---|
| *Amelanchier spp.* | 98.0 | *Chamaebatiaria millefolium* | 97.5 |
| *Chilopsis linearis* | still dormant | *Fallugia paradoxa* | 95.0 |
| *Forestiera neomexicana* | 100.0 | *Pinus nigra* | 100.0 |
| *Prunus besseyi* | 77.5 | *Prunus tomentosa* | 85.0 |
| *Quercus gambelii* | still dormant | *Quercus macrocarpa* | 100.0 |
| *Rhus trilobata* | 97.5 | *Rosa woodsii* | 100.0 |
| *Shepherdia argentea* | 90.0 | *Syringa vulgaris* | 100.0 |

[a] Of the total (40 plants per species)

A follow-up inventory taken on June 10 (prior to the initiation of irrigation treatments) indicated a high degree of mortality for the desert willow and apache plume (Table 71). The trunk diameters of these two species were very small (less than that of a pencil) and they were subject to both wind damage and trunk girdling by cutworms which were found in the soil near the bases of the damaged plants. Some buffaloberry plants were also susceptible to cutworm damage lowering their survival rate from 90% in April to 82.5% in June (Table 71).

**Table 71. Evidence of plant survival (% of plants budding, leaf emergence, etc.) on June 10, 2010 for fourteen shrub and tree seedlings; NMSU Agricultural Science Center at Farmington. 2010.**

| Species | Evidence of Survival (%)[a] | Species | Evidence of Survival (%)[a] |
|---|---|---|---|
| *Amelanchier spp.* | 95.0 | *Chamaebatiaria millefolium* | 97.5 |
| *Chilopsis linearis* | 62.5 | *Fallugia paradoxa* | 67.5 |
| *Forestiera neomexicana* | 100.0 | *Pinus nigra* | 100.0 |
| *Prunus besseyi* | 80.0 | *Prunus tomentosa* | 85.0 |
| *Quercus gambelii* | 97.5 | *Quercus macrocarpa* | 100.0 |
| *Rhus trilobata* | 97.5 | *Rosa woodsii* | 100.0 |
| *Shepherdia argentea* | 82.5 | *Syringa vulgaris* | 100.0 |

[a] Of the total (40 plants per species)

A final 2010 inventory was conducted on August 10 after some of the dead plants had been replaced. Seven species exhibited 100% survival while desert willow, buffaloberry, and Apache plume showed 80, 80, and 77.5% stand survival (Table 72).

**Table 72. Evidence of plant survival (% of plants budding, leaf emergence, etc.) on August 10, 2010 for fourteen shrub and tree seedlings; NMSU Agricultural Science Center at Farmington. 2010.**

| Species | Evidence of Survival (%)[a] | Species | Evidence of Survival (%)[a] |
|---|---|---|---|
| *Amelanchier spp.* | 100.0 | *Chamaebatiaria millefolium* | 97.5 |
| *Chilopsis linearis* | 80.0 | *Fallugia paradoxa* | 77.5 |
| *Forestiera neomexicana* | 100.0 | *Pinus nigra* | 100.0 |
| *Prunus besseyi* | 95.0 | *Prunus tomentosa* | 100.0 |
| *Quercus gambelii* | 97.5 | *Quercus macrocarpa* | 100.0 |
| *Rhus trilobata* | 100.0 | *Rosa woodsii* | 100.0 |
| *Shepherdia argentea* | 80.0 | *Syringa vulgaris* | 100.0 |

[a] Of the total (40 plants per species)

## Grain Yield of Selected Winter Canola Varieties at Various Levels of Sprinkler Irrigation

**Funds provided by the USDA and Kansas State University**

**Dan Smeal, Margaret West, Christen Begay, and Mick O'Neill**

### Abstract

This study was designed to evaluate the effects of different irrigation levels on six cultivars of winter canola. A sprinkler line-source provided varying irrigation treatments to the crop. Seed yield of all cultivars increased with increasing levels of irrigation. Average yields ranged from about 200 to nearly 700 lbs/acre between varieties at the lowest level of water application (18.7 inches) to a high of more than 2,700 lbs/acre for the top yielding cultivar (Hybrisurf) at 32 inches of applied water.

### Introduction

Canola (*Brassica campestris*) is a form of rapeseed usually harvested for its oil. The oil is edible because it has low concentrations of erucic acid and glucosinolates. Once considered a specialty crop in Canada, canola is now a major cash crop of both Canada and northern U.S. (Wikipedia, 2011). In addition to providing cooking oil that is low in saturated fat, the spent seed of the crop makes a high quality meal for animal feed. Canola oil also has many non-food uses, including use as a lubricant and biofuel. In cooperation with the Great Plains Canola Association and Kansas State University, winter performance trials have been implemented at New Mexico State University Agricultural Science Centers (ASC), including the Farmington ASC. One of these trials involves canola irrigation management.

### Objective

- Evaluate the growth and grain yield of selected winter canola varieties at varying levels of sprinkler irrigation.

### Materials and methods

Six cultivars of canola (Flash, Hybristar, Hybrisurf, Safran, Sitro, and Virginia) were planted in a plot area 50 feet wide by 160 feet long. The plot area (which had been disk-harrowed previously) was fertilized on August 20, 2009 with ammonium sulfate (20-0-0) and monoammonium phosphate (11-52-0) at total N and $P_2O_5$ rates of 157 and 127 lbs/acre, respectively. The fertilizer was incorporated into the top few inches of the soil with a rototiller immediately after it was applied. Canola seed was planted on August 27, 2009 in 68-inch wide beds at a row spacing of 11 inches (6 rows per bed) in plot lengths of 18.5 feet at a seeding rate of 0.23 ounces per bed (5.95 lbs/acre). Three irrigation lines, set up on August 27 after planting, were used to apply uniform irrigation for seed germination and establishment. The initial irrigation (1.3 inches) was applied on August 28 and the entire plot area was irrigated uniformly about every 3 to 5 days up through September 16 (Table 73). Irrigation treatments were initiated on September 17, 2009 and continued through the fall up to October 21 and from the first spring irrigation (April 15, 2010) through the final summer irrigation on July 6, 2010 (Table 73). Prior to harvest, a John Deere Gator™

was driven across border areas between plots to clearly delineate the cultivars. This resulted in a harvest plot length of 15 feet (85 $ft^2$ area). The plots were harvested on July 20-21, 2010 with a John Deere 3300™ Combine equipped with a grain gathering box and weigh scale. Seed and trash were weighed immediately and samples were taken from each plot for cleaning and seed moisture analyses to determine clean seed yield at a standard 10% moisture content.

A statistical regression routine (CoStat™) was used to analyze the data.

***Irrigation Treatments***

A single sprinkler line-source (SLS) design (Hanks, 1976) was used to provide six irrigation treatments to the six cultivars of canola. The SLS consisted of a single, 3-inch diameter sprinkler line with Rainbird® 30H sprinklers on 3/4 inch, 4-foot high risers spaced at 20-foot intervals. The line was situated down the center of the plot, parallel to the rows, so that it applied a continuous, decreasing gradient of water to the canola on each side of the line with increasing distance (0 to 45 feet) away from the line. Catch-cans were placed in the center of planted beds in two lines (one at each end of the plot area but within maximum water overlap) perpendicular to the SLS to measure applied water to each treatment after irrigations. Plots equidistant, but on opposite sides of the SLS, received near equal irrigation levels and were considered replicates.

**Table 73. Calculated reference ET ($ET_{RS}$) and average irrigation depths applied to six winter canola varieties with the sprinkler line source; NMSU Agricultural Science Center at Farmington, NM, 2010.**

| | | Average Irrigation Treatment (inches)[a] | | | | | |
|---|---|---|---|---|---|---|---|
| | $ET_{RS}$ | Distance from SLS (feet) | | | | | |
| Date | (in) | 8.5 | 14.2 | 19.8 | 25.5 | 31.2 | 36.8 |
| 8/28/09[b] | 0.34 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 |
| 8/31/09 | 1.00 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| 9/4/09 | 1.28 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| 9/9/09 | 1.43 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |
| 9/16/09 | 1.89 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 |
| 9/17/09 | 0.20 | 0.51 | 0.50 | 0.42 | 0.35 | 0.27 | 0.18 |
| 9/23/09 | 1.38 | 0.57 | 0.51 | 0.45 | 0.38 | 0.33 | 0.27 |
| 9/25/09 | 0.43 | 0.41 | 0.38 | 0.32 | 0.27 | 0.23 | 0.19 |
| 9/30/09 | 1.64 | 0.87 | 0.83 | 0.72 | 0.61 | 0.49 | 0.36 |
| 10/6/09 | 1.81 | 0.61 | 0.58 | 0.50 | 0.46 | 0.40 | 0.34 |
| 10/14/09 | 1.58 | 0.76 | 0.71 | 0.64 | 0.59 | 0.54 | 0.42 |
| 10/21/09 | 1.54 | 1.21 | 1.05 | 0.89 | 0.74 | 0.64 | 0.53 |
| 4/15/10 | 20.90 | 1.28 | 1.12 | 0.94 | 0.74 | 0.55 | 0.41 |
| 4/19/10 | 1.14 | 1.51 | 1.35 | 1.14 | 0.96 | 0.74 | 0.56 |
| 5/1/10 | 3.63 | 1.46 | 1.31 | 1.06 | 0.91 | 0.71 | 0.55 |
| 5/5/10 | 1.09 | 1.29 | 1.13 | 0.96 | 0.82 | 0.65 | 0.49 |

| | | Average Irrigation Treatment (inches)[a] | | | | | |
|---|---|---|---|---|---|---|---|
| | $ET_{RS}$ | Distance from SLS (feet) | | | | | |
| Date | (in) | 8.5 | 14.2 | 19.8 | 25.5 | 31.2 | 36.8 |
| 5/10/10 | 2.09 | 0.75 | 0.66 | 0.55 | 0.42 | 0.35 | 0.25 |
| 5/13/10 | 1.03 | 1.24 | 1.10 | 0.91 | 0.70 | 0.58 | 0.42 |
| 5/20/10 | 2.10 | 1.40 | 1.28 | 1.12 | 0.86 | 0.66 | 0.48 |
| 5/25/10 | 2.29 | 0.55 | 0.48 | 0.42 | 0.36 | 0.28 | 0.17 |
| 5/30/10 | 2.42 | 0.92 | 0.80 | 0.70 | 0.59 | 0.46 | 0.29 |
| 6/4/10 | 1.85 | 1.25 | 1.10 | 1.00 | 0.82 | 0.67 | 0.51 |
| 6/9/10 | 2.15 | 1.30 | 1.15 | 1.01 | 0.89 | 0.76 | 0.61 |
| 6/15/10 | 2.10 | 0.90 | 0.79 | 0.72 | 0.63 | 0.53 | 0.42 |
| 6/21/10 | 2.68 | 1.05 | 0.95 | 0.80 | 0.69 | 0.56 | 0.41 |
| 6/25/10 | 1.85 | 0.90 | 0.84 | 0.75 | 0.63 | 0.50 | 0.39 |
| 7/1/10 | 2.51 | 1.20 | 1.09 | 0.97 | 0.83 | 0.66 | 0.54 |
| 7/6/10 | 2.03 | 1.50 | 1.33 | 1.21 | 1.02 | 0.88 | 0.69 |
| **Totals** | **66.4** | **26.7** | **24.3** | **21.4** | **18.5** | **15.7** | **12.7** |

[a]Irrigations shown represent the average of two plots equidistant (but on opposite sides) from the SLS.
[b]Reference ET from planting through 8/27.

## Results and discussion

Total irrigation applied to the plots from planting to harvest ranged from a high of 26.7 inches at the plots closest to the SLS to a low of 12.7 inches at the plots farthest from the SLS (Table 73). An additional 5.14 inches of precipitation occurred during this same time period. Seed yields increased with increasing water application levels within the range of 18.5 to 30 inches for all six cultivars (Figure 9). Three of the cultivars (Virginia, Hybristar, and Hybristar) exhibited further yield increase at the highest water application level (32 inches) while 3 others (Sitro, Flash, and Safran) exhibited a decrease in yield from 30 to 32 inches of water application (Figure 9). Hybrisurf produced the highest average seed yield (2724 lbs/acre at 32 inches of applied water) of all cultivars, while the yield of 3 others (Sitro, Flash, and Safran) exceeded 2300 lbs/acre (at 30 inches of applied water). Hybristar and Virginia yields were very similar, and were lower than the other cultivars, at all irrigation treatments (Figure 9). The high yields of all cultivars in this irrigation study were lower than average yields obtained from the same cultivars in variety trials conducted at the Science Center during the same season but the yield ranking of cultivars (from high to low yield) were similar between the two studies (i.e. Sitro and Hybrisurf yielding more than Hybristar and Virginia).

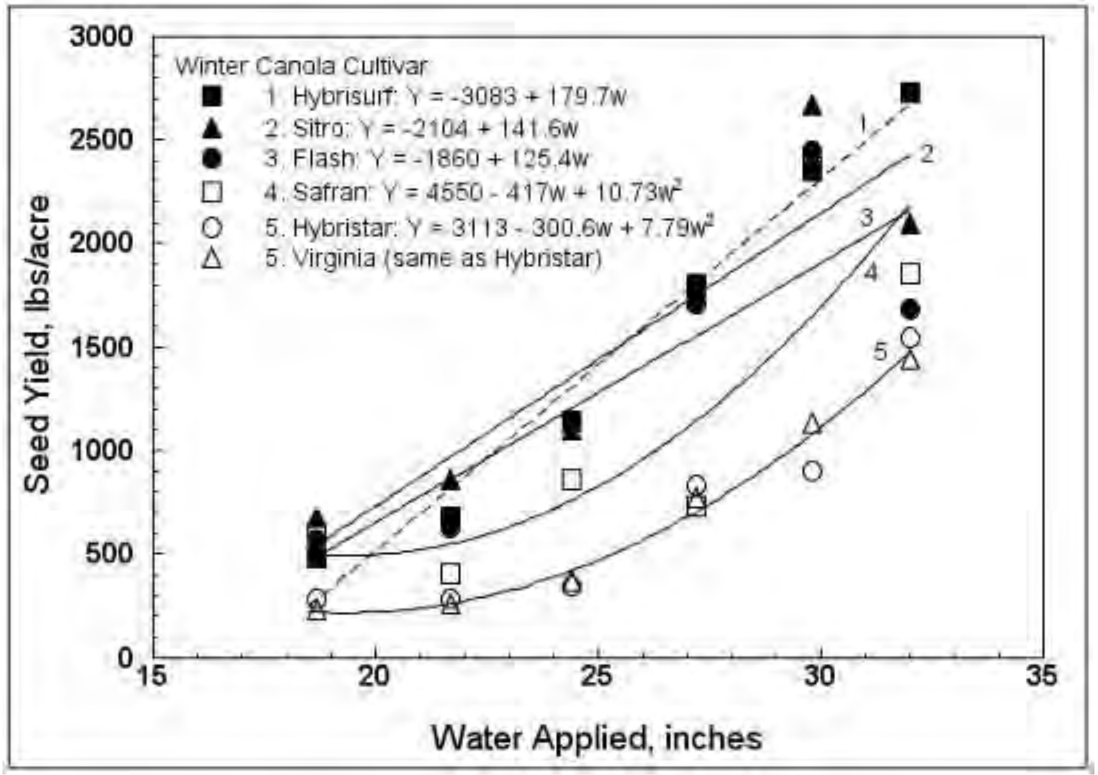


**Figure 9. Seed yields (adjusted to 10% moisture content) of six winter canola cultivars as related to total water applied from planting (August 27, 2009) to harvest (July 21, 2010) and best fit regression lines describing the relationships. Water applied includes 5.14 inches of precipitation; NMSU Agricultural Science Center at Farmington, NM. 2010.**

## Conclusions

As with most agricultural crops, seed (or grain) yield of winter canola responded positively to increased irrigation. Lower than expected yields at the highest irrigation level (32 inches) may have been the result of seedpod shattering and lygus bug damage. In an effort to prevent further yield loss, the crop, particularly at the high irrigation treatments, may have been harvested too early. This resulted in incomplete shatter of some green seed pods by the combine during harvest. Despite this probable reduction in potential yield, maximum average yield of the top three cultivars (about 2600 lbs/acre) was greater than that produced from different winter canola cultivars in irrigation studies conducted at the same site in previous years (Smeal, 1991-1994). In those studies, maximum seed yields ranged from 1500 to 2000 lbs/acre at similar maximum irrigation levels.

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# Horticultural Research, Development, and Education in the Four Corners Region

## Table and Wine Grape Evaluation

**Funds provided by the USDA through the Hatch Program, the State of New Mexico through general appropriations**

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Viticulture activities involve examination of: 1) 15 replicated table grape varieties, 2) 20 replicated wine grape varieties, 3) a Rootstock Trial comprised of two vinifera scions (Gewurztraminer and Refosco) grafted onto nine rootstock combinations (of 110 Richter; 775, 779, 1103, and 1045 Paulsen types; SO4, Kober, Couderc, and Teleki), 4) three selections from the Cornell grape breeding program and 5) six selections of Riesling vines originally cultivated at >5,800 ft (1,700 m) elevation at the Ponderosa Valley Vineyard and Winery. Except for the rootstock trial, all table and wine grape studies are comprised of French (V. vinifera), French-American hybrids and American types grown on their own roots. Only studies one through three are reported. Temperatures at three vineyard sites are also reported.

### Introduction

Over 34 wineries and tasting rooms operate throughout New Mexico producing greater than 400,000 gallons (>1,500,000 L) of wine per year (Alimova and Lillywhite, 2006). Industry revenues top $60 million per annually, although wine grape production has not kept up with demand (Alimova and Lillywhite, 2006). Indeed, commercial grape production in the Four Corners Region is now supported by two boutique wineries: Wines of the San Juan (Blanco, NM) and Guy Drew Vineyards (Cortez, CO). A third winery, Amazing Spirits Vineyards and Winery, is nearing completion in Farmington and a commercial vineyard of > 10 acres (4 ha) is under construction near Aztec, NM. Other Northwest, NM growers have expressed serious interest in commercial grape production for wine and fresh marketable table grapes. The challenges of growing grapes at our high elevation site are numerous and define the objectives of the studies.

### Objectives

- Identify *vinifera* and *vinifera* hybrids capable of supplying market demands to produce quality wines.
- Identify *vinifera* and *vinifera* hybrids capable of surviving extreme winter temperatures, killing spring frosts, and huge diurnal temperature fluctuations found in the region.
- Determine growth of selected grape entries on elevated soil pH.

Growers have also requested assistance on identifying irrigation, weed, and other vineyard management techniques. The data generated from these studies is applicable to other high elevation sites in New Mexico and Southwest Colorado. The data will also be used to complement statewide growth and yield data of similar grape varieties being cultivated at NMSU Agricultural Science Centers located at Los Lunas, Alcalde, and Artesia and at sites in Deming, NM.

## Materials and methods

The region is semi-arid with a mean annual precipitation of 8.2 in (208 mm), an average of 161 frost-free days and mean minimum and maximum temperatures ranging from 19° to 41° F (-7.2° to 5° C) in January to 60° to 91° F (15.5° to 32.8° C) in July (O'Neill et al., 2005). The entire study site comprises 27 rows planted on 4 ft (1.2 m) spacing between vines and 12 ft (3.7 m) between rows. The soil is a sandy loam with a pH above 8. A bamboo stake was placed next to each vine and attached to the fruiting wire located 5 ft (152 cm) above the ground and vines were trained to the stake and wire using a Max-tapener™. Drip lines (0.4 gallons per minute emitters every two feet) provided irrigation.

### *2007 Planted Wine and Table Grapes*

Grapes planted in 2007 consisted of 10 red and 10 white wine cultivars (Table 74) and 15 table/raisin cultivars (Table 75) of French (*Vitis vinifera*), French-American hybrids and American types. The cultivar Bianca came into fruiting in 2010 as a red clustered grape when it is in fact a white wine cultivar. For this reason, it was removed from the analysis.

These vines were top dressed with compost in May 2010.

**Table 74. Table grape cultivars, their parents, and source of parents grown in the experimental vineyard; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Common Name | Code | Parentage | Origin | Color |
|---|---|---|---|---|
| ***Replicated Table Grapes*** | | | | |
| Black Rose | T-1 | *V. vinifera*: (Damas Rose x Black Monukka) x Ribier (Alphonse Lavallée) | United States | Red/Black |
| Centennial | T-2 | *V. vinifera*: (PVP) Gold x Q25-6 | UC Davis | White |
| Crimson | T-3 | *V. vinifera*: Emperor x Selection #C33-199 | USDA Fresno | Red |
| Flame Seedless | T-4 | *V. vinifera*: Complex parentage | USDA Fresno | Red |
| Red Globe | T-5 | *V. vinifera*: Complex parentage | UC Davis | Red |
| Superior Seedless | T-6 | *V. vinifera:* Flame Tokay x Alphone Lavallée | United States | White |
| Christmas Rose | T-7 | *V. vinifera*: Complex parentage | UC Davis | Red |
| Glenora | T-8 | American: (Ontario x Russian Seedless) | Cornell University, Geneva Statn. | Blue |

| Common Name | Code | Parentage | Origin | Color |
|---|---|---|---|---|
| Himrod | T-9 | American: (Ontario x Sultanina) | Cornell University, Geneva Statn. | White |
| Interlaken | T-10 | American: (Ontario x Sultanina). Sister seedling of Himrod | United States | White |
| Marquis | T-11 | American: Athens x Emerald Seedless. | Cornell University, Geneva Station. | White |
| Reliance | T-12 | American (PVP): Ontario x Suffolk Red). | University of Arkansas | Red |
| Saturn | T-13 | American (PVP): Complex Parentage | University of Arkansas | Red |
| Swenson Red | T-14 | American hybrid: (Minnesota #78 x Seibel) | Elmer Swenson Breeding Program, Minnesota | Red |
| Vanessa | T-15 | American hybrid: (Seneca x New York 45910) | Released from Vineland Exp. Station, Ontario, Canada | Red |

**Table 75. Wine grape cultivars, their parents, and source of parents grown in the experimental vineyard. Bianca was removed from the analysis; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Common Name | Code | Parentage | Origin | Color |
|---|---|---|---|---|
| Agria | W-1 | *V. vinifera*: Malbec and Kadarka parentage | Hungary | Red |
| Siegfried | W-2 | *V. vinifera: Oberlin 595 S.P x Riesling complex cross* | Germany | White |
| Baco Noir | W-3 | *French American hybrid: Folle Blanche x V. riparia* | France | Red |
| Chardonel | W-5 | *V. vinifera*: Seyval x Chardonnay | Cornell University Geneva, New York Breeding Program | White |
| Kozma | W-6 | *V. vinifera* | Hungary | Red |
| Leon Millot | W-7 | *V. riparia-rupestris* and *V. vinifera* (Goldriesling) | France | Black |
| Malbec | W-8 | *V. vinifera* | France | Red |
| Müller Thurgau | W-9 | *V. vinifera*: Riesling x Chasselas de Courtillier | Germany | White |
| Valvin Muscat™ | W-10 | *V. vinifera*: Muscat du Moulin x Muscat Ottonel | Cornell University Geneva, New York Breeding Program | White |
| Pinot Noir | W-11 | *V. vinifera* | France | Red |
| Refosco | W-12 | *V. vinifera* | Italy | Red |
| Regent | W-13 | *V. vinifera*: Diana (Müller Thurgau x Silvaner) x Chambourcin | Germany | Red |
| Sangiovese | W-14 | *V. vinifera* | Tuscany, Italy | Red |

| Common Name | Code | Parentage | Origin | Color |
|---|---|---|---|---|
| Sauvignon Blanc | W-15 | *V. vinifera* | Pouilly France, upper Loire Valley | White |
| Traminette | W-16 | *V. vinifera*: Joannes Seyve 23.416 x Gewurztraminer | Cornell University Geneva, New York Breeding Program | White |
| Vidal Blanc | W-17 | French-American hybrid: *V. vinifera* (Ugni Blanc) and early French-American hybrid Rayon d'Or | France | White |
| Viognier | W-18 | *V. vinifera* | France | White |
| Zinfandel | W-19 | *V. vinifera* | Croatia | Red |
| Seyval Blanc | W-20 | French-American hybrid: Seibel 5656 x Seibel 4986 | France | White |

***2008 Planted Rootstock Trial***

The Rootstock Trial consisted of the *vinifera* scions Gewurztraminer and Refosco grafted onto the following rootstocks; 110 Richter, 775 Paulsen, 779 Paulsen, 1045 Paulsen, 1103 Paulsen, SO4, Kober 5BB, 3309 Couderc, and Teleki 5C (Table 76). Grafted vines originated from New Mexico Vineyards of Deming, NM and arrived at the ASC Farmington as bare root material. Prior to planting, vines were soaked for three days in tap water. All but 2 of the 432 planted vines established in 2008. Vines were irrigated and trained to the fruiting wire.

**Table 76. Rootstock Trial scions and rootstock grown in the experimental vineyard; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Scion | Rootstock | Code |
|---|---|---|
| Gewurztraminer | CL4 110 Richter | G-1 |
| | CL4 779 Paulsen | G-2 |
| | CL4 SO4 | G-3 |
| | CL4 Kober 5BB | G-4 |
| | CL4 3309 Couderc | G-5 |
| | CL4 1103 Paulsen | G-6 |
| | CL4 1045 Paulsen | G-7 |
| | CL4 775 Paulsen | G-8 |
| | CL4 5C | G-9 |
| Refosco | CL2 110 Richter | R-1 |
| | CL2 779 Paulsen | R-2 |
| | CL2 SO4 | R-3 |
| | CL2 Kober 5BB | R-4 |
| | CL2 3309 Couderc | R-5 |
| | CL2 1103 Paulsen | R-6 |
| | CL2 1045 Paulsen | R-7 |

| Scion | Rootstock | Code |
|---|---|---|
| | CL2 775 Paulsen | R-8 |
| | CL2 Teleki 5C | R-9 |

***2009 Planted Vines***

The 2009 trial was established to examine cold tolerance of six Riesling selections collected from the Ponderosa Valley Vineyard and Winery (Ponderosa, NM) and numbered cultivars from the Cornell Grape Breeding Program (Geneva, NY). The Ponderosa Riesling selections were made from vines that had survived a late 2008 spring killing freeze event that otherwise destroyed most of the Riesling block in the vineyard. Other Cornell selections planted in 2007 have shown potential for inclusion at high elevation vineyards. Cuttings were established in the greenhouse following previously described methods (O'Neill et al., 2008) and were planted in mid May after the last danger of frost. Vines were allowed to establish without training in 2009. Before bud break in 2010, vines were pruned to 4-6 nodes and the strongest cane was trained for each vine to the stake and fruiting wire. No data was collected in 2010 as these vines are still establishing.

***San Juan County Temperature Monitoring***

Data loggers were installed at three vineyards in 2009 to monitor minimum, maximum, and mean daily temperatures: Wines of the San Juan (Turley, NM), a vineyard site north of Aztec owned by Bart Wilsey, and the NMSU-ASC Farmington vineyard. Temperature probes were placed at the fruiting wire approximately 4-5 feet from the ground.

***Zinc Evaluations***

The presence of leaf chlorosis and puckering resembling Zn deficiency symptoms was not observed in 2010, probably because of residual Zn uptake during the 2008 season when Zn chelate was foliar applied. Zinc deficiency symptoms were not measured in 2009 or 2010.

***Iron Chlorosis Evaluations***

Since 2008, the grape trials have been evaluated for Fe chlorosis using a handheld SPAD-502 meter. The instrument non-destructively measures light transmittance of the leaf in the red and infrared wavelengths at 650 and 940 nm, respectively yielding a numerical output that indicates leaf greenness (the higher the number given by the instrument, the greener the leaf) (Schepers et al., 1998). In 2010, measurements were made on June 9, July 6, July 26, and Aug 4. The Rootstock Trial was evaluated for Fe chlorosis on June 10, July 7, July 27, and Aug 5.

***Vine Growth***

In 2010, grape growth stages were measured using the modified E-L (Eichhorn and Lorenz) system (Coombe, 1995). The system covers 47 stages from winter bud to the end of leaf fall and was chosen because of its well illustrated silhouette drawings that permit field workers to easily distinguish grape growth stage. Growth stages for the 2007 Table and Wine grape study were made on the following dates: 4/9, 4/16, 4/23, 4/26, 5/4, 5/18, 5/24, 6/1, 6/7, 6/18, 6/28, 7/12, 7/26, 8/4, 8/10, and 8/17 with the final E-L stage noted on the date of harvest. Growth stages for the rootstock trial were made on the following dates: 4/12, 4/23, 4/26, 5/5, 5/19, 5/24, 6/1, 6/9, 6/12, 6/28, 7/12, 7/26, 8/4, 8/10, and 8/17. Harvest date constituted the last E-L measurement.

Minimum temperatures of 22.0˚, 23.7˚, 31.4˚, and 28.9˚F were recorded for the period April 30-May 3, just at the period that most vines were beginning to leaf out. A freeze damage assessment was made on 5/4 for the 2007 planted grapes and 5/5 for the rootstock trial. On May 12, a second freeze event of 25.5˚F was recorded. Data was not collected because it was difficult to discern freeze damage from this event and the April 30-May 3.

Grapes were harvested when the seed appeared dark brown. We also attempted to harvest when $^{0}$Brix was above 21. Yield was measured by counting then weighing the total number of clusters harvested from each vine.

A wine too low in acid tastes flat and dull while a wine too high in acid tastes too tart and sour. Sugar content will dictate fermentation and alcohol content. To determine sugar and acid constituents, a composite sample of juice from each vine was analyzed for total soluble solids ($^{0}$Brix) using a hand held digital meter and for pH using a bench pH meter.

***Data Analysis***

The trials were configured as completely randomized designs. Table grapes were replicated three times with 4 plants per plot for a total of 12 vines per cultivar. Wine grapes were replicated 6 times with 4 plants per plot for a total of 24 vines per cultivar. The rootstock trial was designed as a two factor completely randomized design with 2 scions, 9 rootstocks and 4 plants per scion/rootstock combination replicated 6 times for a total of 432 vines in the study. The 2009 planted vines were planted as completely randomized designs with each entry replicated 6 times with 4 plants per plot for a total of 24 vines per cultivar. Data was analyzed in SAS version 9.2 using a combination of PROC GLM and PROC Mixed statements.

*For the purpose of long-term reporting, reference is made to 2008-2010 growing seasons in Tables and Figures but only 2010 seasonal data is reported in the text.*

## Results

***Table Grape Study***

Freeze damage ranged from none in Black Rose and Crimson, 17% in Christmas Rose, to 100% of Himrod, Interlaken, Reliance, Saturn, and Vanessa vines (Table 77). The low amount of freeze damage in Black Rose, Crimson, and Christmas Rose is misleading because none of these vines grew vigorously as seen from the E-L measurements (Figure 10). Mortality measured at the end of the growing season indicated that 50% of Flame Seedless, 33% of Red Globe and 17% of Vanessa vines had died since planting (Table 77). A ―0‖ for mortality does not necessarily indicate adaptability because vines like Black Rose may have required retraining from the ground in 2010 (which was not measured at the beginning of the 2010 growing season). Christmas Rose (18.8), Black Rose (19.7), Centennial (20.5), and Crimson (20.9) had the lowest SPAD values which indicated the potential for Fe chlorosis. Glenora (29.5), Vanessa (29.6), Himrod (29.8), Swenson Red (30.0), and Reliance (30.7) maintained the greenest leaves throughout the growing season ($P$<0.0001; Table 77). The trends were generally similar to those observed in 2009. Growth of Glenora, Himrod, Interlaken, Marquis, Reliance, Swenson Red and Vanessa recovered from secondary buds (Figure 10). These vines bore fruit that was harvested from August 12 to Sept 30 although most harvest dates were three to four weeks later in 2010 than in 2009 (Table 78 and Table 79), a function of the setback from the April 30-May 3 freeze and cool summer. Swenson Red had the highest number of clusters per vine (14) and cluster weight (1,322 g) followed by Reliance (5 clusters at 997 g per vine) and Himrod (5 clusters at 767 g per vine) (Table 78 and Table 79). Sugar content of the juice was highest in Glenora (27.9 $^o$Brix; harvested September 20, 2010). Marquis had the lowest sugar content (17.1 $^o$Brix) followed by Swenson Red (19.0 $^o$Brix) and Himrod (19.9 $^o$Brix). Although the seed were brown when we harvested, we could have achieved higher $^o$Brix by harvesting later in the season. Juice pH ranged from 3.0 for Swenson Red to 3.6 in Vanessa and Reliance.

**Table 77. Mortality, freeze damage, and chlorosis characteristics of table grapes planted in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Cultivar | Vines Retrained (%) | Freeze Damage (%) | Season End Mortality (%) | SPAD (Fe) Season Average | | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2010 | 2008 | 2009 | 2010 |
| Black Rose | 92a | 0f | 0c | 24.0cdef | 26.1ef | 19.7e |
| Centennial | 67abc | 56cd | 0c | 23.6efg | 27.9de | 20.5de |
| Christmas Rose | 100a | 17ef | 0c | 23.2efg | 22.6f | 18.8 e |
| Crimson | 83ab | 0f | 0 c | - | 28.2 de | 20.9de |
| Flame Seedless | 75ab | - | 50a | 24.6bcdef | 24.2ef | 24.5bc |
| Glenora | 25de | 92ab | 0c | 24.7bcdef | 36.1ab | 29.5a |
| Himrod | 33cde | 100a | 0c | 25.3bcde | 34.8bc | 29.8a |
| Interlaken | 25de | 100a | 0c | 24.1defg | 33.6bc | 27.7ab |
| Marquis | 40cde | 78abc | 0c | 22.6fg | 27.7de | 25.4bc |
| Red Globe | 90a | 33de | 33ab | 26.8b | 27.3de | 24.7bc |
| Reliance | 8e | 100a | 0c | 26.5bc | 35.6abc | 30.7a |
| Saturn | 50bcd | 100a | 0c | 26.3bcd | 33.1bc | 25.8bc |
| Superior Seedless | 100a | 67bc | 0c | 24.4defg | 31.4cd | 23.3cd |
| Swenson Red | 25de | 50cd | 0c | 22.2g | 35.5abc | 30.0a |
| Vanessa | 30de | 100a | 17cb | 29.6a | 39.4a | 29.6a |
| LSD | 30 | 33 | 17 | 2.4 | 4.2 | 3.3 |
| F Value | 7.14 | 9.62 | 6.12 | 13.34 | 11.09 | 13.34 |
| Pr>F | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |

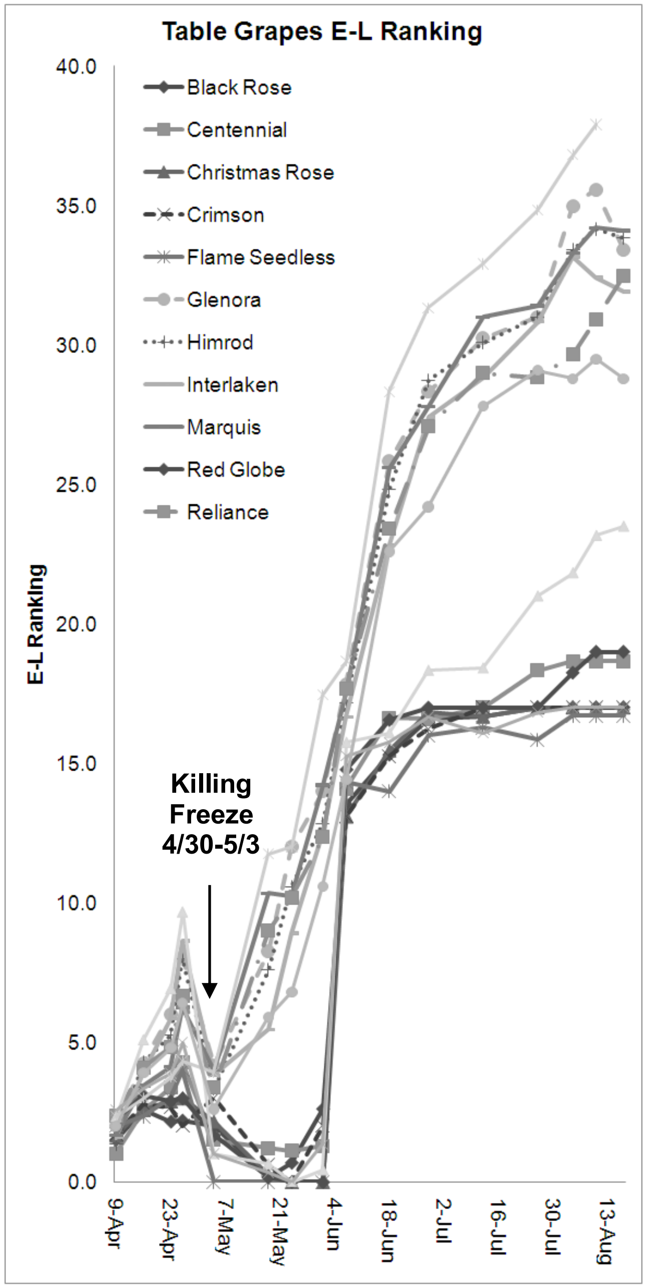



**Figure 10. Modified E-L ranking for table grape cultivars grown on their own roots. Grapes were planted in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

**Table 78. Harvest data for Table grapes planted on their own roots in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Cultivar | Date of Harvest | | Number Vines Harvested (%) | | # Clusters per vine | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Black Rose | NH | NH | 0 | 0 | 0 | 0 |
| Centennial | NH | NH | 0 | 0 | 0 | 0 |
| Christmas Rose | NH | NH | 0 | 0 | 0 | 0 |
| Crimson | NH | NH | 0 | 0 | 0 | 0 |
| Flame Seedless | NH | NH | 0 | 0 | 0 | 0 |
| Glenora | 8/04 | 9/20 | 33 | 75 | 4 | 4b |
| Himrod | 8/04 | 8/23 | 17 | 75 | 5 | 5b |
| Interlaken | 8/04 | 9/30 | 17 | 50 | 5 | 3b |
| Marquis | NH | 9/02 | 0 | 42 | 0 | 4b |
| Red Globe | NH | NH | 0 | 0 | 0 | 0 |
| Reliance | 8/04 | 8/30 | 33 | 58 | 5 | 5b |
| Saturn | NH | NH | 0 | 0 | 0 | 0 |
| Superior Seedless | NH | NH | 0 | 0 | 0 | 0 |
| Swenson Red | 8/04 | 8/12 | 33 | 100 | 15 | 14a |
| Vanessa | 8/04 | 9/02 | 25 | 50 | 6 | 2 |
| LSD | | | | | | 6 |
| F Value | | | | | | 5.45 |
| Pr>F | | | | | | 0.0002 |

**Table 79. Harvest data for Table grapes planted on their own roots in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Cultivar | Cluster Weight per Vine (g) | Soluble Solids ($^{0}$Brix) | Juice pH | Cluster Weight per Vine (g) | Soluble Solids ($^{0}$Brix) | Juice pH |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Black Rose | 0 | 0 | 0.0 | 0 | - | 0 |
| Centennial | 0 | 0 | 0.0 | 0 | - | 0 |
| Christmas Rose | 0 | 0 | 0.0 | 0 | - | 0 |
| Crimson | 0 | 0 | 0.0 | 0 | - | 0 |
| Flame Seedless | 0 | 0 | 0.0 | 0 | - | 0 |
| Glenora | 284 | 253c | 21.3 | 27.9a | - | 3.5a |
| Himrod | 360 | 767abc | 25.2 | 19.9d | - | 3.3b |
| Interlaken | 270 | 453cb | 27.7 | 22.1c | - | 3.3b |
| Marquis | 0 | 340c | 0.0 | 17.1e | - | 3.4b |
| Red Globe | 0 | 0 | 0.0 | 0 | - | 0 |
| Reliance | 765 | 997ab | 23.2 | 24.7b | - | 3.6a |
| Saturn | 0 | 0 | 0.0 | 0 | - | 0 |
| Superior Seedless | 0 | 0 | 0.0 | 0 | - | 0 |
| Swenson Red | 1280 | 1322a | 18.1 | 19.0d | - | 3.0c |
| Vanessa | 960 | 380bc | 21.3 | 23.8bc | - | 3.6a |
| LSD | | 649 | | 2.0 | | 0.1 |
| F Value | | 3.91 | | 29.6 | | 30.6 |
| Pr>F | | 0.0030 | | <0.0001 | | <0.0001 |

***2007 Planted Red and White Wine Grape Varieties***

Among the red wine grape cultivars, freeze damage measured May 5$^{th}$ ranged from 22% (Malbec) to 100% in Baco Noir and Leon Millot (*P*<0.0001;Table 80). There were no differences in mortality, although almost 9% of Refosco vines had died to the ground by the end of 2010. Trends in 2010 SPAD values were generally similar as those observed in 2009. Regent (21.9) followed by Sangiovese (24.5) and Refosco (25.0) had the lowest seasonal SPAD values which indicated potential Fe chlorosis (*P*<0.0001; Table 80) while Baco Noir (27.3), Pinot Noir (27.4), Agria (27.6), Leon Millot (28.0), Kozma (28.1), and Zinfandel (28.6) were highest in mean seasonal SPAD values. Figure 11 shows the impact that the April 30-May 3 freeze had on the vines. Baco Noir, Kozma, Leon Millot made the greatest recovery, followed by Agria and Zinfandel. Harvest dates were one week to a month later in 2010 than in 2009 because of the killing freeze in May and the cooler temperatures observed early in the summer. As in 2009, Malbec and Sangiovese did not produce a crop in 2010 (Table 81). It is unclear if these cultivars are still in a juvenile period or if they were impacted from the April 30-May 3 freeze. Pinot Noir, which bore minimally in 2009 was impacted by the freeze and did not bear a crop in 2010. Baco

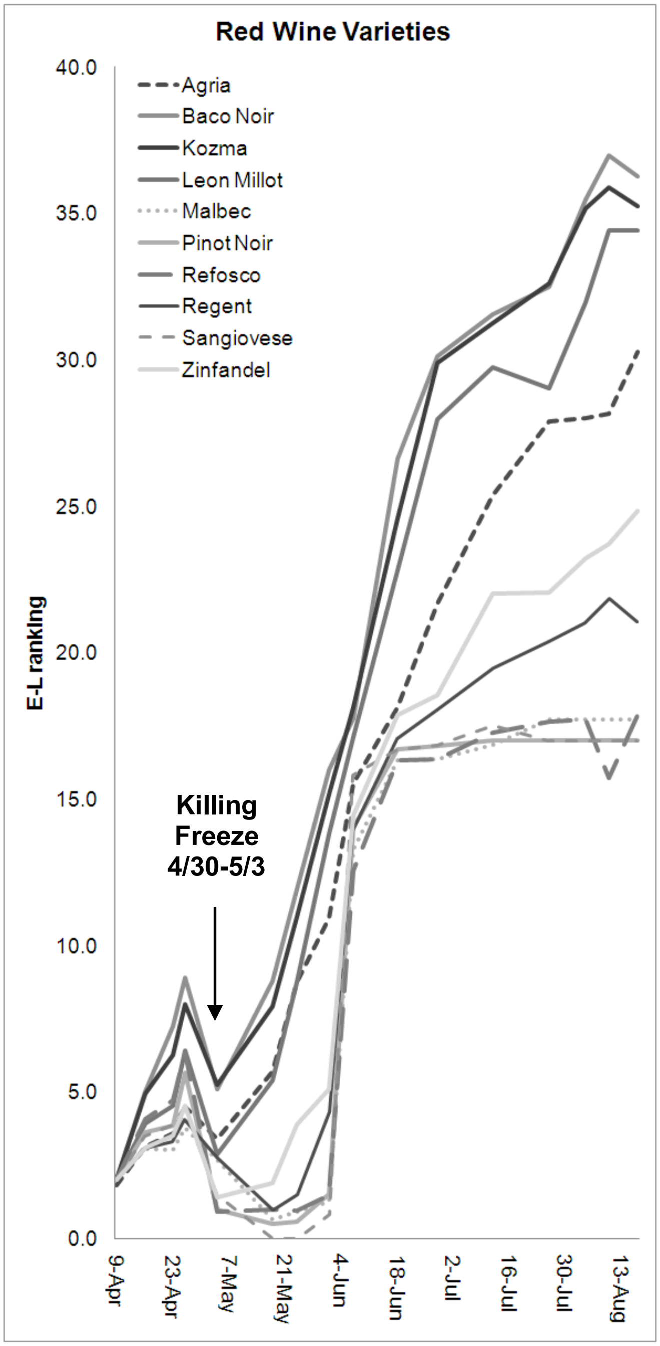
Noir, Kozma, and Leon Millot had greater than 88% of their vines bear fruit in 2010. Of the harvested vines, Baco Noir and Kozma produced 10 and 15 clusters per vine, respectively followed by Agria (6), Leon Millot (5), Zinfandel (5), Regent (4), and Refosco (2) (Table 81). Cluster weights per vine were highest in Kozma (1050 g) being large clusters and lowest in Regent and Baco Noir, being smaller clustered cultivars. In 2010 Baco Noir, harvested September 14, had the highest sugar content (28 $^{o}$Brix) while Zinfandel had the lowest (23.3 $^{o}$Brix); harvest date for Zinfandel was September 15, 2010 (Table 82). Juice pH was equal among the red wine grapes, ranging from 3.1 to 3.5 (Table 82).

Among the white wine grape cultivars, freeze damage measured May 5$^{th}$ ranged from 0% (Vidal Blanc) to 100% in Siegfried ($P$<0.0001; Table 80). There were no differences in mortality measured at the end of the growing season, although 5% of Seyval Blanc grapes died to the ground. Like the red wine grapes, trends in 2010 SPAD values were generally similar as those observed in 2009. The lowest seasonal SPAD values were measured in Müller-Thurgau (24.4) followed by Sauvignon Blanc (26.8) Viognier (28.3) and Valvin Muscat (27.3) while Siegfried (31.9), Chardonel (31.5), and Traminette (30.6) were highest in mean seasonal SPAD values (Table 80). Like with the red wine grapes, the April 30-May 3 freeze event impacted most all the vines; Müller-Thurgau, Viognier and Sauvignon Blanc suffered to the greatest extent (Figure 11). The rest of the cultivars recovered but harvest dates in 2010 were generally delayed two weeks from 2009 (Table 81). As in 2009, Sauvignon Blanc was not harvested in 2010; Müller-Thurgau and Viognier bore minimally (Table 81). The remaining entries, Chardonel, Seyval Blanc, Siegfried, Traminette, Valvin Muscat and Vidal Blanc had greater than 75% of their vines bear fruit in 2010. Of the harvested white wine vines, Seyval Blanc produced 33 clusters per vine followed by Siegfried (27), Vidal Blanc (22), Müller-Thurgau (19), Chardonel (17), Traminette (17) Viognier (17) and Valvin Muscat (11) (Table 81). Cluster weights per vine were highest in Seyval Blanc (3183 g) and lowest in Valvin Muscat (673 g). In 2010, Viognier had the highest sugar content (30 $^{o}$Brix) followed by Chardonel (27.6 $^{o}$Brix) (Table 82). Viognier was harvested September 15 and Chardonel on September 9. Seyval Blanc had the lowest sugar content (19.8 $^{o}$Brix) because we probably harvested it too early on August 25. Juice pH was highest Viognier (3.5) and lowest in Siegfried and Traminette (3.0; Table 82).

**Table 80. Mortality, freeze damage, and chlorosis characteristics of wine grapes planted in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Cultivar | Vines Retrained (%) | Freeze Damage (%) | Season End Mortality (%)[a] | SPAD (Fe) Season Ave | | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2010 | 2008[b] | 2009[c] | 2010[d] |
| **Red** | | | | | | |
| Agria | 67bc | 60d | 4.3a | 25.0ed | 31.7de | 27.6ab |
| Baco Noir | 0e | 100a | 0.0a | 24.1e | 34.4bc | 27.3ab |
| Kozma | 8e | 96ab | 0.0a | 26.6c | 36.2ab | 28.1ab |
| Leon Millot | 4e | 100a | 0.0a | 26.2cd | 36.3ab | 28.0ab |
| Malbec | 78ab | 22e | 8.3a | 28.9b | 35.4abc | 26.6b |
| Pinot Noir | 67bc | 88abc | 0.0a | 27.1c | 36.5ab | 27.4ab |
| Refosco | 54cd | 77bcd | 8.7a | 27.2c | 33.5cd | 25.0c |
| Regent | 75abc | 57d | 0.0a | 22.2f | 29.3e | 21.9d |
| Sangiovese | 96a | 56d | 0.0a | 26.3cd | 30.6e | 24.5c |
| Zinfandel | 39d | 71cd | 8.3a | 30.6a | 37.4a | 28.6a |
| LSD | 20 | 23 | NS | 1.5 | 2.6 | 1.7 |
| F Value | 18.63 | 9.85 | 1.34 | 18.87 | 9.12 | 11.6 |
| Pr>F | <0.0001 | <0.0001 | 0.2193 | <0.0001 | <0.0001 | <0.0001 |
| **White** | | | | | | |
| Chardonel | 0d | 38cd | 4.2a | 24.8c | 39.7a | 31.5a |
| Müller-Thurgau | 29bc | 58bc | 0.0a | 25.2bc | 31.9de | 24.4e |
| Sauvignon Blanc | 48b | 80ab | 4.2a | 26.7ab | 33.2cd | 26.8d |
| Seyval Blanc | 0d | 32d | 5.0a | 24.1cd | 34.4bc | 28.9bc |
| Siegfried | 0d | 100a | 0.0a | 25.7bc | 35.4bc | 31.9a |
| Traminette | 17cd | 43cd | 0.0a | 24.8c | 36.6b | 30.6ab |
| Valvin Muscat | 25c | 87a | 0.0a | 24.8c | 28.7f | 27.3cd |
| Vidal Blanc | 17cd | 0e | 0.0 a | 23.0d | 34.2bcd | 29.1bc |
| Viognier | 87a | 50cd | 4.2a | 27.3a | 33.2cd | 28.3cd |
| LSD | 19 | 24 | NS | 1.7 | 2.5 | 2.0 |
| F Value | 12.43 | 13.53 | 0.66 | 4.75 | 13.42 | 11.14 |
| Pr>F | <0.0001 | <0.0001 | 0.7260 | <0.0001 | <0.0001 | <0.0001 |

[a]Considering that some vines were retrained from the ground at the beginning of the season.
[b]Mean of 2 measurements taken on 7/24 and 8/07/08.
[c] Mean of 2 measurements taken on 7/14 and 8/06/09.
[d]Mean of four measurements taken on 6/9/10, 7/6/2010, 7/26/10, and 8/4/10.


Red Wine Varieties
E-L ranking
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Agria
Baco Noir
Kozma
Leon Millot
Malbec
Pinot Noir
Refosco
Regent
Sangiovese
Zinfandel
Killing Freeze 4/30-5/3
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug

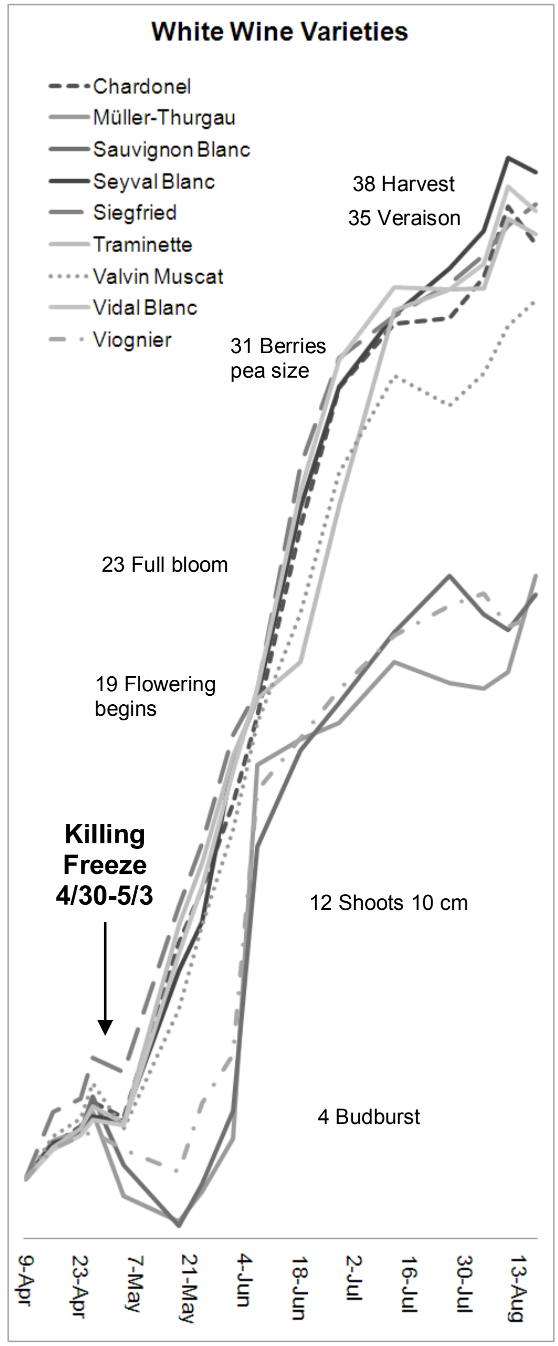

White Wine Varieties
Chardonel
Müller-Thurgau
Sauvignon Blanc
Seyval Blanc
Siegfried
Traminette
Valvin Muscat
Vidal Blanc
Viognier
38 Harvest
35 Veraison
31 Berries pea size
23 Full bloom
19 Flowering begins
12 Shoots 10 cm
4 Budburst
Killing Freeze 4/30-5/3
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug

**Figure 11. Modified E-L ranking for red wine (A) and white wine (B) cultivars grown on their own roots.**

**Table 81. Harvest data for Table grapes planted on their own roots in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Cultivar | Harvest Date | | Number Vines Harvested (%) | | # Clusters Harvested per Vine | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| **Red** | | | | | | |
| Agria | 8/17 | 9/08 | 13 | 54 | 4 | 6b |
| Baco Noir | 8/13 | 9/14 | 88 | 96 | 6 | 10ab |
| Kozma | 8/12 | 9/10 | 75 | 92 | 9 | 15a |
| Leon Millot | 8/12 | 8/20 | 63 | 88 | 4 | 5b |
| Malbec | NH | NH | NH | NH | NH | NH |
| Pinot Noir | 8/26 | NH | 4 | NH | 2 | NH |
| Refosco | NH | 9/16 | 0 | 4 | 0 | 2b |
| Regent | NH | 9/16 | 21 | 25 | 6 | 4b |
| Sangiovese | NH | NH | NH | NH | NH | NH |
| Zinfandel | 8/28 | 9/15 | 21 | 33 | 4 | 5b |
| LSD | | | | | | 9 |
| F Value | | | | | | 6.43 |
| Pr>F | | | | | | <0.0001 |
| **White** | | | | | | |
| Chardonel | 9/17 | 9/09 | 75 | 92 | 5 | 17ab |
| Müller-Thurgau | 8/26 | NH | 8 | 4 | 5 | 19ab |
| Sauvignon Blanc | NH | NH | NH | NH | NH | NH |
| Seyval Blanc | 8/11 | 8/25 | 71 | 75 | 10 | 33a |
| Siegfried | NH | 9/10 | 4 | 100 | 3 | 27ab |
| Traminette | 8/26 | 9/13 | 71 | 96 | 5 | 17ab |
| Valvin Muscat | NH | 9/15 | NH | 79 | NH | 11ab |
| Vidal Blanc | 8/28 | 9/14 | 67 | 100 | 5 | 22ab |
| Viognier | 8/26 | 9/15 | 4 | 4 | 5 | 17ab |
| LSD | | | | | | 16.5 |
| F Value | | | | | | 6.65 |
| Pr>F | | | | | | <0.0001 |

**Table 82. Harvest data for Table grapes planted on their own roots in 2007; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Cultivar | Cluster Weight per Vine (g) | | Soluble Solids (⁰Brix) | | Juice pH | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| **Red** | | | | | | |
| Agria | 300 | 690ab | 22.9 | 26.5ab | 3.5 | 3.5a |
| Baco Noir | 421 | 431b | 25.0 | 28.0a | 3.0 | 3.3a |
| Kozma | 797 | 1050a | 23.2 | 26.3ab | 3.0 | 3.3a |
| Leon Millot | 236 | 269b | 25.4 | 22.6b | 3.3 | 3.3a |
| Malbec | NH | NH | NH | NH | NH | NH |
| Pinot Noir | 140 | NH | 26.1 | NH | 3.3 | NH |
| Refosco | NH | 500ab | NH | 24.2ab | NH | 3.3a |
| Regent | 504 | 357b | 24.3 | 25.5ab | 3.2 | 3.4a |
| Sangiovese | NH | NH | NH | NH | NH | NH |
| Zinfandel | 1076 | 490ab | 22.6 | 23.3b | 3.0 | 3.1a |
| LSD | | 589 | | 4.6 | | NS |
| F Value | | 6.47 | | 5.63 | | 0.41 |
| Pr>F | | <0.0001 | | <0.0001 | | 0.9730 |
| **White** | | | | | | |
| Chardonel | 620 | 2008ab | 22.3 | 27.6ab | 2.8 | 3.1abc |
| Müller-Thurgau | 580 | 1040b | 24.2 | 25.4bc | 3.0 | 3.1abc |
| Sauvignon Blanc | NH | NH | NH | NH | NH | NH |
| Seyval Blanc | 1601 | 3183a | 21.8 | 19.8d | 3.0 | 3.2abc |
| Siegfried | 160 | 1658ab | 24.0 | 21.4cd | 3.2 | 3.0c |
| Traminette | 578 | 1403b | 24.8 | 24.9bc | 2.7 | 3.0c |
| Valvin Muscat | NH | 673b | NH | 23.6bcd | NH | 3.4ab |
| Vidal Blanc | 679 | 2373ab | 20.7 | 21.7cd | 2.9 | 3.2abc |
| Viognier | 600 | 2240ab | 30.1 | 30.0a | 0.0 | 3.5a |
| LSD | | 1731 | | 3.5 | | 0.4 |
| F Value | | 7.64 | | 14.42 | | 4.95 |
| Pr>F | | <0.0001 | | <0.0001 | | <0.0001 |

***2008 Planted Rootstock Trial***

Gewurztraminer vines were greener (28.4) compared to Refosco vines (24.8) regardless of rootstock (Table 83). The trend was the same as observed in 2009. Unlike the 2009 growing season where SPAD values were equal among rootstocks, in 2010, SO4 (27.9), Kober (27.7) 1103 Paulsen (27.4), 110 Richter (27.3), Teleki 5C (26.9), 1145 Paulsen (26.8) had the highest SPAD values while 775 Paulsen (26.0), 779 Paulsen (25.7), and 3309 Couderc (25.6) had the lowest SPAD values (*P*=0.0062; Table 83). Fruit yield was low in part because of the April 30-May 3 freeze and in part because of the juvenility of the vines. Fruiting is therefore not reported.

During data analysis freeze damage, an interaction was detected between scion and rootstock that did not permit data pooling. Therefore, rootstock comparisons within each scion are shown in Table 84. Over 60% of Gewürztraminer vines were affected by freeze damage after bud break and rootstock type did not seem to make a difference. On the other hand, Refosco grafted to Kober 5BB had the least amount of damage (47%) while Refosco grafted to 3309 Couderc suffered 93% damage (*P*=0.0083). Most vines recovered but were set back by weeks (Figure 12). The way the data was collected in 2010 did not permit differentiating between those vines that recovered from secondary bud break and those vines that needed entire retraining from the graft union. By August 17, Gewürztraminer/rootstock combination made no difference in E-L ranking (*P*=0.7265; Figure 12A). Refosco, however showed earlier growth on SO4 rootstock (*P*=0.039; Figure 12B). Gewürztraminer fared better than Refosco for mortality. By the end of the growing season, 8% of Gewürztraminer vines versus 25% of Refosco vines were dead, the result of the April 30-May 3 freeze and carryover from 2009 mortality (*P* <0.0001; Table 83).

**Table 83. Mortality and chlorosis characteristics of Gewurztraminer and Refosco wine grapes grafted onto nine rootstocks; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| | Vines Retrained (%) | Season End Mortality (%) | SPAD (Fe) Season Ave | |
|---|---|---|---|---|
| **Scion Cultivar** | **2009** | **2010** | **2009** | **2010** |
| Gewürztraminer | 15b | 8b | 36.6a | 28.4a |
| Refosco | 45a | 25a | 32.7b | 24.8b |
| LSD | 7 | 6.8 | 1.0 | 0.63 |
| F Value | 53.84 | 21.98 | 58.1 | 121.6 |
| Pr>F | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| **Rootstock** | | | | |
| 3309 Couderc | 38abc | 21abc | 34.6a | 25.6c |
| Kober 5BB | 24cd | 23ab | 34.9a | 27.7a |
| 775 Paulsen | 19d | 8c | 35.0a | 26.0c |
| 779 Paulsen | 19d | 8c | 34.6a | 25.7c |
| 1103 Paulsen | 22bcd | 29a | 35.2a | 27.4a |
| 1145 Paulsen | 27cd | 8c | 35.6a | 26.8abc |
| 110 Richter | 46a | 15bc | 33.6a | 27.3ab |
| SO4 | 44ab | 17abc | 34.9a | 27.9a |
| Teleki 5C | 30abcd | 19abc | 34.6a | 26.9abc |
| LSD | 16 | 14.41 | NS | 1.3 |
| F Value | 2.95 | 2.00 | 0.65 | 2.73 |
| Pr>F | 0.0033 | 0.0455 | 0.736 | 0.0062 |

**Table 84. Freeze damage taken May 5, 2010 of Gewurztraminer and Refosco wine grapes grafted onto nine rootstocks; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| | Freeze Damage (%) | |
|---|---|---|
| **Rootstock** | **Gewürztraminer** | **Refosco** |
| 3309 Couderc | 60a | 93a |
| Kober 5BB | 80a | 47c |
| 775 Paulsen | 73a | 81ab |
| 779 Paulsen | 79a | 90a |
| 1103 Paulsen | 81a | 92a |
| 1145 Paulsen | 100a | 85ab |
| 110 Richter | 83a | 63bc |
| SO4 | 90a | 86ab |
| Teleki 5C | 68a | 82ab |
| LSD | NS | 27 |
| F Value | 1.85 | 2.70 |
| Pr>F | 0.0697 | 0.0083 |

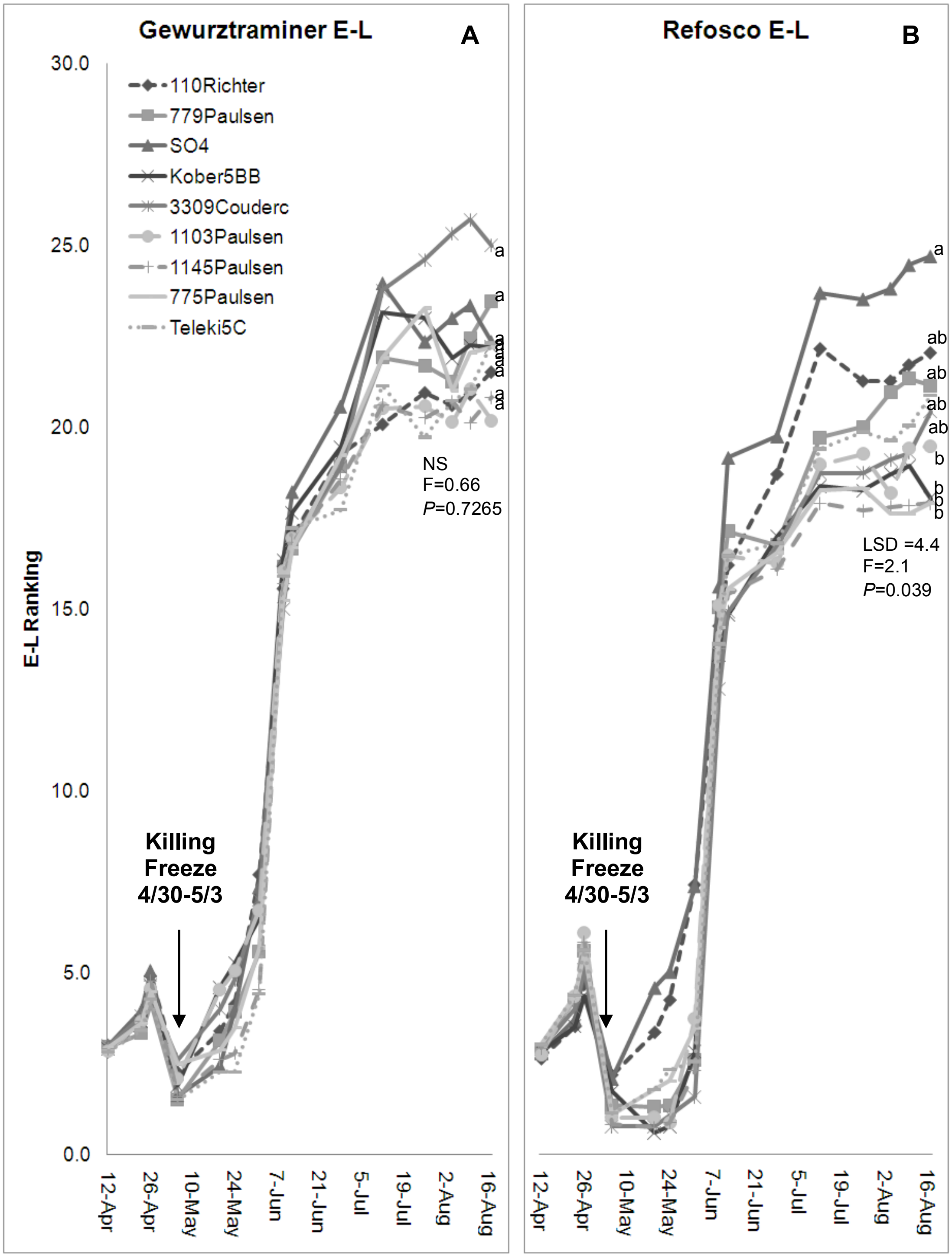



**Figure 12. Modified E-L ranking for Gewurztraminer (A) and Refosco (B) cultivars grown on 3309 Couderc, Kober 5BB, 775 Paulsen, 779 Paulsen, 1103 Paulsen, 1145 Paulsen, 110 Richter, SO4, and Teleki 5C rootstock; NMSU Agricultural Science Center at Farmington, NM. 2010.**

***San Juan County Vineyard Temperature Monitoring***

The NMSU-ASC vineyard was the warmest site while the Wilsey vineyard north of Aztec was the coldest (Figure 13). In 2010, the coldest temperatures recorded were on December 31: a low of -15˚F was recorded at the Wilsey vineyard, -8.6˚F at Wines of San Juan, and 3.4˚F at the ASC-Farmington vineyard. On the same day, the mean low temperatures were 10.7˚F at Wines of the San Juan, 10.0˚F at the Wilsey vineyard, and 14.2˚F in the NMSU-ASC Farmington vineyard. During the period of July 17-19, the mean high temperatures were 81.6˚F at Wines of the San Juan, 82.6˚F at the Wilsey vineyard, and 86.3˚F at the NMSU-ASC Farmington site.

Diurnal temperature change, calculated by subtracting minimum daily recorded temperatures from daily maximum temperatures and averaging by month, is shown in Figure 14 for the three vineyards. While swings in temperature are desirable for quality wine indices (i.e. sugar and acid balance) at fruit maturation during summer and fall months, the huge changes in temperatures during the spring are not desirable as vines begin to emerge from dormancy, increasing the risk of spring freeze damage to vines. During the months of March-May, diurnal temperature swings were largest at the Wilsey site: (36.6 in March; 41˚F in April; 48˚F in May. For the same period at Wines of the San Juan diurnal temperatures averaged 30.1˚F (March), 27.2˚F (April), and 36.2 ˚F (May). At the NMSU-ASC vineyard, diurnal swings were 35.5˚F (March), 39.1˚F (April), and 42.1˚F (May). The cliff rock face on the southern side of the Wines of the San Juan had the effect of storing thermal mass to lessen the severity of temperature swings, whereas the close proximity of the Wilsey vineyard to the Animas River served as a low temperature sink at night. At the time of fruit maturation, diurnal swings were highest at the Wilsey vineyard (46.8˚F August and 50.1˚F Sept), 42.4˚F (August) and 44.9˚F (Sept) at the NMSU-ASC vineyard, and 31.4˚F (August) and 37.0˚F (September) at Wines of the San Juan. Temperature data will continue to be monitored to assist regional growers with site selection.

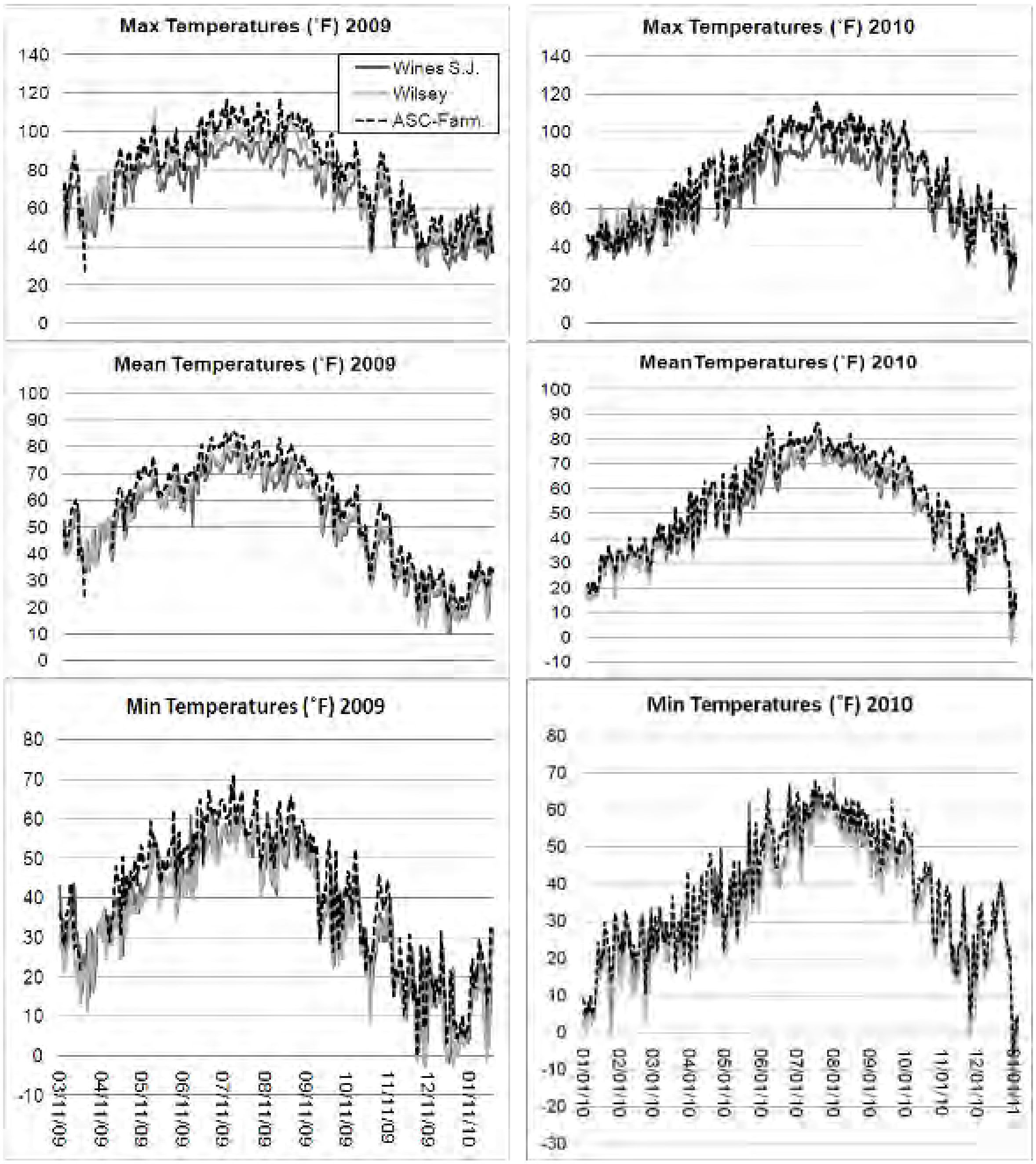



**Figure 13. Minimum, mean, and maximum temperatures at three San Juan County vineyards for 2009 (left) and 2010 (right); NMSU Agricultural Science Center at Farmington, NM. 2010.**

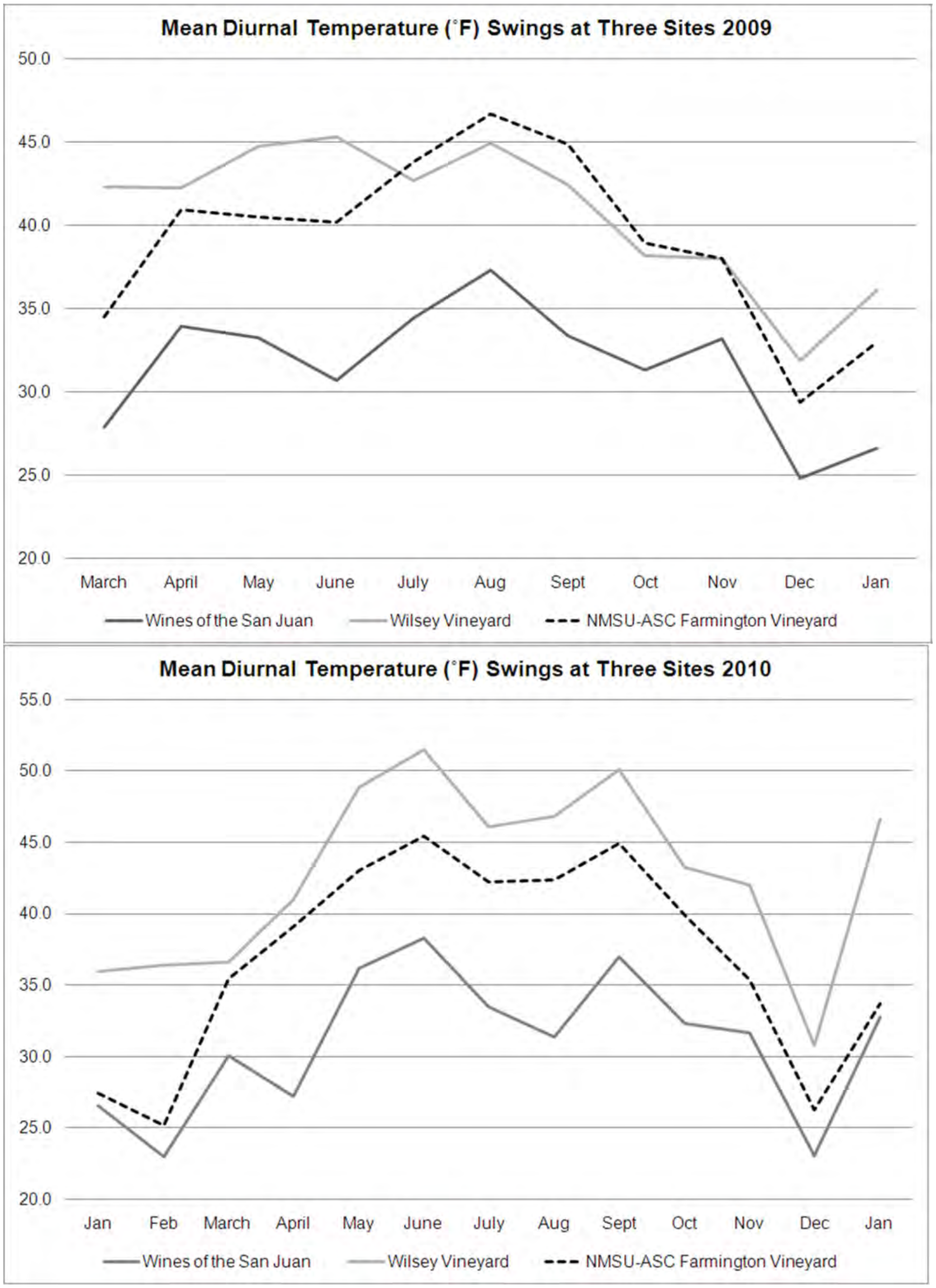



**Figure 14. Mean monthly diurnal temperature swings at Wines of the San Juan (Turley, NM), Wilsey Vineyard (north of Aztec, NM), and the NMSU-ASC Farmington vineyard in 2009 (top) and 2010 (bottom); NMSU Agricultural Science Center at Farmington, NM. 2010.**

## Conclusion

### *Table Grapes*

Table grapes showing the most promise for high elevation sites are Swenson Red, Glenora, Vanessa, Himrod, and Interlaken, Reliance and Marquis. These grapes recovered from a killing spring frost observed April 30-May 3 by producing a crop (especially Swenson Red). These grapes have also generally had high SPAD values, an indication of adaptability to high pH, calcareous soils. Table grapes with American parentage seem better suited to our site than table grapes with *vinifera* parentage.

### *Red and White Wine Grapes Grown on their own Roots*

Among the red wine grapes, Baco Noir, Kozma and Leon Millot and to a lesser extent Agria recovered from the April 30-May 3 freeze by producing a crop on greater than 50% of their vines in the trial. Zinfandel, Refosco, and Regent also produced a crop, although this was minimal and needs further evaluation. Except for Refosco and Regent, the vines that yielded a crop in 2010 had higher SPAD values which indicated adaptability to alkaline pH soil conditions. Baco Noir is a French American Hybrid, Kozma and Agria are vinifera cultivars from Hungary, Leon Millot is a vinifera cultivar from France

Among the white wine grapes, Chardonel, Seyval Blanc, Siegfried, Traminette, Valvin Muscat, and Vidal Blanc had greater than 75% of their vines in the trial yield grapes in 2010. The SPAD values were generally high, indicating adaptability to alkaline soil conditions. Chardonel, Valvin Muscat, and Traminette are releases from the Cornell breeding program (Geneva, NY). These cultivars are generally bred for cold tolerance and adaptability to the Finger Lakes Region of New York. Seyval Blanc, and Vidal Blanc are French American Hybrids. Siegfried is a V. vinifera bred in Germany.

French-American and Cornell grapes and vinifera cultivars from Northern Europe appear to have greater cold tolerance and adaptability potential to high elevation intermountain sites.

Sugar to acid appears to be well balanced and shows that the region does have the potential to produce favorable wines.

### *Rootstock Trial*

Gewurztraminer vines generally recovered from the April 30-May 3 freeze regardless of rootstock and had higher SPAD values regardless of rootstock when compared to the Refosco/rootstock combinations. Fruiting did occur although this was minimal so it is too early to predict yield at this point.

### *Temperature Monitoring*

Diurnal temperature swings are high in San Juan County. While this can be desirable at the time of fruit maturation in late summer, it is undesirable in the spring during bud break. Careful site selection – south facing slopes, upland sites – and vine cultivar selection to match sites cannot be over emphasized. *Further, if grape yields are significantly impacted by two spring killing freeze events, within a 10 year period like the one we observed April 30-May 3, it is not feasible to assume the risk of growing susceptible grape cultivars.*

The data reported here should still be viewed for establishment purposes. Without more seasons of evaluations, it is risky to assume that the suggested recommendations will work for all microclimates in San Juan County or other high elevation sites. Information on fruiting performance is still sparse and will be evaluated in greater detail during the 2011 growing season.

### Acknowledgements

We wish to thank the NMSU-ASC for salary support. We also Dave Arnold (Wines of the San Juan; Turley, NM), Henry Street (Ponderosa Valley Vineyards and Winery; Ponderosa, NM), Bart Wilsey, and Paulo D'Andrea (Luna Rossa Winery/NM Vineyards; Demming, NM) for their support of this project.

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# Hops (*Humulus lupulus*) Evaluation

**Funds provided by the New Mexico Department of Agriculture Specialty Crop Award**

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## Introduction

### *Growth and Utilization of Hops*

Hops (*Humulus lupulus* L), a bittering agent used in beer brewing, are perennial bines reaching up to 18-20 feet in a single season. A trellis traditionally constructed of equivalent height supports growth. Only the cones of the female plant are of value and are harvested each year from bines which re-sprout from rhizomes annually to supply the next year's crop. Most of the bitterness derived from hops are from α-and β-acids, phenolic-like compounds (Fix, 1999). Essential oils (humulene, myrcene, caryophyllene and to a lesser extent, farnesene) provide the overall hop presence and hop aroma. Ratios of α-to β-acids and of the various essential oils form important hops quality indices. The characteristics of hops, like grapes, depend on the growing location (Fix, 1999).

### *Four Corners Area Brewing*

Commercial craft brewing in northwest New Mexico and southwest Colorado continues to see growth. The region supports eight commercial breweries and brew pubs: Three Rivers Brewery (Farmington, NM); Steamworks, Ska, Carver, and Durango Brewing Companies (Durango, CO); Bayworks Brewing Company (Bayfield, CO); Pagosa Brewing Company (Pagosa, CO); and the Delores River Brewery (Cortez, CO). Ska brewing company is now the largest brewery on the western slopes of Colorado.

### *Justification for Research*

The justification for the research was based on an international shortage of hops in 2008 which caused pelletized prices to rise ten-fold. The hops volatility led Four Corners brewers and growers to view hops as an opportunity to diversify farming operation. Both producer groups requested assistance from the NMSU-ASC Farmington to determine the feasibility of producing locally grown hops. Currently, cone prices have stabilized. Acreage in Washington State, where 75% of the U.S. crop is produced, was actually down in 2009 and varieties like Willamette saw declines in demand (Ward, 2009). An estimated 600 acres of aroma and 500 acres of high alpha varieties were left unharvested at the end of the season around the Yakima valley alone (Ward, 2009). It is critical then to find hop cultivars that not only show adaptability but also niche market potential.

## Objectives

- Determine which cultivars are better adapted on a low-trellis system; Off-farm trials may also be initiated. NMSU-ASC Farmington.
- Determine hops tolerance to high pH soil (above 8) and over-winter potential of hops cultivars. NMSU-ASC Farmington and NAPI-Agricultural Testing Research Lab.
- Determine yields (lbs/acre) expressed on a fresh weight and dry weight basis. NMSU-ASC Farmington.
- Determine hop cone chemistry (resins and essential oils) under Four Corners environmental conditions. USDA-ARS Hop Germplasm Center, Corvallis, OR.
- Determine cursory economics on developing production and post harvest systems for hops in the Four Corners Region. NMSU Department of Agricultural Economics and Agricultural Business.

## Materials and Methods

The study was established at New Mexico State University‘s Agricultural Science Center at Farmington in the northwestern part of the state known as the Four Corners region (lat. 36° 41‘ 0” N; long. 108° 18‘ 36” W; elevation 5640 ft). The region is semi-arid with a mean annual precipitation of 208 mm (8 in.), an average of 161 frost-free days and mean minimum and maximum temperatures ranging from -7 to 5°C (20 to 41°F) in January to 16 to 33°C (60 to 91 °F) in July (O'Neill et al., 2005). The soil is a sandy loam and has a pH above 8.

### *Trellis Construction*

In 2008, a 10 feet high x 270 feet long trellis made of 2 3/8” steel pipe was constructed adjacent to a Populus wind break. The following clones representing a range of α-acids were obtained in February, 2008 from the USDA-ARS hops germplasm center, Corvallis Oregon: Cascade, Columbia, Crystal, Hallertauer, Newport, and Northern Brewer. In 2009, the following cultivars were added to the study: Centennial, Horizon, Nugget, Galena, Fuggle, Sterling, and Saaz. In 2010, a private hop breeder, Todd Bates of Taos, New Mexico, contributed selections to the trial which further expand possibilities of evaluating specialty cultivars for regional markets. Rhizomes were rooted in 1 gal nursery containers in Sunshine Mix #2 potting soil at the San Juan College (Farmington, NM) beginning March 2008.

After the last danger of frost, plants were placed under drip irrigation at the trellis site in the following manner: four plants were planted per plot/clone with each plot replicated three times. New plantings were allowed to establish without regard to harvesting cones. Non-destructive foliar measurements using a hand-held Minolta SPAD meter evaluated leaf greenness to determine the Fe chlorosis response on elevated soil pH. The SPAD 502 chlorophyll meter non-destructively measures light transmittance of the leaf in the red and infrared wavelengths at 650 and 940 nm, respectively yielding a numerical output that indicates leaf greenness (the higher the number given by the instrument, the greener the leaf) (Schepers et al., 1998).

Compared to more expensive extraction methods, the SPAD meter can rapidly estimate chlorophyll content (Yamamoto et al., 2002).

Only the 2008 planted cones were harvested in 2010. The remainder of the trial is still establishing. Hops were harvested by hand on two occasions in early September 2010 with assistance from the Three Rivers Brewery staff. Harvest criteria was based on when lower bracts on the cones began to lightly brown, lupulin glands (after splitting cones in half) were visually darker in yellow coloration, and flavor changed from a ―woody" chlorophyll taste to a ―IPA" aromatic flavor. Harvested cones were immediately analyzed for fresh weight (reported in grams) at the NMSU's ASC Farmington.

## Results

Crystal, Horizon, and Hallertauer and Saaz, noble hops varieties from Germany and Czechoslovakia, respectively showed signs of interveinal chlorosis (green veins with yellow leaf blades) on new growth characteristic of Fe deficiency which was confirmed with the SPAD meter. Hallertauer has consistently shown low SPAD values in three years of measurement (Table 85). In 2010, Sterling had the highest SPAD values and greenest leaves (49.4), followed by Galena (47.9). Yields were highest for Cascade followed by Crystal, and Newport. (Table 86). Over 6 kg of Cascade were harvested from the trial. The Three Rivers Brewery blended Cascade, Crystal, and Newport to produce 201 gallons of Aggie Ale. Newport (39 oz) and Crystal (197 oz) were used for bittering/aroma while Cascade was added for flavor (150 oz) and aroma (117 oz).

**Table 85. Chlorosis measurements for 2008 and 2009 planted hops; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| | Iron Chlorosis (SPAD) Measurements | | |
|---|---|---|---|
| **Cultivar** | **2008** | **2009** | **2010** |
| Cascade | 33.1a | 32.2a | 38.1de |
| Columbia | 31.9a | 33.3a | 44.9abc |
| Crystal | 30.0ab | 32.0a | 30.4f |
| Hallertauer | 19.7b | 23.3b | 31.1f |
| Northern Brewer | 23.8ab | 18.9c | 45.2abc |
| Newport | 31.0a | 33.0a | 35.2edf |
| Centennial | - | - | 39.1cde |
| Fuggle | - | - | 40.5cd |
| Galena | - | - | 47.9ab |
| Horizon | - | - | 30.9f |
| Nugget | - | - | 31.2bcd |
| Saaz | - | - | 32.4ef |
| Sterling | - | - | 49.4a |
| LSD | 10.9 | 3.1 | 6.8 |
| F Value | 4.57 | 31.05 | 7.62 |
| Pr>F | 0.0015 | <0.0001 | <0.0001 |

**Table 86. Chlorosis and yield measurements for 2008 planted hops, NMSU Agricultural Science Center at Farmington, NM. 2010.**

| | 2009 Yield | | 2010 Yield | |
|---|---|---|---|---|
| **Cultivar** | **Ave Fresh Weight (g)** | **Tot. Fresh Weight (g)** | **Ave Fresh Weight (g)** | **Tot. Fresh Weight (g)** |
| Cascade | 1713.3a | 5140 | 524.4a | 6293 |
| Columbia | 120.0b | 360 | 0.0b | 0 |
| Crystal | 1802.0a | 5406 | 477.2a | 5726 |
| Hallertauer | 37.9b | 114 | 0.0b | 0 |
| Northern Brewer | 0.0b | 0 | 0.0b | 0 |
| Newport | 413.3b | 1240 | 95.7b | 1149 |
| LSD | 955.9 | | 130.5 | |
| F Value | 7.45 | | 30.42 | |
| Pr>F | 0.0022 | | <0.0001 | |

## Conclusions

Hops may be seen by northwestern NM growers and brewers as a specialty crop which would diversify farming operations and provide a local, stable source of hop cones for brewers. In this study, we had no capacity for mechanization and utilized hand harvesting to pull cones out of the field which would have constituted labor constraints for us without the volunteer harvesting assistance. Still, a pelletizer located in Farmington for producing alfalfa pellets makes local hops production attractive. Future work needs to be oriented to assisting individuals like Mr. Bates and to evaluate New Mexico hops cultivars at statewide experiment stations/farms for response to varying soil and climate conditions. Hops growing for rhizome production should also be examined as a potential cash generating activity by growers. Much more work on harvesting, storage, pelletizing, and the economics behind these activities are needed.

## Acknowledgements

We would like to acknowledge the NMDA for their financial support of this project. We wish to thank the Three Rivers Brewery (Farmington, NM) for their support harvesting. We thank Todd Bates for his contribution of rhizomes in 2010.

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## Gardens for Health: Development of a Behavioral Intervention among the Navajo

**Funds provided by the U-54 Partnership for the Advancement of Cancer Research (PACR) partnership between the National Cancer Institute, the Fred Hutchinson Cancer Research Center and NMSU**

**Kevin Lombard, Shirley Beresford, Carmelita Topaha, Tonia Becenti and Sue Forster-Cox**

The U-54 Partnership for the Advancement of Cancer Research (PACR) project is a cooperative program between NMSU and the Fred Hutchinson Cancer Research Center (Seattle, WA). The program also provides opportunities for Hispanic and Native American students to become trained in health related research.

Numerous studies show that moderate consumption of fruits and vegetables, combined with exercise reduces the risk or delays the onset of some types of cancer. Building on prior success of home and community gardens this project seeks to evaluate the feasibility of taking an integrated approach using gardening as a means to shift eating and exercise habits back toward healthier lifestyles while addressing underlying issues of poor availability of fruits, vegetables, and traditional foods on the Navajo Nation. The study was divided into two aims:

Aim 1 of the study was to network with key influentials/stakeholders on and adjacent to the eastern portion of the Navajo Nation to assess deficiencies and avoid duplication of efforts. Key influentials identified included:

- Senior Citizens Centers: City of Bloomfield, Shiprock Senior Center.
- Boys and Girls Club, Bloomfield, NM.
- Cooperative Extension: Diné College, NMSU Navajo Tribal, Tri-state Cooperative Extension (University of AZ) at Shiprock.
- Indian Health Services: Shiprock.
- Special Diabetes Unit: Shiprock and Window Rock, AZ.
- Educational Units: Diné College Summer Research Enhancement Program in Diabetes and Cancer Research, San Juan College Native American Center, NMSU Bridges to American Indian Students in Community Colleges Program, University of New Mexico.
- Health Centers: San Juan Regional Medical Center, Farmington, NM, and Sage Memorial Medical Center (Ganado, AZ).

*Aim 2* of the pre-pilot was to develop and pilot test culturally appropriate focus group surveys to determine grass roots interest and perceptions about gardening among the Navajo.

### Materials and Methods

Two Navajo undergraduate students from San Juan College were recruited May 18, 2009 to assist with data gathering and networking activities. Both students received training in focus group methodology from the Fred Hutchinson Cancer Research Center (Seattle, WA) in June 2009. The focus group portion of the study was confined to areas adjacent to the Navajo Nation. Interview sessions took place on the following dates: November 09, 2009 (San Juan College, main campus), November 17, 2009, (San Juan College West Campus, Kirtland, NM), January 26, 2010 (Tribal Youth Counsel Workforce Training Center, Farmington, NM), March 17, 2010 (Farmington Senior Center, Farmington, NM), June 28, 2010 (Farmington Senior Citizens Center, Farmington, NM), February 2, 2011 (Bloomfield Senior Citizens Center), and February 9, 2011 (San Juan College, Farmington, NM).

Respondents were recruited by word of mouth by Navajo members of the team. Participant eligibility was determined as being Navajo and over the age of 18. Eligible adults who expressed interest in participating in the focus group were informed of the date(s)/time(s) when information about the project was to be presented and the focus groups conducted under the supervision of a moderator. This allowed the opportunity to ask questions if necessary. Before each session, the moderator distributed consent forms to each participant and read through each form, asking for questions before obtaining consent. In addition to signing a consent form, completion of the focus group was taken to be consent. Focus groups were comprised of groups of Navajo from two to eight people

Questions that were asked included: Where might a garden be placed in your community; that is, (a) a single community spot at a central space preferred? Or (b) is an individual garden at your home preferred? Is gardening important to you? Focus group questions asked are in Table 87. The questions were projected onto a wall so that participants could follow the moderator.

Each focus group session took anywhere from 30 minutes to 1 hour to complete. Focus group sessions were digitally recorded. At the conclusion of the session, each participant received a copy of the consent form he/she signed, in addition to a $20 gift card as gratuity.

After each focus group, the research team discussed went well and what could be improved. Notes were taken to summarize the responsiveness of individuals. Recordings were then transcribed word for word. Although time consuming, this process gave an accurate transcript of what was discussed for data analysis.

**Table 87. Gardening and Health Themed Focus Group Questions; NMSU Agricultural Science Center at Farmington, NM. 2010.**

1. Is gardening important to you?
2. How do you think that your health could be improved by tending a garden?
3. How do you think that your economic and food security could be improved by tending a garden?
4. What kinds of information have you received about gardening?
5. What problems or barriers do you encounter for farming/gardening in your community?
6. Where might a garden be placed in your community; that is,
   a. Is a single community spot at a central space preferred? b. Or is an individual garden at your home preferred?
7. What kind of gardens might work? School gardens? Senior Citizen Center gardens? Other ideas?
8. Would you participate in a gardening class, canning class, or gardening 101? How might this help?
9. In your home community, what are your major health concerns?
10. What do you know about diabetes?
11. Is cancer a health concern?
12. Does your chapter talk about diabetes at their meetings?
13. Does your chapter talk about cancer at their meetings?
14. Can you think of ways we can reduce diabetes among the Navajo people?
15. Final question: "Have we missed anything? Is there anything we didn‘t cover in today‘s discussion? Is there anything you would like to add to the discussion?

## Results

Key influentials informally interviewed included; directors of senior citizen centers, Boys and Girls Club directors, cooperative extension agents (Diné College, NMSU, University of Arizona), Indian Health Services, the Navajo Nation director of the Special Diabetes Unit, educational units (Diné College and San Juan College), and the directors of the NMSU BRIDGES and Diné College‘s Summer Research Enhancement programs. Health care workers in the region still primarily focus on diabetes and cancer screening, treatment, counseling on nutrition, and exercise programs like *Just Move It*, a program sponsored by the Navajo Special Diabetes Unit. The Special Diabetes Unit and the Indian Health Service provide outreach to promote healthy eating. Agricultural workers primarily focus on producing crops in a difficult growing environment of low annual rainfall. NMSU, Dine College, and Tri-State agricultural cooperative extension programs promote nutrition and healthy eating programs through 4-H and home economics. Interest in examining gardening, as a means to address several issues, was high among most key influential and focus group interviewees. *Evidence from this project suggests that several groups have an interest in promoting healthy food production in the form of small-scale gardens. Evidence also suggests a need to expand quantitative survey efforts onto the Navajo Nation in order to tailor an intervention in a more integrated manner.*

Preliminary results from focus group interviews indicate that many issues are involved as to why people do or do not undertake gardening on the Navajo Nation. These issues include land rights, family preference, water access, etc. Generally, health disparities are not discussed at the chapter house level. There was a large consensus of participants indicating interest in obtaining more knowledge on gardening through classes. Education and age seemed to have played a role in getting responses. Focus groups that were attended by older, more educated individuals had more engaging conversations whereas other focus groups required some prompting for responses by the moderators. Some focus group questions need to be revised as indicated by the responses recorded. In particular, the question: *How do you think that your economic and food security could be improved by tending a garden?* was poorly worded and/or there was a lack of knowledge about the subject matter for many of our focus group audiences. It was difficult to recruit participants via flyer and word of mouth (recruitment protocol, January 20, 2010). The study coordinator scheduled the dates of the focus groups in advance and confirmed participation, but prospective participants have canceled and requested to re-schedule, which has delayed participant recruitment and data collection. The focus group method was not necessarily the best method to interview members of the Navajo. Gaps in questions have already been identified, and new questions to assess additional gardening motivators, such as gardening skill of ancestors will be added in the future. Both edited and added questions will be used in the elicitation interviews and ultimately will be incorporated into the quantitative survey that will form future proposed pilot work.

## Establishing the Center for Landscape Water Conservation

**Funds provided by the Rio Grande Basin Initiative, a cooperative between Texas A&M and New Mexico State University, supported by the USDA.**

**Kevin Lombard, Rolston St. Hilaire, Stefan Sutherin, Dan Smeal**

### Background and Justification

Considering that 65-75% of total residential water use is applied to turf, landscape, and other outdoor uses in the Southwestern U.S. (Vickers, 2001), the need to educate residents of New Mexico on lowering their outdoor watering needs is great. Objectives of the center for Landscape Water Conservation are to become a single clearinghouse of NMSU, state, county and non-profit websites dealing with xeriscaping, urban irrigation and other landscape water conservation topics relative to New Mexico and far west Texas and add *integrated* services to strengthen educational and extension outreach related to urban water conservation topics in the urban landscape. The justifications for establishing the Virtual Urban Landscape Water Conservation Center are defined by 1) The need to disseminate water conservation information to homeowners, landscape professionals, and students of the Rio Grande Basin who may be unfamiliar with New Mexico and West Texas's semi-arid climate and the need to conserve water amid drought cycles, increased population growth, and competition of water resources between agricultural and urban end-users; 2) The need to provide information to county extension agents and educators conducting outreach in the area of urban landscape water conservation, and 3), the Virtual Urban Landscape Water Conservation Center will take advantage of more cost effective information technologies for information, training, and educational outreach services of information dissemination. Given the cost constraints of establishing a physical center web-based implementation of the site comes at a time when travel is expensive and state funds are scarce to put on traditional workshops.

### Objectives

- Coalesce existing NMSU, state, county and non-profit websites dealing with xeriscaping, urban irrigation and other landscape water conservation topics relative to NM and far west Texas into a single site with integrated services to strengthen educational and extension outreach related to urban water conservation topics in the urban landscape.

- Establish the Center for Urban Landscape Water Conservation as single clearinghouse of information and/or information transfer.

- Target end-users: 1) homeowners, 2) city and private landscapers, city planners, and park managers 3) county extension agents, and 4) students and adolescents.

## Methods

In order to begin the process of assembling metadata associated with the Center for Landscape Water Conservation, project assistants contacted the 33 listed members of the Urban Landscape Water Conservation Coordinating Committee through email, telephone and poly-com link. Non-ULWCCC members contacted included the Rio Ranch Botanical Garden and Texas Tech University researchers engaged in Xeriscape issues who have agreed to assist the project as it pertains to eastern New Mexico clientele. An interactive map of New Mexico will guide users of the site to these and other outlets committed to conserving water in the urban landscape. The methods employed involve consolidating websites the multiple ULWCCC member websites, county extension fact sheets, streaming video of existing media productions of relevance to urban water conservation and have this under a searchable index. An interactive map of the region is being developed using Flash software indicating the locations of xeriscaping demonstration sites. Undergraduate students from NMSU and San Juan College will participate in the Center's construction through student/classroom participation by developing posters and modules related to urban water conservation topics that can be downloaded or printed and mailed to county extension agents conducting training sessions. Other instructional materials, such as ―smart" irrigation controllers will be built and available on a state-wide loan program for county extension agents to use while conducting training sessions. Modules will be developed to allow online access by county agents to gain continuing education units (CEUs) in urban water conservation topics without the need to travel to a physical site. Age-appropriate fact sheets and animations dealing in urban water conservation topics will be developed and made available to adolescents to begin the process of behavior change which can be carried into adulthood.

## Evaluation

A graduate student, Ms. Stefan Sutherin, is devising evaluation tools, measuring outcomes, and will write results. The Center for Landscape Water Conservation will be evaluated using hit counters which will track numbers of visitors, predominant end-user, and the popularity of individual topics which will range from appropriate plant material usage to using smart irrigation controllers to managing irrigation systems. At two times, focus groups will be formed comprised of the end-user groups to pilot the Center. Feedback through surveys will assess ease of usability and satisfaction in deliverables. Outcomes will be published as a thesis and in a peer reviewed scientific journal.

## Results

The Center for Landscape Water Conservation (http://www.xericenter.com/main.php) was made public in February 2011 but is still considered a Beta version. Figure 15, Figure 16, Figure 17, and Figure 18 shows screen shots of the site. Figure 19 shows filming for the development of virtual garden tours.

**Extension Outputs:**

1. Ms. Sutherin manages day-to-day activities of the site's development including the supervision of web designer and Computer Science grad students, Esther John and Allan Andrew, and the management of the Center for Landscape Water Conservation blog. http://xericenter.wordpress.com. On the site, we continue to focus on functionalities; aesthetics will follow last:
   a. The site templates were re-designed by a CMI student who is working in Ag Media under Connie Padilla. The template was linked-up to all the pieces described below and available online.
   b. Three databases have been created: one that is the backbone of the entire site, containing all links and forms; one holding registered user information and the third is a searchable plant ID database. All databases have been tested and debugged. The backbone is complete; the registered user database is complete and ready for user inputs; the plant ID database is currently being loaded.
   c. Security, link checker application, and statistics counter for user activity are working.
   d. Public pages:
      i. ―Homeowner Resources" contains links to various topic areas including Plants of the Region and searchable plant database, Xeriscaping, Irrigation, How-to-Tools, Water Conservation, and Regional Retailers and Landscapers; ―Student Resources", ―State and Municipal Resources" which include municipal water utility pages and programs, state water programs, university resources, regional extension offices and programs, and Fact sheets and brochures; ―Other Links" includes, events, blogs, recommended reading, About Us, RSS feed, Sitemap, and Contact Webmaster.
      ii. Users of the public pages will also be able to search the site with tags, find their climate zone and weather forecast, locate regional gardens and parks via Google maps, take virtual tours of four regional gardens (Chihuahua Desert Gardens at UTEP, El Paso Botanical Garden, Sandoval County Master Gardener Waterwise Garden in Rio Rancho, and the NMSU Farmington ASC Xeriscape Garden), view Southwest Yard and Garden videos, join a forum discussion, ask a question, and find an expert.
      iii. The public home page contains a center column for articles, columns, and announcements.
      iv. The plant ID searchable database is created where one can search for information about a plant based on various criteria. The underlying program looks for possible matches within the database and sends the results if a match is found.

   e. Registered User Pages:
      i. Only registered users can view pages when they login with their username and password. Those pages are secure, protected and private to only the users who logged in with their username and password and cannot be accessed if not logged in.
      ii. Registered users initially complete a registration form. The form is also validated to check for errors, wrong inputs and insufficient data. To protect the privacy of the members the password is encrypted and stored

in the database. Registration information is used to populate a searchable "peer contact list".

iii. Registered users are encouraged to populate a user profile, upload their photo, upload or link their research and papers, and make available their professional background. The profile is secure and will be available to all registered users via the searchable "peer contact list".

iv. Registered users - specifically extension folks - will have access to topical presentations that will be recorded and posted and available online or via iTunes download.

v. Registered users will have collaborative spaces, such as Wikis, forums, and shared document spaces as well as personal space for storage of "toolkit" data, such as commonly used references, data, statistics, presentations, etc.

vi. Resources for registered users will include; subject matter research, presentations, papers, and articles, the NM Climate Center link, links to suppliers, vendors, and manufacturers, grant and funding opportunities, subscriptions and feeds, job announcements, links to professional organizations, podcasts, recommended reading, and contact information for feedback, webmaster, RSS feed, and a sitemap.

vii. We will depend on help from registered users to maintain current information on the above subject matter. Very simple forms will be accessible at each subject area where users can send in updates and additions.

viii. A center column on the top-level page will have announcements of new research, seminars, events, industry activity, etc.

2. Kevin Lombard, Dan Smeal and Stefan Sutherin staffed the NMSU booth at the New Mexico Xeriscape Council Expo on February 27 and 28, 2010 in order to disseminate cards listing the xericenter.wordpress.com site, network with industry representatives working in xeriscape construction, rainwater harvesting, etc. and to gauge initial public support. Over *5,000* people were in attendance and greater than *24* industry representatives were consulted.
3. During the summer 2010, landscape nurseries (wholesale and retail) were phoned and surveyed by student's Aiessa Wages and Letisha Yazzie. The list was paired down from 93 to 41 state-wide retail and wholesale nurseries that specialize in drought tolerant plant material and businesses that specialize in drip irrigation and rainwater catchment supplies. Nurseries not selling at least 30% native and drought adapted plants were dropped from the list. The vendor list will be searchable and guide users to locations using Google Maps. Additionally, users will be able to recommend regional retailers and landscapers for inclusion in our list via a form that will go through the webmaster for verification before being added to the listing.
4. The following xeriscape demonstration gardens were videotaped in June and July, 2010 by Ag Media with the purpose of showing a walkthrough of each garden as narrated by the curator:
   a. Rio Ranch Botanical Garden – complete and being reviewed by the curator
   b. UTEP Chihuahua Desert Garden – complete and being reviewed by the curator
   c. El Paso Botanical Garden – nearly complete
   d. NMSU-ASC Farmington Xeriscape Demonstration Garden – in-work; completion estimated at mid-January.

   e. All videos will be streamed from youtube and be available for download via iTunes.
   f. An extensive photograph collection was also done at the time of videotaping. Those photos will be used in the searchable plant ID database and on the garden tour pages.
5. Alex Winterhalter, Koogler Middle School (Aztec, NM) borrowed a high quality digital video camera in July, 2010. He is working with a group of his peers to film adolescent oriented videos on water conservation topics for the Kids Section.
6. With Natalie Goldberg, we are discussing professional development modules for NMSU county extension agents that would be uploaded to the site and available via youtube and iTunes
7. Blog and social media continue to serve as a community-building effort during website construction. *The Center for Landscape Water Conservation* blog site http://xericenter.wordpress.com is on-line and distributing information on topics ranging from using drought tolerant plants in the urban landscape to rainwater harvesting. The site will soon be re-designed to handle the public forums, discussion groups, and Q&A segments of the main site.
8. A facebook page is planned for spring 2011.

## Research Outputs

Master‘s candidate Stefan Sutherin continues to make huge contributions to the project. She is based in Las Cruces with the Plant and Environmental Sciences Department. Her research entails designing a ―business plan” for the sustainability of the site and conducting research on the interactive tools, collaborative sites, structure, and design of the site. She will examine a ―Logic Model” of adoption by users, and evaluate the content, use-ability, interactivity, marketability of the site which will in part involve research with participants who will participate in the overall evaluation process. She has completed a draft research proposal and literature review and is navigating the Institutional Board policies concerning surveying future users of the site. She formed her thesis committee (Drs. Kevin Lombard - chair, Rolston St. Hilaire-co-chair, Brenda Seevers, and Dawn Vanleewen) which met on October 1, 2010. User feedback surveys will be done during site development with a final user satisfaction survey intended for late 2011.

1. Online pilot surveys Spring 2011
   a. Zoomerang.com was chosen for online surveys/polls for the 20 survey participants who will work with us through the final development phase. With this number of participants, Zoomerang is a free service. For the final survey, we will increase our targeted number of participants into six mini-surveys of 50 respondents each.
   b. Cardsort.net will be used for the two card sort exercises. The fee is $79 for 11 to 100 participants (up to 10 is free but Nielsen recommends 15). Because there are two distinct sorts, the total fee will be $158.
2. A draft questionnaire edited by Dr. Brenda Seevers was completed in the first week of November.
3. Thesis Methodology section is complete and was forwarded to Drs. St. Hilaire and Lombard for review/edit on 11/27/10. Other committee members Drs. Vanleewen and Seevers received drafts.
4. Survey drafts were sent to Intuitional Review Board (IRB) in Jan, 2011. We are awaiting IRB approval of the survey instruments.

## Literature Cited

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**Figure 15. Screen shot of Home Page of the Center for Landscape Water Conservation; NMSU Agricultural Science Center at Farmington, NM. 2010**

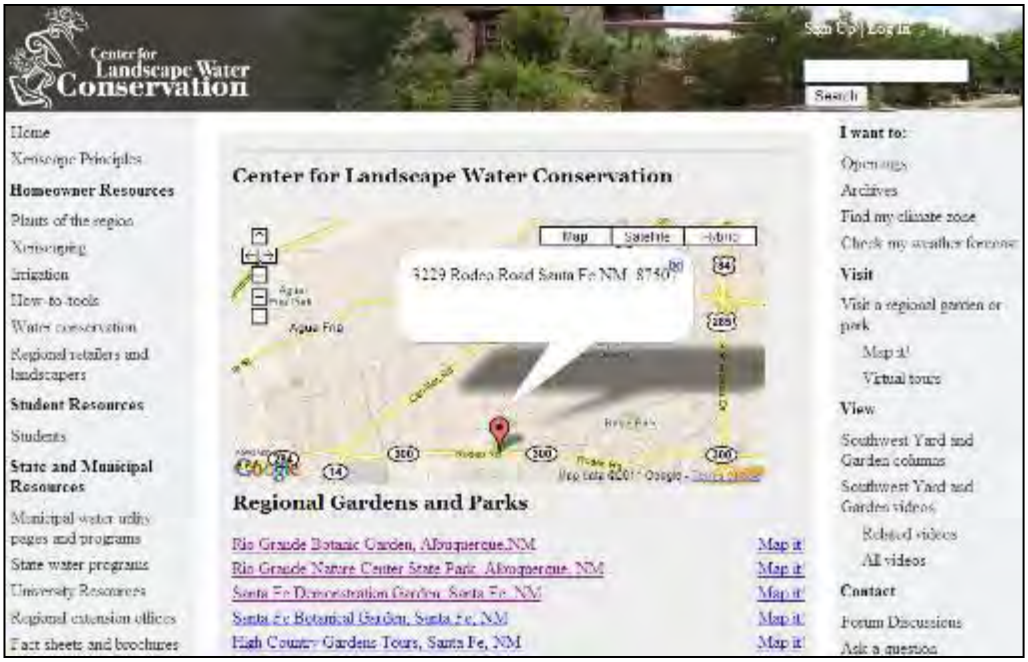
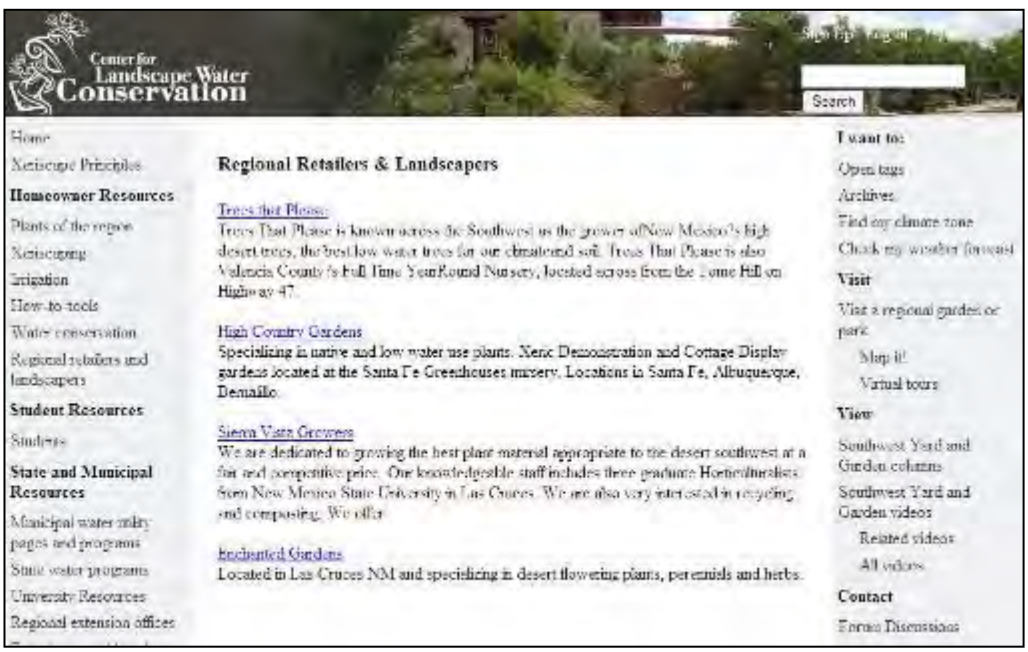



**Figure 16.** **Screen shot of locations of demonstration gardens practicing water conserving practices. Google-Maps is integrated into the website to direct web users to these locations; NMSU Agricultural Science Center at Farmington, NM. 2010.**

**Figure 17.** **Screen shot of Regional Retailers and Landscapers specializing in water**




**conserving plant material and services; NMSU Agricultural Science Center at Farmington, NM. 2010.**


**Figure 18. Video/virtual tour of Xeriscape demonstration garden; NMSU Agricultural Science Center at Farmington, NM. 2010.**

**Figure 19. Shooting video and pictures for virtual tour of NMSU-ASC Farmington Xeriscape Demonstration Garden. July 20, 2010; NMSU Agricultural Science Center at Farmington, NM. 2010.**

# Risk Management Education in Southwest Medicinal Herb Production and Marketing

**Funds provided by the Western Center for Risk Management Education/USDA CSREES.**

**Kevin Lombard and Charles Martin**

Previous herb production research and outreach/educational programs at NMSU have identified several obstacles or risks to the adoption of Southwest herb (SWH) production/value-added agriculture enterprises by socially-disadvantaged growers:

1. Technical risks -- proper identification of SWH species, overharvesting of native stands on tribal or public lands, and the need for mechanized cultivation, harvesting, and processing methods.

2. Legal risks -- illegal harvesting or use on public lands, risk of intellectual property right violations.

3. Financial risks -- the lack of start-up capital, economies of scale, cash flow and the lack of enterprise budgets for specialty medicinal crops/native plant species.

4. Marketing risks -- herb market identification, volatility, competition from established large-scale herb processors/marketers, and initial valuation/pricing of previously unrecognized, underutilized plant species.

5. Intangible risks -- cultural insensitivity leading to objections to commercialization of native herbs, the appropriation of indigenous knowledge and cultural property by non-traditional commercial enterprises.

## Objectives

- Provide an intensive grower/entrepreneur risk management training program.

- Create an online tutorial specifically tailored for socially-disadvantaged producers.

The proposed results will instruct growers in basic risk management principles, help familiarize growers with the above-mentioned risks as they pertain to SW medicinal herb production and value-added product development, provide tools to assist growers in financial management as it pertains to financial risk management, assist growers in framing native SW herb enterprises in proper cultural context, and introduce growers to the recognition of the concept of "intangible" assets and liabilities. We also wish to provide growers the forum to network with other entrepreneurs to develop entrepreneurial skills and new market opportunities.

## Methods

***Workbook Development***

A comprehensive workbook was developed from July-November 2010 which included speaker notes, fact sheets on 20-25 herbs commonly grown in New Mexico, and other relevant financial and marketing information concerning herb production. Two San Juan College students assisted in the fact sheet development.

***Workshops***

Workshops were developed for December 7-8, 2010 (San Juan College, Farmington, NM) and March 4-5, 2011 (NMSU Distant Education Center, Albuquerque, NM). The December workshop schedule was as follows:

Day 1: (8:30am-4:30pm)

1. Introduction to Risk Management – Charles Martin (NMSU).
2. Balancing Culture and Commerce – Carmelita Topaha (San Juan College).
3. Herbal Entrepreneurship – Bill Quiroga (President and CEO of Native American Botanics).
4. Value-Added Herb Products – Roundtable discussion (NM growers and processors).

Day 2: (8:30am-4:30pm)

1. Herb Marketing – Jackie Greenfield, (Gaia Herbs, Brevard, NC).
2. Financial Risk Management – Charles Martin.
3. Herb Production Models – Amy Brown and Steve Heil (NM herb producers).

Participants registered in advance or at the door. Registration was $60 per person; $40 with a valid student ID. The registration fee covered the cost of the workbook and other incidentals, such as room rental. Each participant was asked to sign a consent form in order to be contacted in the future.

***The future:***

- A second workshop will be held March 4 and 5, 2011 at the NMSU Distant Education Center. The registration fee was lowered to $40. Additional speakers will cover value-added products. The Financial Risk session was eliminated to allow for more discussion time. Financial risk will be weaved into other sessions.
- We will have all of the sessions during the March 2011 workshop video and audio recorded. This will form the foundation of an online tutorial which will be produced by NMSU Ag Media. The tutorial will expand the outreach component of the project.

## Other Horticultural Activities 2010:

### Funds provided by the Bridges to American Indian Students in Community Colleges (Bridges) Program, USDA through the Hatch Program, and the State of New Mexico through general appropriations

### Grow-box experiment

Small grow boxes approximately 4 ft x 4 ft x 1 ft deep are becoming more popular with gardeners. Some designs are built at home from plans downloaded from the internet. Other grow boxes can be purchased from suppliers fully assembled. Prices range from $25.00 to >$400.00. Yet, no scientific information exist to provide gardeners with yield data based on the choice of the grow box.

### Objectives

- Compare vegetable yield across four different grow-box designs of differing price range.

### Materials and Methods

Two grow-box designs were constructed of wood on-site. One grow box, Cellu gro™, was purchased as a completed unit. A fourth design consists of a 4ft x 4ft on-ground plot excavated to a depth of about 6 in. All of the grow boxes/plots were filled with a compost and soil mixture (50:50) and were covered with clear greenhouse grade plastic film hoops to allow for cool season crop production during the winter (Figure 20). Two data loggers collected inside and outside temperatures. The experiment was set up along a west facing wall at the San Juan College Horticulture greenhouse as a completely randomized block design. The temperature gradient from the west facing wall served as the blocking factor.

**Figure 20. Grow-box experiment located at San Juan College; NMSU Agricultural Science Center at Farmington, NM. 2010.**

### Summary

Preliminary evidence suggest that simple on-ground plots amended with compost are just as effective as costly grow-box designs for producing cool season crops around the home.

### Asian and Native Medicinal Herbs

Key stakeholders are growers marketing domestically and organically grown Chinese medicinal botanicals directly to licensed Oriental Medicine (OM) practitioners. Having developed this emerging market since the 1990s, growers are requesting the assistance of the land-grant universities and the USDA to help them meet immediate market segment needs, and to stimulate development of the overall market.

Supply for domestically produced Chinese and other Asian medicinal herbs have not kept up with the growing demand of U.S. Oriental Medicine (OM) practitioners. For example, at least a dozen herbalist practitioners and natural food stores in the Durango, CO/Farmington, NM area are expressing interest in obtaining locally produced Asian medicinal herbs. No information on cultivating or marketing these herbs exists for this region. As a beginning study to complement the larger research consortium headed by Jean Giblette, feasibility of cultivating *Lycium chinensis* and *L. barbarum* (sources of Gou Qi Zi and Di Gu Pi) at a semi-arid site in Northwest New Mexico is proposed.

### Objectives:

- Determine potential for weedy invasiveness of exotic *Lycium* entries.
- Determine which cultivars/selections are best adapted to high pH soil (above 8).
- Determine over winter potential of *Lycium* selections.
- Determine yields (lbs/acre) expressed on a fresh weight and dry weight basis.
- Determine *Lycium* chemistry of major bioactive compounds under Four Corners environmental conditions. Compare chemical characteristics of fruit/leaves to other U.S. growing locations.
- Determine economic feasibility through sub-sector analysis using case study approaches to determine production and post harvest potential for *Lycium* in the Four Corners Region.

## Horticulture at San Juan College

**Funds provided by a memorandum of understanding between the Plant and Environmental Sciences Department, NMSU, and San Juan College.**

**Kevin Lombard, Don Hyder, Daniel Smeal, and Linda Reeves**

### San Juan College Appointment

The Horticulture in a Xeric Environment offers a One-year Certificate and Two-year Associate's degree in horticulture techniques and practices with current emphasis on water conserving urban landscapes. The horticulture curriculum also requires entrepreneurial business, ecology, sustainable development, and environmental conservation coursework. The program was launched in the fall semester of the 2008-2009 academic calendar. The curriculum was adopted by the SJC curriculum committee in 2008. The MOU provides the P.I. with the mechanism for a shared faculty appointment between San Juan College (25%) and New Mexico State University. Other ASC-Farmington and San Juan College faculty in the Science and Math Department form the rest of the core faculty of the program. The P.I. instructs one course per semester in the fall and spring semesters, co-leads the program, is the faculty advisor for declared horticulture majors, and is the faculty advisor to the Horticulture Club.

### Key Accomplishments - 2010

- A $ 95,000 State Energy award funded a number of demonstration gardens, infrastructure, and equipment to begin the process of developing the Outdoor Learning Center (OLC) demonstration area. Angi Grubbs oversees grant deliverable activities.

- A OLC coordinating committee comprised of Horticulture, Art, Building/Construction, Ecology faculty was formed to plan for future development activities

- Student enrollment increased from 5 to approximately 35 students in five classes offered during the 2009-2010 academic year.

- The SJC Horticulture Club raised approximately $800 in proceeds during the second annual Earth Day Plant Sale hosted April 22, 2010.

# Development and Evaluation of Drip Irrigation for Northwest New Mexico

**Funds provided by the USDA through the Hatch Program, the State of New Mexico through general appropriations, and the US Bureau of Indian Affairs**

## Hybrid Poplar Production under Drip Irrigation in the Four Corners Region

**Mick O'Neill, Kevin Lombard, and Robert Heyduck**

### Abstract

Hybrid poplar (*Populus* spp.) is recognized as one of the fastest growing temperate trees, capable of producing merchantable products, in short rotations of 3-15 years. Hybrid poplar grown in the Four Corners region could supplement aspen supplies for wood products and provide numerous environmental benefits. To evaluate hybrid poplar in the Four Corners region, 10 hybrid poplar clones were obtained from nurseries in Oregon and Washington. Sixteen cuttings per clone per plot were planted May 15, 2002 on 10 x 10 foot spacing. The 7-inch cuttings with four buds were planted leaving only the topmost bud exposed above soil level. The clone entries were replicated in three blocks for a total of 480 trees.

Irrigation for the current year was started on May 14, 2010 and programmed as prescribed by calculated evapotranspiration (ET) demand. Irrigation was terminated October 8, 2010. Ninth year survival, height, and diameter at breast height (DBH) were determined for all trees on December 2, 3, and 7, 2010. Total crop ET amounted to 42.3 inches while total application plus rainfall was 43.1 inches, for the poplar trees. Clone OP-367 remains the tallest clone; after 9 seasons reaching a mean height of 63.1 feet. Significantly shorter than OP-367 were the clones 311-93, 49-177, and 58-280, but these were significantly taller than the remaining 4 clones. OP-367 had the largest mean DBH at 10.6 inches. This was followed by 311-93 and 58-280, both with DBH greater than 8 inches. Maximum wood volume was obtained by OP-367 at 5,968 $ft^3$/acre and total biomass for OP-367 was 138 tons/acre.

### Introduction

Hybrid poplar (*Populus* spp.) is recognized as one of the fastest growing temperate trees, capable of producing merchantable products in short rotations of 3-15 years. Hybrid poplar grown in the Four Corners region could supplement aspen for use in excelsior production, and could provide wood for fuel, poles for traditional Navajo construction, and tradable carbon credits may create incentives for plantation development around coal burning power plants. The Agricultural Science Center is located on land farmed by the Navajo Agricultural Products Industry (NAPI), a large 85,000-acre commercial operation administered by the Navajo Nation. NAPI represents our largest target community to address agricultural improvement and market development issues. NAPI and Western Excelsior Corporation of Mancos, CO have expressed great interest in the production of poplar as a sustainable substitute for aspen currently harvested from the surrounding national forest. This project can provide an opportunity for collaboration between producers and manufacturers for the development of hybrid poplar production under drip irrigation in the semi-arid Four Corners region.

## Objectives

- Identify hybrid poplar clones suitable for the alkaline soils inherent to the region.
- Determine water use requirements and growth rates of poplar species grown in high pH soils.
- Identify potential post-harvest markets for the material.

## Materials and methods

During spring 2002, 10 hybrid clones were obtained from nurseries in Oregon and Washington (Table 88). These clones were various crosses between *P. deltoides, P. maximowiczii, P. nigra,* and *P. trichocarpa*. Procedures for the hybrid poplar production trial are presented in Table 89. Prior to planting, the field was disked, leveled, and spot sprayed with Roundup. Netafim Ram pressure compensating surface drip line (flow rate of 0.42 gal/hr and with emitters every 3 feet) was installed with two lines per row of trees. Sixteen cuttings per clone per plot were planted May 15, 2002 on 10 x 10 feet spacing. Holes were prepared for cuttings using a soil probe of 0.5-inch diameter, on pre-moistened ground. The 7-inch cuttings with four buds were planted leaving only the topmost bud exposed above soil level. Clone entries were replicated in 3 blocks, for a total of 480 trees. Excess cuttings were potted up into standard nursery containers and kept in the greenhouse for replanting purposes.

**Table 88. Hybrid poplar clones, their parents, and source of parents grown under drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM, 2002-2010.**

| Clone | Code | Taxon | Female Parent | Source | Male Parent | Source |
|---|---|---|---|---|---|---|
| Eridano* | 1 | DM | *P. deltoides* | France | *P. maximowiczii* | Japan |
| NM-6* | 2 | DM | *P. nigra* | Unknown | *P. maximowiczii* | Unknown |
| OP-367* | 3 | DN | *P. deltoides* | Unknown | *P. nigra* | Unknown |
| 49-177 | 4 | TD | *P. trichocarpa* | Orting, WA | *P. deltoides* | Texas |
| 50-194† | 5 | TD | *P. trichocarpa* | Granite Falls, WA | *P. deltoides* | Illinois (ILL 005) |
| 52-225 | 6 | TD | *P. trichocarpa* | Granite Falls, WA | *P. deltoides* | Illinois (ILL 101) |
| 58-280 | 7 | TD | *P. trichocarpa* | Granite Falls, WA | *P. deltoides* | Illinois (ILL 129) |
| 184-411† | 8 | TD | *P. trichocarpa* | Randle, WA | *P. deltoides* | Oklahoma (17-10) |
| 195-529 | 9 | TD | *P. trichocarpa* | Old plantation in WA | *P. deltoides* | Oklahoma (21-7) |
| 311-93 | 10 | TN | *P. trichocarpa* | Nisqually River, WA | *P. nigra* | Loire Valley, France |

* Hybrid came from a breeding program other than Washington State University
† Hybrid dropped from analysis after first season.

Although poplar consumptive-use estimates were not available for the Farmington area, monthly water-use rates of first, second, and third season poplar grown at a site having similar climatic characteristics in Oregon were reported by Gochis and Cuenca (2000). These values were used to generate crop coefficients relating to each year of poplar growth as related to growing degree days (GDD). The crop coefficients are then used to modify the Penman-Monteith reference evapotranspiration value for a given day ($ET_{TALL}$) and the subsequent values are used to program irrigation. Equation 1 is for first season, Equation 2 is for second season, and Equation 3 is for third and subsequent year hybrid poplar production used at Farmington. Equation 4 calculates the ET value for a given day in a given year of poplar production.

$$KC1 = 3.93x10^{-1} – 2.58x10^{-5} (GDD) + 5.39x10^{-8}(GDD^2) – 8.98x10^{-12}(GDD^3) \quad (1)$$

$$KC2 = 3.71x10^{-1} + 1.38x10^{-4} (GDD) + 2.95x10^{-8}(GDD^2) – 8.20x10^{-12}(GDD^3) \quad (2)$$

$$KC3 = 5.18x10^{-1} + 4.57x10^{-5} (GDD) + 1.19x10^{-7}(GDD^2) – 2.40x10^{-11}(GDD^3) \quad (3)$$

$$ET = KC(year) \times ET_{TALL} \quad (4)$$

Where…

$K_{C(year)}$ = Crop coefficient for a given year

GDD = Growing degree days

ET = Evapotranspiration replacement rate (inch)

Irrigation was started on May 14, 2010 and programmed as prescribed by calculated ET demand. Irrigation was terminated October 8, 2010. Calculated ET replacement amounted to 42.2 inches, and actual irrigation application plus rainfall was 43.3.

The soil at the experimental site was originally classified as a Kinnear sandy loan (fine-loamy, mixed, calcareous mesic Typic Camborthid) (Anderson 1970) and later re-classified as a Doak sandy loam (fine-loamy, mixed, mesic Typic Haplargid) (Keetch 1980). Water holding capacity, in a three-foot profile, is 4.98 inches (1.66 in/ft) and pH averages 8.2 resulting in a moderately calcareous soil that might not be conducive to poplar production. At elevated soil pH, iron availability is reduced, resulting in leaf chlorosis (Brady and Weil 1999; Havlin et al. 1999). In an attempt to reduce the degree of chlorosis exhibited, a micronutrient blend was applied (May 26, July 19, and August 24, 2010) through the irrigation system.

Tree height and diameter at breast height (DBH) were determined for all trees on December 2, 3, and 7, 2010. Wood volume per tree was calculated after Browne (1962) using Equation 3 and scaled to $ft^3$/acre.

$$V = 10^{(-2.945047+1.803973*Log (DBH) + 1.238853*Log(Ht))} \quad (5)$$

Where…

V = Bole wood volume expressed without branches ($ft^3$/tree)

DBH = Diameter at breast height (inches)

Ht = Height (feet)

Statistical analysis was carried out using the ANOVA procedure in the CoStat software package version 6.000 (CoHort 2001). Least significant differences were determined at the 0.05 level.

**Table 89. Procedure for the 2002-planted hybrid poplar production in the drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM, 2010.**

| Operations | Procedures |
|---|---|
| Variety: | 8 Clones |
| Planting Date: | 5/15/02 |
| Planting Rate: | 10 x 10 ft spacing |
| Plot Size: | 40 x 40 ft |
| Fertilization: | Custom blend (25-9-0-0.32Zn-0.1Fe) injected at 30, 15, and 15lb N/acre on 5/26, 7/19, and 8/24/2010 |
| Fungicide: | None |
| Herbicide: | None |
| Insecticide: | None |
| Rodenticide: | None |
| Soil Type: | Doak sandy loam |
| Irrigation: | Surface drip irrigation |
| Irrigation Commenced: | 5/14/2010 |
| Irrigation Terminated: | 10/8/2010 |

## Results and discussion

Of the 10 *Populus* sp. evaluated, (Table 88) for production in the semi-arid Four Corners region, 7 had *P. trichocarpa*, 2 had *P. deltoides*, and 1 had *P. nigra* female parentage. There were two clones each with *P. maximowiczii* and *P. nigra* male parentage and six clones with *P. deltoides* male parentage. Johnson and Johnson (2003) suggest that hybrid poplar breeding programs for the semi-arid regions of eastern Washington and Oregon should include *P. nigra* as one of the parents to increase resistance to poplar-and-willow borer (*Cryptorhynchus lapathi*) and reduce water stress. In this trial, NM-6, OP-367, and 311-91 all had *P. nigra* parentage; NM-6 was developed from a female *P. nigra* parent while OP-367 and 311-93 were derived from male *P. nigra* parents. Two clones (50-194, and 184-411) were eliminated from the trial, after the 2002 season due to poor survival.

### *Water applications*

Cumulative crop ET and water application plus rainfall for ninth year hybrid poplar are presented in Figure 21. Application rates were based on equations derived from Gochis and Cuenca (2000) and developed at the Center for relating ET to day of year (DOY) (Smeal, Personal Communication, 2001). During the 2010 season, total crop ET amounted to 42.0 inches while total application plus rainfall was 43.1 inches for the poplar trees, of which 3.5 inches were received as precipitation.

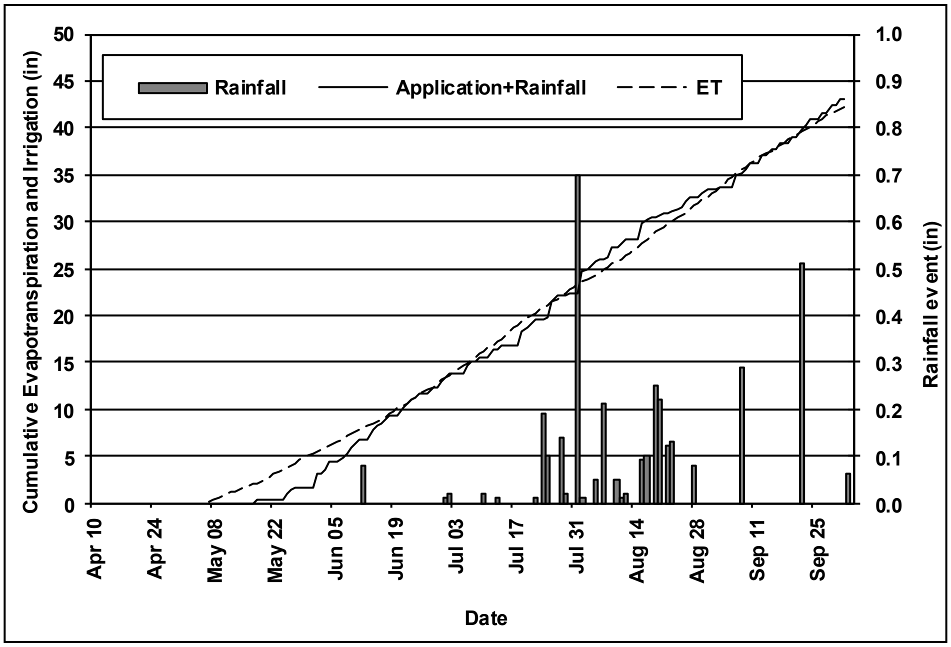



**Figure 21. Cumulative evapotranspiration and irrigation plus rainfall for hybrid poplar production under drip irrigation; NMSU Agricultural Science Center at Farmington, NM, 2010.**

***Growth***

Clone OP-367 remains the tallest clone reaching a mean height of 63.1 feet after 9 seasons. Significantly shorter than OP-367 were the clones 311-93, 58-280, 49-177, and 195-529 with mean heights of 52.4, 49.8, 52.8, and 47.6, respectively. These were significantly taller than the remaining three clones. The shortest clones were 52-225 and Eridano at 40.0 and 39.4 feet, respectively. OP-367 had the largest mean DBH at 10.6 inches. This was followed by 58-280 and 311-93 with DBH greater than 8 inches. The clone 52-225 and Eridano had the smallest DBH of 6.6 and 5.8 inches, respectively. Maximum wood volume was obtained by OP-367 at 5,968 $ft^3$/acre followed by 311-93, 58-280, and 49-177. Wood volume for the lowest ranked two clones was not significantly different at the 0.05 level. OP-367 and 311-93 were the only clones maintaining 100% survival, and mean survival for the trial was just under 90 % (Table 90). Total biomass production to date for OP-367 was 138 tons/acre, significantly greater than all other clones in the trial. Two clones, 195-529 and 52-225, experienced severe mortality, losing practically all trees in one replicate each. Interestingly enough, the other two replicates of these clones did not experience the same fate. The two plots with high mortality are adjacent and located in an area of known high pH (8.5) and very high $CaCO_3$ concentrations (4,200 ppm).

**Table 90. Growth and survival of 8 hybrid poplar clones grown under drip irrigation at the NMSU Agricultural Science Center at Farmington, NM, 2010.**

| Clone | Survival (%) | DBH† (in) | Height (ft) | Wood Vol ($ft^3$/acre) | Biomass (ton/acre) |
|---|---|---|---|---|---|
| OP-367 | 100 | 10.6 | 63.1 | 5,968 | 138.0 |
| 311-93 | 100 | 8.5 | 52.4 | 3,287 | 83.9 |
| 58-280 | 98 | 8.6 | 49.8 | 3,107 | 84.5 |
| 49-177 | 90 | 7.9 | 52.8 | 2,943 | 71.4 |
| 195-529 | 60 | 6.9 | 47.6 | 2,219 | 56.7 |
| NM-6 | 98 | 6.7 | 46.1 | 1,835 | 48.4 |
| 52-225 | 69 | 6.6 | 40.0 | 1,580 | 48.2 |
| Eridano | 90 | 5.8 | 39.4 | 1,268 | 36.1 |
| **Mean‡** | **88** | **7.8** | **49.4** | **2,879** | **73.3** |
| p>F | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV% | 32.7 | 17.1 | 13.8 | 36 | 36.4 |
| LSD(0.05) | 11 | 0.7 | 3.5 | 535 | 13.8 |

† DBH = Diameter at breast height (~ 4.5 ft).
‡ Mean is calculated from 3 replications with 16 trees for each plot.

Elevated soil pH reduces the availability of iron, which is needed to produce chlorophyll, while chelation renders it more available (Brady and Weil 1999; Havlin et al. 1999). Studies have demonstrated reduced growth of hybrid poplar at elevated soil pH. Timmer (1985) found that optimum growth of a single poplar clone was between pH 6.0 and 7.0. Working in south-central Oregon, Leavengood et al. (2001) attributed reduced height of OP-367 by 73%, in various sections of a field, to increased soil pH from 7.7 to 8.5. The pH of the soil used in this trial was 8.2, similar to that used by Shock et al. (2002) at Malheur.

OP-367 remains superior in most characteristics measured during the nine-year growth period, with 311-93 and 58-280 ranked second and third, but with significantly lower wood volume and biomass than OP-367. The loss of a number of trees from clones 52-225 and 195-529 shifts their means slightly from previous years, since dead trees are eliminated from the analysis. Interestingly, the trees were all lost from two adjacent plots, towards the north end of the trial, where high soil calcium carbonate has been previously documented (Lombard, 2007). Neither clone was adversely affected in the other replicates of the trial.

Clone PC-06 (not included in analysis), planted into existing plots in 2003 where clone 184-411 had been eliminated, amassed 2,116 $ft^3$/acre of wood volume and a total biomass of 49 tons/acre, significantly surpassing two clones planted the previous year in 2002: 52-225 and Eridano.

Based on our observations, it appears that the hybrids OP-367, 311-93, and 58-280 show the most promise for high pH soils typical of the area. These clones currently exhibit the least chlorosis and greatest growth potential.

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# Evaluation of Hybrid Poplar Amended with Composted Biosolids

**Kevin Lombard, Mick O'Neill, and Rob Heyduck**

## Abstract

Iron chlorosis induced by high pH soils indigenous to the Four Corners Region variably affects hybrid poplar depending on clone. Composted sewage sludge (biosolids) has been reported to supply plant available Fe and may represent an alternative to more costly chelated Fe fertilizers currently used to remediate chlorosis. Agricultural land application of biosolids has been encouraged by the USEPA as an alternative to land filling. Plots were amended with biosolids (City of Albuquerque Waste Water Treatment Facility) at 10 and 20 ton/acre rates; Sprint 138, a chelated iron, served as a fertilizer check, and control plots received no amendment. Cuttings of the hybrid poplar clone OP-367 were planted on 12 x 12 foot (3.6 x 3.6 meter) grid spacing. Two chlorosis evaluations made during the growing season showed that poplars cultivated on soil amended with biosolids remained the least chlorotic and compared favorably with the Fe chelate check plots. Growth parameters also showed increased biomass compared to control plots. Biosolids could show promise as a cost effective alternative for the remediation of Fe chlorosis in hybrid poplar plantations and other agricultural applications and present new opportunities in northwestern New Mexico for municipalities seeking land disposal options.

## Introduction

Hybrid poplar grown on high pH, calcareous soils typical of the Four Corners Region exhibit iron chlorosis to varied degrees. Plots established at the NMSU Agricultural Science Center at Farmington are periodically given supplemental Fe fertilizer during irrigations which is expensive and provides temporary alleviation of chlorosis symptoms. Composted biosolids, a byproduct of municipal sewage treatment plants, increase levels of plant available Fe on calcareous soils (Moral et al. 2002), have received attention in horticultural applications (Bowman and Durham 2002) but may create public health and environmental concerns (which could translate into political opposition to land use) if not managed properly (Committee on Toxicants and Pathogens in Biosolids Applied to Land 2002; Iranpour et al. 2004).

In a greenhouse study conducted in 2004, two hybrid poplar clones (NM-6 and OP-367) amended with biosolids at 2 rates remained the least chlorotic indicated by a Minolta SPAD 502 meter and compared favorably with poplar amended with expensive chelated Fe. A second greenhouse study in 2005 confirmed these results which served as the impetus for conducting a trial of hybrid polar cultivated in soil amended with biosolids under field conditions.

## Materials and methods

The 1.2-acre (0.5-ha) trial was staked out Feb 21-24, 2005 using a transit and tape measure. Baseline soil samples augured to a depth of 8 inches (20 centimeters) were taken April 6, 2005 prior to the addition of treatments. A composite of four soil samples from each plot were made and air dried in a greenhouse. Selected soil chemistry is shown in Table 91.

Biosolids originating from the City of Albuquerque Pilot Composting Facility (Waste Water Utilities Division, Albuquerque, NM) were produced by mixing dewatered sewage sludge with yard waste. The mixture was then composted to reduce pathogen concentrations in accordance with USEPA public health standards. The resultant products are categorized as ‗Class A' biosolids (Albuquerque 2006). Furthermore, stringent guidelines are followed to ensure that heavy metal contents are below regulatory limits, thus permitting agricultural land application. The biosolids arrived from Albuquerque April 1, 2005 via bottom-drop truck (Haven's Trucking, Farmington, NM) and were unloaded by hand due to compaction of the load during transit.

**Table 91. Selected chemistry of baseline soil and biosolid samples collected in 2005.**

| Parameter | Soil * | Biosolids † |
|---|---|---|
| pH (1:2) | 8.3 | 7.5 |
| EC (mS/cm) | 0.7 | 14.0 |
| SAR | 0.5 | 4.8 |
| NO3-N (ppm) | 7.1 | 99.9 |
| P (ppm) | 5.0 | 340.0 |
| Zn (ppm) | 1.2 | 42.2 |
| Fe (ppm) | 4.8 | 476.0 |
| Mn (ppm) | 4.6 | 42.0 |
| Cu (ppm) | 1.5 | 14.6 |
| Ca (ppm) | 3492.0 | 4540.0 |
| Mg (ppm) | 201.0 | 603.0 |
| Na (ppm) | 9.9 | 456.0 |
| K (ppm) | 224.0 | 3740.0 |

*Mean of 12 samples taken April 6, 2005 and analyzed at the NAPI lab except for EC and SAR which were analyzed in Las Cruces.
†All parameters for biosolids except EC and SAR taken from one composite sample and analyzed at the NAPI lab (EC and SAR mean of 3 samples analyzed from same batch in Las Cruces).

Two application rates were applied for the study: 10 and 20 ton/acre (22.75 and 45.5 metric tons per hectare [Mg/ha], respectively). English units for the application rates will be used from this point forward. Biosolids were added to plots beginning with Block 1 April 6-7, 2005 using a John Deer tractor pulled drop-type fertilizer spreader with a capacity of 600 pounds per load (272 kilograms per load). The fertilizer spreader was loaded using a small Kubota front-end loader. Small rocks picked up from the road during an earlier consolidation of the biosolid pile were initially a problem for operation of the fertilizer spreader and had to be sifted out during the loading process. To apply the 10 ton/acre rate based on plot area, 3.5 loads were required; 7 for the 20 ton/acre rate. After biosolid applications to Block 1 were completed, the entire block was rototilled to a depth of 5 inches

(13 centimeters) to incorporate and prevent windborne movement. The biosolids were applied to Block 2, but were not incorporated due to a slight easterly wind and the fear that rototilling would exacerbate windborne movement. As a precaution, a low fabric wind barrier was erected along the boundary of Block 2 until incorporation was achieved the following day. Block 3 was prepared similarly as Block 1 application and incorporation was carried out on the same day. These procedures are summarized in Table 92.

**Table 92. Operations and procedures for 2005-planted poplars in Biosolid Trial; NMSU Agricultural Science Center at Farmington, NM, 2010.**

| Operations | Procedures |
|---|---|
| Variety: | OP-367 |
| Cultivation and Incorporation of Biosolids: | April 6-7, 2005. Biosolids spread at 10 ton/acre and 20 ton/acre rate using tractor pulled fertilizer spreader. Plots rototilled to a depth of 13 cm (5 in). |
| Planting Date: | April 27-28, 2005 |
| Planting Rate: | 3.6 m x 3.6 m (12 ft x 12 ft) spacing |
| Plot Size: | 14.5 m x 31 m = 450 $m^2$ (48 ft x 96 ft) with 32 trees/plot |
| Fertilization: | UAN-32 at 25, 12.5, and 12.5 lbs N/acre on 5/26, 7/19, and 8/18/10 |
| Micronutrient: | Iron chelate: hand applied as a soil drench to each tree in Fe treatment plots only. 5.55 g/plot applied 6/10/2010 |
| Fungicide: | None |
| Herbicide: | None |
| Insecticide: | None |
| Rodenticide: | None |
| Chlorine: | None |
| Soil Type: | Doak sandy loam |
| Pruning: | Pruned to a single leader |
| Irrigation: | Surface drip irrigation |
| Irrigation Commenced: | 05/14/10 |
| Irrigation Terminated: | 10/08/10 |

Cuttings of OP-367 were obtained in the spring of 2005 and planted on 12 x 12 foot (3.6 x 3.6 meter) spacing on April 27-28. Previous experience had shown that the field should be pre-moistened before planting. Cuttings were placed exactly at a drip emitter although the use of an iron stake pushed into the ground was still needed to make holes deep enough for most planting. Five people planted the entire trial. By May 11, 2005 most of the cuttings had shown dormancy break with the emergence of 1-2 new leaves.

Tree height and diameter at breast height (DBH) were determined for all trees on December 15 and 16, 2010. Wood volume per tree was calculated after Browne (1962) using Equation 1 and scaled to $ft^3$/acre.

$$V = 10^{(-2.945047+1.803973*\mathrm{Log}(DBH) + 1.238853*\mathrm{Log}(Ht))} \quad \text{.......... (1)}$$

Where…

V = Bole wood volume expressed without branches ($ft^3$/tree)

DBH = Diameter at breast height (inches)

Ht = Height (feet)

***Experimental Design and Statistical Analysis***

The experiment was a completely randomized block design with two Biosolid rates, an iron (Fe) fertilizer treatment, and a non-amended control, in each of 3 blocks, for a total of 12 plots. Statistical analysis was carried out using the ANOVA procedure in the CoStat software package version 6.000 (CoHort 2001). Least significant differences were determined at the 0.05 level.

## Results and discussion

Irrigation application rates were based on equations derived from Gochis and Cuenca (2000) and developed at the Center for relating ET to growing degree days (GDD) (Smeal, Personal Communication, 2001). Total ET amounted to 42.6 inches while total application plus rainfall was 43.2 inches for the Biosolids application trial (Figure 22).

Electrical Conductivity (EC) of 14.0 milliSiemens per centimeter (mS/cm) (Table 91). Experimentally derived mixtures of biosolids and Farmington soil produced an EC value of 4.68 mS/cm for the 20 ton/acre level (Figure 23) which exceeds the 4.00 mS/cm benchmark established as the salinity tolerance threshold for most agricultural crops (Maas and Hoffman 1977). Still, this EC level did not exceed 5.37 mS/cm, the tolerance level established for Clone OP-367 (Shannon et al. 1999) and most poplars will not experience yield reductions until even higher ECs are reached (Bãnuelos et al. 1999). Plots subjected to irrigation will push salts below the root zone. Nevertheless, monitoring for salinity will continue in the future to determine if EC values increase above baseline measurements made in 2005.

The Biosolid 10 ton/acre treatment produced the largest diameters (8.4 inches) and heights (62.1 ft), and thus the largest wood volume (3,858.8 $ft^3$/acre), compared to other treatments, which was not significantly greater than the Fe chelate or the control (Table 93). Exceeding salinity levels are likely to be the more pressing issue if judicious management practices are not observed.

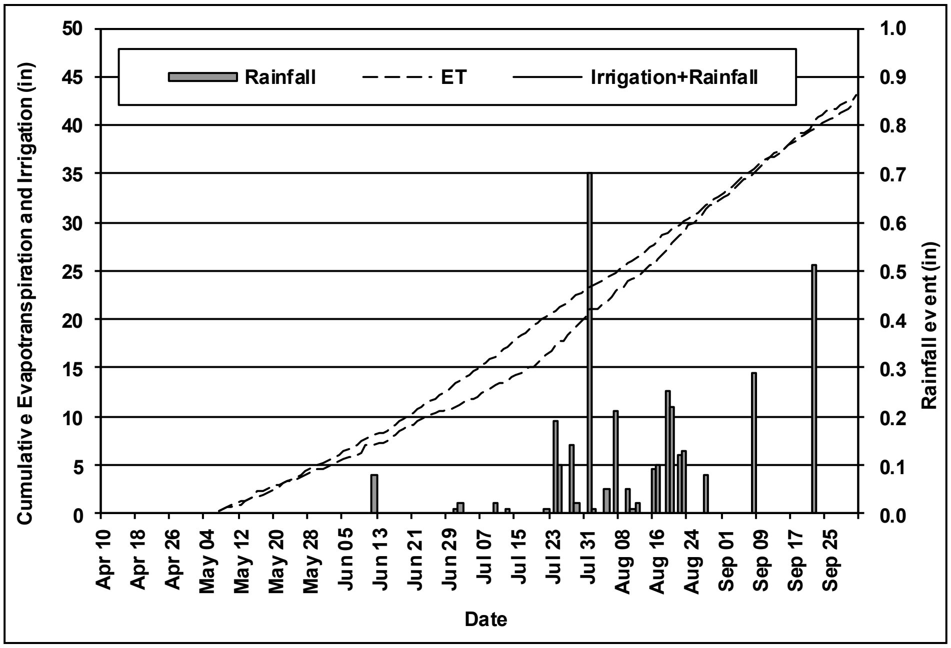
Rainfall
ET
Irrigation+Rainfall
Cumulative Evapotranspiration and Irrigation (in)
Rainfall event (in)
Date
0
5
10
15
20
25
30
35
40
45
50
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Apr 10
Apr 18
Apr 26
May 04
May 12
May 20
May 28
Jun 05
Jun 13
Jun 21
Jun 29
Jul 07
Jul 15
Jul 23
Jul 31
Aug 08
Aug 16
Aug 24
Sep 01
Sep 09
Sep 17
Sep 25

**Figure 22. Cumulative evapotranspiration and water application plus rainfall for Biosolids application trial (2005-planted) hybrid poplar clones grown under drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM, 2010.**

**Table 93. Selected growth parameters for hybrid poplar amended with composted biosolids; NMSU Agricultural Science Center at Farmington, NM, 2010.**

| TRT[†] | DBH[‡] (in) | DBH (cm) | Height (ft) | Height (m) | Wood Vol ($ft^3$/acre) | Wood Vol ($m^3$/ha) | Biomass (ton/acre) | Biomass (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| Bio-10 | 8.4 | 21.3 | 62.1 | 18.9 | 3858.8 | 270.0 | 54.5 | 122,186 |
| Bio-20 | 8.0 | 20.4 | 59.6 | 18.2 | 3407.2 | 238.4 | 50.0 | 112,088 |
| Fe | 8.4 | 21.4 | 60.1 | 18.3 | 3693.4 | 258.4 | 54.7 | 122,693 |
| Control | 8.2 | 20.7 | 62.7 | 19.1 | 3760.5 | 263.1 | 52.1 | 116,831 |
| **Mean** | **8.3** | **21.0** | **61.1** | **18.6** | **3681.3** | **257.6** | **52.9** | **118,507** |
| P | 0.1792 | 0.1880 | 0.0365 | 0.0365 | 0.1085 | 0.1085 | 0.2425 | 0.2425 |
| CV% | 9.6 | 9.6 | 8.6 | 8.6 | 21.0 | 21.0 | 20.4 | 20.4 |
| LSD (0.05) | 0.4 | 1.0 | 2.5 | 0.8 | 371.0 | 30.0 | 5.2 | 11,625.0 |

[†] Treatments = Biosolids @ 10 & 20 tons/acre, Fe (Sprint 138), and Control
[‡] DBH = Diameter at breast height (~ 4.5 ft).
[‡] Mean is calculated from 4 replications with 32 trees for each plot.

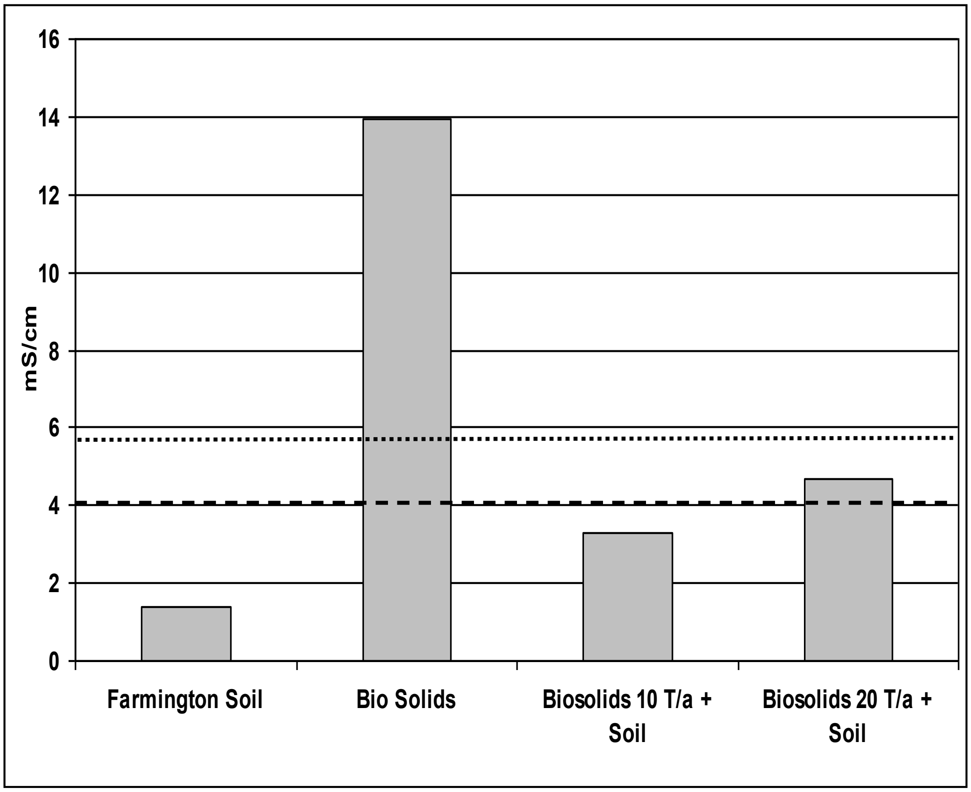


**Figure 23. Experimentally derived EC values for Farmington soil, Albuquerque biosolids, and Farmington soil amended with biosolids at two rates. (— — —) indicates salinity threshold for most agricultural crops. (▪ ▪ ▪) indicates salinity threshold of the clone OP-367 (Shannon et al., 1999). NMSU Agricultural Science Center at Farmington, NM, 2010.**

## Conclusion

Preliminary results indicated that biosolid-amended soil had positive effects on chlorosis alleviation and biomass production for the clone OP-367, but statistically significant differences in parameters measured are lacking in the second through sixth year of this study. A possible reason for the lack of differences seen this year may be attributed to the selection of OP-367 as the clone for this trial. As reported in previous studies conducted at the center, this clone has consistently been the least chlorotic and apparently the most tolerant of soil conditions in the region. On the other hand, it was paramount to select a clone with clear production potential in the area. Perhaps a clone should have been chosen that exhibited above average growth, but also showed more pronounced symptoms associated with high pH soils and associated lack of Fe availability.

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## Acknowledgements

We thank Stephen Glass and the City of Albuquerque Wastewater Utility Division for their generous donation of the biosolids used in this study. We also thank Terry Sterrett of Haven's trucking in Farmington, NM for donating the truck and the driver's time needed for transporting the biosolids from Albuquerque to ASC, Farmington. And lastly, thanks to those who participated in the unloading.

## Evaluation of Hybrid Poplar Grown Under Four Irrigation Treatments

**Rob Heyduck and Mick O'Neill**

### Abstract

This study seeks to determine the effect of differing irrigation levels on hybrid poplar grown in a plantation setting. Since previous work has focused on screening large amounts of germplasm for adaptation to our semi-arid climate and alkaline soils, further investigation of irrigation will hopefully allow more precise water management, in future regional plantations. Four top-yielding clones from ongoing trials at the center were planted April 27, 2007 at 12 x 12 foot spacing and drip irrigated at four levels: 70, 80, 120, and 130% of reference poplar evapotranspiration (ET). Survival for the entire planting was 97% after the first year. Across irrigation treatments, tree growth was greatest for the 120% irrigation level. Across clones, greatest wood volume was achieved by clone 433. As fourth year results from a 10-year trial, growth patterns between clones and irrigation treatments are shifting slightly from previous years, and it is expected that these patterns will become stabilized in subsequent years.

### Introduction

Previous hybrid poplar research on the station has focused mainly on evaluating a large volume of germplasm for adaptation to the semi-arid climate and alkaline soil conditions. Irrigation of these trials has followed from similar work done in eastern Oregon, where hybrid poplar cultivation has a more entrenched history. Daily evapotranspiration (ET), and thus irrigation, is derived from a number of climatic parameters (including minimum and maximum temperature, relative humidity, solar radiation, and wind).

For this study, the mathematical estimation of ET is the same as in our previously established studies. In this case, irrigation is applied to the treatment plots at 70, 80, 120, and 130% of our baseline replacement ET value. Four of our top-yielding clones from previous trials are evaluated across these four irrigation regimes.

First year results for multi-year trials (this trial has a planned life of 10 years) are often unreliable and offer little or no insight into the realities being investigated. In fact, first year trends have been somewhat reversed in the second and third year. This trial will allow us to determine the relative merit of our previous irrigation strategy, and develop water management programs for larger plantations.

### Materials and methods

During the spring of 2007, 4 hybrid clones were obtained from GreenWood Resources, Inc. of Portland, Oregon. In 2005, these clones (433, 544, 910, and 911) were the leading producers in the biomass study. Procedures for the hybrid poplar trial are presented in Table 94. Prior to planting, the field was disked, leveled, and trifluralin, a pre-emergent herbicide, was applied. Netafim Ram pressure compensating surface drip line with four emitter sizes (0.53, 0.62, 0.92, and 1.00 gal/hr with emitters every 3 ft) was installed with one line per row of trees. A whole-plot was set up as four 384-foot long, 12-foot wide rows of a single emitter size (or irrigation level) across which four split-plots (comprised of the four clones, randomly assigned) were superimposed.

Thirty-two cuttings of a single clone per plot were planted in a 4 tree x 8 tree grid April 27, 2007 on 12 x 12 ft spacing. Holes were prepared for cuttings using a fabricated metal re-bar poker (0.5 inch diameter) on pre-moistened ground. The 7-inch cuttings were planted leaving only the topmost bud exposed above soil level. Irrigation treatments and clone entries were replicated in four blocks for a total of 2048 trees across a total area of 6.8 acres. Plot layout and dispersion of irrigation treatments and clone are detailed in Figure 24.

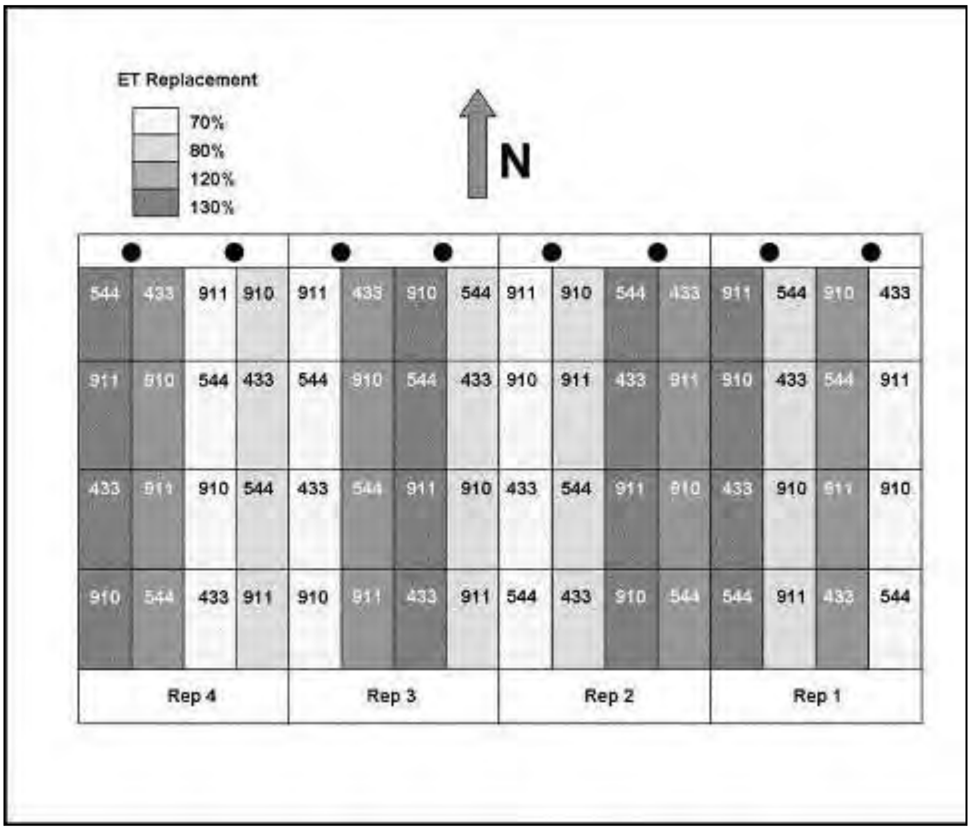


**Figure 24. Detailed plot plan of four hybrid poplar clones grown under four irrigation levels. Clones are designated by 3-digit code in each subplot, shaded tones designate whole plot irrigation levels; NMSU Agricultural Science Center at Farmington, NM. 2010.**

By early June, cool season weeds had grown to a height of 2-3 feet, but warm season problem weeds were just beginning to germinate. Taller weeds were mown at this time and a broadcast application of RoundUp Ultramax (2 pints per acre) and Sharpen (2 ounces per acre) was made in late June.

Although poplar consumptive-use estimates were not available in the Farmington area, monthly water-use rates of first, second, and third season poplars grown at a site with similar climatic conditions in Oregon were reported by Gochis and Cuenca

(2000). These values were used to generate crop coefficients relating to each year of poplar growth and to growing degree days (GDD). The crop coefficients then modify the Penman-Monteith Evapotranspiration value for a given day ($ET_{TALL}$) and these values are used to program irrigation. Equation 1 is for first season, Equation 2 is for second season, and Equation 3 is for third and subsequent year hybrid poplar production used at Farmington. Equation 4 calculates the ET value for a given day in a given year of poplar production.

$$K_{C1} = 3.93x10^{-1} – 2.58x10^{-5} (GDD) + 5.39x10^{-8}(GDD^2) – 8.98x10^{-12}(GDD^3) \quad ...... (1)$$

$$K_{C2} = 3.71x10^{-1} + 1.38x10^{-4} (GDD) + 2.95x10^{-8}(GDD^2) – 8.20x10^{-12}(GDD^3) \quad ....... (2)$$

$$K_{C3} = 5.18x10^{-1} + 4.57x10^{-5} (GDD) + 1.19x10^{-7}(GDD^2) – 2.40x10^{-11}(GDD^3) \quad ....... (3)$$

$$ET = K_{C(year)} \text{ x } ET_{TALL} \quad ...... (4)$$

Where…

$K_{C(year)}$ = Crop coefficient for a given year

GDD = Growing degree days

ET = Evapotranspiration replacement rate (inch)

The output ET replacement value was then further modified by multiplying by our treatment levels: 70, 80, 120, or 130%. This was accomplished in practice by running all units for the same time period each day, while the differential irrigation levels were applied by the differing emitter sizes. Irrigation was started on May 7, 2009 and programmed as prescribed by calculated ET demand. Irrigation was terminated October 3, 2009.

Data collection occurred November 24, 25, and 30, 2010, with DBH and height recorded for the central 12 trees in each experimental unit (subplot=clone within irrigation treatment). If one of the central trees was dead, then an adjacent tree was measured, and its identity noted so that it would be measured the following years of the trial. Survival was assessed for all trees in the trial. Wood volume for each tree was determined after Browne (1962). Growth parameters were analyzed using the CoStat ANOVA procedure with mean separation by Fisher‘s LSD (CoHort, 2001).

**Table 94. Operations and procedures for 2007-planted poplars; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Operations | Procedures |
|---|---|
| Variety: | 4 Clones: 433, 544, 910, 911 |
| Planting Date: | 4/27/07 |
| Planting Rate: | 12 x 12 ft spacing |
| Plot Size: | 48 ft x 96 ft each containing 32 trees |
| Fertilization: | Custom blend (25-9-0-0.32Zn-0.1Fe) injected at 25, 12.5 and 12.5 lbs N per acre on May 27 and 28, July 23 and August 19, 2010. |
| Fungicide: | None |
| Herbicide: | RoundUp Ultramax 2pt/ac; Sharpen 2 oz/acre |
| Insecticide: | None |
| Rodenticide: | None |
| Soil Type: | Doak sandy loam |
| Irrigation: | Surface drip irrigation |
| Irrigation Commenced: | May 14, 2010 |
| Irrigation Terminated: | October 8, 2010 |

## Results and discussion

Total ET (at 100% replacement) for the 2010 growing season was calculated at 42.3 inches for fourth year hybrid poplar (Figure 25). For the irrigation treatments, this would mean 29.6, 33.8, 50.8, and 55.0 inches at the 70, 80, 120, and 130% levels, respectively. Actual application for the respective treatments was 29.5, 35.8, 44.5, and 49.7 inches or 99.7, 105.9, 87.6, and 90.4 percent of calculated applications at the four treatment rates, respectively.

Across water treatments, the 120% and 130% irrigation levels showed the greatest growth in diameter (6.2 inches) and height (40.4 and 40.7, respectively) (Table 95). Mean wood volume for the irrigation treatments ranged from 496 $ft^3$/acre for the 70% irrigation level to 931 $ft^3$/acre for the 120% irrigation level, which was not significantly different than the 130% irrigation treatment (928 $ft^3$/acre).

Diameter was greatest for clone 433, with a mean of 6.0 inches, followed by 544, 911 and 910 with mean diameters of 5.7, 5.4, and 5.4 inches, respectively (Table 95). Clone 433 also had the greatest mean height, 41.2 feet, significantly taller than all the other Entries. Wood volume was also greatest for clone 433, which amassed 910 $ft^3$/acre in 2010, significantly greater than other clones.

This year, 2010, Clone 433 led for all growth parameters. Also, while there is significant interaction between clones and irrigation treatments, the 120% ET irrigation treatment produced the most growth on average (Figure 26).

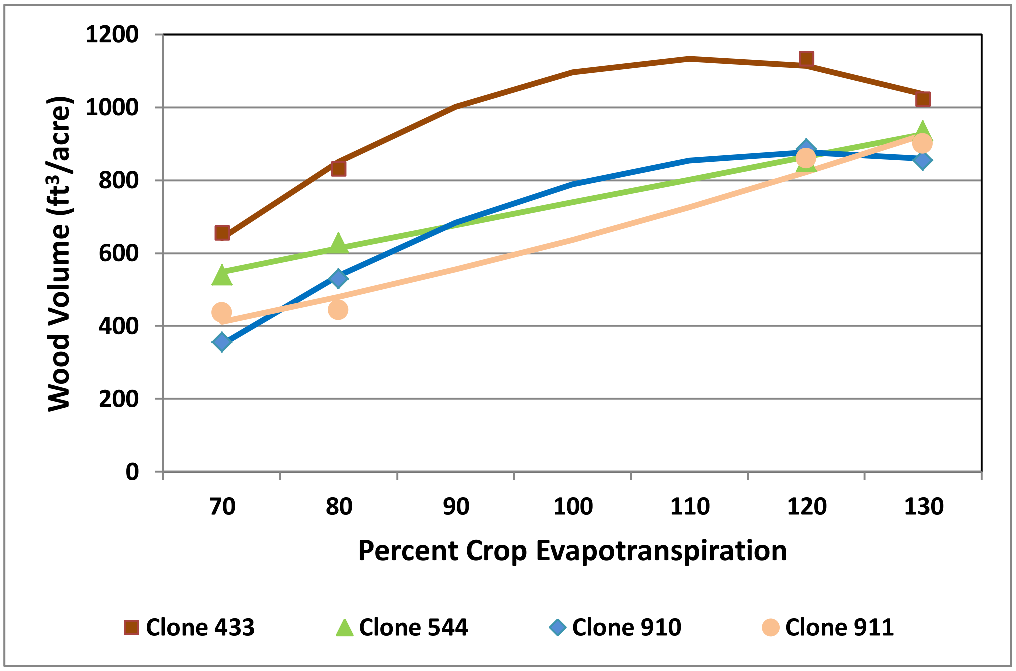


**Figure 25.** **Cumulative evapotranspiration and water application plus rainfall for hybrid poplar water-use trial (2007-planted) grown under drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM. 2010.**

**Table 95.** **Mean DBH, height, and wood volume for four clones grown under four irrigation regimes; NMSU Agricultural Science Center at Farmington, NM. 2010.**

| Irr.Factor or Clone | DBH (in) | DBH (cm) | Height (ft) | Height (m) | Wood Volume ($ft^3$/acre) | Wood Volume ($m^3$/ha) |
|---|---|---|---|---|---|---|
| 1 | 4.9 | 12.5 | 33.8 | 10.3 | 496 | 34.7 |
| 2 | 5.2 | 13.3 | 36.5 | 11.1 | 607 | 42.5 |
| 3 | 6.2 | 15.9 | 40.4 | 12.3 | 931 | 65.2 |
| 4 | 6.2 | 15.7 | 40.7 | 12.4 | 928 | 64.9 |
| 433 | 6.0 | 15.3 | 41.2 | 12.6 | 910 | 63.6 |
| 544 | 5.7 | 14.6 | 37.6 | 11.5 | 738 | 51.6 |
| 911 | 5.4 | 13.7 | 36.4 | 11.1 | 656 | 46.0 |
| 910 | 5.4 | 13.7 | 36.2 | 11.0 | 657 | 45.9 |
| **Mean** | **5.6** | **14.3** | **37.8** | **11.5** | **740** | **51.8** |
| P (irr.) | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| P (clone) | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| P (interact) | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| CV% | 10.80 | 10.80 | 8.10 | 8.10 | 23.20 | 23.20 |
| LSD (0.05) Clone | 0.12 | 0.31 | 0.61 | 0.19 | 34.60 | 2.42 |
| LSD (0.05) Irr. | 0.23 | 0.58 | 1.88 | 0.57 | 77.00 | 5.39 |

**Figure 26. Wood volume for four hybrid poplar clones grown across four irrigation regimes (70, 80, 120, and 130% reference ET); NMSU Agricultural Science Center at Farmington, NM, 2010.**

## Conclusion

The 120% water application level appears to be the most productive in this trial. The clone OP-367 continues to outperform the other clones with respect to diameter, height and wood volume. By using regression analysis, it appears that productivity of Clones OP-367 and 910 levels off at about 100% of Crop Evapotranspiration (Figure 26) while productivity of clones 544 and 911 continues to increase linearly.

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# Dissemination and Staff Development

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Arnold, Richard N., Michael K. O'Neill and Daniel Smeal. 2010. Pest control in crops grown in northwestern New Mexico, 1999. NMSU Annual Data Report 100-1999.

Arnold, Richard N., Michael K. O'Neill and Daniel Smeal. 2010. Pest control in crops grown in northwestern New Mexico, 2000. NMSU Annual Data Report 100-2000.

Arnold, Richard N., Michael K. O'Neill and Daniel Smeal. 2010. Pest control in crops grown in northwestern New Mexico, 2001. NMSU Annual Data Report 100-2001.

Arnold, Richard N., Michael K. O'Neill and Daniel Smeal. 2010. Pest control in crops grown in northwestern New Mexico, 2002. NMSU Annual Data Report 100-2002.

Arnold, Richard N., Michael K. O'Neill, and Kevin Lombard. 2010. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Proceeding Western Society of Weed Science Vol:63 p79. ISSN:0091-4487.

Arnold, Richard N., Michael K. O'Neill, and Kevin Lombard. 2010. Broadleaf weed control in field corn with postemergence applications of topramezone and diflufenzopyr plus dicamba applied alone or in combination with glyphosate. Western Society of Weed Science Research Report. p.81. ISSN:0090-8142.

Arnold, Richard N., Michael K. O'Neill, and Kevin Lombard. 2010. Broadleaf weed control in field corn with preemergence herbicides. Western Society of Weed Science Research Report. p.82. ISSN:0090-8142.

Arnold, Richard N., Michael K. O'Neill, and Kevin Lombard. 2010. Broadleaf weed control in field corn with early and late applied postemergence herbicides. Western Society of Weed Science Research Report. p.83. ISSN:0090-8142.

Arnold, Richard N., Michael K. O'Neill, and Kevin Lombard. 2010. Broadleaf weed control in spring wheat. Western Society of Weed Science Research Report. p.98. ISSN:0090-8142.

Arnold, Richard N., Michael K. O'Neill, and Kevin Lombard. 2010. Tumble mustard control in winter wheat. Western Society of Weed Science Research Report. p.114. ISSN:0090-8142.

Lauriault, L.M., I.M. Ray, C.A. Pierce, R.P. Flynn, M.K. O'Neill, and T. Place. 2010. The 2009 New Mexico Alfalfa Variety Test Report. Agricultural Experiment Station Variety Test Reports. New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/variety_trials/var09.pdf.

Lombard, K.A., Mick O'Neill, Robert Heyduck, Blake Onken, April Ulery, John Mexal, and Adrian Unc. 2010. Composted biosolids as a source of iron for hybrid poplars (*Populus* sp) grown in Northwest New Mexico. Agroforestry Systems Online First: 1-12. http://www.springerlink.com/content/v73123244hl383h1/fulltext.pdf

Lombard, K.A., M.K. O'Neill, J.G. Mexal, A.L. Ulery, B.M. Onken, G. Bettmann, and R.F. Heyduck. 2010. Can soil plant analysis development (SPAD) values predict chlorophyll and total Fe in hybrid poplar? Agroforestry Systems 78:1-11.

Lombard K.A., J. Henning, R. Pablo, and Ram Acharya. 2010. Feasibility of Hops (*Humulus lupulus* L.) Production in the Four Corners Region of New Mexico. Final Report to the New Mexico Department of Agriculture. Las Cruces, NM.

Marsalis, M.A., R.E. Kirksey, F.E. Contreras-Govea, L. Carrasco, M.K. O'Neill, L.M. Lauriault, and M. Place. 2010. New Mexico 2009 Corn and Sorghum Performance Tests. Agricultural Experiment Station Variety Test Reports. New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/variety_trials/09cornsorghum.pdf.

O'Neill, M.K., C.C. Shock, K.A. Lombard, R.F. Heyduck, E.B.G. Feibert, D. Smeal, and R.N. Arnold. 2010. Hybrid poplar (*Populus* ssp.) selections for arid and semi-arid intermountain regions of the western United States. Agroforestry Systems, 79:409-418. http://www.springerlink.com/content/t746n6933u6u81lx/fulltext.pdf.

O'Neill, M.K. and M.M. West (eds.) 2010 Forty-third Annual Progress Report: 2009 Cropping Season. With contributions from R.N. Arnold, D. Smeal, R.F. Heyduck, C.K. Owen, K.D. Kohler, K.A. Lombard. NMSU Agricultural Science Center at Farmington. Agricultural Experiment Station and Cooperative Extension Service. New Mexico State University. Las Cruces, NM.

## Proceedings

Lombard, K.A. 2010. Northwest, NM Viticulture update: NMSU Agricultural Science Center at Farmington. Proceedings of the 29th Southwest Wine and Vine Annual Meetings. March 5-6, 2010. Albuquerque, NM.

Smeal, D., M.K. O'Neill, K.A. Lombard, and R.N. Arnold. 2010. Climate-based coefficients for scheduling irrigations in urban xeriscapes. December 5 - 8, 2010. 5th National Decennial Irrigation Conference. Sponsored jointly by ASABE and the Irrigation Association. Phoenix, AZ.

Smeal, D., R. N.Arnold, and M.K. O'Neill. 2010. Tumble mustard control in Jagaline winter wheat. Proceedings Western Society of Weed Science Vol: 63 p. 82. ISSN: 0091-4487.

## Abstract, Posters and/or Oral Presentations

Angadi, S., W. Ahmed, S. Begna, M.R. Umesh, C. Trostle, A. Ulery and M.K. O'Neill. 2010. Deficit irrigation management of winter canola in the southern high plains. Oct. 31 – Nov. 4, 2010. International Annual Meeting, American Society of Agronomy. Long Beach, CA.

Arnold, R.N. 2010. Broadleaf weed control in corn, dry beans and seedling alfalfa. Ruidoso, NM. New Mexico Crop Production Association. January 25.

Arnold, R.N. 2010. Economic management of weeds and insects in alfalfa. Monte Vista, Colorado. 2010 Southern Rocky Mountain Agricultural Conference. February 10.

Arnold, R.N. 2010. Principles of weed management. McGee Park, NM. 18$^{th}$ Annual Four Corners Weed Symposium. February 24.

Arnold, R.N. 2010. Tumble mustard control in Jagaline winter wheat. Waikoloa, Hawaii. 63$^{rd}$ Meeting Western Society of Wee Science. March 11.

Arnold, R.N. 2010. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Waikoloa, Hawaii. 63$^{rd}$ Meeting Western Society of Wee Science. March 11.

Arnold, R.N. 2010. Weed control in hayfields. Santa Fe, NM. New Mexico Pueblo and Community Agriculture Conference. April 15.

Arnold, R.N. 2010. Insects and weed management in alfalfa. Cortez, CO. April 27.

Arnold, R.N. Weed control in corn, alfalfa, dry beans, sugar beets and small grains. University of Wyoming and University of Nebraska Scottsbluff, Annual Weed Tour. June 21-23.

Arnold, R.N. DuPont Crop Protection MAT 28 New Mexico update. Denver, CO August 2-3.

Arnold, R.N. 2010. Weed control in alfalfa, field corn, dry beans, and winter wheat. CoAAA Annual Convention. Colorado Springs, CO. November 9.

Arnold, R.N. 2010. MAT-28 efficacy and vegetation response. 18$^{th}$ New Mexico Vegetation Management Association. Albuquerque, NM. November 18.

Dick, W.A., D.A. Kost, L. Chen, T.M. DeSutter, C.C. Mitchell, L.D. Norton, D. Smeal, H.A. Torbert, D.B. Watts, and D. Wolkowski. 2010. Assessment of mercury in soils, crops, earthworms, and water when soil is treated with gypsum. ASA-CSSA-SSSA 2010 International Meetings, Oct. 31 - Nov. 4, Long Beach, CA. Abstract 139-5. http://a-c-s.confex.com/crops/2010am/webprogram/Paper59222.html

Emerson, P., G. Beauchamp, R. Heyduck, J. Kallestead, M.K. O'Neill, R. Shuren, B. Stanton, and M. Swanson. 2010. Hybrid poplar suitability for regional deployment as a bio-fuel feedstock. Sept. 20 – 25, 2010. Fifth International Poplar Symposium, International Union of Forest Research Organizations (IFURO). Orvieto, Italy.

Lee, L., D. Hyder, and K.A. Lombard. 2010. Taxonomy and history of Lycium pallidum. Society for Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference. Anaheim, CA. September 30-October 3, 2010.

Lombard, K., S. A.A. Beresford, C. Topaha, T. Becenti, S.C. Forster-Cox, D. Smeal, and M. O'Neill. 2010. Is gardening feasible for inclusion into a diabetes intervention project among a Native American tribe in Northwest New Mexico? American Society for Horticultural Sciences. August 2-Sptember 5, 2010. Palm Desert, CA. HortScience 45(8):S118. (Abstr.)

Marsalis, M., S. Angadi, R. Kirksey, R. Hagevoort, and M.K. O'Neill. 2010. Wheat residue yield and composition for estimation of biofuel feedstock potential. Oct. 31 – Nov. 4, 2010. International Annual Meeting, American Society of Agronomy. Long Beach, CA. http://a-c-s.confex.com/crops/2010am/webprogram/Paper59234.html.

O'Neill, M.K., S. Angadi, R. Flynn, and D. Smeal. 2010. Canola adaption to irrigated production in New Mexico. Oct. 31 – Nov. 4, 2010. International Annual Meeting, American Society of Agronomy. Long Beach, CA.

O'Neill M.K., R.N. Arnold, R. Heyduck, K.A. Lombard, and D. Smeal. 2010. Hybrid poplar in arid regions: the case for a versatile clone, OP-367. Sept 20 – 25, 2010. Fifth International Poplar Symposium, International Union of Forest Research Organizations (IFURO). Orvieto, Italy.

Smeal, D., K. Lombard, M. O'Neill, and R. Arnold. 2010. Chile pepper production in Northwestern New Mexico as related to microirrigation. 20$^{th}$ International Pepper Conference. Las Cruces, NM September 12-14, 2010. Abstract pg. 31.

Smeal, D. 2010. Drip Irrigation. Sustainable San Juan Meeting. Aztec, NM. May 10, 2010.

Smeal, D. Gravity drip systems. 2nd. Annual Native American Women in Agriculture Conference. Farmington, NM. June 23, 2010.

Smeal, D., K.A. Lombard, M.K. O'Neill, and R.N. Arnold. 2010. Scheduling irrigations on drip-irrigated vegetable crops using climate-based coefficients and canopy measurements. August 2 – 5, 2010. Annual Conference of the American Society for Horticultural Science. Supplement to HortScience 45(8)216. Palm Desert, CA. http://hortsci.ashspublications.org/content/vol45/issue8/ Abstract Number 216; page 264

Smeal, D. 2010. Tumble mustard control in Jagaline winter wheat. Western Society of Weed Science Annual Conference. Waikoloa, Hawaii. March 11, 2010.

Smeal, D. 2010. Turf research and management. NMSU Coop. Ext. Svc. Pesticide Applicators Workshop. Farmington, NM. February 11, 2010.

Thomas, D., K.A. Lombard. 2010. Project X (for Exercise) Garden: Measuring Energy Expenditures in Small Scale Gardening. Society for Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference. Anaheim, CA. September 30-October 3, 2010. http://www.sacnas.org/pdfs/Abstract_10.pdf p191

## Meetings

Angadi, S., W. Ahmed, S. Begna, M.R. Umesh, C. Trostle, A. Ulery and M.K. O'Neill. 2010. Deficit irrigation management of winter canola in the southern high plains. Oct. 31 – Nov. 4, 2010. International Annual Meeting, American Society of Agronomy. Long Beach, CA.

Arnold, R.N. 2010. Rocky Mountain Agribusiness Conference. Denver, CO. January 12-14, (participant)

Arnold, R.N. 2010. New Mexico Crop Production Association. Ruidoso, NM. January 25-26, (presenter).

Arnold, R.N. 2010. Southern rocky Mountain Agricultural Conference. Monte Vista, CO. February 9-11, (presenter).

Arnold, R.N. 2010. 18th Annual Four Corners Weed Conference. McGee Park, Farmington, NM. February 24, (presenter).

Arnold, R.N. 2010, Western Society of Weed Science. Waikoloa, HI. March 8-11, (presenter).

Arnold, R.N. 2010. NMSU ASC, Advisory Conference. San Juan College, Farmington, NM. April 6, (presenter).

Arnold, R.N. 2010. New Mexico Pueblo & community Agriculture Conference. Santa Fe, NM. April 15, (presenter).

Arnold, R.N. 2010. Pasture and Alfalfa Management Workshop. Cortez, CO. April 17, (presenter).

Arnold, R.N. 2010. Colorado State University, University of Wyoming and University of Nebraska, Scottsbluff. Fort Collins, CO. Lingle, WY. Scottsbluff, NE. June 22-24, (presenter and participant).

Arnold, R.N. 2010. DuPont Crop Protection MAT-28 Update. Denver, CO. August 2-3, (presenter and participant).

Arnold, R.N. 2010. B.E.S.T., Sandia Labs and ConocoPhillips, Desalinization Update. San Juan County, NM. August 18, (presenter and participant).

Arnold, R.N. 2010. DuPont Crop Protection and BASF, Mountain States Weed Scientists, Weed Protocols 2009. Sterling, CO. September 15-20, (presenter and participant).

Arnold, R.N. 2010. CoAAA Annual Convention. Colorado Springs, CO. September 8, (presenter).

Arnold, R.N. 2010. New Mexico Vegetation Management Conference. Albuquerque, NM. November 18, (presenter).

Arnold, R.N. 2010. Navajo Agricultural Products Industry. Grower meetings once a month or more with Chief Executive Officer, Chief Operations Officer and Crop Managers. Farmington, NM. (presenter and participant).

Arnold, R.N. 2010. Bureau of Land Management FFO. Four Corners Weed Committee, met once per three months, Farmington, NM. (presenter and participant).

Emerson, P., G. Beauchamp, R. Heyduck, J. Kallestead, M.K. O'Neill, R. Shuren, B. Stanton, and M. Swanson. 2010. Hybrid poplar suitability for regional deployment as a bio-fuel feedstock. Sept. 20 – 25, 2010. Fifth International Poplar Symposium, International Union of Forest Research Organizations (IFURO). Orvieto, Italy. http://ocs.entecra.it/index.php/IPS/5/paper/view/263.

Lombard, K.A. 2010. Southwest Wine and Vine Annual Meetings. Feb 28-March 1. Albuquerque, NM. Nature of participation: Moderator morning sessions and lunch presentation.

Lombard, K.A. 2010. San Juan College Curriculum committee. Nature of participation: presented to the curriculum committee changes to the horticulture program, specifically the creation of a Landscape Architect one-and two-year track. Farmington, NM. Dec. 2, 2010.

Lombard, K.A. 2010. Risk Management Education in Southwest Medicinal Herbs Workshop. Nature of participation: Moderated sessions. Farmington, NM. Dec. 8-9, 2010.

Marsalis, M., S. Angadi, R. Kirksey, R. Hagevoort, and M.K. O'Neill. 2010. Wheat residue yield and composition for estimation of biofuel feedstock potential. Oct. 31 – Nov. 4, 2010. International Annual Meeting, American Society of Agronomy. Long Beach, CA. http://a-c-s.confex.com/crops/2010am/webprogram/Paper59234.html.

O'Neill, M.K. 2010. Southwest Biofuels Association Advisory Group Meetings. Jan 19, 2010. Albuquerque, NM. Participate in planning meeting for NM Biofuels Roadmap.

O'Neill, M.K. 2010. New Mexico Soil and Water Conservation Society Annual Meeting. Jan 19, 2010. Tucumcari, NM. Oral presentation of soil and water conservation projects in Africa.

O'Neill, M.K. 2010. NAPI-GreenWood Resources Strategy Meeting. Feb 11, 2010. Farmington, NM. Organize and facilitated meeting between NAPI and GreenWood Resources to develop strategy for expansion of poplar plantations.

O'Neill, M.K. 2010. US Peace Corps Fellows/USA Program Evaluation. March 1-2, 2010. Las Cruces, NM. Met with Program Director from Washington, DC and Co-Coordinators for program evaluation.

O'Neill, M.K. 2010. Southwest Biofuels Association Advisory Group Meetings. March 8, 2010. Las Cruces, NM. Participate in planning meeting for NM Biofuels Roadmap.

O'Neill, M.K. 2010. Southwest Biofuels Association Advisory Group Meetings. March 15, 2010. Santa Fe, NM. Participate in planning meeting for NM Biofuels Roadmap.

O'Neill, M.K. 2010. ASC-Farmington Advisory Committee Meeting. April 6, 2010. Farmington, NM.

O'Neill, M.K. 2010. Southwest Biofuels Policy Summit. April 13-14, 2010. Albuquerque, NM.

O'Neill, M.K. 2010. ACES Awards Day. April 22, 2010. Las Cruces. Received Jose Fernandez Memorial Chair in Crop Production and the ACES 10-Year Service Award.

O'Neill, M.K. 2010. Meetings with Rich Kitt, University Attorney and President Barbara Couture. May 19, 2010. Las Cruces, NM. Discuss travel authorization for Owen Cortner who had planned to travel to Nairobi, Kenya for a student attachment with the World Agroforestry. Accompanied by Delano Lewis, Rich Phillips, and Owen Cortner.

O'Neill, M.K. 2010. Fifth International Poplar Commission. Sept 20 – 25, 2010. Orvieto, Italy. Poster presentation and co-author.

O'Neill, M.K., R.N. Arnold, R. Heyduck, K.A. Lombard, and D. Smeal. 2010. Hybrid poplar in arid regions: the case for a versatile clone, OP-367. Sept 20 – 25, 2010. Fifth International Poplar Symposium, International Union of Forest Research Organizations (IFURO). Orvieto, Italy. http://ocs.entecra.it/index.php/IPS/5/paper/view/188.

O'Neill, M.K. 2010. Master's International Coordinators Meeting. United States Peace Corps. Sept 27-28, 2010. Washington, DC.

O'Neill, M.K. 2010. Fellows/USA Coordinators Meeting. United States Peace Corps. Sept 29-30, 2010. Washington, DC.

O'Neill, M.K. 2010. Seminar Presentation by Mr. Maimbo Malesu. Horticulture Class presentation at 9:00 am. Sustainable Agricultural Production in Africa: Overcome Water Management Challenges from Local to Regional Scales. San Juan College. Oct 19, 2010. Farmington. Organize and facilitated trip to New Mexico by Mr. Maimbo Malesu, Coordinator, World Agroforestry Centre. Nairobi, Kenya.

O'Neill, M.K. 2010. Seminar Presentation by Mr. Maimbo Malesu. General Public Presentation at 5:30 pm. Overcoming Food Crises: Rainwater Harvesting in Sub-Saharan Africa and South Asia. San Juan College. Oct 19, 2010. Farmington. Organize and facilitated trip to New Mexico by Mr. Maimbo Malesu, Coordinator, World Agroforestry Centre. Nairobi, Kenya.

O'Neill, M.K. 2010. Seminar Presentation by Mr. Maimbo Malesu. Lowenstein Speaker Presentation at 5:30 pm. Overcoming Food Crises: Rainwater Harvesting in Sub-Saharan Africa and South Asia. NMSU Chemistry Building. Oct 21, 2010. Las Cruces, NM. Organize and facilitated trip to New Mexico by Mr. Maimbo Malesu, Coordinator, World Agroforestry Centre. Nairobi, Kenya.

O'Neill, M.K. 2010. Seminar Presentation by Mr. Maimbo Malesu. PES Graduate Student presentation at 3:30 pm. Sustainable Agricultural Production in Africa: Overcome Water Management Challenges from Local to Regional Scales. NMSU Gerald Thomas Rm. 200. Oct 22, 2010. Las Cruces, NM. Organize and facilitated trip to New Mexico by Mr. Maimbo Malesu, Coordinator, World Agroforestry Centre. Nairobi, Kenya.

O'Neill, M.K. 2010. American Society of Agronomy Annual Meeting in conjunction with the US Canola Association. Oct 30 – Nov 4, 2010. Long Beach, CA. Oral presentation and co-author.

O'Neill, M.K., S. Angadi, R. Flynn, and D. Smeal. 2010. Canola adaption to irrigated production in New Mexico. Oct. 31 – Nov. 4, 2010. International Annual Meeting, American Society of Agronomy. Long Beach, CA. http://a-c-s.confex.com/crops/2010am/webprogram/Paper58782.html.

Smeal, D. 2010. 20$^{th}$ International Pepper Conference. Las Cruces, NM September 12-14, 2010.

Smeal, D. 2010. Annual Conference of the American Society for Horticultural Science. Palm Desert, CA. August 4, 2010.

Smeal, D. 2010. National Decennial Irrigation Conference. Phoenix, AZ. December 5, 2010.

Smeal, D. 2010. NMSU Farmington ASC Advisory Committee Meeting. Farmington, NM. April 6, 2010. Active participant, presentation of research overview.

Smeal, D. 2010. NMSU Farmington ASC Field Day. Farmington, NM. July 23, 2010. Study plot presentations and tours.

Smeal, D. 2010. NMSU Farmington ASC Open House for Navajo delegates. Farmington, NM. July 30, 2010. Study plot presentations and tours.

Smeal, D. 2010. NMSU Farmington ASC Field Day. Farmington, NM. July 23, 2010. Study plot presentations and tours.

Smeal, D. 2010. Water Conservation Expo and Xeriscape Conference. Albuquerque, NM. February 27-28, 2010. Set up and helped man booth for promotion of urban landscape website and xeriscape demo garden.

Smeal, D. 2010. Western Society of Weed Science Annual Conference. Waikoloa, Hawaii. March 11, 2010.

## Awards

Arnold, R.N. 2010. Western Society of Weed Science Fellow Award, March 2010.

Kohler, Kennith. 2010. ACES Staff Award (off-campus). April 22, 2010. College of Agricultural, Consumer and Environmental Sciences, New Mexico State University. Las Cruces, NM.

O'Neill, M.K. 2010. Jose Fernandez Memorial Chair for Crop Production. April 22, 2010. College of Agricultural, Consumer and Environmental Sciences, New Mexico State University. Las Cruces, NM. http://research.nmsu.edu/nl/ovprgi_newsletter_apr2010.pdf.

## Proposals and Grants

Sattler, A. and R.N. Arnold and et al. 2010. Sandia National Laboratory and United States Department of Energy. *Desalinization of Coal Bed Methane Produced Water for Rangeland Grass Production* ................................................(pending).

O'Neil, M.K., J. Mexal, S. Forster-Cox 2010. Master's International. United States Peace Corps.

Stringam, B., M.K. O'Neill, B. Seevers, M. Malesu. 2010 USDA International Science and Education Grants Program. *Enhancing Water Harvesting to Benefit the Rual Communities of Rwanda.* ........................................................................$150,000

## Grants Received

**Arnold, Richard N. (PI)**
Chemical Weed Control ...........................................................................2010
Hatch Project, State of New Mexico Allocation ................................................$5,000

**Arnold, Richard N. (PI)**
Broadleaf Weed Control in Field Corn, Winter Wheat, Grain Sorghum, Native Grass response to herbicides and microbes vs. full rate of nitrogen for corn production. 2010

Corporation Support

BASF ........................................................................................................ $4,900
Bayer Crop Sciences ........................................................................................ $5,500
Dupont Crop Protection .................................................................................... $15,350
Microbial Energy ............................................................................................. $3,000
Total ........................................................................................................... $28,750

**Lombard, Kevin A. (PI)**
Viticulture and Specialty Horticulture
Hatch Project, State of New Mexico Allocation ................................................ $5,000

**Lombard, K.A. (PI)** and S. A.A. Beresford. 2010 Gardens For Health: Development of an Intervention Model for the Prevention and Management of Diet Related Illness Among the Navajo. NIH FHCRC/NMSU U-54 Cooperation............................. $7,500

Martin, C, (PI) and **K.A. Lombard**. 2010. Risk Management Education in Southwest Medicinal Herb Production and Marketing. Western Center for Risk Management Education
USDA CSREES ................................................................................................ $46,201

Unc, A., A. Ulery, and **K.A. Lombard**. 2010. Non-Specific Microbial Symbionts Inoculation and Plant Fitness for Remediation of Surface Coal Mining Sites... $55,000

**Lombard, K.A.** and St.Hilaire. 2008. Establishing the Center for Urban Landscape Water Conservation. 2010 support ............................................................... $32,000

**O'Neill, Michael K. (PI)**
Drip Irrigation in the Four Corners .......................................................................... 2010
Hatch Project, State of New Mexico Allocation ................................................ $5,000

**Smeal, Daniel (PI)**
Appropriate Water Conservation Technologies for Small Farms and Urban Landscapes 2010
Hatch Project, State of New Mexico Allocation ................................................ $5,000

**Smeal, Daniel** (PI) ............................................................................................. 2010
Research on Agricultural uses of Gypsum and other FGD Materials
Cooperative Agreement with Ohio State University
1 year no-cost extension 2010 (Initial 2 year funding for 2008 - 2009 Total $31,500)$15,750

## Proposals Submitted but not Accepted

**Lombard, K.A.** and S. A.A. Beresford. NIH FHCRC/NMSU U-54 Cooperation – Pilot study 2010 *Gardens For Health: Development of an Intervention Model for the Prevention and Management of Diet Related Illness Among the Navajo.* ...... $212,350

Martin, C, and **K.A. Lombard**. 2010. Western Center for Risk Management. *Asian Medicinal Herb Production and Marketing: Enhancing Risk Management Results*.$45,575

Craker, L., J. Giblette, C. Hassel., V. Jeliazkov, **K.A. Lombard**, and J. McCoy. 2010. *Diversifying Small Organic Production Systems with Chinese Medicinal Botanicals.*
Award amount under sub-contract .............................................................. $164,721

**O'Neil, M.K.**, J. Wang, D. W. DuBois, T. Sammis, D. R. Miller, J.O. Bash, F. Fujioka, R.N. Arnold, D. Smeal, K.A. Lombard, K. Heil, National Park Service, Air Resources Division. 2010*. Assessing risk to natural and cultural resources in the Four corners area from excess nitrogen deposition.* ........................................................$60,000

**O'Neil, M.K.**, A. Ulery, C.Sengupta-Gopalan, R.N. Acharya, R. N. Arnold, D. Smeal, B. Stanton,
D. Fox. USDA NIFA Agriculture and Food Research Initiative, Competitive Grants Program – Sustainable Bioenergy. 2010. *Sustainable production of hybrid poplar for biofuel feedstock using saline water.*..........................................................$988,174

**O'Neill, M.K.**, A. Kalinganire, J. Bayala, J.M. Dakouo. Adaptive Livestock Systems to Climate Change Collaborative Research Support Program (CRSP) managed by Colorado State University. 2010. *Improved Agro-silvo-pastoral systems for Mali.* $80,000

Stanton, B., R Aurora, G. Kishore, D. Neale, **M.K. O'Neill**, R. Quatrano, C. Tauer, R. Will, R.N. Acharya. USDA-NIFA Agriculture and Food Research Initiative, Competitive Grants Program – Sustainable Bioenergy. 2010. *Improved carbon sequestration associated with poplar bio-energy feedstock production on dry land farms in the western United States.* ......................................................~$1,000,000

## Press Releases 2010

Moorman, Jane. 2010. Two NMSU weed scientists honored by Western Society of Weed Science. NMSU News Center. April 1,2010. http://newscenter.nmsu.edu/news/article/?action=show&id=5035

Moorman, Jane. 2010. NMSU's Farmington Ag Science Center participates in national winter canola variety trial. NMSU News Center July 13, 2010. http://newscenter.nmsu.edu/?page=article&action=show&id=5232

Moorman, Jane. 2010. NMSU studies Four Corners region hops production for San Juan River Valley microbrewery industry. November 12, 2010. http://newscenter.nmsu.edu/news/article/?action=show&id=7420

Rad, Hamid M. 2010. Developing an irrigation master plan in Rwanda: NMSU researcher helps improving farming in Africa. NMSU Research News, February 2010. Vol. 3 (8) 4-5. http://research.nmsu.edu/nl/ovprgi_newsletter_feb2010.pdf.

Rad, Hamid M. 2010. NMSU Student Spends Summer in Africa Helping to Improve Irrigation Practices in Rwanda. NMSU Research News. Vol 3 (11) 10-11. http://research.nmsu.edu/nl/ovpr_newsletter_v3_n11.pdf.

Rad, Hamid M. 2010. Mick O'Neill, Associate Professor of Agronomy, Recipient of Jose Fernandez Memorial Chair Award. NMSU Research News, April 2010. Vol. 3 (9) 7. http://research.nmsu.edu/nl/ovprgi_newsletter_apr2010.pdf.

Rad, Hamid M. 2010. Guest Scientist from Kenya Strengthens NMSU's International Partnerships in Africa. NMSU Research News, December 2010. Vol. 3 (13). http://research.nmsu.edu/nl/11/ovpr_newsletter_v3_n13.pdf.

Schaefer, Rhonda. 2010. SJC Demonstration Garden Gives Lessons in Sustainability. San Juan College Communicator. September/October. Vol 30 (5).

http://www.sanjuancollege.edu/documents/PR/Communicator/2010/Communicator_Sept-Oct-2010.pdf

## Guest Presentations Hosted by 2010 Jose Fernandez Chair

Dr. Michael K. O'Neill, 2010 Jose Fernandez Chair, hosted an international lecture on water and food scarcity in Nairobi, Kenya presented by Dr. Maimbo Malesu.

Maimbo Malesu, Coordinator for the Water Management Unit with the World Agroforestry Centre based in Nairobi, Kenya, visited New Mexico State University to give two guest lectures about water and food scarcities and their mitigation in Africa. He presented a Lowenstein Lecture, arranged through the Department of Plant and Environmental Sciences, entitled Overcoming Food Crises: Rainwater Harvesting in Sub-Saharan Africa and South Asia.

Lecture Part 1 of 2 and Lecture Part 2 of 2

Dr. Malesu's second lecture was with the PES Gradute Student Seminar Series. It was entitled "Sustainable Agricultural Production in Africa: Overcome Water Management Challenges from Local to Regional Scales."

## Stories from the Popular Press

### More than 1,000 attend candlelight vigil for Kyler Beaty

June 25--FARMINGTON -- No one was a stranger to the young man who died suddenly Thursday morning after his red 1989 Nissan pickup truck slammed into the back of a dump truck on Navajo Route 36.

Kyler Beaty, 17, stopped by his house to change his clothes after morning football practice and grab his lunch. He told his mother, who was going shopping, what kind of new shoes he wanted before heading to work at New Mexico State University Science Center.

"I said I love you and be good' and he said Ok Mom," said Heather, Kyler's mom.

Minutes later -- cleats still in the back of the truck -- Kyler drove around a small bend on Navajo Route 36 and slammed into the back of dump truck full of scrap asphalt that was attempting to make a left turn into the Consolidated Construction gravel pit.

Sheriff deputies report he was unresponsive when emergency crews arrived on scene and he was pronounced dead at San Juan Regional Medical Center.

More than 1,000 community members gathered Thursday evening on the practice football field at Piedra Vista High School to mourn and pay homage to the young man whose life so abruptly was taken.

"Kyler will be missed in so many places," said Wes Pringle, assistant track coach and teacher.

Crowds gathered in the parking lot before the vigil as the sun was sinking in the west, holding one another, telling stories and sharing tears.

Conversations lingered on what his last Facebook posting was, the last phone call he made and the details of the accident.

Witnesses, following the accident, told sheriff's deputies the dump truck was visible in the roadway and the left turn signal and brake lights were working.

Yet, based on the skid marks in the road, Beaty slammed on his brakes 90 feet before he hit the truck. The impact was so great it broke the dump truck's rear dual tires loose, pushing them to the front, and ripped off part of Beaty's pickup truck roof .

Authorities believe speed may have factored in the crash, but pending further investigation, the exact cause remains unclear. Deputies reported Kyler's cell phone was found in his pocket.

The groups of mourners poured onto the field, stopping to sign large poster boards and console Kyler's parents. Silence blanketed the field broken only by small whispers, sniffles and sobs.

"This is a testament to what a fine young man he was and how well-liked he was to have so many people come out," said Piedra Vista High School Principal Ann Gattis.

The Piedra Vista football team, which met privately before the vigil, walked onto the field and formed a semi-circle around in front of the crowd. Players openly cried for their teammate.

The silence was broken momentarily and laughter erupted when the sprinklers turned on and the crowd scattered before coming together again on the tarmac, the same spot where Kyler practiced throwing the javelin for the field and track team.

"It was all Kyler," said one young girl of the laughter. Kyler's coaches, friends and family all spoke of his unending smile and sense of humor.

"Kyler -- he's just one of those guys you just have to smile when you're around," said Rebecca Debrick, 16.

Kyler was a friend to everyone and reached across all social groups, friends said.

"He taught me how to see everyone for who they are and love them for who they are and that life is good," Heather said.

Defensive end and running back and deemed one of the best players on the football field, the 17-year-old had dreams to play in college.

"He had a shot," PV football Coach Jared Howell said. "He had a really good year last year and was looking to build on that."

Kyler and his mom visited schools in Arizona to talk about playing football, she said.

He also reached beyond the sidelines of the football field and onto the track, where he was the 2010 District Champion in the javelin event. He also finished fourth at the state track meet in 2010, said track Coach Mark Turner, who coached Beaty for three years.

"He was extremely proud he threw over 160 feet, which is a pretty good throw for the state of New Mexico," Turner said. "Winning the district was a big thing for him."

While naturally athletic, not everything came easily for the 17-year-old.

"Kyler was a kid that had to work hard in school. Had to work hard," said Turner. "He was extremely well-liked and a very personable young man. There was no give-up' in him."

Pringle played "Amazing Grace" on the bagpipes, which prompted sobs from the crowd swathed in candlelight.

Football players throughout the county gathered in the center of the crowd to say a prayer before the PV football players ran to the center of the field to give one final "hurrah" to Kyler.

"He was my boy," Heather said. "He saw the good in everyone. He loved everyone one of you."

Elizabeth Piazza: epiazza@daily-times.com

## Thousands of mourners attend funeral service

June 30--FARMINGTON -- The young man born on Valentine's Day 17 years ago and whose family and friends remember as being filled only with love, was laid to rest Tuesday at Kirtland-Fruitland Cemetery in Kirtland.

Kyler Beaty's life abruptly ended Thursday in a car crash on Navajo Route 36, near the intersection of NM 371. He was preparing for his senior year at Piedra Vista High School, where he was hoping to continue playing football.

About 1,000 people filed on Tuesday into Emmanuel Baptist Church and mourners packed into the main sanctuary and two overflow rooms. Services were broadcast via television to those unable to find room inside the church.

Songs chosen by the family played as people settled into their seats. The lyrics echoed sentiments of family and friends, such as Chris Daughtry's song, "Going Home:"

"I am going home to a place where I belong, where your love has always been enough for me. I don't regret this life you chose for me."

Kyler was "one of those guys you don't not become friends with," said Rebecca Debrick, 16. "There were no regrets about his life."

From the time Kyler took his mother's checkbook in first grade to write $1 million checks for all of his friends, it was evident he cared about others and making people happy.

"He would bring a good mood to everyone no matter what time it was," said Jordan Eddleman, 17. "He always had a smile on his face."

Eddleman and many members of the Kirtland Central High School football team wore

their jerseys in a show of camaraderie for Kyler, who they considered a teammate and friend.

The six pallbearers, Ryan Arnold, Dennis Simmonson, Tyler Finch, Eli Finch, Phil Logan and Joe Chavez, dressed in Pittsburgh Steelers football jerseys over white shirts and ties, carried the midnight blue casket inside the church.

One of Kyler's favorite biblical passages spoke to who Kyler was, said his uncle, James Ray. "By the grace of God, I am who I am."

The cowboy who wore baggy jeans, Holister shirts, rodeo buckles and his football practice shoes when he wrestled cows was a "gentle giant," Ray said.

"He seldom let obstacles get in the way of celebrating life," Ray said of the teen who loved family, friends, football and the Congo drums.

The Rev. Scott Wilson, who met Kyler four years ago when he was his youth pastor, officiated.

Kyler's mother Heather, who last saw her son moments before the crash Thursday morning when he stopped home to change his clothes for work and grab his lunch, spoke to the mourners and thanked them for their outpouring of support.

"OK, Mom," were the last words she heard her son speak.

She told him she loved him and to "be good."

Heather remembered a time on the football field during a championship game when a frustrated Kyler came to her on the sidelines looking for help.

"Boy, you can do this," Heather said to her son that day. Now Kyler is on the sidelines, Heather said Tuesday, taking her hand and telling her she could get through this.

Pallbearers, following the services, carried the casket through the Piedra Vista Panthers tunnel,giving Kyler a final "hurrah," before placing the casket into the hearse.

A full police escort, including 10 Farmington Police Department officers and three sheriff's units, held off traffic at each intersection and led the funeral procession to the cemetery.

Shiprock stood tall on the horizon as the motorcade, approximately 80 cars and more than one mile long, wound its way along U.S. 64, transporting Kyler's body to a plot in the Kirtland-Fruitland Cemetery, where various family members already are buried.

Heather clutched her stomach with her hand and exhaled as the casket was laid in front of the family seated under a white canopy.

Family members tapped on the metal casket, a sound heard above sobs and whispers, to say goodbye.

The receiving line to offer condolences to the family, nearly 1,000 people long, formed a circle around the grave site.

The little things that accumulate in life often leave the biggest impression, Ray said. That was true of Kyler -- the nicknames, the personal sayings, the handshakes -- all memories that his family and friends will hold close.

"By the grace of God, I am who I am -- a Congo cowboy with a Holister shirt and baggy pants," Ray said. "Sometimes the teacher becomes the student and Kyler taught us the best about life."

Elizabeth Piazza: epiazza@daily-times.com

**Two NMSU weed scientists honored by Western Society of Weed Science**

The Western Society of Weed Science honored three New Mexico State University College of Agricultural, Consumer and Environmental Sciences professors during the group's annual conference March 8 in Waikoloa, Hawaii.

Rick Arnold and Tracy Sterling were selected as fellows by the society for their contributions to weed science research and to the profession. Cheryl Fiore received the outstanding professional staff award.

NMSU professors Rick Arnold and Tracy Sterling, first and third from left, have been selected as fellows of the Western Society of Weed Science during the group's annual conference March 8 in Waikoloa, Hawaii. Also pictured are Drew Lyon, University of Nebraska, Outstanding Weed Scientist, second from left; and Ian Burke of Washington State University, Outstanding Early Career Weed Scientist. (WSWS submitted photo)

"I was surprised and humbled to receive this prestigious award. It demonstrates that the research I have been doing is recognized by the society members as top-notch work," said Arnold, professor and researcher at the Farmington Agricultural Science Center.

"I am extremely humbled to receive this award because it really deserves to go to the multitude of students and colleagues, at both New Mexico State University and the Western Society of Weed Science, with whom I have had the honor of working over the years," said Sterling, formerly a professor in NMSU's entomology plant pathology and weed science department, and currently head of the land resources and environmental sciences department at Montana State University.

"It is an honor to be nominated for this recognition and to be selected for the award by this professional organization," she said.

During his 30 years with NMSU, Arnold has successfully developed a weed management program of value and relevance in the Four Corners region of New Mexico, Colorado, Arizona and Utah. University and industry scientists outside of New Mexico have also recognized his work and contributions.

Currently his areas of focus include weed control in cropland and non-cropland and insect control in agronomic and horticultural crops. He is also focusing on using water produced from coal-bed methane wells to re-vegetate disturbed lands in the oil- and gas-producing basin of northwest New Mexico. The water is used to help establish native and introduced grasses in the area.

Arnold is the principal investigator for weed and insect control in northwest New Mexico and has conducted numerous trials evaluating the efficacy and selectivity of herbicides for major crops grown in the Four Corners region.

Sterling was with NMSU 20 years before moving to Montana State University in August 2009. While at NMSU, she taught plant physiology and developed a nationally recognized research program in weed physiology. She has bridged the gap between applied and basic research by discovering fundamental aspects of important weedy species of arid rangeland vegetation and the role of oxidative stress tolerance in crop and weed interactions.

She has won several national awards for creating and developing teaching modules and animations, which are being used in an e-learning distance delivery graduate course in herbicide physiology.

This is Fiore's second recognition from professional weed science societies. The NMSU Masters of Science graduate received an undergraduate research award from the Weed Science Society of America in 1996.

As a research specialist, Fiore is responsible for managing the weed science field research program at the weed science lab in Las Cruces.

"Cheryl is a conscientious and talented researcher, excelling at developing methods and troubleshooting problems that could affect the outcome of the projects," said Jill Schroeder, NMSU professor in entomology, plant pathology and weed science, who nominated Fiore for the award.

As a supervisor, Fiore looks for ways to allow the student researchers to develop their skills and learn on the job.

"She has worked with undergraduates on special research projects, both the research and the development of poster presentations, which they have subsequently presented at Western Society of Weed Science meetings," Schroeder said. "She also works with graduate students to help them achieve their research goals and graduate."

Other researchers in the College of Agricultural, Consumer and Environmental Sciences, as well as local consultants, rely on Fiore's expertise to help with weed identification, sprayer calibration, herbicide label interpretation and other issues related to weed control in their programs.

Fiore has published one journal article, one experimental station report, 21 abstracts and 12 annual weed science progress reports during her time at NMSU. She continues to be active in the weed science discipline, both in her job and as a society member.

Arnold, Sterling and Fiore have all been active members of the Western Society of Weed Science and Weed Science Society of America, serving on several committees through the years. During the annual conference, research by both Arnold and Sterling were among the six presentations from NMSU.

In 2006 the Western Society of Weed Science named Arnold Outstanding Weed Scientist for the Public Sector. In 2004 he received NMSU's Staff Appreciation Award for outstanding teamwork with the oil and gas industry, cattle producers, Bureau of Land Management and the U.S. Forest Service for the amelioration of disturbed rangelands.

During her years at NMSU, Sterling received several awards, including the 2008 Honorary Member for Faculty Development Initiatives-NMSU Teaching Academy, the 1994 El Paso Natural Gas Foundation Faculty Achievement Award and the 1992 National Association of Colleges and Teachers of Agriculture Teaching Award of Merit.

Fiore has attended every society annual meeting since becoming a member in 1997 and has presented a poster on research conducted at NMSU at all but one meeting. She has served on the poster committee and currently as the society's newsletter editor.

Western Society of Weed Science members are weed science professionals working throughout the Western U.S. The society, established in 1938, fosters and encourages education and research in weed science; fosters state, federal and private agency cooperation on weed science issues; helps commercial, private and public agencies solve weed problems; supports legislation governing weed control programs and weed research and education programs; and supports state and regional organizations and agencies interested in weed control.

Jane Moorman, New Mexico State University‘s University Communications.

**Seminar - "Overcoming food crises: Rainwater harvesting in Sub-Saharan Africa and South Asia" by Mr. Maimbo Malesu.**

The San Juan College Horticulture Club will present a seminar, open to the general public, by Mr. Maimbo Malesu, Agricultural Engineer with the World Agroforestry Centre based in Nairobi, Kenya. The seminar entitled **—Overcoming Food Crises: Rainwater Harvesting in Sub-Saharan Africa and South Asia"** will be held Tuesday, October 19, 2010; 5:30-6:30 p.m. at the SJC Cultural Center located at the Outdoor Learning Center adjacent to the athletic playing fields and Teaching Greenhouse. Enter from Piñon Boulevard. For a map to the SJC Culture Center, go to the NMSU Agricultural Science Center in Farmington Home Page (http://farmingtonsc.nmsu.edu). A downloadable map is available on the site.

Farmington Daily Times: towntalk@daily-times.com

## NMSU's Farmington Ag Science Center participates in national winter canola variety trial

### NMSU's Farmington Ag Science Center participates in national winter canola variety trial

*Date: 2010-07-13*

*Writer:* **Jane Moorman**, 505-249-0527,
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FARMINGTON, N.M. – Canola, a source for heart-healthy cooking oil and bio-diesel fuel, could be another alternative crop for Northern New Mexico farmers. Researchers at New Mexico State University's Farmington Agricultural Science Center are helping with a national study to see which variety fares best in the environment of the Four Corners region.

*Dan Smeal, college professor and irrigation expert at New Mexico State University's Agricultural Science Center at Farmington, looks at the field of winter canola he is using for his water requirement study. A winter canola variety trial is among the research projects being done at the science center. This year's field day tour will begin at 9:30 a.m. Friday, July 23, at the farm located south of Farmington. (NMSU Photo by Margaret West)*

NMSU is participating in the National Winter Canola Variety Trial being conducted at 63 locations in 24 states. Michael Stamm, assistant agronomist at Kansas State University, is coordinating the study, which is evaluating the performance of released and experimental varieties to determine where these varieties are best adapted.

The Farmington science center has participated in the trial for two years.

"This year we planted between 40 and 50 varieties. So far it looks like this area is very good for winter canola compared to other areas in the country," said Curtis Owen, the NMSU research assistant responsible for NMSU's portion of the study.

"Winter canola variety performance has really excelled in northwestern New Mexico," Stamm said. "The environment at Farmington, with its plentiful irrigation and high elevation, is ideal for winter canola to show its true yield potential. So far, this has been one of the highest yielding environments of the trial."

In 2009, Farmington's fields had a two-year average yield of 3,969 pounds per acre, or 79 bushels per acre, with the highest yielding variety averaging 106 bushels per acre.

"This was the highest yielding environment out of 29 harvested locations of the 2009 variety trial," Stamm said. "In 2008, the Farmington location, with an average of 76 bushels per acres, was the second highest yielding environment out of 37. The highest yielding variety at this location averaged 95 bushels per acre that year."

The trial compares the various varieties for fall stand establishment, winter survival, bloom date and plant height; percentage of shatter, yield and test weight; and moisture, protein and oil content of the seed.

Winter canola is a good fit for small-grain cropping systems because it and winter wheat require the same equipment.

"Wheat crops following canola have shown a 10 percent or greater increase in yield compared with continuous planting of wheat," Stamm said. "Canola is a broadleaf crop, which allows use of some effective herbicides to control grassy winter annual weeds. Canola and wheat have no major diseases in common, so growing canola breaks weed and disease cycles."

Also, because canola is an oilseed, Stamm says its commodity price is not tied to prices of cereal grains and this spreads economic risks over more than one commodity class.

Winter canola is planted in the late summer. Owen says he plants during the first half of September. The canola plant is similar to winter wheat, which grows until winter temperatures cause it to go dormant. Then as temperatures warm and daylight increases, the plants resume growing in the spring, and the crop is harvested in July or August.

"Canola likes the cooler weather. Presently, commercial canola growers are mostly in Canada and the northern United States, but it appears that our spring climate is conducive for the canola to grow here in the Four Corners region," Owen said.

Owen will give an update about this variety trial and other crop trials that he is managing during the science center's field day on Friday, July 23. The open house will be from 8:30 a.m. to 3 p.m. The field tour, which begins at 9:30 a.m., is free and includes a barbecue lunch at noon.

In addition to the winter canola variety trial, the center is participating in NMSU crop physiologist Sangu Angadi's study of canola as an oilseed crop for biodiesel.

Farmington's irrigation expert, Dan Smeal, is also studying the optimal amount of water needed to raise productive canola.

"We are trying to determine the least amount of water required to get a good yield," said Smeal, NMSU college professor and irrigation expert at the Farmington science center. "We are applying water at different percentages of reference evapotranspiration, which is calculated using weather data such as temperature, humidity, solar radiation and wind speed."

During the field days, visitors will also learn about the ongoing poplar tree project, viticulture research for New Mexico's wine industry, weed research and low-pressure drip irrigation.

NMSU's Agricultural Science Center in Farmington has provided science-based information since 1966 for large and small agricultural producers, industrial operators interested in natural resource management, rural and urban home owners, and interested growers in the Four Corners region.

The science center is located six miles south of Farmington on N.M. 371. Just south of NAPI headquarters, turn right (west) on Navajo Road 3003. Travel west approximately four miles to the green NMSU Experimental Station sign, then turn right on Navajo Road 4063 and travel north three miles to the science center. For more information about the field day, call 505-960-7757 or visit the science center's website at **http://farmingtonsc.nmsu.edu**.

## NMSU studies Four Corners region hops production for San Juan River Valley microbrewery industry

### NMSU studies hops production for San Juan River Valley microbrewery industry

*Date: 2010-11-12*
*Writer: Jane Moorman, 505-249-0527, jmoorman@nmsu.edu*

FARMINGTON, N.M. – As the microbrewery industry thrives in the San Juan River Valley of northwestern New Mexico and southwestern Colorado, a researcher at New Mexico State University is studying the feasibility of raising hops, a primary ingredient of most beers and ales, in the Four Corners region.

A field day visitor and Mike Kelly, Farmington Agricultural Science Center staff member, look at the hops flower cone to see if the lupulin glands have formed. Cooperating with the USDA and independent grower Todd Bates, NMSU is conducting a variety trial, including native Neo mexicana, to determine if hops can grow in the Four Corners, San Juan River Valley region. (NMSU Photo by Geraint Smith)

Kevin Lombard, NMSU College of Agricultural, Consumer and Environmental Sciences horticultural researcher at the Farmington Agricultural Science Center, is conducting a multi-year variety trial of the plant that provides the aroma and bitter flavor of beer. He began the study in 2008 when he learned of trends in the brewing industry that were affecting the region's five microbreweries.

"During the winter of 2008, I started hearing and reading reports that the hops prices were spiking," said Lombard. "There was a shortfall in the crop in Washington's Yakima Valley and the Pacific Northwest, which is the biggest hops producing region in the United States. As a researcher I felt we needed to be ahead of the curve and see if this could become an alternative crop for small-acreage farms in our region."

The brewmasters in Farmington and in Durango, Colo., agreed it would be interesting to see what flavors would come from hops grown within their region since soil and climate are known to affect hops flavor.

"Historically, hops were added to ale when it was shipped from England to India for the British troops stationed there. When the soldiers returned home they had acquired a taste for the Indian Pale Ale, now commonly called IPA," said Ryan Thompson, brewmaster at Three Rivers Brewery in Farmington and formerly with Ska Brewing Company, a large microbrewery in Durango. Hops have since become widely used in the brewing process, more for flavor than for preservative properties.

During the first year of the variety trial in 2009, Lombard raised six varieties of hops that he obtained from the United States Department of Agriculture hops germplasm center in Corvallis, Ore.

"We planted the Cascade, Columbia, Crystal, Hallertauer, Newport and Northern Brewer varieties," Lombard said. "The head breeder in Corvalis, John Henning, formerly with NMSU's agronomy department, was interested in the concept of us doing a variety trial since the climate of the Four Corners area is similar to the Washington Yakima Valley."

Lombard's first research question has already been answered: Hops will grow in the Four Corners region in a drip-irrigated environment.

"We learned that Cascade was the best variety for this region in both yield and chemical compounds, which were comparable to the same variety grown in the Pacific Northwest," Lombard said. "The European variety Hallertauer, a noble hops that is raised in the Czech Republic, did not grow more than three feet and suffered from iron chlorosis, a yellowing of leaves related to our high pH soils."

The second stage of the trial involves assessing the taste of products brewed with the locally grown hops. Three Rivers Brewery produced 150 gallons of specialty beer using the harvested hops cones and featured it on its specialty batch menu, called Cascade Ale, during the winter of 2009. "It had a good flavor and was popular with our customers," said Thompson.

During the 2009 growing season, Lombard learned of Embudo farmer Todd Bates' work with native wild hops. For the second phase of the variety trial, he approached Bates for cuttings from his plants to see if native hops, Neo mexicana, found in the Rio Grande Basin from Colorado to Mexico, will grow in the Four Corners region.

The plants were planted in 2010 and became established during the season. Data from the plants will be gathered after the 2011 season and harvest.

"Todd Bates has been cultivating native hops for many years for medicinal essential oils and home brewing," said Lombard. "He has gone through all of the trials and tribulations of bringing plants from the wild and cultivating them in a field setting. During that time he has taken hops plants through a natural selection process to find plants that grow well in that location's soil type and climate."

Bates discovered hops in various canyons and arroyos in north central New Mexico while harvesting native medicinal herbs for his personal use. Called lupulo by the early settlers, the Neo mexicana variety Bates found is genetically unique.

"People thought the plants we found had been planted by early settlers, but they were not in areas where humans would go. They were at high elevations where they suffered extreme conditions that hops elsewhere do not experience," Bates said.

Bates sent plant samples to Corvallis for genetic testing to determine if in fact they were transplants from Europe or native to the region. "The genetic testing of the Neo mexicana is nothing like anything in the whole USDA germplasm records," Bates said. "That's when I knew we had something special."

In his research, Bates has found reference to the native hops by U.S. General Surveyors in the 1800s, speculating that the plant might become a viable agricultural crop. Now, nearly 200 years later, Lombard is waiting for next summer's harvest to see if the prediction will hold true for the Four Corners region.

"EYE ON RESEARCH" is provided by New Mexico State University. This week's feature was written by Jane Moorman of University Communications.

## SJC Demonstration Garden Gives Lessons in Sustainability

september/october 2010
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san juan college
# communicator
san juan college's community news and events

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## Going Green

## SJC Demonstration Garden Gives Lessons in Sustainability

**SJC Demonstration Garden Gives Lessons in Sustainability**

September/October 2010 San Juan College Communicator
An energy wise grant is providing hands-on learning as well as offering San Juan College students and the community insight about sustainabilityand green technology.

The grant, called the 2009 Clean Energy Demonstration Program Grant, ispart of the Federal Sustainable Living Initiative, which is given to states to promotewise energy use. A portion of the grant is being used at the San Juan College Outdoor Learning Center Community demonstration Garden to develop educational and community gardens, as well as a curriculum for sustainable living.

Angela Grubbs, SJC Outdoor Learning coordinator, Dr. Don Hyder, associate professor of biology, and Dr. Kevin Lombard, assistant professor of horticulture with New Mexico State University, are overseeing the project.

“We are basically creating three different types of gardens – a cottagestyle garden, an urban agricultural brick raised bed garden, and a community garden,” Grubbs explains. “While each has a different and specific purpose, they all are being developed with a common goal – to help students and the community learn how to foster a movement toward sustainability and wise use of our natural resources.”

The oval shaped cottage-style garden, which was the vision of Alice Barnard, SJC Grounds maintenance supervisor, is designed to grow xeric-adapted plants (those requiring minimal water). It will showcase plants that adapt well to the local environment and are aesthetically pleasing in a low maintenance yard.

“We want to get rid of the notion that native plants are weeds or that they are unattractive,” Grubbs says. “We'll demonstrate how to design a beautiful outdoor space by using plants that have varied textures, bloom throughout the year – and better yet – require little water and are easy to maintain.”

The urban agricultural brick raised bed demonstration garden will feature medicinal plants, edible flowers, and herbs. The plants will be grown in approximately 20 raised beds that go beyond the usual rectangular design. In addition to using split-faced block, non-typical items such as stock tanks and bamboo poles with teepee-shaped design also will be used to construct the beds.

“The raised beds are a perfect solution for areas that have poor growing soil,” Grubbs says. “It also adds to the sustainability principle that the plants are both edible and medicinal.”

The community garden will demonstrate various ways to grow vegetables and herbs.

“Through ideas from the raised bed garden, people also can learn how to utilize various options and watering systems to grow a productive garden at their home – even with limited space,” says Kevin Lombard.

The irrigation systems for the gardens follow the energy wise approach and are all designed with drip irrigation. For instance, the cottage-style garden features a low-flow gravity feed barrel drip system. It utilizes wine barrels that gather and house water from a rainwater harvest system. Gravity then sends water through the lines to irrigate the plants.

“These systems are the most energy efficient method of irrigation, as the water is applied directly to the soil, avoiding water evaporation and reducing the number of weeds,” Grubbs continues.

In addition to the gardens, there are projects in the pipeline being created to sustain the future of the gardens. These include a composting system that utilizes the waste from SJC‘s Mary‘s Kitchen to create natural fertilizer as well as completing the rainwater harvesting system for irrigation. A lath house will also be built to raise seedlings and rooted cuttings prior to putting them in the gardens, thus reducing the cost of purchasing plants.

All of the Outdoor Learning Center energy is solar and geothermal powered, including the electric cart, used for transporting plants and materials. Under the direction of Grubbs, Hyder, and Lombard, SJC horticulture students got hands-on experience as they were responsible for designing the gardens and irrigation systems. New Mexico Youth Conservation Corps (NMYCC) students, from various high schools throughout San Juan County, completed the implementation of the gardens.

“Not only was it a great summer job, but I feel good knowing that in some way I‘m helping future generations,” says Wyatt Granger, YCC student.

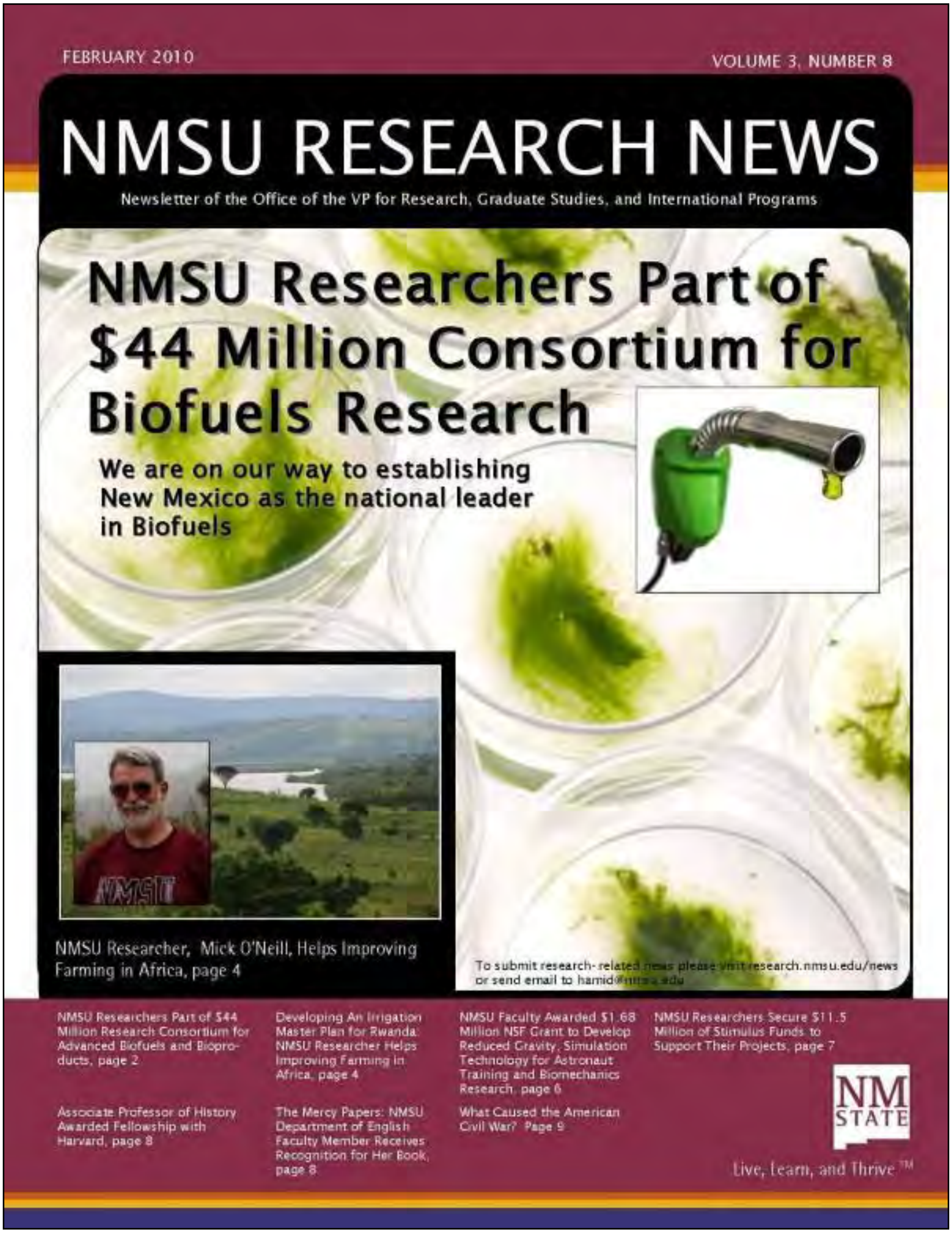
“I‘m proud to have been a part of this project,” continues Aiessa Wages, SJC horticulture student. “It‘s a perfect example of how people can put these sustainable practices to work in their own lives – it just makes good sense from an economic, health and energy efficient standpoint.”

While the project is ongoing, Grubbs says all of the Demonstration Garden‘s systems are expected to be in place by February 2011.

Rhonda Schaefer, San Juan College Communicator

http://www.sanjuancollege.edu/documents/PR/Communicator/2010/Communicator_Sept-Oct-2010.pdf

## Developing an Irrigation Master Plan in Rwanda: NMSU Researcher Helps Improving Farming in Africa



FEBRUARY 2010 VOLUME 3, NUMBER 8

# NMSU RESEARCH NEWS

Newsletter of the Office of the VP for Research, Graduate Studies, and International Programs

## NMSU Researchers Part of $44 Million Consortium for Biofuels Research

We are on our way to establishing New Mexico as the national leader in Biofuels

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To submit research-related news please visit research.nmsu.edu/news or send email to hamid@[illegible]


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What Caused the American Civil War? Page 9


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# DEVELOPING AN IRRIGATION MASTER PLAN IN RWANDA: NMSU RESEARCHER HELPS IMPROVING FARMING IN AFRICA

*By Hamid M. Rad*

**Rwanda is up in the highlands. It's called the Switzerland of Africa. They have a lot of lakes, streams and ponds, but they are all on the slopes, as a result there are issues with water management, not just simply water storage.**

After spending six months in Kenya and Rwanda to oversee the development of an irrigation master plan for those countries, Dr. Mick O'Neill, superintendent of NMSU's Agricultural Science Center at Farmington, has returned to New Mexico.

As a senior scientist, agronomist and agroforester, Dr. O'Neill has spent more than 20 years conducting agricultural research and development in both West and East Africa. Before joining NMSU, he spent 10 years in Kenya working in soil and water conservation, development of fodder trees/shrubs, and fruit trees improvement for the International Centre for Research in Agroforestry (ICRAF).

"Rwanda is in the East African highlands and is called the Switzerland of Africa," says Dr. O'Neill. "There are lots of lakes, streams and ponds, but they are surrounded by sloping fields; as a result there are major issues with water management, not just simply water storage," he adds.

The practice of rainwater harvesting for farms involves the creation of water runoff areas, collection ponds where rainwater can be stored, and small agroforestry gardens irrigated with water diverted from these ponds. From 2006 to 2008, the ICRAF trained Rwandan farmers and soil and water conservation technicians about rainwater harvesting and constructed more than 100 rainwater collection ponds and agroforestry gardens.


In 2009, during his sabbatical, Dr. O'Neill spent six months in Africa working along with his team of collaborators on developing an irrigation master plan for Rwanda. They were initially based in Nairobi, frequently travelling to Rwanda for their work. This master plan will be used as a tool for the Rwandan Ministry of Agriculture and Livestock Resources (MINIAGRI) for their long-term strategic plan to facilitate irrigation to the rural population. "Rwanda has the highest population density on the continent – 450 people per square kilometer – which is mostly a rural population," says Dr. O'Neill.

During Phase I, the team was looking for regions appropriate for irrigation with contiguous areas of up to 200 hectares. Initially, they were looking for suitable areas with slopes of up to 60%. This was later reduced to sloping areas of less than 15%. During these initial visits, the areas that the team focused on included Kigali, Bugasera, Nyagatera, and Gitarama Districts.

Based on his work in Africa, Dr. O'Neill along with one of his colleagues from Australia have submitted a proposal to the National Science Foundation's Basic Research to Enable Agricultural Development (BREAD) program. In addition he


Rainwater harvesting collection pond in Rwanda


Dr. O'Neill and Maimbo Malesu, ICRAF (World Agroforestry Centre)'s water programs coordinator and manager of the Rwanda Irrigation Master Plan team.

has written several peer-reviewed articles, authored or co-authored five posters during the 2009 World Agroforestry Congress in Kenya, and organized educational workshops while in Kenya.

"There are opportunities for collaboration between ICRAF and NMSU," emphasized Dr. O'Neill in his recent colloquium at the College of Agricultural, Consumer and Environmental Sciences. As he explains it, both NMSU and ICRAF scientists conduct research dealing with irrigation, rain-fed agriculture, wildlife issues, and rangeland management. Since the ICRAF's involvement spans Africa, Southeast Asia, China, India, and Latin America, it deals with border issues as well. As a result ICRAF would be a suitable partner for NMSU researchers working in other areas such as agriculture, environmental and the social sciences.

"ICRAF and NMSU could pursue a scientist exchange program, where all of our departments could participate," suggests Dr. O'Neill.

Student internships are another avenue of collaboration that can be pursued between NMSU and ICRAF. Dr. O'Neill's work has already provided an internship opportunity for one of his students, Owen Cortner. In 2009, he, along with Dr. Rich Phillips, Director for Programs for the College of Agricultural, Consumer and Environmental Sciences, participated in the second World Congress for Agroforestry, hosted by ICRAF, in Nairobi, Kenya, and as part of his internship in Africa Mr. Cortner will join ICRAF in a research attachment position during the Summer of 2010.

Asked to comment about ethnic troubles in that part of Africa, Dr. O'Neill said that those problems are caused by poverty. "Fortunately there are a number of organizations in the world trying to do something about it," he added.

Dr. O'Neill holds a Ph.D. in Agronomy and Plant Genetics from the University of Arizona. He has published more than 46 peer-reviewed articles and technical reports. He joined NMSU in 1999. He and his wife, Amy, also a former Peace Corps volunteer, have lived in Africa for many years and their two sons, Casey and Kyle, grew up in Kenya speaking Ki-Swahili and English.

Dr. O'Neill can be reached at moneill@nmsu.edu


Owen Cortner NMSU's Plant and Environmental Sciences student in Kenya.

Facilitated by the efforts of Dr. Mick O'Neill, Owen has applied for a student attachment position with the Watershed Management Program of research at the World Agroforestry Centre in Kenya. During the summer he will research how rainwater harvesting can enhance irrigation water supplies for small rural farmers.

**NMSU Student Spends Summer in Africa Helping to Improve Irrigation Practices in Rwanda**


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VOLUME 3, NUMBER 11

# NMSU Student Spends Summer in Africa Helping to Improve Irrigation Practices in Rwanda

*By Hamid M. Rad, OSI*

Photos courtesy of Owen Cortner

NMSU student Owen Cortner working with farmers in Rwanda, Africa

Owen Cortner, an NMSU Plant and Environmental Sciences major, spent this summer working on an internship in Africa. Through an agreement between NMSU and the World Agroforestry Centre (WAC), Owen was hosted by the WAC as an attached undergraduate student. The Centre, one of fifteen institutions around the world that make up the Consultative Group on International Agricultural Research, works to develop more productive, diversified, integrated, and intensified agroforestry systems that provide livelihood and environmental benefits. A key element within this goal is smart water management.

Owen's assignment in Rwanda was to conduct a rapid assessment of runoff harvesting pond irrigation systems for small farmers engaged in agroforestry and determine strategies for improvement.

Preliminary findings of Mr. Cortner's study indicate that inefficient hand-watering techniques are widespread due to a lack of capital to invest in metered systems such as drip irrigation. "There are efficient low-cost irrigation methods available which farmers could be educated about," says Owen. "The runoff harvesting ponds themselves work very well, but the amount of water stored by the ponds is often not matched to the size of the plot that is intended to receive irrigation, resulting in water deficits for crops towards the end of the dry season. There is a great opportunity to address these and other small holder agricultural issues through improved extension efforts and farmer capacity building."


To analyze the runoff harvesting ponds the team used two strategies: on-site observations and geographic information system (GIS) data including soil type, watershed delineations, rainfall, land cover, and temperature. On-site observations gave an idea of the experience the farmers had using the system and their perceptions of the system. GIS analysis showed what potential water harvests could be, and the amount of water a farm would need given its location and cropping system.

This internship was funded by a linkages grant from USAID via the World Agroforestry Centre, as well as support from Aggies Go Global. This combined assistance covered Owen's work-related living expenses in Rwanda.

Professor Maimbo Malesu, director of the

Rwandan farmer holding a container that they use to water their farm.

Watershed Management Program at the WAC, and Dr. Mick O'Neill, Jose Fernandez Memorial Chair in Crop Production at NMSU, jointly supervised the internship. Work was performed collaboratively with a dedicated group of Kenyan and Rwandan agroforestry professionals.

"I would take a job in Africa tomorrow if I was finished with my degree, and I plan to do just that once I graduate."

"A foreign student in Rwanda faces many challenges including cultural differences such as cuisine and the slower pace of life, although eventually these turn into enjoyable aspects," says Owen. "Also, though it is a pleasant, friendly country, it is not the developed world, and students should not expect the ubiquitous conveniences of life in the United States."

Asked for his advice to other students, Owen suggests that they should work diligently to engage the community around them so that they have a sense of belonging and purpose. "I recommend that students with the drive to succeed and the will to be humble in a foreign culture pursue internships, service-learning experiences, or any other international opportunity they can find," adds Owen. "It is invaluable as a complement to a student's education. I would take a job in Africa tomorrow if I was finished with my degree, and I plan to do just that once I graduate."

"NMSU and WAC are looking at future possibilities for student attachments as part of the existing agreement," says Dr. O'Neill. Professor Malesu will be on campus in October to meet with students and faculty and to present two guest lectures. These lectures will be a follow-up to a seminar to be presented by Cortner to the Plant and Environmental Sciences Graduate Student Seminar, at 3:30 on October 8, 2010.

For further information, contact Dr. O'Neill, moneill@nmsu.edu. Owen Cortner can be reached at ocortner@nmsu.edu.

Owen with a gorilla in the background at Volcano National Park in Rwanda.

## Mick O'Neill, Associate Professor of Agronomy, Recipient of Jose Fernandez Memorial Chair Award


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Meet Gloricelys Rivera, NMSU's Biology PhD Candidate from San Juan, Puerto Rico

President Couture expressing gratitude to all NMSU researchers who make us proud through their hard work and ingenuity.

To submit research- related news please visit research.nmsu.edu/news or send email to hamid@nmsu.edu

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into one such WFM. "The second purpose of the TAMDAR-U project is to evaluate to what extent the accuracy of the WFM might be improved by having the benefit of the TAMDAR-U data," adds Mr. Jameson.

"Weather-sensitive" users include the aviation industry (military, commercial, and general aviation) as well as industries such as agriculture, transportation (besides aviation), forestry etc. Also, most all types of military operations on the battlefield are greatly affected by weather conditions. Instruments such as TAMDAR/TAMDAR-U promise to improve the accuracy of meteorological forecast models, which in turn would result in more precise forecast availability for anyone interested in weather that might affect their planned activities.

The NMSU Unmanned Aircraft Team plans to continue research flights to provide weather data to the Battlefield Environment Division of the Army Research Laboratory at White Sands Missile Range.

At NMSU's Physical Sciences Laboratory, Mr. Forrest Carpenter oversees the planning, coordination, and execution of the flights. During the flights, he also serves as the Pilot-In-Command (PIC) of the unmanned aircraft. For additional information about this project please contact Mr. Carpenter at 575-646-9585 or via email at fcarpenter@psl.nmsu.edu.

## Mick O'Neill, Associate Professor of Agronomy, Recipient of Jose Fernandez Memorial Chair Award


From left, Dr. Lowell B. Catlett, Dean of the College of Agricultural, Consumer and Environmental Sciences, Dr. Jay Jordan, Interim Exec. VP and Provost, Dr. Mick O'Neill, Assoc. Professor of Agronomy, Amy O'Neill, Kyle O'Neill, Dr. Jon Boren, Assoc. Dean of Coop. Extension Service, Casey O'Neill, Dr. LeRoy Dougherty, Assoc. Dean/Dir. of Ag. Exp. Station, and Dr. Jim Libin Assoc. Dean/Dir. of Academic Programs

Dr. Mick O'Neill, Associate Professor of Agronomy in NMSU's College of Agricultural, Consumer and Environmental Sciences, was awarded the Jose Fernandez Memorial Chair in Crop Production for his outstanding efforts in crop research . In this ceremony, in which Dr. O'Neill's colleagues and family attended, Dr. Jay Jordan Interim Executive VP and Provost presented Dr. O'Neill with this prestigious award.

As the former superintendent of the Agricultural Science Center at Farmington, Dr. O'Neill oversaw the operation of this branch of NMSU for 10 years in Farmington that serves the agricultural needs for large and small scale producers in the San Juan River basin of northwest New Mexico and the Four Corners. Currently, Dr. O'Neill is devoting his research interests to the adaptation of hybrid poplar to arid/semi-arid environments, characteristic of much of the western United States Intermountain Region. He is also focusing on the sustainable development of biofuel crops including poplar for cellulosic ethanol production and oilseed crops for biodiesel.

Before joining NMSU in 1999, Dr. O'Neill spent 10 years in Kenya, Africa, working in soil and water conservation, the development of fodder trees/shrubs for small holder dairy animals, and improvement of fruit trees with the International Centre for Research in Agroforestry (ICRAF). In 2009 he spent six months in Kenya and Rwanda to development crop water use evaluations for the Rwandan Irrigation Master Plan.

Dr. O'Neill has published more than 46 peer-reviewed articles and technical reports. He holds a M.S. in soil and Water Science and a Ph.D. in Agronomy and Plant Genetics from the University of Arizona.

The Jose Fernandez Memorial Chair in Crop Production (aces.nmsu.edu/aes/fernandezchair) was established in 1992 by the Enrique Chavez family in recognition of Mr. Fernandez's contribution to NMSU and the agricultural community.

Dr. O'Neill can be reached at moneill@nmsu.edu.

## Guest Scientist from Kenya Strengthens NMSU's International Partnership in Africa

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# Guest Scientist from Kenya Strengthens NMSU's International Partnerships in Africa

*by Hamid M. Rad, OSI*

Photo by Hamid M. Rad, OSI

Mr. Maimbo Malesu describing rainwater harvesting methods used in Kenya.

Mr. Maimbo Malesu, coordinator for the Water Management Unit at the World Agroforestry Centre (ICRAF) in Nairobi, Kenya, visited NMSU last October and lectured for the College of Agricultural, Consumer and Environmental Science's annual Lowenstein Lecture series and the Plant and Environmental Sciences (PES) graduate student seminar. His lectures on overcoming the food crises in Africa and the formation of an irrigation master plan for Rwanda were attended by NMSU faculty, researchers, and students.

Mr. Malesu's collaboration with NMSU is through an MOU between ICRAF and NMSU that was finalized in 2005 by Dr. Mick O'Neill, professor of agronomy at NMSU's Agricultural Science Center, in Farmington.

"The problem water managers are facing in Rwanda is a lack of capacity to harness rainwater and distribute it to farms and industry," says Dr. O'Neill. By participating in seminars and workshops, Mr. Malesu is campaigning to raise awareness and sensitize governments and universities all over the world to the importance of rainwater harvesting management.

He coordinates rainwater harvesting research and dissemination for ICRAF in Eastern and Southern Africa and in South Asia, where he and his team train communities about best practices in water management, set up pilot projects, and share their experiences with policymakers so they may implement the necessary improvements in the policies they develop. The pilot projects that involve rainwater harvesting and associated irrigation systems have been installed in many regions in Rwanda in collaboration with the Rwandan Ministry of Agriculture and Animal Resources. A previously developed MOU between NMSU and ICRAF contains opportunities for an exchange program, where students and faculty can participate in a range of research activities including efforts to develop more effective water management strategies.

It was through this exchange program that PES student Owen Cortner spent the 2010 summer conducting an evaluation of previously installed runoff harvesting ponds and irrigation systems for agroforestry gardens. Also within this MOU, Dr. O'Neill spent a sabbatical in Nairobi working with Mr. Malesu on an Irrigation Master Plan (IMP) project for the Government of Rwanda. The recommendations of the IMP team were approved by the government of Rwanda in September 2010, and the Prime Minister of Rwanda launched the implementation of the Irrigation Master Plan through the publication of a technical report.

In his lecture on the food crisis in Rwanda, Mr. Malesu highlighted poor agricultural practices prevalent in farming communities. "We found that it is a political issue as well," says Mr. Malesu. "People in that region do not have sufficient economic investment in place despite an abundant water supply. Governments mainly invest in dam construction. The problem with dams is that there cannot be enough of them. Only 5% of the total land mass would provide good locations for the construction of dams. The other option is creating wells, but they are too expensive for farmers to construct."

*SearNet Associations*
*Botswana*
*Ethiopia*
*Kenya*
*Malawi*
*Rwanda*
*Somalia*
*Tanzania*
*Uganda*
*Zambia*
*Zimbabwe*

*Affiliations*
*Eritrea*
*Mozambique*

To promote the practice of rainwater harvesting, Mr. Malesu and his colleagues established the Southern and Eastern Africa Rainwater Network (SearNet), which is a network of national rainwater harvesting associations from 12 African countries. The aim of each association is to promote rainwater harvesting practices within each country. The members include government and non-government organizations.

Mr. Malesu's visit and the cooperation from ICRAF showcase the importance of international partnerships for the university. Faculty and students must be engaged in today's world, and opportunities for international education should be further integrated into curriculum and coordinated across departments to maximize benefits.

Mr. Malesu's visit was made possible through the Dr. Lowenstein Lecture Series, International Programs, and the Jose Fernandez Memorial Chair in Crop Production.

For additional information about NMSU's collaboration with ICRAF, contact Dr. O'Neil at moneill@nmsu.edu.

## WRRI's New Interim Director

Photo by Hamid M. Rad, OSI

Dr. Sam Fernald, Interim Director of NMSU WRRI speaking on the newly funded research project addressing the conditions of New Mexico acequias

Dr. Sam Fernald was appointed the interim director of NMSU's Water Research Resources Institute (WRRI). Sam is an associate professor of Watershed Management in the Department of Animal and Range Sciences (College of Agricultural, Consumer, and Environmental Sciences). He has led a number of prestigious research projects including the Acequia Water Systems Linking Culture and Nature: Integrated Analysis of Community Resilience to Climate and Land Use Changes, a $1.4 million project recently funded by the National Science Foundation.

For additional information about NMSU's WRRI, please visit: http://wrri.nmsu.edu. Dr. Fernald can be reached at afernald@nmsu.edu.

*'Meet NMSU's New Biosafety Manager' continued from page 4*

The "Haz Waste" class is required for the person in the lab who is listed on the posted signage as the contact for waste accumulation and disposal procedures. The Blood-Borne Pathogens training, which is currently offered online, is required annually for anyone who has exposure or potential for contact with human blood, internal body fluids, unfixed tissues, or viruses that transmit blood-borne diseases, such as HIV or hepatitis.

Dr. Dupre can help investigators assess safety standards and personnel practices in their labs and work areas, and provide advice on safety regulations and biological laboratory security. "When I survey labs and research areas around campus, I will ask the Principal Investigator and lab workers to show me documentation of personnel training" says Dr. Dupre. "This should be considered as a standard piece of information that a site inspector from a federal agency might request from anyone in the lab area. A good laboratory practice is to ensure documents are kept in an accessible place: training records, standard operating procedures (SOPs) and lab-specific protocols, Emergency Response Plans, log sheets for Incident/Injury/Spills, and sterilization validations. These laboratory standards, policies, and prudent practices have been developed by the scientific community to protect the health and safety of laboratory workers and to prevent adverse impacts on the environment. As a microbiologist, I want to see the names of my colleagues in print for the outstanding quality of their work, not associated with a lab acquired infection." Biosafety resources will be available at Dr. Dupre's office in Anderson Hall, room E2102C, and online at http://www.research.nmsu.edu/compliance/IBC/ibc.html.

In the coming months, look for the Biosafety website to become a convenient place to access the NMSU Biosafety Manual, IBC policies and procedures, links to training classes, and FAQs. "As I continue and extend my working relationships with investigators in NMSU research, I am committed to maintaining open communication with faculty, laboratory students, and staff," says Dr. Dupre. "Questions, comments, and suggestions are always welcome. I invite everyone to share my contact information with new personnel in your departments."

For assistance with any biosafety issues, please contact Dr. Dupre at (575) 646-4663.