New Mexico State University

2011 Annual Progress Report

Agricultural Science Center
At Farmington
April 2012

Forty-fifth Annual Progress Report For 2011 New Mexico State University Agricultural Science Center at Farmington

P. O. Box 1018
Farmington, NM 87401

Michael K. O'Neill & Margaret M. West – Editors

Richard N. Arnold
Interim Superintendent, College Professor

Michael K. O'Neill
Professor

Dan Smeal
College Professor

Kevin Lombard
Assistant Professor

Tom Jim
Farm/Ranch Superintendent

Samual Allen
Ag. Research Scientist

Margaret M. West
Research Specialist

Curtis K. Owen
Research Assistant

Jonah Joe
Research Technician

Joseph Ward
Research Technician

Kenneth D. Kohler
Farm/Ranch Laborer

Nathan Begay
Farm/Ranch Laborer

Sue Stone
Asso. Administrative Asst.

Cover: Garden cosmos (*Cosmos bipinnatus*) flower being pollinated by honey bee in a multi-locational Altenate Pollinator Trial. Locations include Farmington, Los Lunas, Tucumcari, and Vado (photo by Dan Smeal). Most of the ASC faculty, staff, and and temporary employees during July 2011 (photo by Mick O'Neill).

Temporary Employees

2011Student Employees

Aiessa Wages
Technician

Christen Begay
Lab Assistant

Dennis Simonson
Lab Assistant

Dustin Thomas
Lab Assistant

Faith Benally
JFC[†] – Intern, Lab Assistant

Jason Thomas
Lab Assistant

Justine Harvey
JFC – Intern, Lab Assistant

Kevin Hooper
Research Technician

Lyle Lee
Lab Assistant

Sara Billie
Clerical Aide

Zena Archie
JFC – Intern, Lab Assistant

[†]JFC: Funds for JFC Internship provided by the Jose Fernandez Mamorial Chair din Crop Production.

Collaborators List

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

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

New Mexico State University Ag Science Center – Los Lunas

Tessa Grasswitz	IPM Specialist

New Mexico State University, San Juan County Cooperative Extension Service

Craig Painter	Dir., County Director, 4-H Agent

Arizona, New Mexico, Utah, Tri-Universities Cooperative Extension Service

Jeannie Benally	Director, Agriculture Extension Agent
Valery Sandoval	Agriculture Agent

University of Arizona

Ed Martin	Professor, Irrigation Specialist

Colorado State University, Agricultural Experiment Station

Jessica Davis	Director, Institute for Livestock and the Environment
George Beck	Professor, Weed Science
Abdel Berrada	Research Scientist, Agronomist
Scott Nissen	Professor, Weed Science
Phil Westra	Professor, Weed Science

Colorado State University, Cooperative Extension Service

Tom Hooten	Agriculture Extension Agent

Diné College

Marnie Carroll	Head, Environmental Programs
Benita Litson	Program Manager, Inst. Integrated Rural Dev.

Navajo Prepatory School

Betty Ojaye	Executive Director

Ohio State University

Warren A. Dick	Professor
David Kost	Research Associate

Oregon State University

Clint Shock	Professor, Superintendent Malheur Exp. Station
John Henning	Professor, Hop Geneticist

San Juan College

Michael Tacha	Interium President
Carol Spenser	President (former)
Sheryl Hruska	Vice President for Instruction
Merrill Adams	Dean, Sciences
Callie Vanderbilt	Instructor, Biology
Don Hyder	Instructor, Entomology
Marjorie Black	Program Developer, Encore Program

University of Nebraska-Lincoln, Scottsbluff

Robert Wilson	Professor, Weed Science

University of Wyoming

Andrew Kniss	Assistan Professor, Weed Science

Washington State University

Jeff Kallestad	Research Technologist

Navajo Agricultural Products Industry

Tsosie Lewis	Chief Executive Officer
Leonard Scott	Chief Operations Officer
Wilton Charley	Director, Operations & Maintenance
Beulah John	Director, Human Resources
Orvalle Begay	Director, On-farm Development and
Martina Murray	Agronomist
Renae Pablo	Manager, Agricultural Research and Testing Lab
Anthony Valdez	Projects Manager
Daniel Tso	Manager, Marketing
Dan Spare	Engineer
Aaron Benally	Crop Manager, Potatoes
Albert Etcitty	Crop Manager, Corn
Lewis Pinto	Crop Manager, Corn
Roselyn Yazzie	Crop Manager, Dry Beans
Lance Johnson	Crop Manager, Small Grains

Kathy Lowe	Technician, Conservation and Organics Anderson
AndersonTyler	Irrigation Technician, Potatoes
Hal Thompson	Marketing Director
Anthony Valdez	Projects Manager

Agri-Inject, Inc.

Arnold Page	Sales Manager

Albuquerque Wastewater Treatment Facility

Steven Glass	Program Manager, Wastewater Utility Division

Animas Environmental Services, LLC

Ross Kennemer	Senior Project Manager
Blaine Watson	Senior Project Manager
Deborah Watson	Project Manager

Arizona Drip and Sundance Farms

Howard Wuertz	Owner
David Wuertz	President

BASF

Harry Quicke	Research Representative
Larry Schield	Sales Representtative

Basin Cooperative

Steve Trudeau	General Manager
Tom Campbell	Crop Specialist, Durango

Bayer CropScience

Charley Hicks	Research Representative
Russell Perkins	Research Representative

BHP-Billiton Mine

Steve Perkins	Environmental Quality

BioTech Remediation

Michael Beauparlant	Environmental Field Specialist
Chad Dawson	Environmental Technician

Buchannan Consultants, Ltd.

Bruce Buchannan	President
Justin Tucker	Project Development Manager

Bureau of Indian Affairs, Navajo Indian Irrigation Project

Steven Lynch	Director

Bureau of Land Management, Farmington Field Office

Mark Kelly	Inspector
Bill Papich	Community Relations

Dale Wirth	Natural Resources
Dave Mankiewicz	Natural Resources
Daniel Sandoval	Natural Resources
Jeff Tafoya	Range Specialist

Bureau of Reclamation, Durango Field Office

Pat Page	Water Management Coordinator

Carver Farms, Cortez, CO

Doug Carver	Owner

City of Aztec, NM

Dennis Taylor	Farmer

City of Bloomfield, NM

Jessica Polatty	Director, Senior Citizen Center
Norman Tucker	Director, Cultural Center

Conoco/Phillips

Gwen Frost	Representative
Bob Wirtanen	Representative
Monica Johnston	Representative

Crop Quest

John Hecht	Agronomist

Croplan Genetics

Dennis Gehler	Forage Production Manager
Matt Sowder	Sales Representative

Dow AgroSciences

Jesse Richardson	Research and Sales Representative

Dyna-Gro Seed

John Griffin	Research and Sales Representative

E.I. Du Pont

Jim Harbour	Research Representative

El Paso Field Services

Ron Sipe	Representative
Kent Leidy	Representative
Joe Velasquez	Representative

Environmental Sensors, Inc.

Pierre Ballester	Customer Sales Manager
Bruce Chambers	Support Technician

Eureka Seed

Craig Sharp	Research and Sales Representative

Fred Hutchinson Cancer Research Center

Shirley Beresford	Research Scientist

Grand Junction Pipe and Supply Co.

Ken Thorson	Branch Manager, Durango Office

Grand Valley Hybrids

Alan Ferris	President
Bill Rooks	Agronomist
Mark Harris	Sales Manager

Garst Seed

Jeff Schaef	Research and Sales Representative
Mark Meyer	Area Agronomist

GreenWood Resources, Inc.

Jeff Nuss	President and CEO
Brian Stanton	Managing Director of Resource Management
Richard Shuren	Farm Manager, Columbia Tree Farm

Hammond Conservancy District

Teresa Lane	Manager

Independent Energy Center

Richard Gary Chacon	Owner

Jose Fernandez Chair

Gary R. Lowe	Global Mentoring Coordinator, Aggies Go Global
Thomas Dormody	Professor, AXED
Brenda Seevers	Professor, AXED
April Ulery	Professor, PES
Stephanie Walker	Assistant Professor, EPS/PES
Katherine (Kari) Bachman	Extension Program Coordinator, Nutrition, EFCS
Mark Gladden	Major Gift Officer, ACES
Sue Foster-Cox	Associate Professor, CHSS
Linda Stout	SLW/AWARD Program Gift Donor

Ku Tips Nursery & Landscape

Willie Kutac	Proprietor

Logan-Zenner Seeds Inc.

Les Watada	Seed Specialist

Manning's Greenhouse

Jack Manning	Proprietor

Modern Farm Equipment, Corp.

Gary Cranston	Owner
Neal Ziller	Communications Specialist

Monsanto

Jeff Tichota	Technical Representative
Robert Leisy	Research and Sales Representative

NC+ Hybrids

Ron Joiner	Research and Sales Representative

NM Native Plant Society (San Juan Chapter)

Donna Thatcher	President

NM Office of the State Engineer

Patti J. Bushee	Project Manager
John W. Longworth	Professional Engineer
Cheri Vogel	Water Conservation Coordinator

Netafim-USA

Pat Fernandes	Sales Manager

Pioneer Hi-Bred International, Inc.

Russell French	District Sales Manager

Public Service Company of New Mexico

Mike Farley	San Juan Power Plant

Rain Bird, Inc.

Inge Bisconer	National Sales Manager
John McHugh	Central US District Manager, Agri-Products
Rob Kowalewski	Drip Irrigation Specialist

Raindrops, Inc.

Lloyd Husted	Owner

San Juan Nurseries, Inc.

Donnie Pigford	Proprietor

Sandia Laboratories

Mike Hightower	Representative
Alan Sattler	Representative

Santa Ana Native Plants Nursery

Mike Halverson	Manager

Southwest Seed, Inc.

Walter Henis, Sr.	Owner
Walter Henis, Jr.	President

Stoller Corporation

Jody Waugh	Principal Scientist, Environmental Sciences Lab.

Syngenta

Buddy Viramontes	Consultant
Mick Urwiler	Research Representative

USDA-ARS Plant Material Center

David Dreesen	Agronomist
Keith White	Biological Science Technician
Alex Taylor	Biological Science Technician

Ute Mountain Farm and Ranch

Paul Evans	General Manager

Western Excelsior

Norm Birtcher	Assistant Plant Manager

Wilber Ellis

Dennis Coleman	Director and Head of Fertilizer Applications
Bill Suess	Agronomist/Entomologist

Williams Production

Mark Lepich	Representative
Sterg Katirgis	Representative

XTO Energy

Del Craddock	Representative

Private parties

William ‘Bill’ Blythe Mayfield	William (Xeriscape Endowment)
Laura Fink	William (Xeriscape Endowment)

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, Dupont Crop Protection, 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 (1), 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 2011 growing season for the 2007-planted variety trial, 3 entries yielded over 10 dry tons per acre for the 4 cuttings. The highest yielding entry was PG1459 from Producer's Choice Seed with a total yield of 10.3 dry tons per acre. At a farm gate sales price of $195 per ton of hay (National Agricultural Statistics for New Mexico – 2011), this would represent a sales price of $2,009 per acre. The average yield for the 24 varieties in 2011 was 9.1 tons per acre and the 4-year average (2008-2011) 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. Two corn variety trials with a total of 11 entries had an average yield of 220 bu/ac. The highest yielding entry in the Early Maturity trial was TRX 95502S from Triumph with a total yield of 246 bu/acre while the highest yielding entry in the Full Maturity trial was DKC66-96 from Monsanto with a total yield of 258 bu/acre. Combined over both trials, there were 8 out of 11 entries that had grain yields greater than 200 bu/ac, representing approximately $1,200/acre at $6.00/bu (National Agricultural Statistics for New Mexico – 2011). 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 44 entries tested in 2011, Safran, had a yield of 3,437 lb/acre or $791 per acre at the December 31, 2011 close price of $0.23 per pound (National Agricultural Statistics for New Mexico – 2011).

In 2011, there were four broadleaf weed control trials conducted on ASC-Farmington with corn. There were also broadleaf weed control trials for grain sorghum, winter wheat, and Roundup Ready alfalfa. With appropriate irrigation and combinations of preemergence and postemergence herbicides, adequate control of broadleaf weeds in corn was achieved. The control plots averaged 71 bu/acre while the herbicide treated plots ranged from 140 to 278 bu/acre across the four 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 ninth year at the science center. Depending on irrigation level, total seasonal irrigation (May – Oct) ranged from only precipitation (4.2 inches) to 300 gallons per plant. As in previous years, nearly half (49 species) the entries exhibited acceptable plant quality when irrigated weekly at irrigation levels between 0 (rain only) to 4 gallons of water per week (0% to 20% of ET_{RS}). A study was initiated to evaluate the performance selected drip irrigation point source emitters and drip lines at water pressures less than those specified or recommended by the emitter manufacturer or dealer. In 2011, flow rates were measured from 20 different models of point source emitters at two different pressures (1.5 psi and 2.4 psi) or heads (3.5 feet and 5.5 feet, respectively). Measured flow rate at 5.5 and 3.5 ft of head averaged 33.6 % and 14.8 %, respectively, of that specified by the manufacturer at the recommended pressures (usually >

10 psi or 23 feet). Water application uniformity (AU), expressed as 1 – *cv* (where *cv* = standard deviation / mean of measurements from eight replicates along a 80 foot long, 0.5 inch lateral) was greater than 0.90 for eleven of the twenty emitters. 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 0.0 to 157 gallons per plant at the no and high irrigation treatments, respectively, plus an additional 3.0 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, three selections from the Cornell grape breeding program, and 6 Riesling varieties planted in 2009. Visible freeze damage was observed in half of the entries in the 2007-planted trial and ranged from 8% of vines impacted for Swenson Red to 75% in Himrod. Growth of Glenora, Himrod, Interlaken, Marquis, Reliance, Swenson Red and Vanessa recovered from secondary buds. Swenson Red produced on 100% of vines. Table grapes showing the most promise for our high elevation site are Swenson Red, Glenora, Vanessa, and, Reliance. Among the red wine grapes, Baco Noir, Kozma and Leon Millot continue to yield despite cold winters and the May 2 spring freeze. Among the white wine grapes, Chardonel, Seyval Blanc, Siegfried, Traminette, Valvin Muscat, and Vidal Blanc had greater than 71% of their vines in the trial yield grapes in 2011. Key 2011 accomplishments for the collaborative horticulture program at San Juan College include enhancement 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 expansion 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 10 seasons, the clone OP-367 remained the tallest entry reaching a mean height of 65 feet. OP-367 also had the largest mean DBH at 11.0 inches and maximum wood volume of 6,758 ft^3/ac. A water application trial was established in 2007 with OP-367 and three other clones crossed from the same species. Although significantly under-irrigated due to mechanical problems, the clone OP-367 led for height (45.2 ft), Wood Volume (1,306 ft^3/acre), and total aboveground biomass (35 ton/acre). 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 at the center. 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

Table of Contents

Table Of Tables

Table Of Figures

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 2011 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. Both anemometers were replaced in 2011. 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/).

The 2011 growing season had 157 days of above freezing temperatures and was below the 43-year average of 161.6 days free of freezing temperatures (Table 3). The freeze-free period was from May 3 through October 8 (Table 3).

During 2011, the temperature conditions were near normal compared to the 43 year average. The annual mean temperature of 51.5 ºF for 2011 was 1.1 ºF lower than the 43 year mean of 52.6 ºF (Table 5).The annual mean temperature was 3.6 ºF less than the highest year occurring in 2003 which had an annual mean temperature of 55.1 ºF. The annual mean temperature for 2011 was 1.5 ºF greater than the lowest year of 50.0 ºF occurring in 1975. The mean monthly temperatures in 2011 were lower than average for 8 months of the year. The month of January had a mean temperature of 24 ºF and was 6.1 ºF below the 43 year January mean of 30.1 ºF. The month of February had a mean temperature of 32 ºF and was 4.1 ºF below the 43 year February mean of 36.1 ºF (Table 5).

A below average 6.94 inches of precipitation was recorded in 2011. The wettest month was October which received 1.86 inches and was 0.85 inches greater than the 43 year monthly average of 1.01 inches. January, June and August were especially dry when only 0.03, 0.01 and 0.05 inches of precipitation were recorded in each month, respectively (Table 4).

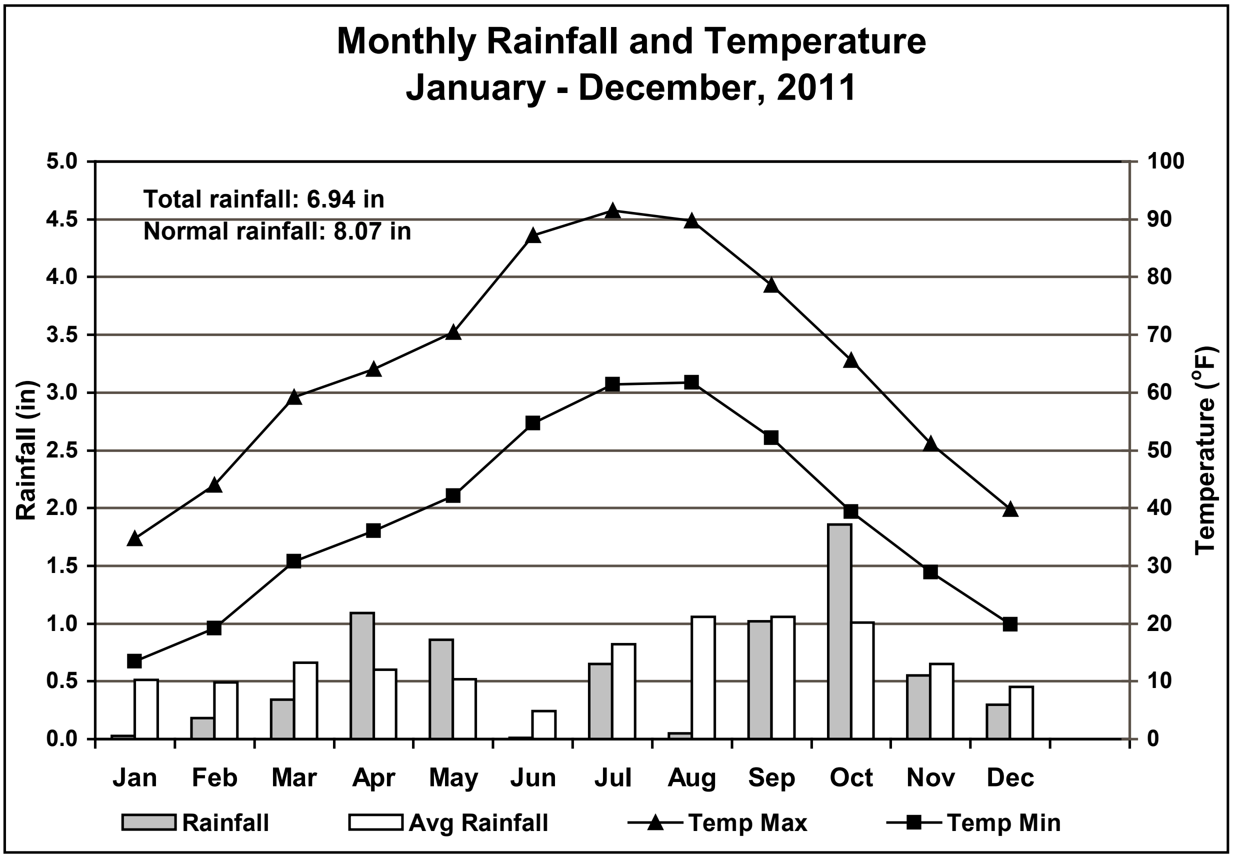

Figure 1. **Monthly and average precipitation (in), monthly maximum and minimum temperatures (ºF); NMSU Agricultural Science Center at Farmington, NM. 2011.**

Table 1. Mean daily climatological data; NMSU Agricultural Science Center at Farmington, NM. January through December 2011.

Month	Mean Temperature Max (ºF)	Mean Temperature Min (ºF)	Mean Temperature Mean (ºF)	Extreme Temp. Max (ºF)	Extreme Temp. Min (ºF)	Precipitation (in)	Wind Speed 18 in height (mi)	Wind Speed 2 m height (mi)	Evaporation (in)	Sunshine (Langley)
January	34.7	13.5	24.1	50.0	-5.0	0.03		78		264
February	44.0	19.2	31.6	63.0	-6.0	0.18		113		354
March	59.2	30.8	45.0	72.0	19.0	0.34		130		465
April	64.1	36.1	50.1	79.0	21.0	1.09		159	9.02	562
May	70.5	42.1	56.3	87.0	26.0	0.86		127	10.68	668
June	87.2	54.7	71.0	96.0	46.0	0.01	74	107	14.46	712
July	91.5	61.4	76.5	97.0	51.0	0.65	60	82	13.15	652
August	89.7	61.7	75.7	95.0	57.0	0.05	57	78	11.71	570
September	78.6	52.2	65.4	89.0	44.0	1.02	58	79	7.57	465
October	65.6	39.4	52.5	81.0	27.0	1.86	61	85	5.32	374
November	51.2	28.9	40.1	68.0	19.0	0.55	72	102		260
December	39.8	19.8	29.8	57	4	0.3	51	74		202
Total	**776.1**	**459.8**	**618.0**	**934.0**	**303.0**	**6.9**	**432.6**	**1213.8**	**71.9**	**5548**
Mean	**64.7**	**38.3**	**51.5**	**77.8**	**25.3**	**0.6**	**61.8**	**101.2**	**10.3**	**462**

<u>Freeze-Free Period</u>
Last Spring reading of 32 ºF or below: May 3 (32 ºF)
First Fall reading of 32 ºF or below: October 8 (32 ºF)
Number of freeze-free days: 157
<u>Killing Freeze-Free Period</u>
Last Spring reading of 28 ºF or below: May 2 (26 ºF)
First Fall reading killing freeze: October 28 (27 ºF)
Number of freeze free days: 178

Table 2. Forty-three year average monthly weather conditions; NMSU Agriculture Science Center at Farmington, NM. 1969 – 2011.

Month	Precip-tation (in)	Mean Temperature Maximum (ºF)	Mean Temperature Minimum (ºF)	Extreme Temperature Maximum (ºF)	Year Recorded	Minimum (ºF)	Year Recorded
January	0.51	41	19	66	2000	-18	1971
February	0.49	48	24	70	1986	-14	1989
March	0.66	57	30	82	2004	3	2002
April	0.60	66	36	86	1992	16	1979
May	0.52	76	45	97	2000	23	1975
June	0.24	87	54	100	1981-1990-1994	32	1999
July	0.82	91	60	103	1989,90,03,05	43	1969
August	1.06	88	59	99	1969,70,83,02	41	1980
September	1.06	80	51	97	1995	28	1971-1999
October	1.01	68	40	88	2010	15	1989
November	0.65	53	28	75	1999-2001	1	1976
December	0.45	43	20	67	1999	-16	1990
Total	**8.07**						
Mean	**0.67**	**66.4**	**38.8**				

Table 3. Freeze dates and number of freeze-free days; NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011.

Date	Less than or equal to 32 ºF: Last Spring Freeze (date)	First Fall Freeze (date)	Freeze-free Period (days)	Less than or equal to 28 ºF: 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
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****

Date	Less than or equal to 32 ºF: Last Spring Freeze (date)	First Fall Freeze (date)	Freeze-free Period (days)	Less than or equal to 28 ºF: Last Spring Killing Freeze (date)	First Fall Killing Freeze (date)	Killing Freeze-free Period (days)
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
2011	May 03	Oct 08	157	May 02	Oct 28	178
Mean	**May 03**	**Oct 12**	**161.6**	**Apr 21**	**Oct 21**	**182.8**

* Earliest date (or shortest freeze-free period) of 43 years.
** Latest date (or longest freeze-free period) of 43 years.

Table 4. Mean monthly precipitation (in); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011.

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**
2011	0.03	0.18	0.34	1.09	0.86	0.01	0.65	0.05	1.02	1.86	0.55	0.30	**6.94**
Mean	**0.51**	**0.49**	**0.66**	**0.60**	**0.52**	**0.24**	**0.82**	**1.06**	**1.06**	**1.01**	**0.65**	**0.45**	**8.07**

* 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 – 2011.

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**
2011	24	32	45	50	56	71	77	76	65	53	40	30	**51.5**
Mean	**30.1**	**36.1**	**43.2**	**50.9**	**60.2**	**70.1**	**75.7**	**73.7**	**65.9**	**53.6**	**40.7**	**31.4**	**52.6**

*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 – 2011.

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**
2011	35	44	59	64	71	87	92	90	79	66	51	40	**64.7**
Mean	**41.0**	**47.9**	**57.0**	**65.7**	**75.8**	**86.5**	**91.1**	**88.0**	**80.4**	**67.5**	**53.1**	**42.5**	**66.4**

Table 7. Summary of monthly average of the minimum temperature (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011.

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**
2011	14	19	31	36	42	55	61	62	52	39	29	20	**38.3**
Mean	**19.1**	**24.2**	**29.5**	**35.9**	**44.8**	**53.5**	**60.4**	**59.3**	**51.2**	**39.7**	**28.4**	**20.2**	**38.8**

Table 8. Highest temperatures (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011.

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**
2011	50	63	72	79	87	96	97	95	89	81	68	57	**77.8**
Mean	**54.3**	**62.4**	**71.7**	**79.4**	**87.6**	**95.9**	**98.0**	**95.3**	**90.4**	**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** **1990** **1994**	**1989** **1990** **2003** **2005**	**1969** **1970** **1983** **2002**	**1995**	**2010**	**1999** **2001**	**1999**	

Table 9. Lowest temperatures (ºF); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011.

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
2011	-5	-6	19	21	26	46	51	57	44	27	19	4	25.3
Mean	**4.1**	**8.8**	**15.8**	**22.8**	**31.5**	**41.1**	**52.6**	**51.8**	**37.5**	**24.7**	**12.6**	**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 1999**	**1989**	**1976**	**1990**	

Table 10. Number of days 32 ºF or below and 0 ºF in critical months; NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011.

	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**
2011	31	25	18	9	3	0	0	6	23	31	**146**	2	3	0	**5**
Mean	**29.5**	**24.5**	**20.0**	**9.7**	**1.3**	**0**	**0.2**	**5.7**	**21.2**	**29.3**	**142**	**1**	**0.2**	**0.3**	**1.3**
Total	**1267**	**1053**	**869**	**416**	**57**	**1**	**10**	**245**	**912**	**1259**	**6089**	**30**	**10**	**14**	**54**

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 – 2011.

	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**
2011	0	3	4	2	0	**9**	0	0	**0**
Mean	**0.1**	**2.9**	**7.6**	**2.1**	**0.0**	**12.8**	**0.1**	**0.8**	**0.8**
Total	**3**	**126**	**328**	**90**	**2**	**549**	**3**	**33**	**36**

Table 12. Mean daily evaporation (inches per day); NMSU Agricultural Science Center at Farmington, NM. 1972 – 2011.

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**
2011		0.300	0.344	0.482	0.424	0.377	0.252	0.171		**0.336**
Mean	**0.226**	**0.275**	**0.351**	**0.438**	**0.421**	**0.362**	**0.287**	**0.199**	**0.154**	**0.335**
Years	**1**	**35**	**39**	**40**	**40**	**40**	**40**	**39**	**3**	**40**

Table 13. Mean monthly evaporation (inches per month); NMSU Agricultural Science Center at Farmington, NM. 1972 – 2011.

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**
2011	9.02	10.68	14.46	13.15	11.71	7.57	5.32	**71.9**
Mean	**8.17**	**10.80**	**13.13**	**13.05**	**11.20**	**8.57**	**5.95**	**68.57**
Years	**35**	**39**	**40**	**40**	**40**	**40**	**39**	**40**

Table 14. Wind movement in miles per day (MPD) at 6 inch height above evaporation pan; NMSU Agricultural Science Center at Farmington, NM. 1980 – 2011.

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	-	-	-	-	-	-	-	-	
2011						74	60	57	58	61	72	51	
Mean (MPD)	**62.7**	**71.6**	**83.8**	**85.8**	**73.9**	**67.1**	**62.2**	**59.1**	**56.4**	**59.2**	**65.1**	**60.2**	**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 – 2011.

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**
2011	78	113	130	159	127	107	82	78	79	85	102	74	**101.2**
Mean (MPD)	**112.3**	**128.2**	**144.9**	**154.8**	**136.1**	**120.2**	**109.2**	**103.1**	**105.3**	**105.6**	**110.1**	**109.7**	**120.2**
Mean (MPH)	**4.7**	**5.3**	**6.0**	**6.5**	**5.7**	**5.0**	**4.5**	**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 – 2011.

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**
2011	264	354	465	562	668	712	652	570	465	374	260	202	5,548	**462.3**
Mean	**218.5**	**293.5**	**410.3**	**524.2**	**604.8**	**648.9**	**636.7**	**572.6**	**484.6**	**360.9**	**252.0**	**198.6**	**5,206**	**433.8**

Table 17. Forty-three year total monthly Growing Degree Days* (May thru Sept. and first fall freeze); NMSU Agricultural Science Center at Farmington, NM. 1969 – 2011. (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**
2011	352	584	729	722	476	**2,863**	**Oct 08**	**2,929**
Mean	**402**	**577**	**714**	**691**	**485**	**2,869**	**Oct 12**	**2,965**
Accum-mulation	**402**	**979**	**1,693**	**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 2011.

Month	Mean High	Mean Low	Mean*	Extreme High	Extreme Low
January	34.8	30.8	32.8	40.8	25.0
February	41.9	34.2	38.1	52.3	29.1
March	54.3	40.6	47.5	64.3	34.0
April	66.0	49.1	57.6	76.9	39.4
May	78.0	59.4	68.7	87.9	48.3
June	88.9	70.2	79.6	96.2	62.3
July	95.5	76.0	85.8	101.1	69.0
August	92.7	73.7	83.2	98.9	66.5
September	83.2	65.4	74.3	93.0	55.8
October	66.5	51.5	59.0	78.9	41.2
November	48.6	39.0	43.8	59.4	31.6
December	36.3	31.6	34.0	45.3	25.6
Mean	**65.3**	**51.8**	**58.6**	**74.6**	**44.0**

*Mean between high and low.

Table 19. Mean high soil temperatures (ºF) four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2011.

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**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
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**
2011	30.4	35.8	53.0	62.0	69.3	84.0	90.2	89.8	77.4	61.1	44.7	32.5	**60.9**
Mean	**34.8**	**41.9**	**54.3**	**66.0**	**78.0**	**88.9**	**95.5**	**92.7**	**83.2**	**66.5**	**48.6**	**36.3**	**65.3**

Table 20. Mean low soil temperature (ºF) four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2011.

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**
2011	28.6	29.4	42.7	51.5	58.9	73.1	81.2	81.8	68.8	52.4	38.1	30.1	**53.1**
Mean	**30.8**	**34.2**	**40.6**	**49.1**	**59.4**	**70.2**	**76.0**	**73.7**	**65.4**	**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 – 2011.

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**
2011	38	45	64	71	78	87	98	97	86	75	55	42	**69.7**
Mean	**40.8**	**52.3**	**64.3**	**76.9**	**87.9**	**96.2**	**101.1**	**98.9**	**93.0**	**78.8**	**59.4**	**45.3**	**74.6**

Table 22. Soil low temperature (ºF) extremes, four inches below surface; NMSU Agricultural Science Center at Farmington, NM. 1976 – 2011.

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**
2011	25	18	34	35	47	68	77	78	61	41	34	26	**45.3**
Mean	**25.0**	**29.1**	**34.0**	**39.4**	**48.3**	**62.3**	**69.0**	**66.5**	**55.8**	**41.2**	**31.6**	**25.6**	**44.0**

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. 2011 mean seasonal total yield for this trial was 9.13 ton/acre (Table 24). The highest yielding entry of 10.32 ton/acre was PGI1459, an entry from Producer's Choice Seed. The lowest yielding entry of 7.81 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 13 top yielding entries within this trial. The second cut yielded the highest with a mean of 2.45 ton/acre, while the fourth cutting was the lowest yielding cut with a mean of 1.78 ton/acre (Table 24).

The highest yielding entries, over a four year period from 2008 through 2011, were Mountaineer 2.0, a check entry from Croplan Genetics, and 54V09 entered by Pioneer HiBred International with an average yield of 10.02 and 9.92 ton/acre, respectively. The lowest yielding entry over a four year period was NM Common, a check entry, with an average of 7.77 ton/acre. The average yield over a four year period of all entries was 9.03 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. 2011.

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 8, July 14, August 17 and October 13, 2011
Fertilization:	Pre-plant Fertilizer applied on March 1, 2011 at 350 lb of 5-25-30-10 zinc sulfate e.g. N 18 lb/acre, P_2O_5 88 lb/acre, K_2O 105 lb/acre and zinc sulfate 35 lb/acre
Herbicide:	None
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Solid set pipe, watered as needed; generally 4 to 5 hours 3 times per week; 43.2 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 1, 2011 at the rate of N 18 lb/acre, P_2O_5 88 lb/acre, K_2O 105 lb/acre and zinc sulfate 35 lb/acre. During the 2011 growing season, there were four cutting dates; June 8, July 14, August 17, and October 13, 2011. 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 2011 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. 2011 was the fourth year to obtain harvest data from this trial as it was planted in August of 2007.

2011 mean seasonal total yield for this trial was 9.13 ton/acre (Table 24). The highest yielding entry of 10.32 ton/acre was PGI1459, an entry from Producer's Choice Seed. The lowest yielding entry of 7.81 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 13 top yielding entries within this trial.

The second cut yielded the highest with a mean of 2.45 ton/acre, while the fourth cutting was the lowest yielding cut with a mean of 1.78 ton/acre (Table 24).

The highest yielding entries, over a four year period from 2008 through 2011, were Mountaineer 2.0, a check entry from Croplan Genetics, and 54V09 entered by Pioneer HiBred International with an average yield of 10.02 and 9.92 ton/acre, respectively. The lowest yielding entry over a four year period was NM Common, a check entry, with an average of 7.77 ton/acre. The average yield over a four year period of all entries was 9.03 ton/acre (Table 25).

Table 24. Forage yield of the 2007-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2011.

		Yield dry ton/acre				
Variety	**Company**	**Cut-1**	**Cut-2**	**Cut-3**	**Cut-4**	**Total**
PGI459	Producer's Choice Seed	2.74	3.19	2.53	1.87	10.32
NM0307	NMSU	2.92	2.75	2.30	2.07	10.05
Grandstand	W.F.S.	2.87	2.77	2.38	2.02	10.04
Medalist	Intermountain Farmers Association	3.04	2.87	2.18	1.73	9.81
Legend	Arkansas Valley Seed Co. (Check)	2.64	2.99	2.33	1.81	9.76
CW 95026	Producer's Choice Seed	2.80	2.85	2.35	1.76	9.76
A-5225	Cal/West Seeds	2.59	2.83	2.36	1.76	9.54
Masterpiece	JR Simplot Co	2.34	2.71	2.47	2.00	9.53
African Common	Public (Check)	2.44	2.57	2.43	1.92	9.36
Integra 8400	Wilbur-Ellis Co	2.54	2.66	2.28	1.82	9.30
Mountaineer 2.0	Croplan Genetics (Check)	2.29	2.86	2.21	1.89	9.25
54V09	Pioneer HiBred Int'l	2.53	2.73	2.22	1.74	9.23
FSG 528SF	Allied Seed, LLC	2.17	2.65	2.38	1.90	9.09
Wilson	Public (Check)	2.30	2.45	2.34	1.88	8.97
Archer II	America's Alfalfa (Check)	2.47	2.64	2.16	1.53	8.80
Ranger	Public (Check)	2.50	2.63	1.95	1.72	8.79
Archer III	America's Alfalfa	2.37	2.67	2.10	1.63	8.77
AmeriStand 444NT	America's Alfalfa	2.28	2.62	2.07	1.76	8.73
AmeriStand 407TQ	America's Alfalfa	2.31	2.68	2.26	1.48	8.72
NM0313	NMSU	2.22	2.48	2.11	1.84	8.65
Dona Ana	Public (Check)	2.26	2.48	2.13	1.60	8.47
WL343HQ	W-L Research	2.22	2.56	1.88	1.53	8.19
NM0306	NMSU	1.90	2.35	2.06	1.74	8.06
NM Common	Public (Check)	1.93	2.09	1.94	1.85	7.81
Mean		**2.45**	**2.67**	**2.23**	**1.78**	**9.13**
LSD (0.05)		0.66	0.48	0.35	0.36	1.37
CV (%)		19.1	12.8	11.3	14.3	10.6
P Value		0.0859	0.0588	0.0237	0.1113	0.0270
Significance		ns	ns	*	ns	*

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

Table 25. Four Year Forage yield of the 2007-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2008-2011.

		Yield dry ton/acre				
Variety	**Company**	**2008**	**2009**	**2010**	**2011**	**4 year**
Mountaineer 2.0	Croplan Genetics (Check) #1 in 04	9.12	10.41	11.29	9.25	10.02
54V09	Pioneer HiBred Int'l	9.12	10.42	10.91	9.23	9.92
Masterpiece	JR Simplot Co	8.32	10.40	11.03	9.53	9.82
PGI459	Producer's Choice Seed	7.70	9.60	10.84	10.32	9.61
FSG 528SF	Allied Seed, LLC	7.73	10.56	10.71	9.09	9.53
CW 95026	Producer's Choice Seed	7.88	9.90	10.50	9.76	9.51
Grandstand	W.F.S.	7.45	9.12	10.58	10.04	9.30
Wilson	Public (Check)	8.51	9.24	10.40	8.97	9.28
A-5225	Cal/West Seeds	7.09	9.65	10.66	9.54	9.24
African Common	Public (Check)	7.80	9.43	9.34	9.36	8.99
NM0306	NMSU	7.68	9.78	10.38	8.06	8.98
Ranger	Public (Check)	7.50	9.41	10.14	8.79	8.96
AmeriStand 407TQ	America's Alfalfa	8.02	9.19	9.89	8.72	8.95
Integra 8400	Wilbur-Ellis Co	6.78	8.97	10.49	9.30	8.88
NM0307	NMSU	6.29	9.40	9.68	10.05	8.86
Medalist	Intermountain Farmers Association	6.49	9.02	10.00	9.81	8.83
Dona Ana	Public (Check)	6.98	9.53	10.27	8.47	8.81
Legend	Arkansas Valley Seed Co. (Check)	5.45	9.14	10.86	9.76	8.80
AmeriStand 444NT	America's Alfalfa	6.53	9.36	10.47	8.73	8.77
Archer II	America's Alfalfa (Check)	6.52	9.58	9.50	8.80	8.60
NM0313	NMSU	7.35	8.71	9.04	8.65	8.44
Archer III	America's Alfalfa	5.65	8.83	10.32	8.77	8.39
WL343HQ	W-L Research	7.39	8.44	9.47	8.19	8.37
NM Common	Public (Check)	6.26	8.19	8.82	7.81	7.77
Mean		**7.32**	**9.43**	**10.2**	**9.1**	**9.03**
LSD (0.05)		2.3	0.2	1.15	1.37	1.02
CV (%)		21.8	6.9	8.0	10.6	8.07
P Value		0.1186	<0.0001	0.0019	0.0270	0.0072
Significance		ns	***	**	*	**

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

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 26) from public varieties and private seed companies. Mean seasonal total yield for this trial in 2011 was 9.06 ton/acre (Table 27). The highest yielding entry of 10.12 ton/acre was Lahontan, a public check entry. The lowest yielding entry of 8.53 ton/acre was SW6330 from S&W Seeds. Lahontan, the highest yielding entry, was significantly higher in seasonal total yield over the other entries at the 95% probability level. There were no significant differences in the second highest yielding entry Mountaineer 2.0 and the next 16 highest yielding entries. The first cut yielded the highest with a mean of 2.79 ton/acre, while the fourth cutting was the lowest yielding with a mean of 1.73 ton/acre (Table 27).

The highest yielding entries over a two year period from 2010 through 2011 were Lahontan a check entry, and Mountaineer 2.0, also a check entry from Croplan Genetics with an average yield of 10.12 and 9.75 ton/acre, respectively. The lowest yielding entry over a two year period was SW6330, from S&W Seed, with an average of 8.53 ton/acre. The average yield over a two year period of all entries was 9.0 ton/acre (Table 28).

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 26) 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 26. Procedures for the 2009-Planted Alfalfa Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

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 7, July 13, August 18 and October 11, 2011
Fertilization:	Pre-plant Fertilizer applied on March 1, 2011 at 350 lb of 5-25-30-10 zinc sulfate e.g. N 18 lb/acre, P_2O_5 88 lb/acre, K_2O 105 lb/acre and zinc sulfate 35 lb/acre
Herbicide:	Raptor applied at 0.4 pints/acre on April 5, 2011
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Solid set pipe, watered as needed; generally 2 hours 3 times per week; 73.0 inches applied including precipitation
Results and Discussion:	Yield and other characteristics are presented in Table 27

Dry fertilizer was applied pre-plant on March 1, 2011 at the rate of N 18 lb/acre, P_2O_5 88 lb/acre, K_2O 105 lb/acre and zinc sulfate 35 lb/acre.

The plot area was chemically treated with the herbicide Raptor at a rate of 0.4 pints per acre on April 5, 2011 using a tractor mounted spray rig.

During the 2011 growing season, there were four cutting dates; June 7, July 13, August 18, and October 11, 2011. 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 2011 growing season of the 2009-Planted Alfalfa Variety Trial are presented in Table 27. Yield for each cut, along with the seasonal total yield, are shown for each entry as dry ton/acre. 2011 was the second year to obtain harvest data from this trial as it was planted in August of 2009.

Mean seasonal total yield for this trial in 2011 was 9.06 ton/acre (Table 27). The highest yielding entry of 10.12 ton/acre was Lahontan, a public check entry. The lowest yielding entry of 8.53 ton/acre was SW6330 from S&W Seeds. Lahontan, the highest yielding entry, was significantly higher in seasonal total yield over the other entries at the 95% probability level. There were no significant differences in the second highest yielding entry Mountaineer 2.0 and the next 16 highest yielding entries. The first cut yielded the highest with a mean of 2.79 ton/acre, while the fourth cutting was the lowest yielding with a mean of 1.73 ton/acre (Table 27).

The highest yielding entries over a two year period from 2010 through 2011 were Lahontan a check entry, and Mountaineer 2.0, also a check entry from Croplan Genetics with an average yield of 10.12 and 9.75 ton/acre respectively. The lowest yielding entry over a two year period was SW6330, from S&W Seed, with an average of 8.53 ton/acre. The average yield over a two year period of all entries was 9.0 ton/acre (Table 28).

Table 27. Forage yield of the 2009-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2011.

		Yield dry ton/acre				
Variety	**Company**	**Cut-1**	**Cut-2**	**Cut-3**	**Cut-4**	**Total**
Lahontan	Check	3.29	2.69	2.28	1.86	10.12
Mountaineer 2.0	Croplan Genetics	2.86	2.56	2.34	1.99	9.75
SW435	S&W Seed	3.08	2.46	2.22	1.86	9.62
4S417	Mycogen Seed	2.99	2.31	2.31	1.82	9.42
AmeriStand 201+Z	America's Alfalfa	3.04	2.38	2.21	1.78	9.41
HybriForce 2400	Dairyland Seed	3.01	2.43	2.18	1.78	9.40
HybriForce 2420/wet	Dairyland Seed	3.04	2.41	2.22	1.65	9.32
63Q105	Syngenta Seeds	3.00	2.59	2.03	1.67	9.29
NM Common	Roswell Seed	2.56	2.68	2.13	1.69	9.06
Dona Ana	Roswell Seed	2.66	2.49	2.12	1.69	8.96
Dura 843	Croplan Genetics	2.64	2.40	2.10	1.83	8.96
LegenDairy 5.0	Croplan Genetics	3.01	2.59	1.85	1.50	8.95
Maxi-Graze GT	Croplan Genetics	3.01	2.35	2.01	1.58	8.95
Ranger	Check	2.90	2.29	2.09	1.66	8.94
Velvet	Producers Choice Seeds	2.95	2.28	2.16	1.52	8.91
African Common	Roswell Seed	2.56	2.50	2.19	1.64	8.90
Malone	Roswell Seed	2.49	2.57	2.10	1.74	8.90
WL440HQ	W-L Research	2.66	2.42	2.07	1.75	8.89
Rugged	Producers Choice Seeds	2.84	2.33	2.05	1.57	8.79
6422Q	Syngenta Seeds	2.98	2.50	1.72	1.56	8.76
WL363HQ	W-L Research	2.67	2.43	1.93	1.57	8.60
Wilson	Roswell Seed	2.51	2.24	2.10	1.69	8.54
Artesian Sunrise	Croplan Genetics	2.11	2.15	2.31	1.97	8.54

		Yield dry ton/acre				
Variety	**Company**	**Cut-1**	**Cut-2**	**Cut-3**	**Cut-4**	**Total**
SW6330	S&W Seed	2.17	2.11	2.18	2.06	8.53
Mean		**2.79**	**2.42**	**2.12**	**1.73**	**9.06**
LSD (0.05)		0.41	0.34	0.29	0.27	0.87
CV (%)		10.38	9.95	9.74	11.20	6.83
P Value		<0.0001	0.0799	0.0152	0.0020	0.0469
Significance		***	ns	*	**	*

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

Table 28. Two Year Forage yield of the 2009-planted Alfalfa Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2010-2011.

		Yield dry ton/acre		
Variety	**Company**	**2010**	**2011**	**2 Year Ave.**
Lahontan	Check	9.57	10.12	9.85
Mountaineer 2.0	Croplan Genetics	9.41	9.75	9.58
4S417	Mycogen Seed	9.27	9.42	9.35
HybriForce 2400	Dairyland Seed	9.25	9.40	9.33
SW435	S&W Seed	8.96	9.62	9.29
Dura 843	Croplan Genetics	9.39	8.96	9.18
HybriForce 2420/wet	Dairyland Seed	8.86	9.32	9.09
African Common	Roswell Seed	9.17	8.90	9.03
NM Common	Roswell Seed	8.97	9.06	9.01
Dona Ana	Roswell Seed	9.00	8.96	8.98
63Q105	Syngenta Seeds	8.63	9.29	8.96
AmeriStand 201+Z	America's Alfalfa	8.51	9.41	8.96
LegenDairy 5.0	Croplan Genetics	8.95	8.95	8.95
WL440HQ	W-L Research	8.92	8.89	8.91
Artesian Sunrise	Croplan Genetics	9.21	8.54	8.87
Velvet	Producers Choice Seeds	8.80	8.91	8.85
WL363HQ	W-L Research	9.08	8.60	8.84
Ranger	Check	8.72	8.94	8.83
Malone	Roswell Seed	8.75	8.90	8.82
SW6330	S&W Seed	9.04	8.53	8.78
Rugged	Producers Choice Seeds	8.57	8.79	8.68
Wilson	Roswell Seed	8.75	8.54	8.65
Maxi-Graze GT	Croplan Genetics	8.26	8.95	8.61
6422Q	Syngenta Seeds	8.38	8.76	8.57
Mean		**8.93**	**9.06**	**9.00**
LSD (0.05)		0.78	0.87	0.65
CV (%)		6.24	6.83	5.16
P Value		0.1390	0.0469	0.0403
Significance		ns	*	*

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

Canola – 2011 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 44 entries of canola from public and private sources. The trial was planted September 7, 2010 and harvested July 21, 2011 (Table 29). Mean yield of this trial was 2,517.0 lb/acre. The highest yielding entry, at 3,437.4 lb/acre was Safran. The lowest yielding entry at 1,436.6 lb/acre was AAMU6207. There were no significant differences in yield between the top yielding variety and the next seventeen varieties. The moisture content averaged 6.7 % for the 44 entries. The average test weight was 47.0 lb/bu. The average plant height was 42.9 inches (Table 30). MH06E11 had the tallest height of 48.0 inches. The shortest entry was DKW41-10 at 37.0 inches (Table 30). The mean 50 % flowering date was May 4.

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 7, 2010 (Table 29). The trial consisted of 44 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 29. Procedures for the Winter Canola Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010-2011.

Operation	Procedure
Number of Entries:	Forty-four
Planting Date:	September 7, 2010
Planting Rate:	5 lb/acre
Plot Design:	Randomized block with three replications
Plot Size:	Six 10-in rows, 20 ft long
Harvest Date:	July 21, 2011
Fertilization:	N 165 lb/acre, P_2O_5 0 lb/acre, K_2O 0 lb/acre
Herbicide:	None, hand weeded
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from September 6 through October 12, 2010; and April 7 through July 9, 2011. 27.7 inches irrigation water applied and 5.6 inches of precipitation for a total of 33.3 inches total water
Results and Discussion:	Yield and other characteristics are presented in Table 30.

No dry fertilizer was applied prior to planting and land preparation. During the growing season, 165 lb/acre of liquid nitrogen fertilizer was applied through the irrigation water.

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 6 through October 12, 2010; and April 7 through July 9, 2011. Twenty-seven and seven tenths of inches irrigation water was applied and 5.6 inches of precipitation fell from September 2010 through June 2011 for a total of 33.3 inches total water.

Plots were harvested on July 21, 2011 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 30. Yields of all entries were adjusted to a uniform 10% moisture content.

Mean yield of this trial was 2,517.0 lb/acre (Table 30). The highest yielding entry, at 3437.4 lb/acre, was Safran. The lowest yielding entry at 1,436.6 lb/acre, was AAMU6207. There were no significant differences in yield between the top yielding variety and the next seventeen varieties. The moisture content averaged 6.7 % for the 44 entries. The average test weight was 47.0 lb/bu. The average plant height was 42.9 inches (Table 30). MH06E11 had the tallest height of 48.0 inches. The shortest entry was DKW41-10 at 37.0 inches (Table 30). The mean 50 % flowering date was May 4.

There were seven common varieties for the Winter Canola Hybrid and Variety Trials 2008 through 2011. Table 31 shows their comparison in pounds per acre by year and the four year mean for each variety.

Table 30. Yield and other characteristics for the Winter Canola Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2010-2011.

Variety or Selection	Yield (lb/acre)	Moisture Content (%)	Test Weight (lb/bu)	Plant Height (in)	50 % Flower (date)	Fall Plant Stand (%)	Winter Kill (%)
Safran	3437.4	6.2	48.7	43.3	3-May	77.3	0.0
Flash	3382.0	6.6	47.2	47.0	4-May	92.0	0.0
Sitro	3106.9	6.2	44.8	46.3	28-Apr	83.3	0.0
MH06E11	3050.7	6.0	45.5	48.0	5-May	82.7	0.0
Hornet	3046.8	6.1	48.4	44.7	29-Apr	64.7	0.0
VSX-3	2974.2	7.0	47.7	42.7	5-May	78.7	0.0
Dynastie	2908.2	6.0	48.2	43.0	3-May	76.3	0.0
HYBRISTAR	2866.3	6.8	47.4	43.7	6-May	81.0	0.0
HPX-7341	2846.0	5.9	48.1	43.0	29-Apr	83.0	0.0
Visby	2839.0	6.1	46.5	43.0	25-Apr	86.3	0.0
Baldur	2783.4	6.9	48.0	42.3	6-May	86.3	0.0
Kiowa	2762.9	8.1	47.4	45.0	5-May	89.0	0.0
HYBRISURF	2750.6	7.0	47.6	42.0	6-May	91.7	0.0
MH06E10	2744.4	6.4	47.1	37.3	5-May	91.7	0.0
Rossini	2741.9	6.6	47.2	44.7	25-Apr	66.3	0.0
KS4083	2733.3	5.9	48.0	46.3	9-May	81.0	0.0
KADORE	2688.2	6.3	48.1	39.7	6-May	78.0	0.0
Virginia	2685.3	7.0	47.8	43.0	3-May	82.3	0.0
Chrome	2669.0	6.6	47.1	44.0	5-May	80.0	0.0
HPX-7228	2650.1	6.6	47.5	44.3	30-Apr	78.3	0.0
KS4428	2612.4	6.7	47.6	43.0	4-May	85.7	0.0
Durola	2572.9	5.9	47.5	44.0	2-May	85.0	0.0
HPX-501	2566.1	6.2	47.3	45.3	9-May	91.0	0.0
Dimension	2432.7	7.8	47.2	43.3	5-May	82.7	0.0
Wichita	2430.5	5.8	45.4	42.7	9-May	82.0	0.0
DKW47-15	2418.5	6.9	45.3	42.7	5-May	72.3	0.0
Athena	2406.0	6.2	47.7	42.7	9-May	79.3	0.0
HYBRILUX	2397.0	7.1	47.6	43.3	10-May	72.3	0.0
HyCLASS125W	2323.6	6.9	47.8	43.0	30-Apr	77.7	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 (%)
Amanda	2304.0	6.5	48.0	43.0	4-May	84.7	0.0
Riley	2281.2	6.1	47.6	43.0	4-May	88.3	0.0
KS4426	2271.0	7.2	47.6	40.0	6-May	72.3	0.0
DKW44-10	2265.1	6.2	46.9	41.7	8-May	86.0	0.0
HyCLASS154W	2238.0	7.3	48.3	43.0	4-May	72.7	0.0
HyCLASS110W	2236.2	6.7	47.3	40.7	11-May	82.3	0.0
MH06E4	2228.5	7.5	47.2	43.0	4-May	64.3	0.0
DKW46-15	2139.8	6.0	43.2	41.3	7-May	76.7	0.0
Sumner	2131.4	5.6	46.0	43.0	27-Apr	67.3	0.0
AAMU607	2116.1	6.9	47.0	42.7	23-Apr	86.3	0.0
AAMU3307	1876.1	7.9	43.8	41.3	1-May	78.7	0.0
AAMU6407	1830.0	7.9	44.2	41.7	3-May	85.0	0.0
DKW41-10	1796.1	7.3	46.9	37.0	8-May	87.0	0.0
HyCLASS115W	1771.1	7.0	47.2	41.7	6-May	65.7	0.0
AAMU6207	1436.6	7.1	44.2	41.0	4-May	77.0	0.0
Mean	**2517.0**	**6.7**	**47.0**	**42.9**	**4-May**	**80.3**	**0.0**
LSD .05	770.0	1.4	3.4	4.3		17.7	
CV %	18.9	13.1	4.5	6.2		13.6	
P	0.0003	0.0522	0.2813	0.0066		0.1018	
significant	***	ns	ns	**		ns	

Yields adjusted to 10 % moisture

Table 31. Four Year Grain yield of Winter Canola Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2008-2011.

	2008	2009	2010	2011	4 year
Variety			lbs./acre		
Sitro	4561.4	5166.0	4458.5	3106.9	**4323.2**
Flash	4615.1	5716.7	3190.6	3382.0	**4226.1**
Virginia	4363.2	4381.6	3407.8	2685.3	**3709.5**
Visby	3835.2	4362.8	3439.2	2839.0	**3619.1**
Baldur	3922.5	4725.6	2492.7	2783.4	**3481.1**
Wichita	3639.6	4726.1	2541.4	2430.5	**3334.4**
Sumner	2348.3	2681.2	2469.3	2131.4	**2407.6**
Mean	**3897.9**	**4537.1**	**3142.8**	**2765.5**	**3585.9**

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. Seven hybrids of early season corn were planted in a randomized block design with three replications on the Agriculture Science Center at Farmington on May 11, 2011 and harvested November 28, 2011. (Table 32) Mean yield of this trial was 199.3 bu/acre. The highest yielding entry, at 246.2 bu/acre, was the hybrid TRX 95502 S from Triumph Seed Company Inc. There was no significant difference in yield between entries at the 95% probability level. The lowest yielding hybrid, at 151.3 bu/acre was N37D-3000GT from NK Seeds. The test weights averaged 57.8 lb/bu (Table 33).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

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

Seven hybrids of early season corn were planted in a randomized block design with three replications on the Agriculture Science Center at Farmington on May 11, 2011 (Table 32). 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 32. Procedures for the Early Season Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operation	Procedure
Number of Entries:	Seven
Planting Date:	May 11, 2011
Planting Rate:	35,000 seeds per acre (46 seeds per 20 ft row)
Plot Design:	Randomized block with three replications
Plot Size:	Four 34-in rows by 20 ft long
Harvest Date:	November 28, 2011
Fertilization:	N 225 lb/acre, P_2O_5 75 lb/acre, K_2O 90 lb/acre, 30 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Guardsman Max and 3 oz Clarity applied on May 17, 2011; 1 qt/acre Prowl H_2O and 5 oz/acre Status applied on June 15, 2011
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 12 through September 22, 2011; Irrigation water applied: 38.1 inches Total water received including precipitation: 42.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 33.

Dry fertilizer was applied prior to planting on March 1, 2011 at the rate of N 15 lb/acre, P_2O_5 75 lb/acre, K_2O 90 lb/acre and zinc sulfate 30 lb/acre. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 210 lb/acre. Total nitrogen received was 225 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.5 qt/acre) and 3 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 6 days after planting on May 17, 2011. 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 15, 2011. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 12 through September 22, 2011. During the growing season, 42.6 inches of irrigation water and precipitation was received.

The plots were harvested November 28, 2011 using a small John Deere 4420 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 three replications.

The previous crop grown on this plot was wheat that was harvested in July, 2009.

Results and discussion

Yield results and other data collected from this trial are presented in Table 33. 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 33) was 199.3 bu/acre. The highest yielding entry, at 246.2 bu/acre, was the hybrid TRX 95502 S from Triumph Seed Company Inc. There was no significant difference in yield between entries at the 95% probability level. The lowest yielding hybrid, at 151.3 bu/acre was N37D-3000GT from NK Seeds. The test weights averaged 57.8 lb/bu (**Error! Reference source not found.**).

Stand counts at the end of the growing season averaged 29,686 plants/acre (Table 33). The plant heights averaged 101.5 inches (8.5 feet) and ranged from 93.8 to 106.5 inches. The moisture content of the grain at harvest averaged 15.4 % and ranged from 13.9 % to 16.9 % (Table 33).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

Table 33. Grain yield and other attributes of the Early Season Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2011.

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)
TRX 95502 S	Triumph	246.2	57.6	16.0	104.3	51.0	81	0	29,411	105
3212 X	Triumph	221.7	58.6	16.0	107.3	45.0	79	0	28,738	102
N38U-3000GT	NK Seeds	212.3	56.8	15.1	93.8	38.3	76	0	35,563	97
7830 R	Triumph	208.4	58.6	16.9	99.8	43.5	81	0	29,988	107
9934 S	Triumph	178.5	57.7	15.1	106.5	44.3	81	0	26,432	99

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)
N36K-3000GT	NK Seeds	177.0	57.4	13.9	96.8	37.5	76	0	29,507	96
N37D-3000GT	NK Seeds	151.3	58.4	14.8	102.0	36.8	79	0	28,162	97
Mean		**199.3**	**57.8**	**15.4**	**101.5**	**42.3**	**79**	**0**	**29,686**	**100.4**
LSD (0.05)		68.1	0.8	0.7	5.6	6.3	2		3,638	
CV (%)		23.0	0.9	3.2	3.7	10.0	2		8	
P Value		0.1250	0.0006	<0.0001	0.0006	0.0016	0.0001		0.0024	
significant		ns	***	***	***	**	***		**	

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. Four hybrids of full season corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 11, 2011 and harvested November 28, 2011 (Table 34). Mean yield of this trial was 241.0 bu/acre. The highest yielding entry at 258.1 bu/acre was hybrid Dekalb DKC 66-96 from Monsanto. There were no significant differences in yield at the 95% probability level between the four entries. The lowest yielding hybrid at 229.2 bu/acre was PO751HR from Pioneer Hi-Bred International. The test weights averaged 56.1 lb/bu and ranged from a low of 54.2 lb/bu to a high of 57.3 lb/bu (Table 35). Plant populations at the end of the growing season averaged 32,463 plant/acre. The plant heights averaged 102.8 inches (8.6 feet) and ranged from 100.5 to 105.8 inches. The moisture content of the grain at harvest averaged 18.1 % and ranged from 16.1 % to 21.7 % (Table 35).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

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

Four hybrids of full season corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 11, 2011 (Table 34). 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 34. Procedures for the Full Season Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operation	Procedure
Number of Entries:	Four
Planting Date:	May 11, 2011
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:	November 28, 2011
Fertilization:	N 225 lb/acre, P_2O_5 75 lb/acre, K_2O 90 lb/acre, 30 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Guardsman Max & 3 oz Clarity applied on May 17, 2011; 1 qt/acre Prowl H_2O & 5 oz/acre Status applied on June 15, 2011
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 12 through September 22, 2011; Irrigation water applied: 38.1 inches Total water received including precipitation: 42.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 35.

Dry fertilizer was applied prior to planting on March 1, 2011 at the rate of N 15 lb/acre, P2O5 75 lb/acre, K2O 90 lb/acre and zinc sulfate 30 lb/acre. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 210 lb/acre. Total nitrogen received was 225 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.5 qt/acre) and 3 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 6 days after planting on May 17, 2011. 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 H2O (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 H2O is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 15, 2011. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 12 through September 22, 2011. During the growing season, 42.6 inches of irrigation water and precipitation was received.

The plots were harvested November 28, 2011 using a small John Deere 4420 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 three replications.

The previous crop grown on this plot was wheat that was harvested in July, 2009.

Results and discussion

Yield results and other data collected from this trial are presented in Table 35. Yields of all hybrids were adjusted to a uniform 15.5% moisture content and a 56.1 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 241.0 bu/acre. The highest yielding entry at 258.1 bu/acre was hybrid Dekalb DKC 66-96 from Monsanto. There were no significant differences in yield at the 95% probability level between the four entries. The lowest yielding hybrid at 229.2 bu/acre was PO751HR from Pioneer Hi-Bred International. The test weights, averaged 56.1 lb/bu and ranged from a low of 54.2 lb/bu to a high of 57.3 lb/bu (Table 35). Plant populations at the end of the growing season averaged 32,463 plant/acre. The plant heights averaged 102.8 inches (8.6 feet) and ranged from 100.5 to 105.8 inches. The moisture content of the grain at harvest averaged 18.1 % and ranged from 16.1 % to 21.7 % (Table 35).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

Table 35. Grain yield and other attributes of the Full Season Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2011.

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)
DKC 66-96	Monsanto	258.1	54.2	21.7	105.8	45.8	85.0	0	36,235	116
DKC 64-69	Monsanto	245.2	57.3	18.1	102.8	45.0	84.5		32,006	114
TRX17872S	Triumph	231.3	57.1	16.1	102.0	47.3	83.8	0	31,045	108
PO751HR	Pioneer	229.2	56.1	16.6	100.5	41.3	84.3	0	30,565	107
Mean		**241.0**	**56.1**	**18.1**	**102.8**	**44.8**	**84.4**	**0**	**32,463**	**111.3**
LSD (0.05)		34.5	1.6	2.2	5.3	7.1	1.9		2,890	
CV (%)		8.9	1.8	7.7	3.2	9.9	1.4		6	
P Value		0.2672	0.0080	0.0013	0.2221	0.3333	0.5565		0.0061	
significant		ns	**	**	ns	ns	ns		**	

Corn – USTN Corn Hybrid and Variety Trial

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

Abstract

The US Testing Network (USTN) Corn Trial is a program that tests corn from private and public sources in co-operation with Sarah Carlson of Practical Farmers of Iowa http://practicalfarmers.org. The emphasis of this trial is testing non-GMO corn hybrids for grain yield. Farmers are required to grow non-GMO hybrids to qualify as being organically grown. Most seed companies are moving toward producing a majority of GMO plant material leaving less available seed stock to the organic grower. This trial is conducted at multiple sites in the country (mostly in the mid-west). Fifty hybrids of corn were proposed to be planted in a randomized block design with two replications on the Agriculture Science Center at Farmington on May 11, 2011 (Table 36). Nine of the proposed entries scheduled to be planted did not arrive so a substitution of one commercially available hybrid was entered in place of the missing nine entries. This was done to keep the pre-determined randomization of the test plot intact. That hybrid will remain unnamed for privacy reasons. Mean yield of this trial was 209.1.0 bu/acre. The highest yielding entry at 275.2 bu/acre was hybrid Proprietary 3 from a private seed company. There were no significant differences in yield at the 95% probability level between the top yielding entry and the next 21 entries. The lowest yielding hybrid at 146.1 bu/acre was GG923 from OSU. The test weights, averaged 57.7 lb/bu and ranged from a low of 54.3 lb/bu to a high of 60.7 lb/bu (Table 37). Plant populations at the end of the growing season averaged 28,050 plant/acre. The plant heights averaged 103.1 inches (8.6 feet) and ranged from 94.5 to 115.5 inches. The moisture content of the grain at harvest averaged 15.9 % and ranged from 14.4 % to 18.6 % (Table 37).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

Introduction

The US Testing Network (USTN) Corn Trial is a program that tests corn from private and public sources in co-operation with Sarah Carlson of Practical Farmers of Iowa http://practicalfarmers.org . The emphasis of this trial is testing non-GMO corn hybrids for grain yield. Farmers are required to grow non-GMO hybrids to qualify as being organically grown. Most seed companies are moving toward producing a majority of GMO plant material leaving less available seed stock to the organic grower. This trial is conducted at multiple sites in the country (mostly in the mid-west).

Objectives

- Test non-GMO corn varieties and hybrids for grain yield and yield components.

- Relate non-GMO corn productivity at the Agricultural Science Center at Farmington with productivity at other sites within the country.

Materials and methods

Fifty hybrids of corn were proposed to be planted in a randomized block design with two replications on the Agriculture Science Center at Farmington on May 11, 2011 (Table 36). Nine of the proposed entries scheduled to be planted did not arrive so a substitution of one commercially available hybrid was entered in place of the missing nine entries. This was done to keep the pre-determined randomization of the test plot intact. That hybrid will remain unnamed for privacy reasons. Plots were planted using cone seeders that fit on John Deere 71 flex planters. Individual plots were two 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 36. Procedures for the USTN Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operation	Procedure
Number of Entries:	Fifty
Planting Date:	May 11, 2011
Planting Rate:	35,000 seeds per acre (46 seeds per 20 ft row)
Plot Design:	Randomized block with two replications
Plot Size:	Two 34-in rows by 20 ft long
Harvest Date:	November 29, 2011
Fertilization:	N 225 lb/acre, P_2O_5 75 lb/acre, K_2O 90 lb/acre, 30 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Guardsman Max & 3 oz Clarity applied on May 17, 2011; 1 qt/acre Prowl H_2O & 5 oz/acre Status applied on June 15, 2011
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 12 through September 22, 2011; Irrigation water applied: 38.1 inches Total water received including precipitation: 42.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 37.

Dry fertilizer was applied prior to planting on March 1, 2011 at the rate of N 15 lb/acre, P2O5 75 lb/acre, K2O 90 lb/acre and zinc sulfate 30 lb/acre. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 210 lb/acre. Total nitrogen received was 225 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.5 qt/acre) and 3 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 6 days after planting on May 17, 2011. 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 H2O (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 H2O is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 15, 2011. Irrigation water was applied immediately after the herbicide application

This trial was grown under a center pivot irrigation system and was watered from May 12 through September 22, 2011. During the growing season, 42.6 inches of irrigation water and precipitation was received.

The plots were harvested November 29, 2011 using a small John Deere 4420 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 two replications.

The previous crop grown on this plot was wheat that was harvested in July, 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 was 209.1.0 bu/acre. The highest yielding entry at 275.2 bu/acre was hybrid Proprietary 3 from a private seed company. There were no significant differences in yield at the 95% probability level between the top yielding entry and the next 21 entries. The lowest yielding hybrid at 146.1 bu/acre was GG923 from OSU. The test weights, averaged 57.7 lb/bu and ranged from a low of 54.3 lb/bu to a high of 60.7 lb/bu (Table 37). Plant populations at the end of the growing season averaged 28,050 plant/acre. The plant heights averaged 103.1 inches (8.6 feet) and ranged from 94.5 to 115.5 inches. The moisture content of the grain at harvest averaged 15.9 % and ranged from 14.4 % to 18.6 % (Table 37).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

Table 37. Grain yield and other attributes of the USTN Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2011.

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)
Proprietary 3	Private	275.2	56.1	15.7	100.5	36.0	85	0	30,949	107
Proprietary 9	Private	261.4	56.1	15.3	102.0	43.5	85	0	31,526	107
Proprietary 4	Private	253.9	56.7	16.0	102.0	40.5	85	0	30,757	107
Proprietary 2	Private	253.7	55.9	15.0	100.5	39.0	86	0	29,796	107
Proprietary 5	Private	246.3	56.3	16.3	100.5	42.0	86	0	29,796	107
unnamed 5	GPS	245.3	59.3	16.0	106.5	46.5	84	0	32,487	107
Proprietary 6	Private	241.7	56.5	15.3	97.5	39.0	86	0	28,450	107
528J	MC	240.8	58.9	15.2	115.5	45.0	84	0	31,333	107
40-07N	AL	237.0	59.8	15.5	100.5	42.0	86	0	30,180	107
Proprietary 8	Private	236.3	56.2	15.1	100.5	40.5	86	0	28,258	107
SX610	eMerge	235.2	58.5	15.4	103.5	42.0	82	0	25,567	108
unnamed 9	GPS	232.5	60.4	15.0	108.0	45.0	85	0	28,450	107
unnamed 3	GPS	231.0	56.1	17.4	106.5	42.0	85	0	28,066	111
SX619	eMerge	229.2	57.0	16.4	103.5	45.0	84	0	27,297	109
575K	MC	228.1	57.2	14.8	105.0	48.0	85	0	25,374	105
SX588	eMerge	226.2	54.5	15.7	108.0	42.0	86	0	26,143	104
GQ931	OSU	225.6	59.7	15.4	114.0	51.0	85	0	29,411	103
Proprietary 1	Private	223.4	56.6	14.6	102.0	40.5	84	0	32,102	107
Dk933	OSU	222.3	55.6	17.4	99.0	36.0	86	0	29,027	109
unnamed 4	GPS	222.2	54.3	18.6	100.5	45.0	88	0	24,798	109
4817	Becks	221.0	56.6	15.2	103.5	45.0	82	0	31,526	104
533J	MC	220.2	58.7	17.0	114.0	46.5	85	0	24,990	108
unnamed 2	GPS	219.1	56.8	17.2	105.0	43.5	85	0	26,143	109
SX600	eMerge	218.7	59.9	15.4	103.5	45.0	84	0	28,450	107
SX522	eMerge	218.2	58.2	15.0	100.5	37.5	81	0	31,141	101
unnamed 7	GPS	217.0	57.5	16.7	100.5	40.5	84	0	29,411	113
unnamed 6	GPS	210.2	59.6	14.9	103.5	46.5	84	0	27,104	110
CB5357	cbseed	202.7	57.1	18.4	94.5	33.0	87	0	28,642	105
543J	MC	202.7	55.8	15.2	112.5	51.0	85	0	30,180	106
Proprietary 7	Private	201.7	56.0	16.3	102.0	43.5	86	0	29,796	107
40-09N	AL	200.7	60.0	15.1	100.5	42.0	85	0	29,219	109
60-01N	AL	200.2	57.8	15.4	100.5	37.5	82	0	24,221	101
50-04N	AL	200.1	57.1	15.2	108.0	46.5	85	0	25,374	104
unnamed 1	check	200.1	58.8	15.7	102.0	45.0	82	0	25,759	103
CB5404	cbseed	197.6	57.8	15.1	99.0	36.0	82	0	22,683	104
DK932	OSU	194.2	56.9	15.7	99.0	39.0	85	0	27,297	109
BHG926	OSU	190.6	57.2	15.9	103.5	42.0	83	0	28,258	105
CB5361	cbseed	190.6	57.8	15.0	105.0	45.0	85	0	28,450	102
577K	MC	188.1	57.0	16.0	100.5	42.0	86	0	28,450	107
BHG925	OSU	182.8	60.0	16.4	105.0	46.5	83	0	30,949	105
unnamed 8	GPS	179.4	59.5	15.3	97.5	37.5	82	0	26,336	104

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)
622E	MC	175.4	56.6	16.7	100.5	43.5	86	0	27,681	109
GQ930	OSU	168.1	60.5	17.1	105.0	49.5	82	0	26,336	103
931H	MC	166.5	56.0	15.0	102.0	42.0	86	0	22,299	105
526K	MC	164.8	57.8	15.3	106.5	43.5	82	0	27,104	104
unnamed 10	GPS	157.7	58.9	16.9	99.0	49.5	85	0	27,297	108
CB5968	cbseed	155.9	58.0	17.2	96.0	42.0	86	0	28,450	105
CB6981	cbseed	153.4	58.9	17.2	106.5	45.0	84	0	25,759	105
540K	MC	146.4	59.5	14.4	99.0	46.5	81	00	25,951	102
GG923	OSU	146.1	60.7	15.8	102.0	51.0	83	0	27,489	105
Mean		**209.1**	**57.7**	**15.9**	**103.1**	**43.1**	**84**	**0**	**28,050**	**106.2**
LSD (0.05)		55.2	1.7	1	7.4	6.8			5,440	
CV (%)		13.1	1.4	3	3.6	7.8			10	
P Value		0.0	<0.0001	<0.0001	0.0001	0.0001			0.6410	
significant		***	***	***	***	***			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. Six hybrids of forage corn were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on May 11, 2011 and harvested September 27, 2011 (Table 38). The highest yielding entry during the 2011 growing season was D 58VP30 from Dyna-Gro with a total yield of 12.8 dry ton/acre. The lowest yielding entry in the 2011 growing season was DKC 66-96 from Monsanto with a total yield of 10.8 dry ton/acre. The mean yield of all 6 entries in the 2011 growing season was 11.8 dry ton/acre (Table 39). The mean moisture content at harvest was 61.1% wet weight. The mean plant height was 106 inches. The mean days to 50% silk was 85 days. The mean plants/acre was 33,670 (Table 39). D 58VP30 from Dyna-Gro from Monsanto had the highest production of milk per acre with 36,890 lb milk/acre. The mean of all 6 entries of milk production per acre was 34,622 lb milk/acre (Table 40).

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 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 Forage Corn Hybrid and Variety Trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operation	Procedure
Number of Entries:	Six
Planting Date:	May 11, 2011
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:	September 27, 2011
Fertilization:	N 225 lb/acre, P_2O_5 75 lb/acre, K_2O 90 lb/acre, 30 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Guardsman Max and 3 oz Clarity applied on May 17, 2011; 1 qt/acre Prowl H_2O and 5 oz/acre Status applied on June 15, 2011
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 12 through September 22, 2011; Irrigation water applied: 38.1 inches Total water received including precipitation: 42.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 39.

Dry fertilizer was applied prior to planting on March 1, 2011 at the rate of N 15 lb/acre, P2O5 75 lb/acre, K2O 90 lb/acre and zinc sulfate 30 lb/acre. Nitrogen fertilizer was applied 9 times during the growing season through the irrigation water for a total of 210 lb/acre. Total nitrogen received was 225 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Guardsman Max (1.5 qt/acre) and 3 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 6 days after planting on May 17, 2011. 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 H2O (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 H2O is pendimethalin (0.95 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed on June 15, 2011. Irrigation water was applied immediately after the herbicide application.

This trial was grown under a center pivot irrigation system and was watered from May 12 through September 22, 2011. During the growing season, 42.6 inches of irrigation water and precipitation was received.

The previous crop grown on this plot was wheat that was harvested in July, 2009.

The plots were harvested for forage September 27, 2011 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.

Results and discussion

Yield results and other data collected in this trial are presented in Table 39. Chemical analysis data for forage quality is presented in Table 40.

The highest yielding entry during the 2011 growing season was D 58VP30 from Dyna-Gro with a total yield of 12.8 dry ton/acre. The lowest yielding entry in the 2011 growing season was DKC 66-96 from Monsanto with a total yield of 10.8 dry ton/acre. The mean yield of all 6 entries in the 2011 growing season was 11.8 dry ton/acre (Table 39). The mean moisture content at harvest was 61.1% wet weight. The mean plant height was 106 inches. The mean days to 50% silk was 85 days. The mean plants/acre was 33,670 (Table 39). D 58VP30 from Dyna-Gro from Monsanto had the highest production of milk per acre with 36,890 lb milk/acre. The mean of all 6 entries of milk production per acre was 34,622 lb milk/acre (Table 40).

The weed control from the Guardsman Max and Clarity along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season with the exception of sandbur which was present in scattered patches. The Status and Prowl H2O application could have been done earlier in the season to help prevent this. Very little hand weeding was done.

Table 39. Forage yield (dry and green) and other attributes of the Forage Corn Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2011.

Hybrid or Selection	Source	Forage Dry (ton/acre)	Forage Wet	Wet Weight (%)	Plant Pop. (plants/acre)	Plant Height (in)	Ear Height	Silk Date # days	Relative Maturity #days
D 58VP30	Dyna-Gro	12.8	32.2	60.0	34,633	109	52	85	118
DKC 64-24	Monsanto	12.4	31.5	60.4	31,939	98	44	83	114
CX 11615	Dyna-Gro	12.2	31.4	61.5	34,633	107	42	86	115
D 56VP69	Dyna-Gro	12.0	30.6	60.7	34,633	104	50	87	116
D 55Q80	Dyna-Gro	10.9	31.2	65.0	32,324	110	50	85	115
DKC 66-96	Monsanto	10.8	26.5	59.3	33,863	107	44	87	116
Mean		**11.8**	**30.6**	**61.1**	**33,670**	**106**	**47**	**85**	**115.7**
LSD (0.05)		2.1	4.1	4.4	6,992	5	4	1	
CV (%)		11.7	8.8	4.8	14	3	6	1	
P Value		0.2556	0.0994	0.1514	0.9149	0.0018	0.0006	<0.0001	
significant		ns	ns	ns	ns	**	***	***	

Table 40. 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. 2011.

Hybrid or Selection	Source	Forage Dry (ton/acre)	CP (%)	NDF (%)	NDFD 48hr (%)	Starch (%)	Ash (%)	Fat DM (%)	Milk/ ton (lb/ton)	Milk/ acre (lb/acre)
D 58VP30	Dyna-Gro	12.8	8.0	38.6	56.4	36.8	5.3	2.6	3,146	36,890
DKC 64-24	Monsanto	12.4	7.9	36.1	57.2	40.2	5.4	2.7	3,230	36,812
CX 11615	Dyna-Gro	12.2	8.5	38.8	56.3	37.0	5.5	2.6	3,116	35,313
D 56VP69	Dyna-Gro	12.0	7.5	37.3	54.2	39.6	5.9	2.6	3,080	33,717
D 55Q80	Dyna-Gro	10.9	7.5	36.9	58.0	41.2	5.3	2.6	3,224	35,023
DKC 66-96	Monsanto	10.8	8.4	39.5	55.6	37.0	5.5	2.7	3,090	29,980
Mean		**11.8**	**8.0**	**37.9**	**56.3**	**38.6**	**5.5**	**2.7**	**3,148**	**34,622**
LSD (0.05)		2.1	0.5	2.5	2.5	2.6	0.5	0.2	84.7	5,022
CV (%)		11.7	4.26	4.36	2.95	4.44	6.14	6.16	1.78	9.6
P Value		0.2556	.003	0.089	0.073	0.006	0.132	0.756	0.005	0.089
Significant		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. Thirty-eight entries were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on September 15, 2010 and harvested August 1 and 31, 2011 (Table 41). Mean yield of this trial was 50.33 bu/acre (Table 42). The highest yielding entry at 67.06 bu/acre was an Oklahoma State University selection OK07209. The top yielding entry was not significantly different in yield from the next sixteen highest yielding entries at the 95% probability level. The lowest yielding entry at 38.57 bu/acre was OK08328, an entry from Oklahoma State University. The tallest entry in this trial at 36.8 inches was Kharkof, a check variety. The shortest entries in height at 26.0 inches were TX03A0563-07AZHR247 from Texas A&M University and KS020638-5-1 from Kansas State University at Manhattan. The moisture content of all the entries ranged from 7.4 to 10.5% (Table 42). Bushel weights ranged from 45.9 to 54.4 lb/bu (Table 42).

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, 2010 (Table 41). The nursery consisted of 38 winter wheat entries from university breeding programs in Colorado, Kansas, Oklahoma, Texas and Nebraska. 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 41. Procedures for the Southern Regional Winter Wheat Performance Nursery; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operation	Procedure
Number of Entries:	Thirty-eight
Check Entries:	TAM-107, Scout 66, Kharkof, Fuller, Anton, Mace
Planting Date:	September 15, 2010
Planting Rate:	100 lb/acre
Plot Design:	Randomized block with four replications
Plot Size:	Six 10-in rows, 20 ft long
Harvest Date:	August 1 and 31, 2011
Fertilization:	N 165 lb/acre, P_2O_5 0 lb/acre, K_2O 0 lb/acre
Herbicide:	Lo Vol 6 Ester weed killer 0.5 pt/acre applied on April 5, 2011
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered from September 17 through October 13, 2010 and from April 7 through July 4, 2011 as needed, 27.7 in of irrigation water and 5.6 in of precipitation for total received water of 33.3 in. for 2011 growing season.
Results and Discussion:	Yield and other characteristics are presented in Table 42.

No dry fertilizer was applied prior to planting and land preparation. During the growing season, 165 lb of liquid nitrogen fertilizer was applied through the irrigation water for a seasonal total N 165 lb/acre.

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 5, 2011.

This trial was grown under a center pivot irrigation system and was watered from September 17 through October 13, 2010 and from April 7 through July 4, 2011. During the growing season, 27.7 inches of water was applied along with 5.6 inches of precipitation for a total amount of received water of 33.3 inches.

Plots were harvested on August 1 and 31, 2011. A small John Deere 3300 combine equipped with a special gathering box and weigh scale was used on August 1 until a breakdown occurred. Harvest continued on August 31 using a small Wintersteiger plot combine. 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 fair. Some hand weeding was necessary.

Yield results and other data collected in this trial are presented in Table 42. Yields of all entries were adjusted to a uniform 14% moisture content and a 60-lb bushel.

Mean yield of this trial was 50.33 bu/acre (Table 42). The highest yielding entry at 67.06 bu/acre was an Oklahoma State University selection OK07209. The top yielding entry was not significantly different in yield from the next sixteen highest yielding entries at the 95% probability level. The lowest yielding entry at 38.57 bu/acre was OK08328, an entry from Oklahoma State University. The tallest entry in this trial at 36.8 inches was Kharkof, a check variety. The shortest entries in height at 26.0 inches were TX03A0563-07AZHR247 from Texas A&M University and KS020638-5-1 from Kansas State University at Manhattan. The moisture content of all the entries ranged from 7.4 to 10.5% (Table 42). Bushel weights ranged from 45.9 to 54.4 lb/bu (Table 42).

Table 42. Winter wheat grain yield and other characteristics of the Southern Regional Performance Nursery; NMSU Agriculture Science Center at Farmington, NM. 2011.

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)
OK07209	OSU	HRW	67.06	4,517.1	8.6	54.0	29.3	17-May
CO06424	CSU	HRW	65.57	4,416.9	9.1	53.2	29.3	18-May
CO06052	CSU	HRW	63.96	4,308.9	8.7	53.3	30.0	18-May
TX06V7266	TAMU	HRW	61.79	4,162.7	8.0	49.9	28.5	17-May
CO050337-2	CSU	HRW	61.19	4,122.2	8.8	54.4	28.8	21-May
TX05A001188	TAMU	HRW	60.40	4,069.0	8.7	52.7	28.8	17-May
CO05W111	CSU	HWW	58.81	3,961.6	9.0	52.9	30.5	20-May
CO050233-2	CSU	HRW	58.68	3,953.0	9.0	53.2	30.0	18-May
TX07A001118	TAMU	HRW	57.12	3,847.8	10.5	54.3	27.3	18-May
OK07218	OSU	HRW	56.93	3,834.8	9.5	52.7	28.8	16-May
NI08708	UNL	HRW	56.74	3,822.2	8.7	50.5	28.8	19-May
NE06430	UNL	HRW	56.64	3,815.4	8.5	50.6	28.3	18-May
KS020822-M-5	KSU Manhattan	HRW	56.43	3,801.4	8.2	52.1	27.3	17-May
CO050303-2	CSU	HRW	55.58	3,744.2	8.5	54.1	30.8	23-May
TX05V7259	TAMU	HRW	54.97	3,703.1	8.3	51.9	28.5	17-May
CO050322	CSU	HRW	52.78	3,555.2	8.6	53.5	27.0	22-May
TX07A001505	TAMU	HRW	52.00	3,503.2	8.2	51.5	28.0	17-May
KS020319-7-2	KSU Manhattan	HRW	51.38	3,460.9	8.8	48.9	29.3	18-May
OK07231	OSU	HRW	49.90	3,361.7	8.5	50.6	29.5	18-May
Anton	check	HWW	49.33	3,323.3	8.0	52.5	27.5	17-May
NX04Y2107	ARS-LNK	waxy	49.10	3,307.4	8.1	51.5	28.3	16-May
TX06A001281	TAMU	HRW	48.03	3,235.2	8.4	50.9	28.3	15-May
Kharkof	check	HRW	46.16	3,109.7	8.5	52.6	36.8	21-May
OK07214	OSU	HRW	45.38	3,056.9	8.0	49.2	28.5	18-May
NX05MD4180-6	ARS-LNK	waxy	44.40	2,991.1	7.4	45.9	29.0	18-May
TX07A001305	TAMU	HRW	43.84	2,953.4	9.3	54.1	28.8	16-May
TX03A0563-07AZHR247	TAMU	HRW	43.60	2,937.0	8.6	53.5	26.0	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)
NE06607	UNL	HRW	42.66	2,873.5	8.0	49.0	29.8	18-May
Fuller	check	HRW	42.60	2,869.5	8.2	50.0	27.3	18-May
KS020319-7-3	KSU Manhattan	HRW	42.02	2,830.3	9.4	50.6	28.5	20-May
OK06336	OSU	HRW	41.56	2,799.8	8.2	46.1	32.0	19-May
TAM-107	check	HRW	40.73	2,743.4	9.5	54.4	28.3	17-May
Mace	check	HRW	40.34	2,717.6	8.4	52.7	27.3	17-May
KS08HW35-1	KSU Hays	HWW	39.62	2,669.0	8.6	54.1	28.3	17-May
NE07444	UNL	HRW	39.01	2,627.9	7.9	46.9	30.0	18-May
KS020638-5-1	KSU Manhattan	HRW	38.98	2,626.0	8.7	53.8	26.0	20-May
Scout 66	check	HRW	38.57	2,598.4	9.0	51.8	34.3	17-May
OK08328	OSU	HRW	38.57	2,598.1	8.3	50.1	27.5	19-May
Mean			**50.33**	**3,390.2**	**8.6**	**51.7**	**29.0**	**18-May**
CV (%)			21.60	21.6	8.0	4.0	6.6	
LSD .05%			15.24	1027.0	1.0	2.9	2.7	
P Value			0.0001	0.0001	<0.0001	<0.0001	<0.0001	
Significance			***	***	***	***	***	

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 1st in potato production, 2nd in alfalfa production and 4th 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.

References

Anonymous. 1986. Crop Protection. Crops and Soils. 38 (7)29-30.

Chandler, J.M., A.S. Hamill, and A.G. Thomas. 1984. Crop losses due to weeds in Canada and the United States. Weed Sci. Soc. Am., Champaign, IL.

Lorenzi, H.J. and L.S. Jeffery. 1987. Weeds of the United States and Their Control. Pp.2-21. Van Nostrand Reinhold Co. Inc. New York, NY.

National Academy of Sciences. 1969. Insect-pest management and control. Principles of plant and animal pest control series. Vol.3.

Peairs, F.B., L. Brooks, G. Hein, G. Johnson, B. Massey, D. McBride, P. Morrison, J.T. Schultz, and E. Spackman. 1989. Economic impact of the Russian wheat aphid in the western United States: 198701988. A report by the Russian Wheat Aphid Investigative committee to the Great Plains Agricultural Council (F. Peairs, Chairman, December 1989. Great Plains Agricultural Council Publ. No. 129.

Richardson, L. 1986. Agrichemical anomie: Why it won't go away, In. Proc. Western Soc. Weed Sci., pp 3-4, San Diego, CA. March 18-20, 1986.

USDA and New Mexico Agricultural Statistics-1998. United States Department of Agriculture and New Mexico Agricultural Statistics Service, Las Cruces, NM.

Monsanto, Broadleaf Weed Control in Spring-Seeded Roundup Ready Alfalfa

Richard N. Arnold

Introduction

Seedling alfalfa requires effective broad-spectrum weed control for successful establishment; however, few herbicides are registered for postemergence broadleaf weed control. Pursuit, Raptor and recently Roundup applied to Roundup Ready alfalfa have been registered for broadleaf weed control in seedling alfalfa. Field trials were conducted to evaluate broadleaf weed control and Roundup applied alone or in combination with other selected herbicides.

Objectives

- Determine herbicide efficacy of Roundup applied alone or in combination for control of broadleaf weeds in Roundup Ready spring-seeded alfalfa.
- Determine Roundup Ready alfalfa tolerance and yield to applied selected herbicides.

Materials and methods

In 2011, a field experiment was conducted at Farmington, New Mexico to evaluate the response of Roundup Ready alfalfa (DeKalb DKA41-18RR) and annual broadleaf weeds to postemergence applications of Roundup applied alone or in combination with other selected 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 10 ft wide by 30 ft long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Alfalfa was planted at 20 lbs/A with a Massey Ferguson grain drill on May 23. Preemergence treatments were applied on May 24 and immediately incorporated with 0.75 inch of sprinkler applied water. Soils had a maximum and minimum temperature of 75 and 60 degrees F. Postemergence treatments were applied on June 14 and June 28 when seedling alfalfa was in the 2nd to 3rd trifoliate leaf stage and weeds were small (less than 2 in). Air temperature maximum and minimum during postemergence applications was 86 and 50 degrees F. One postemergence treatment of Roundup powermax was applied on June 28 when seedling alfalfa was in the 5th to 6th trifoliate leaf stage and weeds were 4 to 6 inch tall. Air temperature maximum and minimum during this postemergence application was 95 and 66 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 and weed control on June 14. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 13. Postemergence treatments were rated for crop injury and weed control on July 13. Alfalfa was harvested with an Almaco self-propelled plot harvester on August 22. A grab sample was taken from each plot to determine protein content and relative feed value. 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 43 and Table 44. On June 14 both Sharpen and Warrant applied preemergence at 2.5 and 48 oz/A caused crop injury ratings of 11 and 6, respectively. All treatments except the weedy check gave excellent to good control of redroot and prostrate pigweed, black nightshade, and common lambsquarters. Russian thistle control was poor with Sharpen and Warrant applied preemergence at 2.5 and 48 oz/A. On July 13 Roundup powermax applied postemergence on June 28 at the 5th to 6th trifoliate leaf stage caused an injury rating (stunting) of 9. On July 13 all treatments except the weedy check gave good to excellent control of all broadleaf weeds (Table 44).

Yield and protein content

Results of yield, protein content, and relative feed values are given in Table 45. The weedy check had the highest yield during the first cutting of 3.5 t/A. Relative feed value and percent protein content were 6 to 75 and 1.5 to 7.9 percentage points higher in the treated plots as compared to the weedy check.

Table 43. Control of annual broadleaf weeds with preemergence herbicides in spring-seeded Roundup Ready alfalfa, June 14, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments	Rate	Crop Injury[a]	Weed Control[a,b] Amare	Amabl	Solni	Saskr	Cheal
	oz/A	%	%				
Sharpen	2.5	11	92	92	88	43	98
Warrant	48	6	100	100	96	43	98
Weedy check		0	0	0	0	0	0
LSD 0.05		2	4	1	6	5	3

[a] Based on visual scale from 0 to 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 44. Control of annual broadleaf weeds with preemergence, preemergence followed by sequential postemergence, and postemergence herbicides in spring-seeded Roundup Ready alfalfa, July 13, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate	Crop Injury[c]	Weed Control[c,d] Amare	Amabl	Solni	Saskr	Cheal
	oz/A	%	%				
Roundup powermax+AMS	22+3 lb/A	0	100	100	95	100	100
Roundup powermax+AMS[b]	44+3 lb/A	9	100	100	100	100	100
Sharpen/roundup powermax+AMS	2.5/22+3 lb/A	9	85	100	86	100	100
Raptor+select max+MSO+AMS	5+9+24+3 lb/A	0	100	100	80	100	100
Butyrac+roundup powermax+AMS	64+22+3 lb/A	0	100	100	100	100	100
Raptor+roundup powermax+MSO+AMS	5+22+24+3 lb/A	0	100	100	100	100	100
Pursuit+roundup powermax+MSO+AMS	4+22+24+3 lb/A	0	100	100	100	100	100
Prowl H20+roundup powermax+AMS	32+22+3 lb/A	0	100	100	90	86	100
Roundup powermax+select max+MSO+AMS	22+9+24+3 lb/A	0	100	100	99	100	100
Warrant/roundup powermax+AMS	48/22+3 lb/A	3	100	100	100	100	100
Warrant+roundup powermax+AMS	48+22+3 lb/A	0	100	98	98	82	100
Raptor+prowlH20+MSO +AMS	6+32+24+3 lb/A	0	100	100	100	100	100
Pursuit+ prowlH20+MSO+AMS	6+32+24+3 lb/A	0	100	100	98	100	100
Raptor+prowlH20+ roundup powermax+MSO+AMS	6+32+22+24+ 3 lb/A	0	100	100	100	100	100
Pursuit+ prowlH20+ roundup powermax+MSO+AMS	6+32+22+24+ 3 lb/A	0	100	100	100	100	100
Weedy check		0	0	0	0	0	0
LSD 0.05		1	4	1	2	1	1

[a] First treatment applied preemergence followed by a sequential postemergence treatment and AMS, MSO denote ammonium sulfate and methylated seed oil.
[b] Treatment applied postemergence on June 28.
[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.

Table 45. Yield, protein and RFV of spring-seeded Roundup Ready alfalfa, from herbicide applications of preemergence, preemergence followed by sequential postemergence, and postemergence herbicides in, August 22, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate	Yield[c]	RFV[d]	Protein Content
	oz/A	t/A	%	%
Roundup powermax+AMS	22+3 lb/A	2.3	188	22.8
Roundup powermax+AMS[b]	44+3 lb/A	2.4	198	23.7
Sharpen/roundup powermax+AMS	2.5/22+3 lb/A	2.9	154	17.3
Raptor+select max+MSO+AMS	5+9+24+3 lb/A	2.3	167	21.3
Butyrac+roundup powermax+AMS	64+22+3 lb/A	2.3	186	22.0
Raptor+roundup powermax+MSO+AMS	5+22+24+3 lb/A	2.3	163	20.7
Pursuit+roundup powermax+MSO+AMS	4+22+24+3 lb/A	2.2	202	23.5
Prowl H20+roundup powermax+AMS	32+22+3 lb/A	2.8	134	17.7
Roundup powermax+select max+MSO+AMS	22+9+24+3 lb/A	2.3	156	19.1
Warrant/roundup powermax+AMS	48/22+3 lb/A	2.3	181	21.7
Warrant+roundup powermax+AMS	48+22+3 lb/A	2.9	133	17.4
Raptor+prowlH20+MSO+AMS	6+32+24+3 lb/A	2.4	176	21.8
Pursuit+ prowlH20+MSO+AMS	6+32+24+3 lb/A	2.3	185	22.3
Raptor+prowlH20+ roundup powermax+MSO+AMS	6+32+22+24+ 3 lb/A	2.2	178	22.3
Pursuit+ prowlH20+ roundup powermax+MSO+AMS	6+32+22+24+ 3 lb/A	2.3	187	22.4
Weedy check		3.5	127	15.8
LSD 0.05		0.3	38	3.6

[a] First treatment applied preemergence followed by a sequential postemergence treatment and AMS, MSO denote ammonium sulfate and methylated seed oil.
[b] Treatment applied postemergence on June 28.
[c] Tons/A based on a 20 percent moisture basis.
dRFV denotes relative feed value.

BASF, 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 2011, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO231HR) 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 11 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soils had a maximum and minimum temperature of 67 and 59 degrees F. Postemergence treatments were applied on June 13, when field corn was in the 3rd to 5th stage and weeds were small (less than 2 in). Air temperature maximum and minimum during postemergence applications was 84 and 55 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 13 and weed control on June 13 and July 12. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 12. Stand counts were made on June 13 by counting individual plants per 10 ft of the third row of each plot. Field corn was harvested on November 14, by combining the center two rows of each plot using a John Deere 4420 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 46. Weed control evaluations are given in Table 46 and Table 47. There was no crop injury and there were no significant differences among treatments for stand count (Table 46). On June 13 all treatments except the weedy check gave excellent control of redroot and prostrate pigweed, black nightshade and common lambsquarters. Russian thistle control was poor with Sharpen plus Prowl H20 and Zidua applied at 2+32 and 1.5 oz/A (Table 46). On July 12 all treatments except the weedy check gave excellent control of black nightshade and common lambsquarters. Preemergence applications of Verdict, Balance flex, Sharpen plus Prowl H20, and Sharpen plus G-max lite applied at 12 and 10, 3, 2 plus 32 oz/A followed by a sequential postemergence application of Roundup powermax at 22 oz/A gave poor control of redroot pigweed. Prostrate pigweed control was excellent with all treatments except Verdict applied preemergence at 12 oz/A followed by a sequential postemergence treatment of Roundup powermax at 22 oz/A and the weedy check. Verdict, Sharpen plus Prowl H20 applied preemergence at 12 and 10, 2 plus 32 oz/A followed by a sequential postemergence treatment of Roundup powermax at 22 oz/A gave poor control of Russian thistle. Zidua applied preemergence at 1.5 oz/A gave poor control of Russian thistle (Table 47).

Crop yields

Yields are given in Table 47. Yields were 154 to 211 bu/A higher in the treated plots as compared to the weedy check.

Table 46. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 13, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments	Rate	Stand Count	Crop Injury[a]	Weed Control[a,b]				
				Amare	Amabl	Solni	Saskr	Cheal
	oz/A	no	%	%				
Verdict	12	25	0	100	100	100	96	100
Lumax	64	23	0	100	100	100	94	100
Balance flexx	3	24	0	98	100	100	100	100
Sharpen+Prowl H20	2+32	24	0	94	99	100	67	100
Sharpen+G-max lite	2+32	23	0	100	100	100	99	100
Verdict	10	24	0	100	100	100	94	100
Zidua	1.5	25	0	100	100	100	51	100
Zidua+verdict	1.5+10	23	0	100	100	100	99	100
G-max lite	40	24	0	100	100	100	84	100
Weedy check		23	0	0	0	0	0	0
LSD 0.05		ns		2	1	1	12	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 47. Control of annual broadleaf weeds with preemergence followed by sequential postemergence herbicides in field corn on July 12, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate	Weed Control[b,c] Amare	Amabl	Solni	Saskr	Cheal	Yield
	oz/A	%					bu/A
Verdict/roundup power max+NIS+AMS	12/22+10+ 5 lb/A	13	68	100	42	100	221
Lumax/roundup power max+NIS+AMS	65/22+10+ 5 lb/A	91	100	100	95	100	272
Balance flexx/roundup power max+NIS+AMS	3/22+10+ 5 lb/A	23	94	100	92	100	230
Sharpen+Prowl H20/ roundup power max+NIS+AMS	2+32/22+10+ 5 lb/A	45	96	100	71	100	234
Sharpen+G-max lite/ roundup power max+NIS+AMS	2+32/22+10+ 5 lb/A	50	98	100	90	100	267
Verdict/ roundup power max+NIS+AMS	10/22+10+5 lb/A	12	95	99	50	100	226
Zidua	1.5	83	96	100	13	100	227
Zidua+verdict	1.5+10	96	99	100	98	100	273
Zidua+verdict/ roundup power max+status+AMS	1.5+10/22+5 +5 lb/A	95	100	100	99	100	277
Verdict/Zidua+ roundup power max+status+AMS	10/1.5+22+5 +5 lb/A	99	100	100	100	100	278
G-max lite/status+AMS	40/5+5 lb/A	72	99	100	98	100	262
Weedy check		0	0	0	0	0	67
LSD 0.05		10	3	1	8	1	17

[a] First treatment applied preemergence then a slash followed by a sequential postemergence treatment, NIS and AMS denote a non-ionic surfactant and ammonium sulfate.
[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, Broadleaf Weed Control in Field Corn with either Preemergence or Postemergence Herbicides

Richard N. Arnold

Introduction

Controlling annual weeds in corn usually is a two pass program with a preemergence followed by a postemergence herbicide. With increasing cost of herbicides and application, this study was to evaluate season long control of annual broadleaf weeds with either preemergence or postemergence herbicides.

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 2011, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO231HR) and annual broadleaf weeds to either preemergence or 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 11. Preemergence treatments were applied on May 12 and immediately incorporated with 0.75 inch of sprinkler applied water. Soils had a maximum and minimum temperature of 65 and 60 degrees F. Postemergence treatments were applied on June 13 when field corn was in the 3rd to 5th leaf stage and weeds were small (less than 2 in). Air temperature maximum and minimum during postemergence applications were 84 and 55 degrees F. Black nightshade, redroot and prostrate pigweed infestations were heavy and common lambsquarters infestations and Russian thistle infestations were moderate throughout the experimental area. Preemergence treatments were rated visually for crop injury on June 13 and weed control on June 13 and July 13. Postemergence treatments were rated visually for weed control on July 13. Stand counts were made on June 13 by counting individual plants per 10 feet of the third row of each plot. Field corn was harvested on November 15, by combining the center two rows of each plot using a John Deere 4420 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

Stand counts are given in Table 48. Weed control and injury evaluations are given in Table 48 and Table 49. On June 13, Corvus applied preemergence at 5.6 oz/A in combination with either atrazine or sharpen at 16 and 2.5 oz/A had the highest injury rating of 6. All treatments except the weedy check gave excellent control of broadleaf weeds (Table 48). On July 13 preemergence treatments of Corvus plus Sharpen, Verdict plus Atrazine and Bicep II mag, applied at 5.6 plus 2.5, 15 plus 16 and 48 oz/A and postemergence treatments of Capreno alone or in combination with Atrazine applied at 3 and 3 plus 16 oz/A gave excellent control of redroot pigweed. Prostrate pigweed and black nightshade control was good to excellent with all treatments except the weedy check, Verdict plus Atrazine applied preemergence at 15 plus 16 oz/A and the postemergence treatment of Roundup powermax applied at 22 oz/A. Preemergence treatments of Verdict plus Atrazine and Bicep II mag at 15 plus 16 and 48 oz/A and postemergence treatments of Halex GT and Roundup powermax applied at 58 and 22 oz/A gave poor control of Russian thistle. Common lambsquarters control was marginal with the preemergence treatment of Verdict plus Atrazine applied at 15 plus 16 oz/A and the postemergence treatment of Roundup powermax applied at 22 oz/A (Table 49).

Crop yields

Yields are given in Table 49. Yields were 130 to 207 bu/A higher in the herbicide treated plots as compared to the check.

Table 48. Control of annual broadleaf weeds with preemergence, herbicides in field corn on June 13, 2011; NMSU Agricultural Science Center at Farmington, New Mexico. 2011.

Treatments	Rate	Stand Count	Crop Injury[a]	Weed Control [a,b]				
				Amare	Amabl	Solni	Saskr	Cheal
	oz/A	no	%	%				
Corvus+atrazine	5.6+16	25	6	100	100	100	100	100
Corvus+sharpen	5.6+2.5	24	6	100	100	100	100	100
Balance flexx+atrazine	6+16	24	0	100	100	100	100	100
Lumax	48	24	0	100	100	100	100	100
Harness xtra	48	24	0	100	100	100	100	100
Verdict+atrazine	15+16	23	0	100	100	100	100	100
Bicep II mag	48	25	0	100	100	100	99	100
Weedy check		24	0	0	0	0	0	0
LSD 0.05		ns	1	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 49. Control of annual broadleaf weeds with either preemergence or postemergence herbicides in field corn on July 13, 2011; NMSU Agricultural Science Center at Farmington, New Mexico. 2011.

Treatments	Rate	Crop Injury[b]	Weed Control[b,c]					Yield
			Amare	Amabl	Solni	Saskr	Cheal	
	oz/A	%	%					bu/A
Corvus+atrazine	5.6+16	6	79	99	100	100	100	242
Corvus+sharpen	5.6+2.5	6	99	98	100	100	100	247
Balance flexx+atrazine	6+16	0	33	100	100	100	100	268
Lumax	48	0	79	98	100	80	100	263
Harness xtra	48	0	50	91	100	82	100	250
Verdict+atrazine	15+16	0	99	60	77	73	80	251
Bicep II mag	48	0	88	95	100	58	100	263
Capreno+COC+AMS[a]	3+38+ 2.5 lb	0	95	99	100	100	100	277
Capreno+atrazine+ COC+AMS[a]	3+16+38+ 2.5 lb	0	97	99	100	100	100	278
Halex GT+NIS+AMS[a]	58+10+ 2.5 IB	0	40	92	100	78	100	242
Roundup powermax+AMS[a]	22+2.5 lb	0	15	47	81	33	81	201
Weedy check		0	0	0	0	0	0	71
LSD 0.05		1	7	6	3	5	2	16

[a] Treatments applied postemergence, COC, AMS, and NIS denote crop oil concentrate, ammonium sulfate, and non-ionic surfactant.
[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 ightshade, Saskr = Russian thistle, and Cheal = common lambsquarters.

Bayer CropScience, 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 2011, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO231HR) and annual broadleaf weeds to preemergence, and 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 11 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soil had a maximum and minimum temperature of 67 and 59 degrees F. Postemergence treatments were applied on June 13, when field corn was in the 3rd to 5th leaf stage and weeds were small (less than 2 inch). Air temperature maximum and minimum during postemergence applications was 84 and 55 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 and weed control on June 13. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 12. Stand counts were made on June 13 by counting individual plants per 10 ft of the third row of each plot. Field corn was harvested on November 14, by combining the center two rows of each plot using a John Deere 4420 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 50. Weed control evaluations are given in Table 50 and Table 51. There was no crop injury from any of the treatments (Table 50). On June 13, all treatments except the weedy check gave excellent control of prostrate pigweed, black nightshade, and common lambsquarters. Sharpen at 2.5 oz/A gave poor control of redroot pigweed. Corvus or Balance flex applied preemergence at 3 oz/A in combination with Atrazine at 16 oz/A gave excellent control of Russian thistle (Table 50). On July 12 Corvus plus Atrazine applied preemergence at 3 plus 16 oz/A followed by sequential postemergence applications of Laudis, Ignite, Roundup powermax and Capreno at 3, 22 oz/A and Balance flex applied preemergence at 3 oz/A followed by a sequential postemergence application of Capreno at 3 oz/A gave excellent control of all broadleaf weeds (Table 51).

Crop yields

Yields are given in Table 51. Yields were 167 to 200 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 13, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments	Rate	Stand Count	Crop Injury[a]	Weed Control[a,b]				
				Amare	Amabl	Solni	Saskr	Cheal
	oz/A	no	%	%				
Corvus+atrazine	3+16	25	0	100	100	100	98	100
Balance flexx+atrazine	3+16	23	0	100	100	100	97	100
Lumax	48	24	0	100	100	100	36	100
Harness xtra	48	24	0	100	100	100	40	100
Verdict	15	24	0	100	100	100	73	100
Verdict	12	25	0	88	100	100	30	100
G-max lite	48	24	0	100	100	100	70	100
Sharpen	2.5	24	0	38	100	100	33	100
Weedy check		24	0	0	0	0	0	0
LSD 0.05		ns		3	1	1	16	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 July 12, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

		Weed Control[b,c]					
Treatments[a]	Rate oz/A	Amare	Amabl	Solni	Saskr	Cheal	Yield bu/A
		%					
Corvus+atrazine/laudis+MSO+AMS	3+16/3+38+2.5 lb	97	100	100	99	100	266
Corvus+atrazine/ignite+AMS	3+16/22+3 lb	99	100	100	99	100	270
Corvus+atrazine/roundup powermax+AMS	3+16/22+3 lb	90	100	100	90	100	274
Corvus+atrazine/Capreno+COC+AMS	3+16/3+38+2.5 lb	100	97	100	100	100	268
Balance flexx+atrazine/laudis+MSO+AMS	3+16/3+38+2.5 lb	86	99	100	100	100	255
Balance flexx+atrazine/ignite+AMS	3+16/22+3 lb	18	92	100	62	100	252
Balance flex+atrazine/Roundup powermax+AMS	3+16/22+3 lb	20	95	100	92	100	259
Balance flex+atrazine/Capreno+COC+AMS	3+16/3+38+2.5 lb	100	100	100	100	100	265
Lumax/touchdown total+AMS	48/24+2.5 lb	96	100	100	18	100	270
Lumax/Halex GT+NIS+AMS	48/58+10+2.5 lb	100	100	100	86	100	268
Harness xtra/roundup powermax+AMS	48/22+2.5 lb	40	86	100	46	100	256
Verdict/status+AMS	15/2.5+2.5 lb	30	94	100	92	100	249
Verdict/status+AMS	12/2.5+2.5 lb	11	94	100	70	100	241
G-max lite/status+AMS	48/2.5+2.5 lb	86	96	100	26	100	265
Sharpen/status+AMS	2.5/2.5+2.5 lb	11	90	100	43	100	249
Weedy check		0	0	0	0	0	74
LSD 0.05		11	3	1	22	1	17

[a] First treatment applied preemergence then a slash followed by a sequential postemergence treatment, MSO, COC, NIS, and AMS denote methylated seed oil, crop oil concentrate, non-ionic surfactant, and ammonium sulfate.
[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.

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 2011, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO231HR) and annual broadleaf weeds to preemergence, and 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 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 65 and 60 degrees F. Postemergence treatments were applied on June 13, when field corn was in the 3rd to 5th leaf stage and weeds were small (less than 2 inch). Air temperature maximum and minimum

during postemergence application were 84 and 55 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 and weed control on June 13. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 13. Stand counts were made on June 13 by counting individual plants per 10 ft of the third row of each plot. Field corn was harvested on November 15, by combining the center two rows of each plot using a John Deere 4420 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 52. Weed control evaluations are given in Table 52 and Table 53. On June 13 Lumax applied preemergence at 96 oz/A and the weedy check were the only treatments that did not cause significant crop injury (Table 52). All treatments gave excellent control of redroot and prostrate pigweed, black nightshade and common lambsquarters. Rimsulfuron plus mesotrione applied preemergence alone or in combination with thifensulfuron at 1 plus 4.5 oz/A plus 0.5 oz/A gave poor control of Russian thistle (Table 52). On July 13 Lumax applied preemergence at 96 oz/A and followed by a sequential postemergence treatments of Roundup power max applied at 32 ox/A gave good to excellent control of redroot pigweed. Prostrate pigweed control was poor with Rimsulfuron plus mesotrione applied preemergence at 1.5 plus 4.5 oz/A. Rimsulfuron plus mesotrione applied alone at 1 plus 4.5 oz/A or in combination with either thifensulfuron or atrazine at 0.5 and 32 oz/A gave poor control of black nightshade. Rimsulfuron plus mesotrione plus atrazine applied preemergence at 1 plus 4.5 plus 32 oz/A and Lumax applied preemergence at 96 oz/A both followed by a sequential postemergence treatment of Roundup powermax at 32 oz/A gave excellent control of Russian thistle. All treatments except the weedy check gave excellent control of common lambsquarters (Table 53).

Crop yields

Yields are given in Table 53. Yields were 68 to 205 bu/A higher in the herbicide treated plots as compared to the check.

Table 52. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 13, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments	Rate oz/A	Stand Count no	Crop Injury[a] (%)	Weed Control[a,b] Amare	Amabl	Solni	Saskr	Cheal
				%				
Rimsulfuron+mesotrione	1.0+4.5	25	18	99	100	100	57	100
Rimsulfuron+mesotrione	1.5+4.5	23	23	100	100	100	58	100
Rimsulfuron+mesotrione +thifensulfuron	1.0+4.5+ 0.5	24	22	99	100	100	58	100
Rimsulfuron+mesotrione +atrazine	1.0+4.5+ 32	24	22	99	100	100	99	100
Rimsulfuron+mesotrione +atrazine	1.5+4.5+ 32	24	24	100	100	100	99	100
Rimsulfuron+mesotrione +atrazine+thifensulfuron	1.0+4.5+ 32+0.5	24	17	97	100	100	94	100
Lumax	96	25	0	100	100	100	99	100
Weedy check		24	0	0	0	0	0	0
LSD 0.05		ns	5	2	1	1	6	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 53. Control of annual broadleaf weeds with preemergence followed by sequential postemergence herbicides in field corn on July 13, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate	Weed Control[b,c]					Yield
		Amare	Amabl	Solni	Saskr	Cheal	
	oz/A	%					bu/A
Rimsulfuron+mesotrione	1.0+4.5	50	90	73	16	99	184
Rimsulfuron+mesotrione	1.5+4.5	35	78	85	15	100	193
Rimsulfuron+mesotrione+thifensulfuron	1.0+4.5+0.5	74	91	78	51	99	185
Rimsulfuron+mesotrione+atrazine	1.0+4.5+32	28	91	99	82	100	169
Rimsulfuron+mesotrione+atrazine	1.5+4.5+32	26	89	97	90	100	140
Rimsulfuron+mesotrione+atrazine+thifensulfuron	1.0+4.5+32+0.5	26	88	79	51	100	159
Rimsulfuron+mesotrione+atrazine/roundup powermax+AMS	1.0+4.5+32/32+2 lb/A	25	99	97	83	100	183
Rimsulfuron+mesotrione+atrazine/roundup powermax+AMS	1.5+4.5+32/32+2 lb/A	45	93	100	96	100	184
Rimsulfuron+mesotrione+atrazine+thifensulfuron/roundup powermax+AMS	1.0+4.5+32+0.5/32+2 lb/A	36	92	98	82	100	183
Lumax	96	88	98	100	78	100	270
Lumax/roundup powermax+AMS	96/32+2 lb/A	90	99	100	98	100	277
Weedy check		0	0	0	0	0	72
LSD 0.05		6	3	3	4	1	26

[a] First treatment applied preemergence then a slash followed by a sequential postemergence treatment and AMS denote ammonium sulfate.
[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 CropSciences, Broadleaf Weed Control in Grain Sorghum with Preemergence Followed by Sequential 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 postemergence herbicides applied to 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 2011, 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 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. Grain sorghum was planted with flexi-planters equipped with disk openers on May 31. Preemergence treatments were applied on June 2 and immediately incorporated with 0.75 inch of sprinkler applied water. Soil temperature maximum and minimum during application were 70 and 69 degrees F. Postemergence treatments were applied on June 28 when grain sorghum was in the V5 leaf stage and weeds were less than 4 inches in height. Air temperatures for postemergence applications were 95 and 66 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 June 28. Preemergence followed by a sequential postemergence treatment were evaluated for weed control on July 28. Grain sorghum was harvested on November 17, by combining the center two rows of each plot using a John Deere 4420 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 are given in Table 54. Weed control evaluations are given in Table 54 and Table 55. There were no crop injury symptoms from any of the treatments for both rating periods. One June 28 all treatments except the weedy check gave excellent control of redroot and prostrate pigweed, black nightshade and common lambsquarters. Atrazine applied preemergence at 32 oz/A gave poor control of Russian thistle (Table 54). On July 28 Atrazine plus Buctril applied at 16 plus 16 oz/A gave poor control of redroot pigweed. All treatments except the weedy check gave excellent control of prostrate pigweed, black nightshade and common lambsquarters. Russian thistle control was poor with the preemergence application of Guardsman max applied at 48 oz/A (Table 55).

Crop yields

Yields are given in Table 55. Yields were 57 to 125 bu/A higher in the herbicide treated plots as compared to the weedy check.

Table 54. Control of annual broadleaf weeds with preemergence herbicides in grain sorghum on June 28, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments	Rate	Crop Injury[a]	Weed Control[a,b]				
	oz/A	%	Amare	Amabl	Solni	Saskr	Cheal
			%				
Guardsman max	48	0	99	100	100	93	100
Cinch ATZ	48	0	98	99	100	94	100
Atrazine	32	0	99	100	99	82	100
Weedy check		0	0	0	0	0	0
LSD 0.05		ns	2	1	1	9	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 55. Control of annual broadleaf weeds with preemergence followed by sequential postemergence herbicides in grain sorghum on July 28, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate	Weed Control[b] Amare	Amabl	Solni	Saskr	Cheal	Yield
	oz/A	%					bu/A
Huskie+atrazine+AMS	13+16+ 1 lb/A	98	99	100	100	100	110
Huskie+atrazine+AMS	16+16+1 lb/A	98	100	100	99	100	109
Huskie+AMS	13+1 lb/A	87	88	95	90	100	117
Atrazine+buctril	16+16	66	93	100	100	100	77
Huskie+atrazine+AMS	16+16+ 2 lb/A	100	100	100	100	100	134
Huskie+atrazine+AMS	10+16+ 2 lb/A	100	100	100	100	100	122
Guardsman max	48	100	100	100	79	100	139
Guardsman max/Huskie+AMS	48/13+ 1 lb/A	100	100	100	100	100	124
Cinch ATZ	48	100	100	100	100	100	121
Cinch ATZ/Huskie+AMS	48/13+ 1 lb/A	100	100	100	100	100	145
Atrazine/Huskie+AMS	32/13+ 1 lb/A	100	100	100	100	100	142
Weedy check		0	0	0	0	0	20
LSD 0.05		2	3	2	2	1	31

[a] First treatment applied preemergence followed by a slash then a sequential postemergence treatment, AMS denote ammonium sulfate and all other treatments were applied postemergence.

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

Dow AgroSciences, Jim Hill Mustard Control in Winter Wheat.

Richard N. Arnold

Introduction

Jim Hill mustard (tumble mustard) 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 Jim Hill mustard 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 2011 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 Jim Hill mustard (tumble mustard) 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. Promontory) was planted in 18 inch rows at 100 lb/A with a Massey Ferguson grain drill on September 12, 2010. Eighteen inch row spacing were used to ensure mustard pressure. Treatments were applied on March 30, prior to winter wheat at Feekes 6 growth stage. Air temperature maximum and minimum during treatment application was 57 to 28 degrees F. Other postemergence treatments were applied on April 28 when winter wheat was approximately at the Feekes 9 growth stage. Air temperature maximum and minimum during treatment application was 52 to 29 degrees F. On March 30 and April 28 Jim Hill mustard heights were less than 4 and greater than 8 inch in height. Jim Hill mustard infestation was heavy throughout the experimental area. Crop injury and weed control evaluations were made on May 23. Winter wheat was harvested with a John Deere 3300 combine equipped with a load cell on July 28. 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 56. On May 23 there were no crop injury symptoms from any of the treatments. Banvel, and BASF 8100H applied at 4, 2, and 2.2 oz/A in combination with Harmony GT XP at either 0.3 or 0.6 oz/A , Olympus, Maverick and Axial applied at 0.9, 0.66 and 16.4 oz/A gave poor control of Jim Hill mustard (Table 56).

Crop yield

Results of yield are given in Table 56. Yields were 7 to 33 bu/A higher in the herbicide treated plots as compared to the weedy check.

Table 56. Control of Jim Hill mustard in Promontory winter wheat on May 23, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate oz/A	Crop Injury[c] —%—	Weed Control[c,d] SSYAL —%—	Yield bu/A
BASF 8100H+harmony GT XP+NIS	4.4+0.3+20	0	94	68
Banvel+harmony GT XP+NIS	4+0.3+20	0	65	65
BASF 8100H+harmony GT XP+NIS[b]	2.2+0.6+20	0	68	64
Banvel+harmony GT XP+NIS[b]	2+0.6+20	0	68	67
Powerflex+NIS+AMS	3.5+20+1.52 lb/A	0	99	66
Pyroxsulam+cloquintocet+NIS+ AMS	2+20+1.52 lb/A	0	100	61
Olympus+NIS	0.9+20	0	78	65
Olympus flex+NIS+AMS	3.17+20+1.52 lb/A	0	89	76
Maverick+NIS	0.66+20	0	43	52
Axial	16.4	0	28	55
Harmony GT XP+2,4-D ester+NIS	0.6+6+20	0	96	68
Harmony GT XP+2,4-D ester+Uran	0.6+6+384	0	96	72
Harmony GT XP+2,4-D ester+Uran	0.6+4+768	0	97	78
Harmony GT XP+2,4-D ester+Uran	0.6+4+1152	5	96	71
Weedy check		0	0	45
LSD 0.05			5	8

[a] Treatments applied prior to Feekes 6 and NIS, AMS and Uran denotes non-ionic surfactant, ammonium sulfate and urea ammonium nitrate.

[b] Treatments applied prior to Feekes 9.

[c] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.

[d] SSYAL = Jim Hill mustard (tumble mustard).

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 of 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 yield of selected non-native and native cool season grasses to MAT 28 applied alone or in combination with other herbicides.

Materials and methods

In 2011, 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), respectively. Mat 28 was applied preemergence at 4 oz/A on August 25 and 26, 2009-2010, and was immediately incorporated with 0.75 inch of sprinkler applied water. All other treatments were applied postemergence with a non-ionic surfactant at 22 oz/A on April 22 and 28, 2010-2011. Preemergence treatment soil maximum and minimum on April 22 and 28, 2010-2011 were 94, 72 and 80,72 degrees F. Air temperature maximum and minimum for the postemergence treatments on April 28, 2011 were 77 and 48 degrees F. Grass stand establishment ratings for 2011 were similar to 2010 (data not presented). Plots were harvested with an Almaco plot harvester on June 9, 2011. Only 2011 grass green weight yield in lbs/plot will be presented. Results obtained were subjected to analysis of variance at P=0.05.

Results and discussion

Grass yield

Grass green weight yields are given in Table 57. MAT 28 applied preemergence at 4.0 oz/A yielded significantly less grass per plot as compared to the other treatments. Oahe Intermediate Wheatgrass, Fawn Tall Fescue and Luna Pubescent Wheatgrass were the highest yielding grasses (Table 57).

Table 57. Yield of grasses to MAT-28 alone or in combination with other herbicides on June 9, 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Treatments[a]	Rate	SLSW	MSM	RIR	HCCW	OIW	LPW	POG	FTF[d]	Treatment means herbicides[c]
	oz/A	———————	———	———	———	lb/plot	———	———	———	
MAT-28	1.0	23.4	58.6	10.5	59.9	108.6	116.6	32.6	74.0	60.5[ab]
MAT-28	2.0	21.5	60.1	11.6	45.5	110.3	116.0	32.8	77.9	71.9[a]
MAT-28	4.0	21.7	37.7	10.1	23.9	112.6	105.8	33.5	67.6	51.6[b]
MAT-28+telar	2.0+0.5	17.8	60.1	9.4	55.5	100.9	118.6	33.4	74.6	58.8[b]
MAT-28+ escort XP	2.0+0.33	17.0	59.6	7.0	45.3	98.1	113.2	39.2	78.0	57.2[b]
MAT-28[b]	4.0	3.8	10.4	9.9	29.1	51.9	102.4	19.9	49.3	34.6[c]
Milestone	7.0	22.3	60.9	12.4	55.0	115.0	114.7	34.7	79.5	61.8[ab]
Untreated		22.3	63.2	15.1	69.5	96.0	130.2	33.6	76.2	63.2[ab]
Treatment mean grass[c]		31.2[e]	51.3[d]	10.7[f]	47.9[d]	99.2[b]	114.7[a]	32.4[e]	72.1[c]	

[a] Treatments applied with a nonionic surfactant at 22 oz/A.
[b] Treatment applied preemergence on August 28, 2010.
[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 Smoothbrome grass, RIR - Rimrock Indianrice grass, HCCW – Hy Crest Crested Wheatgrass, OIW – Oahe Intermediate Wheatgrass, LPW – Luna Pubescent Wheatgrass, POG = Potomac Orchardgrass, and FTF = Fawn Tall Fescue

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. The effects of global warming on future water supplies for the county are also uncertain but 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 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 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 amount 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 upon 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} or K_C) 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_Cs 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_Cs 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 2011 progress of these studies.

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 K_C transferability caused by the use of different empirical methods used to derive ET_{REF} at various research sites in the past.

In 2011, cumulative ET_{RS}, PET, and ET_{OS} at the ASCF research site totaled 82, 77, and 59 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) but from mid-June through mid-July, average daily ET_{RS}, PET, and ET_{OS} values were 0.42, 0.38, and 0.31 inch, respectively.

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

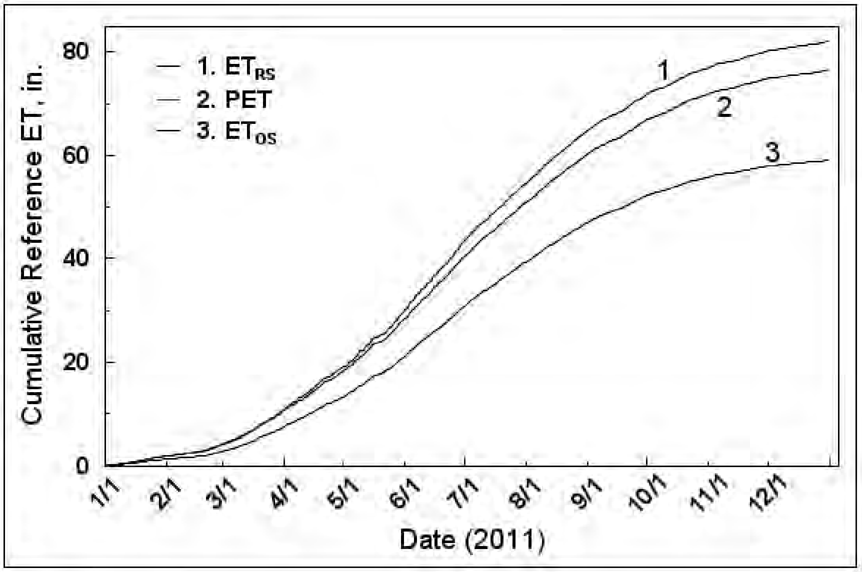

Figure 3. **Cumulative, 2011 FAO-56 Penman-Monteith standardized reference ET based on alfalfa (ETRS) and grass (ETOS) as compared to the FAO-24 modified Penman method (PET); NMSU Agricultural Science Center at Farmington, NM. 2011.**

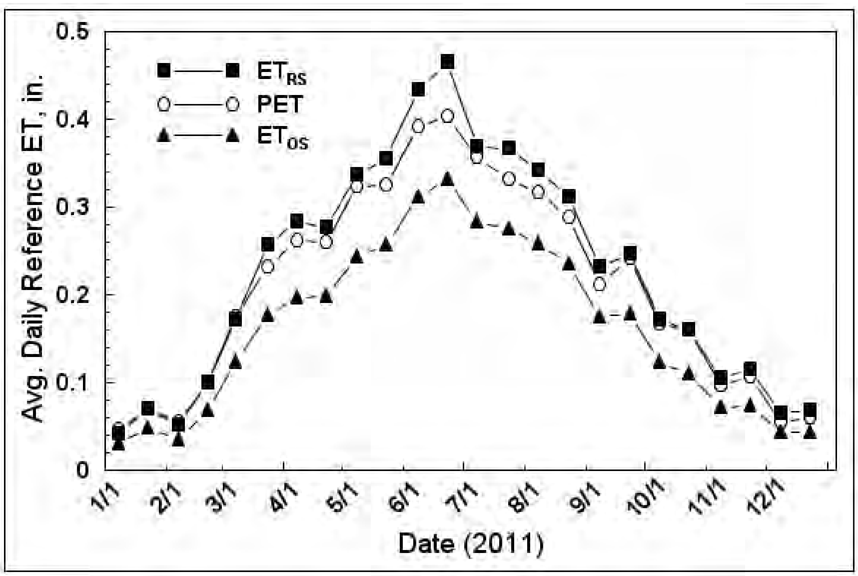

Figure 4. **Average daily 2011 FAO-56 Penman-Monteith standardized reference ET based on alfalfa (ETRS) and grass (ETOS) as compared to the FAO-24 modified Penman method (PET). Note: each point on the graph represents the daily average from half-month periods during the year; NMSU Agricultural Science Center at Farmington, NM. 2011.**

Xeriscape Demonstration Garden

Dan Smeal, Joe Ward, Angi Grubbs, and Christen Begay

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 9th year at the ASCF. 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 averaged 7.56 inches from 2004 through 2009. In 2010, water application levels were decreased to 3.0, 5.5, and 8.0 gpw per plant in the low, medium, and high irrigation treatments, respectively and total water volumes applied per plant from May 1 to October 15 were 0, 84, 134, and 176 gallons in the no, low, medium, and high treatments, respectively. Total annual precipitation in 2010 was 9.8 inches. Due to obvious water stress symptoms and some dieback in 2010, irrigation levels were returned to 4, 8 and 12 gallons of water per week in the respective treatments in 2011. A list of all plant species in the garden, along with survival information is presented in the NMSU – ASCF 2010 Annual Report (http://aces.nmsu.edu/aes/farm/documents/NMSU%20AnnRpt%202010.pdf). Photos of most of the plants, along with more information on each species, are available through the Farmington Agricultural Science Center's web site (http://aces.nmsu.edu/aes/farm/xeriscape-plants.html). A virtual (video) tour of the garden is also available through the Center for Landscape Water Conservation (Xericenter) website (http://www.xericenter.com/links/NMSU_ASC_Farmington.php).

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 2011, 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

Materials and methods were similar in 2011 as in previous years. Details can be accessed through annual reports from the ASCF web site (http://farmingtonsc.nmsu.edu) and will not be repeated here.

Results and discussion

Drip irrigations were applied weekly between April 20 and October 14, 2011 at rates of 0, 4, 8, and 12 gallons per plant per week except during the week of October 2 when no irrigations were applied due to significant (about 0.75 inch) precipitation. The total volume of irrigation water applied per plant during the April 20 to October 14 time period was 0, 100, 200, and 300 gallons, in the no, low, medium, and high irrigation quadrants, respectively. An additional 4.24 inches of precipitation was measured at the NWS weather station located near the garden site during this same time period.

A list of species that have done well without supplemental irrigation or with only four gallons of irrigation water (or less) per week during the growing season since 2004 are presented in Table 58.

Summary and conclusions

This demonstration/research project has shown that several different species of plants suitable for landscaping in northwestern New Mexico can be sustained on very low volumes of water and should be considered as water becomes much more limited and/or expensive in the region.

Table 58. List of plant species that have survived and maintained acceptable landscape quality with no supplemental irrigation (0) or with only four gallons of water per week per plant (L) during the growing season since 2004; NMSU Agricultural Science Center at Farmington, NM. 2011.

Species Name	Common Name	Quadrant
Amelanchier utahensis	Utah serviceberry	0
Artemisia tridentata	big sagebrush	0
Berberis fremontii	Fremont barberry	0
Berlandiera lyrata	chocolate flower	0
Brickellia californica	California bricklebush	0
Caragana arborescens	Siberian peashrub	0
Caryopteris clandonensis	blue mist spirea	L
Cercocarpus ledifolius	curlleaf mountain mahogany	0
Cercocarpus montanus	true mountain mahogany	0
Chamaebatiaria millefolium	fernbush	0
Chilopsis linearis	Desert willow	0
Chrysothamnus nauseosus	rubber rabbitbrush	L
Cowania mexicana	cliffrose	0
Cylindropuntia imbricata	tree cholla	0
Eriogonum jamesii	James' buckwheat	0
Fallugia paradoxa	Apache plume	0
Forestiera neomexicana	New Mexico olive	0
Hesperaloe parviflora	red yucca	0
Hylotelephium telephium	autumn joy sedum	L
Juniperus scopulorum	Rocky Mountain juniper	0
Krascheninnikovia lanata	winterfat	L
Liatris punctata[†]	dotted gayfeather	L
Mirabilis multiflora[†]	giant four o'clock	L
Nolina microcarpa	beargrass	L
Oenothera caespitosa[‡]	tufted evening primrose	0
Parthenium incanum	mariola	0
Penstemon "abuelitas" [‡]	abuelita penstemon	0
Penstemon ambiguus	bush penstemon	0
Penstemon angustifolia	narrow-leaf beardtongue	0
Penstemon barbatus[†]	scarlet bugler penstemon	L
Penstemon clutei	Sunset Crater beardtongue	L
Penstemon eatonii	firecracker penstemon	L
Penstemon palmeri	Palmer penstemon	0
Penstemon pinifolius[†]	pineleaf penstemon	L
Penstemon strictus	Rocky Mountain penstemon	L
Peraphyllum ramosissimum	squaw apple	0
Perovskia atriplicifolia	Russian sage	0
Pinus nigra	black pine	L

Species Name	Common Name	Quadrant
Prunus besseyi	western sandcherry	L
Rhus trilobata	three-leaf sumac	0
Rhus trilobata pilosissima	pubescent squawbush	0
Robinia neomexicana	New Mexico locust	L
Salvia greggii	cherry sage	L
Salvia pinguifolia	rock sage	L
Sphaeralcea ambigua[‡]	desert globemallow	0
Sporobolus wrightii	giant sacaton	L
Yucca baccata	banana yucca	0
Yucca elata	soaptree yucca	0
Zinnia grandiflora	desert zinnia	0

[†] Seems to do better in partial shade.
[‡] Short lived.

Evaluation of Drip Irrigation Emitters at Low Water Pressure

Dan Smeal and Kevin Hooper

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 drip lines at water pressures less than those specified or recommended by the emitter manufacturer or dealer. In 2011, flow rates were measured from 20 different models of point source emitters at two different pressures (1.5 psi and 2.4 psi) or heads (3.5 feet and 5.5 feet, respectively). These heads were maintained throughout the tests by maintaining a constant water level in elevated water barrels containing float valves. Measured flow rate at 5.5 and 3.5 ft of head averaged 33.6 % and 14.8 %, respectively, of that specified by the manufacturer at the recommended pressures (usually > 10 psi or 23 feet). Water application uniformity (AU), expressed as 1 – *cv* (where *cv* = standard deviation / mean of measurements from eight replicates along a 80 foot long, 0.5 inch lateral) was greater than 0.90 for eleven of the twenty emitters.

Introduction

Rainwater catchment systems that collect and store 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 by 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 until adequate studies designed to identify the functionality of various drip components at low pressures have been conducted. This study was implemented to evaluate the effects of low pressures on the output and application efficiency of various point source drip emitters so that intelligent recommendations can be provided to the increasing number of gardeners and small-plot farmers that want to use rainwater catchment systems or that haul water to remote garden sites in pick-up trucks or trailers.

Objective

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

Materials and methods

This study was undertaken in September 2011 to measure the flow rates and water application uniformities (AU) of twenty different models of point source emitters at two different substandard pressures (or heads). Water was provided by an elevated plastic water drum in which the water level was maintained with a float valve at a height of 5.5 feet (evaluation 1) and 3.5 feet (evaluation 2) to simulate potential conditions of rainwater catchment systems and tanks in a pick-up truck bed, respectively. In each evaluation, a 0.6 inch ID (nominal ½ inch) polyethylene (PE) lateral, attached to the downspout on the elevated drum, was hung on a lower wire of a level, sheep fence (2 inch by four inch woven wire) at a height of about 6 inches above ground to facilitate emitter flow rate measurements. Eight sets (or replicates) of 5 emitter models were inserted into 4 separate, 80 foot long laterals at a spacing of 24 inches. After ensuring the water level in the tank and the lateral pressure was stabilized, water flow from each emitter along each lateral was caught in a small plastic cup for a timed period (several seconds to several minutes depending on the emitter model's observed flow). The captured water was poured into a graduated cylinder for precise measurement in ml and the flow rate in gallons per hour (gph) was calculated as: FR = ml / seconds x 3600 / 3785: where FR = flow rate in gph; ml = water measured in milliliters; seconds = number of seconds from start to end of water collection; 3785 = number of ml per gallon. 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

Since replicates were at varying distances (D) away from the water source along each lateral, emitter flow rates were plotted against relative distance (i.e. reps 1-8) and then regression analyses (CoStat 6, 2001) were used to define suspected significant relationships between flow rate and D.

Seventeen of the twenty drip emitters used in the evaluations were purchased from 'The Drip Store' http://www.dripirrigation.com/ and three were purchased from a local home improvement retailer. Emitter styles were variable (e.g. button, flag, Katif, etc.) and manufacturer specified flow rates (MSFR) ranged from 0.5 to 4.0 gph (Table 59). Manufacturer's specified operating pressures (MSOP) ranged from 7 psi (16 ft of head) to 50 psi (115 ft of head).

Table 59. Drip emitter models included in the low-pressure evaluations with manufacturer specified flow rates (MSFR) and recommended operating water pressures (MSOP); NMSU Agricultural Science Center at Farmington. NM, 2011.

Brand Name	Emitter Model (or Part Number)	Color and Style [a]	MSFR (gph)	MSOP (psi) [b]
Supertif	D001	Black Button, PC	1.0	8 - 50
Supertif	D002	Green Button, PC	2.0	8 - 50
Supertif	D004	Red Button, PC	3.3	8 - 50
Supertif	D006	Black Side Outlet, PC	1.0	8 - 50
Unknown	D012	Black Button, NC	1.0	10 - 20
Unknown	D013	Green Button, NC	2.0	10 - 20
John Deere Water	D015	Black Easy-Open, NC	1.0	15 - 20
Unknown	D021	Black Flag, NC	1.0	10 - 25
Unknown	D022	Blue Flag, NC	2.0	10 - 25
Katif	D043	Purple Katif, PC	3.3	10 - 50
Katif	D044	Green Katif, PC	2.0	10 - 50
Katif	D045	Red Katif, PC	1.0	10 - 50
DIG	D076	Black, PC	1.0	8 - 40
DIG	D077	Green, PC	2.0	8 - 50
DIG	D078	Red, PC	4.0	8 - 50
Netafim	D079	Red Self Cleaning PC	0.5	7 – 45
Netafim	D080	Black Self Cleaning PC	1.0	7 - 45
Orbit 4G	unknown	Green Flag NC	4.0	unknown
Orbit 1G	unknown	Black Flag NC	1.0	unknown
Orbit 2G	unknown	Blue Flag NC	2.0	unknown

[a] PC indicates a pressure compensating emitter; NC indicates a non-pressure compensating emitter
[b] Recommended pressure range may be narrower but within operating range

Results and discussion

Measured average emitter flow rate (FR) at 5.5 ft of head ranged from 0.075 gph (model D021) to 2.15 gph (model D078). These rates were 7.5 and 53.8 % of MSFR, respectively (Table 60). The average FR of all emitters at the 5.5 ft water height was 33.6 % of MSFR but the measured FR from one emitter (D045) was about equal to MSFR at the MSOP (Table 60). The average FR of all emitters at 3.5 ft of head (14.8 % of MSFR) was considerably less than that at the 5.5 height. As with the 5.5 ft height, the lowest and highest FR (0.018 and 0.822 gph, respectively) was measured from emitter models D021 and D078 (Table 60). Unless the FR is so low (such as with emitter D021) that it would be difficult to satisfy the irrigated plant's daily water requirement during peak ET, consideration of water application uniformity (AU) is more important than FR in efficient drip irrigation design. Calculated AU ranged from a high of 0.957 (emitter Orbit 4G) to a low of 0.376 (emitter D077) at 5.5 ft of head; and from 0.925 (emitter D013) to 0.327 (emitter Orbit 1G) at 3.5 ft of head (Table 60). Eleven of the twenty emitters exhibited AUs greater than 0.90 at 5.5 ft of head but only two of the eleven (D043 and D013) maintained an AU greater than 0.90 at the lower head (3.5 ft).

Table 60. Average flow ratea, expressed as measured gph and as % of manufacturer's specified flow rates (MSFR), and water application uniformity, expressed as 1 – cv, for 20 different point source emitter models at two substandard heads (5.5 feet and 3.5 feet); NMSU Agricultural Science Center, Farmington, NM. 2011.

Head	5.5 feet			3.5 feet		
	Flow Rate		Uniformity	Flow Rate		Uniformity
Emitter[b]	gph	% of MSFR	(1 – *cv*)	gph	% of MSFR	(1 – *cv*)
Orbit 4G	0.791	19.8	0.957	0.310	7.7	0.794
D043	0.475	14.4	0.956	0.378	11.5	0.923
D015	0.210	21.0	0.954	0.092	9.2	0.845
D006	0.442	44.2	0.948	0.235	23.5	0.773
D001	0.447	44.7	0.946	0.200	20.0	0.842
D012	0.172	17.2	0.941	0.123	12.3	0.880
D013	0.354	17.7	0.936	0.251	12.6	0.925
Orbit 2G	0.435	21.7	0.933	0.141	7.1	0.797
D044	1.124	56.2	0.928	0.320	16.0	0.603
D002	0.890	44.5	0.928	0.342	17.1	0.717
D004	0.760	23.0	0.925	0.311	9.4	0.714
D076	0.377	37.7	0.897	0.152	15.2	0.526
D021	0.075	7.5	0.893	0.018	1.8	0.596
D045	1.018	101.8	0.855	0.382	38.2	0.575
D078	2.152	53.8	0.828	0.822	20.6	0.688
D022	0.222	11.1	0.825	0.064	3.2	0.681
Orbit 1G	0.305	30.5	0.774	0.123	12.3	0.327
D077	0.775	38.8	0.376	0.560	28.0	0.347
D079	Insufficient data – some units had zero flow					
D080	Insufficient data – some units had zero flow					

[a] Flow rate values represent the mean of eight replications.
[b] Ordered from highest to lowest application uniformity at 5.5 feet of head.

Regression analyses showed some significant, but somewhat unexpected, correlations between FR of some emitter models and distance (D) of the emitter away from the tank outlet valve (Figure 5, Figure 6, Figure 7, and Figure 8). At a head of 5.5 ft, FR of most emitters was either fairly uniform between different D or was positively correlated with increasing D (e.g. D002, D022, D045, and D078; Figure 6). Only two of the emitters (D012; Figure 7 and D001; Figure 8) exhibited a decreasing FR with increasing D but the AUs for both were greater than 0.94 at this head.

At the lower head (3.5 ft), there was a statistically significant trend of lower FR towards the center of each lateral (i.e. D between 30 and 60 ft) than at the beginning or end of the lateral for seven of the twenty emitters (Figure 5 and Figure 6). This same trend was noted in two emitters (D013 and D043) at the higher head of 5.5 ft (Figure 7). When FR data from all emitters that exhibited this trend were combined, the resultant regression curve (Figure 9) indicated that, on average, FR fell below 60 % of maximum FR in the 40 to 60 ft D range.

Ideally, the irrigator using a low pressure drip system should choose an emitter that has a high AU and a FR that will satisfy the peak ET requirements of all plants in the garden or landscape (e.g. when they are at maximum size in mid-summer) in a set management time frame. For example, chile peppers and tomatoes require about 0.6 gals and 1.2 gals of water per plant per day, respectively, at maximum ET during mid-summer to produce maximum yields. If irrigating every other day, total water application per irrigation would then be 1.2 gal per chile plant and 2.4 gal per tomato plant. Three emitters have an AU of greater than 0.95 (Orbit 4G, D043, and D015) but the FRs vary considerably (0.791, 0.475, and 0.210 gph, respectively). So, it would take 1.5, 2.5, and 5.7 hours to irrigate the chile and 3.0, 5.0, and 11.4 hours to irrigate the tomatoes using these emitters, respectively. If water availability is limited, or if several zones must be watered, then the Orbit 4G emitter might be the best choice because it has the highest FR. However, if water is available all day or night, and only one or two zones are being irrigated, the D015 emitter may be sufficient. If irrigating from a tall tank that will slowly empty, the D043 emitter would be the most logical choice because it has the highest AU of the three at 3.5 ft of head (0.923).

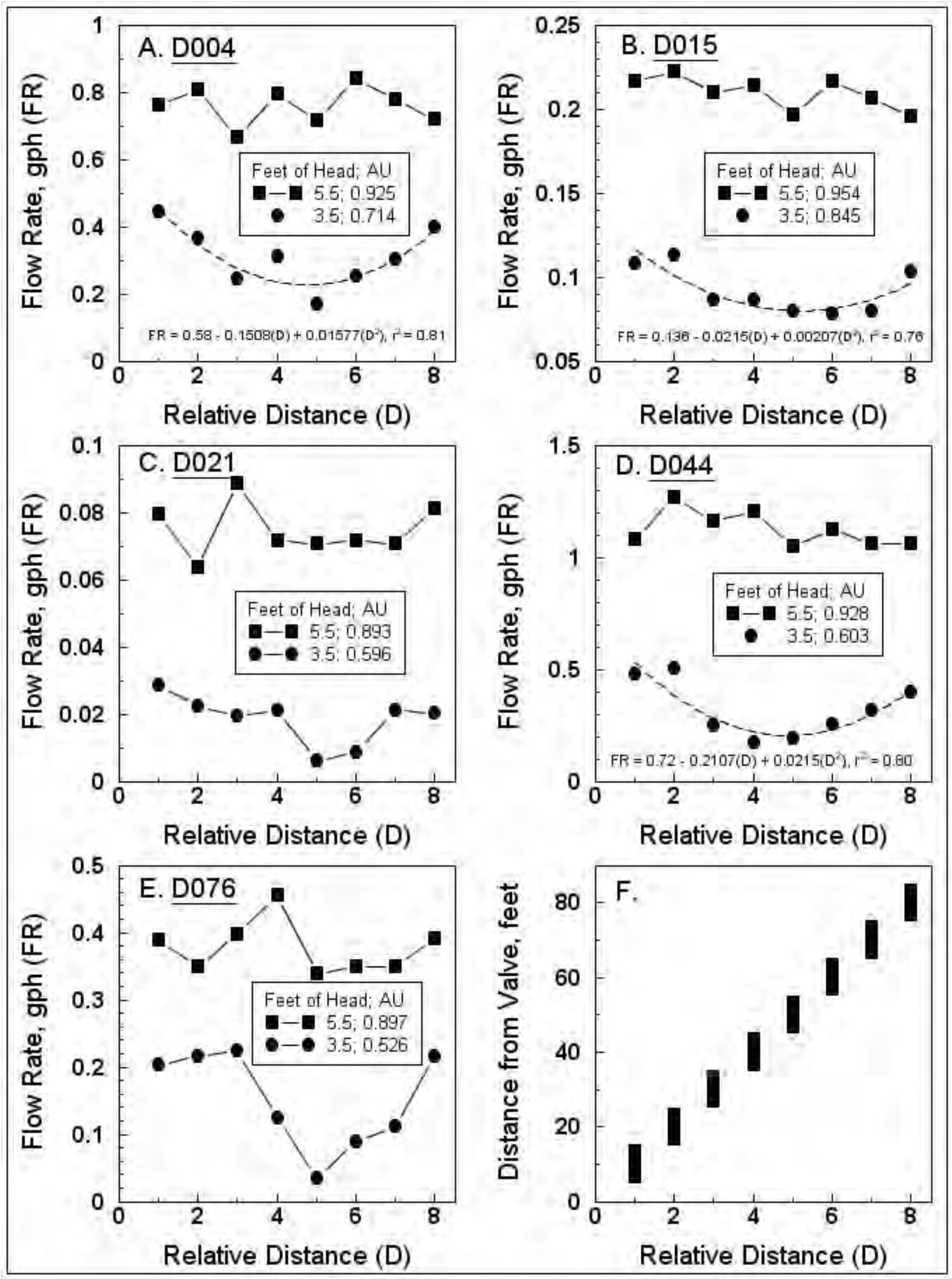

Figure 5. **Measured flow rates of five emitters (A – E) in eight replications located different distances (graph F) away from the tank valve (lateral 1) at two different water level heights (head). Significant correlations based on regression analyses are shown with dashed lines and descriptive equations. AU = calculated water application uniformity (1 – cv); NMSU Agricultural Science Center at Farmington, NM. 2011.**

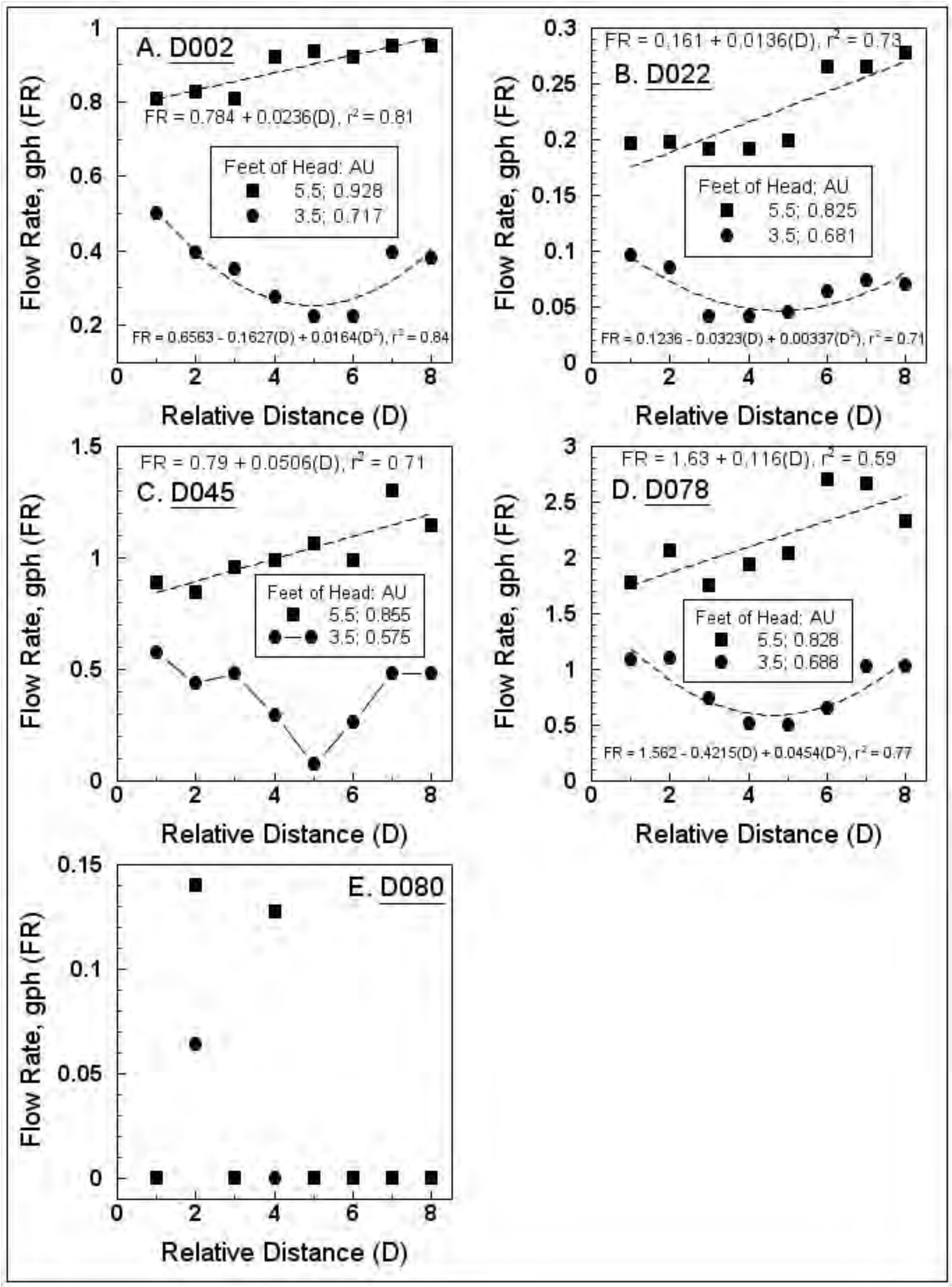

Figure 6. **Measured flow rates of five emitters (A – E) in eight replications located different distances (Figure 5, F) away from the tank valve (lateral 2) at two different water level heights (head). Significant correlations based on regression analyses are shown with dashed lines and descriptive equations. AU = calculated water application uniformity (1 – cv); NMSU Agricultural Science Center at Farmington, NM. 2011.**

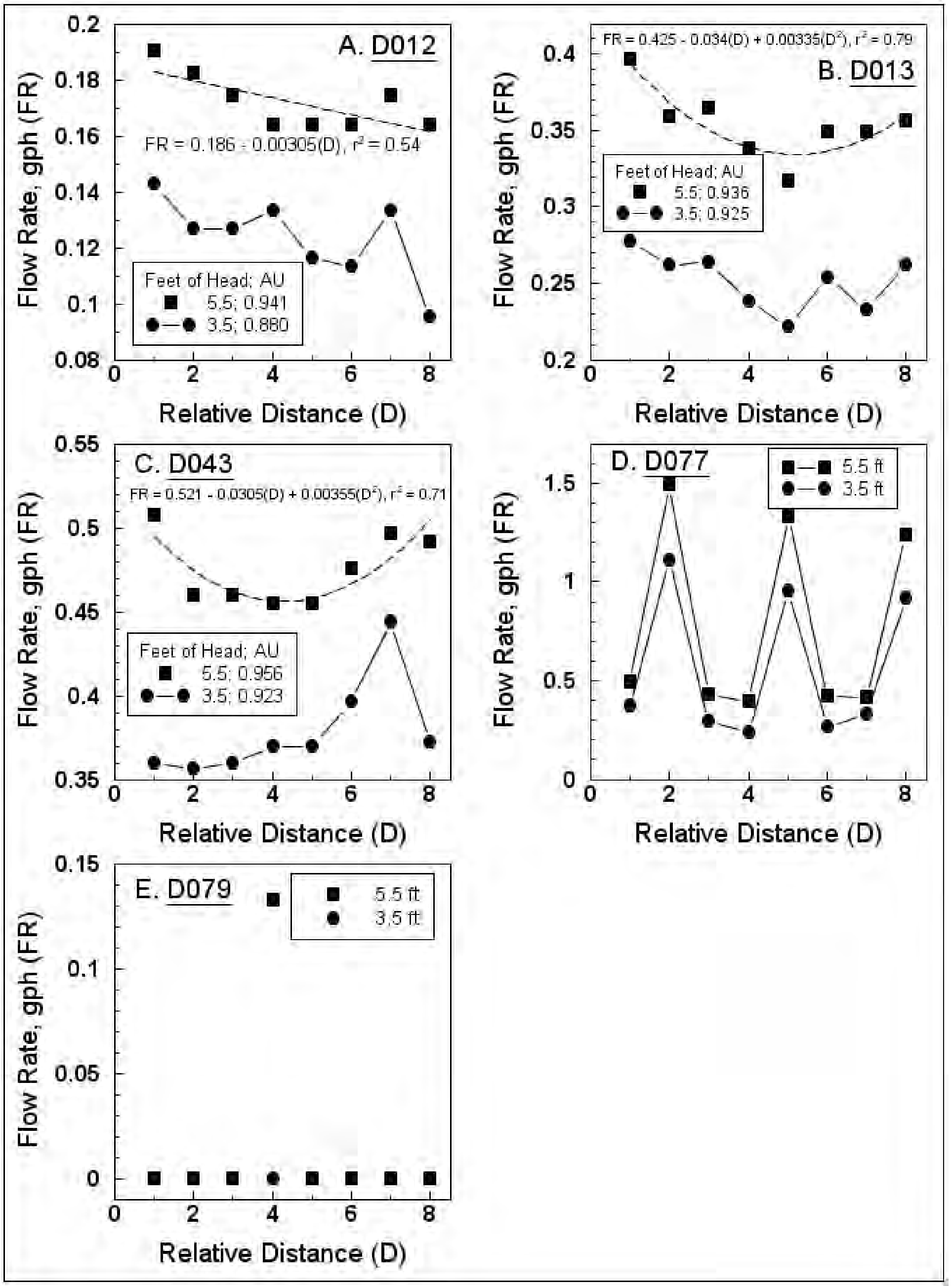

Figure 7. **Measured flow rates of five emitters (A – E) in eight replications located different distances (Figure 5, F) away from the tank valve (lateral 3) at two different water level heights (head). Significant correlations based on regression analyses are shown with dashed lines and descriptive equations. AU = calculated water application uniformity (1 – cv); NMSU Agricultural Science Center at Farmington. NM. 2011.**

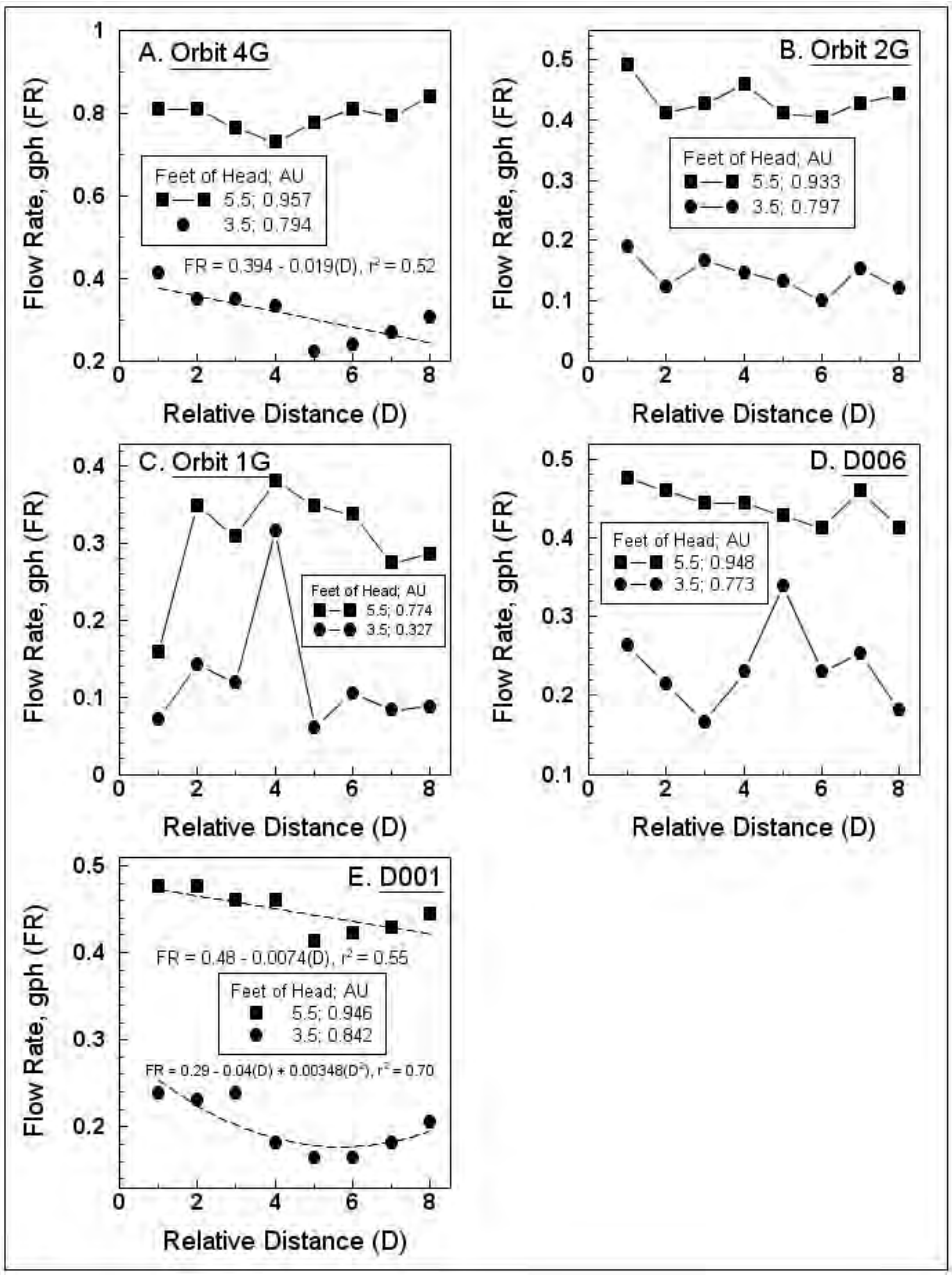

Figure 8. Measured flow rates of five emitters (A – E) in eight replications located different distances (Figure 5, F) away from the tank valve (lateral 4) at two different water level heights (head). Significant correlations based on regression analyses are shown with dashed lines and descriptive equations. AU = calculated water application uniformity (1 – cv); NMSU Agricultural Science Center at Farmington, NM. 2011.

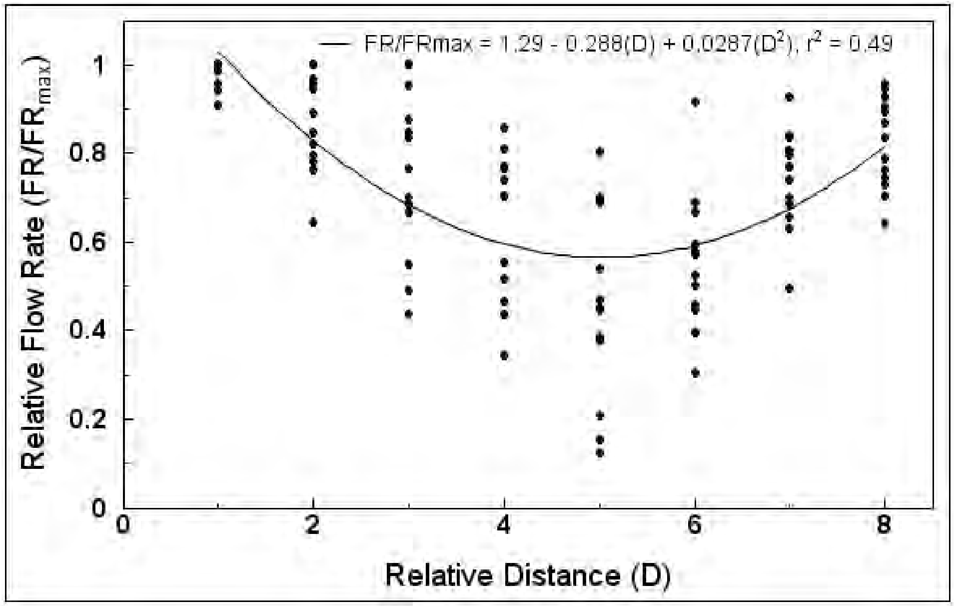

Figure 9. Relative emitter flow rate (FR of emitter at point D / maximum FR of same model) as related to relative distance (Figure 5, F) of emitter away from tank valve at a head of 3.5 feet. Points for only those emitters that exhibited lower FR near middle of lateral (13 of 20 models) are shown; NMSU Agricultural Science Center at Farmington, NM. 2001.

Summary and conclusions

To irrigate efficiently, and provide garden or landscape plants with the volume of water they require for adequate quality or growth, the drip irrigator must know the output (FR) and water application uniformity (AU) of the emitter selected. This study has shown that the manufacturer's specified FR for a given emitter cannot be relied on if the available pressure (head) is lower than the minimum recommended by the manufacturer (usually greater than 10 psi or 23 ft). The study has identified the FRs and AUs of several point source emitters at two very low heads (3.5 and 5.5 ft) and it found that most had acceptable FRs and AUs at a head of 5.5 feet. When head was decreased to 3.5 feet, however, the average (all emitters combined) FR decreased by more than 50 % and the average AU decreased about 20 %. In selecting emitters for delivering water from rainwater catch systems or other elevated tanks where heads are low and water level will fluctuate, the best choice would be those that exhibit high AUs and relatively low fluctuations in both FR and AU as water level changes. Emitters (D012, D013, and D043) for example, all exhibited AUs of greater than 0.85 at both heads and FR reductions of less than 30% between the two heads. So, drip irrigation can be a reliable and efficient method of irrigating from low pressure systems if the correct emitter is chosen and the irrigator knows the FR and AU of that emitter.

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

Dan Smeal, Christen Begay, Kevin Hooper, and Joe Ward

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 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 upon 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 61). 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, 2009, 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 10). 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 10).

Plants were irrigated weekly in 2009 at a rate of about 3.5 gals per week for establishment. Irrigation treatments, based on Equation 1, were implemented in 2010. Irrigations were usually applied once per week and the calculated volume of water was delivered to each treatment by manually turning on and off lateral valves after the appropriate runtimes.

$I = ET_R \times TF \times 0.623 \times CA$ .... (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 = average plant canopy area (ft^2)

In 2011, plant canopy area (CA) and height measurements were taken in May and August to evaluate the effect of irrigation treatment on plant growth and survival. Two plant diameter (D) measurements were taken, one from east to west (D1) and the other from north to south (D2). Plant CA (in ft^2), assumed to be circular, was calculated as D1 x D2 x 0.785. Plant height was measured with an 8-foot long piece of PVC pipe marked with 1-inch gradations.

Table 61. 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. 2011.

Species (common name)	Species (common name)
Amelanchier spp. (serviceberry) - B	*Chamaebatiaria millefolium* (fernbush) - P
Chilopsis linearis (desert willow) - P	*Fallugia paradoxa* (Apache plume) - P
Forestiera neomexicana (New Mexico privet) - 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

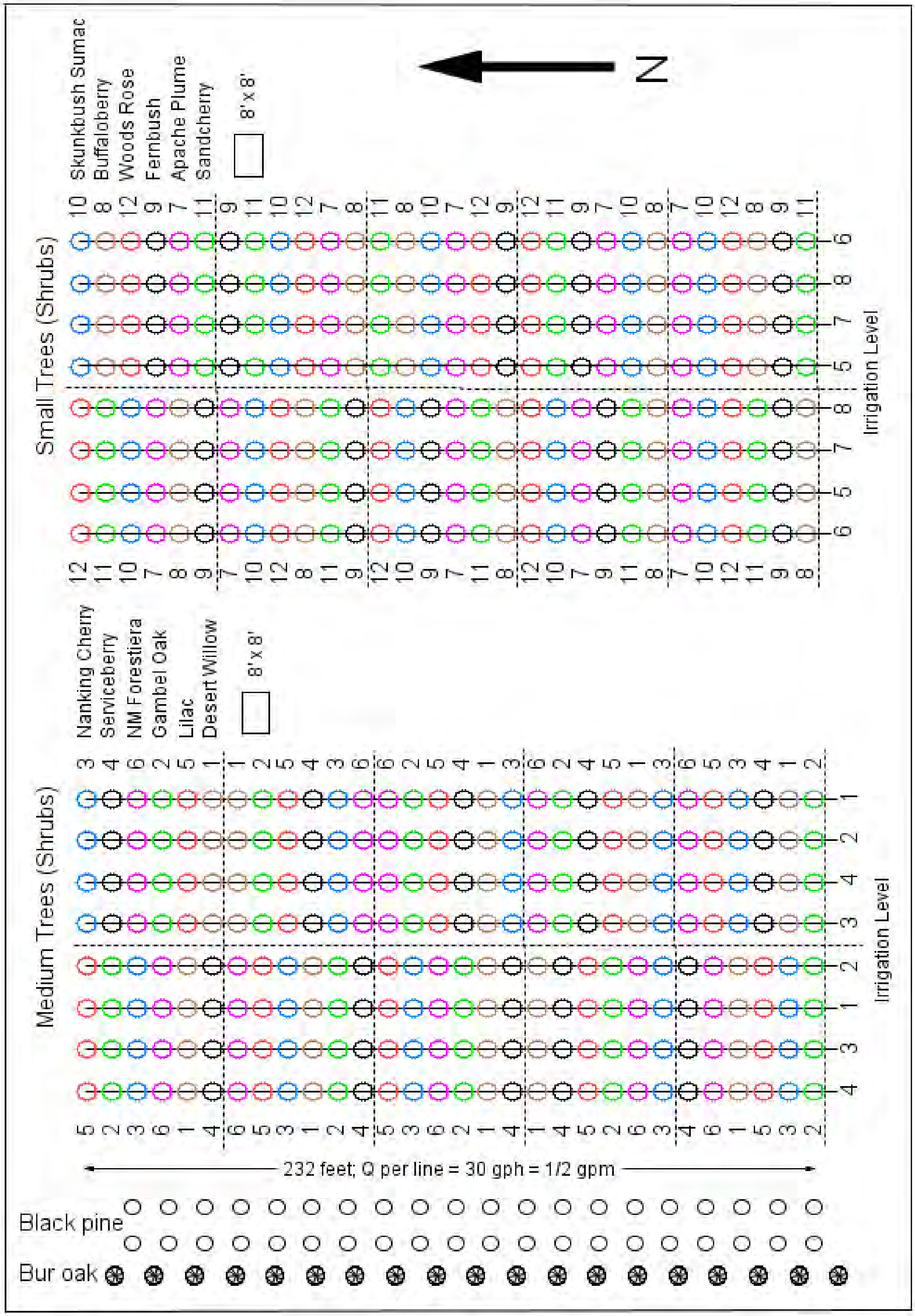

Figure 10. Plot diagram for the study designed to evaluate the drip irrigation requirements of trees and shrubs; NMSU Agricultural Science Center at Farmington, NM. 2011.

Results and discussion

Irrigation (2011)

Drip irrigations were scheduled on an approximate weekly basis from May 2 to September 29. Different irrigation (I) treatments were initiated to all plants except the bur oaks and black pines after May 10. Total I applied during the season ranged from one application of 3.0 gallons per plant (gpp) at the no I treatment (level 1) to 28 applications totaling about 156 gpp at the high (I level 4) treatment (Table 62). An additional 6.9 inches of precipitation occurred during 2011.

Table 62. Record of drip irrigations applied to drought-tolerant trees and shrubs at four different irrigation treatments; NMSU Agricultural Science Center at Farmington, NM. 2011.

Date	Bur Oak	Black Pine	—— Large Trees (west plot) ——				—— Small Trees (east plot) ——			
	All	All	No (1)	Low (2)	Med (3)	High (4)	No (1)	Low (2)	Med (3)	High (4)
	gallons per plant (gpp)									
5/2	2.0	2.0	0	0	0	0	0	0	0	0
5/9	0	0	3.0	3.0	3.0	3.0	0	0	0	0
5/10	0	0	0	0	0	0	3.0	3.0	3.0	3.0
5/25	2.2	2.2	0	1.2	2.2	3.4	0	1.1	2.2	3.4
6/2	5.7	5.7	0	3.3	5.7	5.7	0	3.3	5.7	5.7
6/3	0	0	0	0	1.8	4.2	0	0	1.8	4.2
6/8	4.7	2.2	0	2.2	4.7	8.2	0	2.2	4.7	8.2
6/16	6.3	3.7	0	3.7	6.3	6.3	0	3.7	6.3	6.3
6/17	0	0	0	0	0	3.0	0	0	0	3.0
6/30	8	4	0	4	8	8	0	4	8	8
7/1	0	0	0	0	0	4	0	0	0	4
7/6	8	4	0	4	8	8	0	4	8	8
7/8	0	0	0	0	0	4	0	0	0	4
7/14	5	2.5	0	2.5	5	7.5	0	2.5	5	7.5
7/21	6	4	0	3	6	6	0	3	6	6
7/22	0	0	0	0	0	4	0	0	0	4
7/28	5	5	0	5	8	8	0	8	8	8
7/29	0	0	0	0	0	3.5	0	0	0	3.5
8/4	4.5	4.5	0	2.8	2.8	7.3	0	2.8	2.8	7.3
8/9a	0	0	0	0	0	0	0	3	3	3
8/11	2.7	3.7	0	1.5	1.5	1.5	0	0	0	0
8/11[a]	0	0	0	3.6	3.6	3.6	0	0	0	0
8/16[b]	3	3	0	3			0	3		
8/17[a]	1.8	1.8	0	5.5	5.5	5.5	0	5.5	5.5	5.5
8/19	3	3	0	3	3	3	0	3	3	3
8/24	4.3	4.3	0	4.3	4.3	4.3	0	4.3	4.3	4.3

Date	Bur Oak	Black Pine	—— Large Trees (west plot) ——				—— Small Trees (east plot) ——			
	All	All	No (1)	Low (2)	Med (3)	High (4)	No (1)	Low (2)	Med (3)	High (4)
	gallons per plant (gpp)									
8/25	0	0	0	0	3	8	0	0	3	8
8/29	FLOOD in center of field (east side of west plot and west side of east plot)									
9/1[c]	6	3	0	3.3	6	6	0	3.3	6	6
9/8	7	7	0	4	7	7	0	4	7	7
9/21	6	6	0	4	8	8	0	4	8	8
9/22	0	0	0	0	0	4	0	0	0	4
9/28	6	6	0	4	8	8	0	4	8	8
9/29	0	0	0	0	0	4	0	0	0	4
Totals	**97.2**	**77.6**	**3.0**	**70.9**	**111.4**	**157.0**	**3.0**	**71.7**	**109.3**	**154.9**

[a] Miracle Grow – 1.25 lb in 30 gals water; west plot on 8/11, east plot on 8/17.
[b] Fertilized pines and oaks only – 1.25 lbs/60 plants 24-8-16 all purpose
[c] From 9/1 to 9/29 - irrigated only the west side of west plot and east side of east plot due to flood.

Height and canopy area (2011)

There was no significant difference (P ≤ 0.05) between plant heights measured at different I levels within any given species in the west plot in either May or August (Table 63). New Mexico privet (*F. neomexicana*) had the greatest mean height of the six species in this plot at all I levels in both May and August (4.24 and 4.49 feet, respectively). Desert willow (*C. linearis*) was not measured in May since it had not yet broken dormancy, but in August, it had the second greatest mean height of 3.88 feet (Table 63). Overall, all plants increased in height between May and August at all I levels. Gambel oak (*Q. gambelii*) was short but exhibited the greatest rate of growth between May and August of 30.7 %, followed by that of serviceberry (*Amelanchier sp*.) at 27.0 % and Nanking cherry (*P. tomentosa*) at 14.6 %.

Table 63. Average[†] measured height (feet) of six plant species at four different drip irrigation (I) levels in the west plot of study area in May and August; NMSU Agricultural Science Center at Farmington, NM. 2011.

Species		I Level, total gals / plant				
		3.0	**70.9**	**111.4**	**157.0**	**Mean**
Forestiera neomexicana	May	4.71	3.97	3.69	4.58	4.24
	August	4.69	4.32	3.93	5.03	4.49
Prunus tomentosa	May	3.16	2.96 (9)	2.62	2.75	2.87
	August	3.42	3.27 (9)	3.18	3.27	3.29
Syringa vulgaris	May	2.30	2.20	2.54	2.22	2.32
	August	2.48	2.26	2.59	2.32	2.41
Amelanchier spp.	May	1.53	1.59	1.70	1.70	1.63

Species		I Level, total gals / plant				
		3.0	70.9	111.4	157.0	Mean
	August	1.94	1.90	2.11	2.31	2.07
Quercus gambelii	May	1.29 (9)	1.66	2.26	1.55	1.69
	August	1.77(9)	1.99	2.58	2.48	2.21
Chilopsis linearis	May ±	-	-	-	-	-
	August	3.65 (6)	3.93	4.09 (9)	3.86	3.88

† Numbers in parentheses represents the number of replications used in calculating that mean value, all other values represent the mean of 10 replications.
± *Chilopsis linearis* had not yet broken out of dormancy
ANOVA indicated no significant differences in plant heights between different irrigation levels within any species in neither month.

There was a positive correlation between height and measured canopy area for the six species of the west plot such that the tallest plants generally also had the largest canopy areas (Table 64). Unlike with height however, irrigation treatment had a significant positive effect on the measured August canopy area of most species. The increase in august CA with I showed a linear trend in NM privet, Nanking cherry, gambel oak, and desert willow (Table 64) but in the lilac (S. vulgaris), maximum CA was measured at I level 3 (111.4 gpp) and in the serviceberry, CA was not significantly different between I levels 1, 2 and 3 (mean of 4.7 ft^2) but was significantly greater (7.8 ft^2) at I level 4 (157 gpp).

Table 64. Average† measured canopy area (ft^2) of six plant species at four different drip irrigation (I) levels in the west plot of study area in May and August; NMSU Agricultural Science Center at Farmington, NM. 2011.

Species	Month	I Level, total gals / plant				
		3.0	70.9	111.4	157.0	Mean
Forestiera neomexicana	May	15.4	18.0	18.8	17.7	17.5
	August	19.8 b	23.0 ab	25.5 a	27.4 a	23.9
Prunus tomentosa	May	6.7	6.2 (9)	6.0	6.4	6.3
	August	8.5	9.1 (9)	10.6	11.3	9.9
Syringa vulgaris	May	3.4	3.9	5.5	4.4	4.3
	August	3.7 b	3.8 b	5.5 a	4.7 ab	4.4
Amelanchier spp.	May	2.5 ab	3.4 a	1.5 b	2.8 a	2.6
	August	4.2 b	5.7 b	4.2 b	7.8 a	5.5
Quercus gambelii	May	1.0 (9)	1.6	4.0	2.0	2.2
	August	1.8 b (9)	2.4 b	3.6 ab	4.3 a	3.0
Chilopsis linearis	May	-	-	-	-	-
	August	6.2 b (6)	12.3 ab	15.2 a (9)	16.0 a	12.4

† Numbers in parentheses represent the number of replications used in calculating that mean value, all other values represent the mean of 10 replications. Values in a row followed by the same letter are not significantly different than each other based on ANOVA at the 0.05 level of significance. The absence of letters indicates no significant difference between values within a row.

There was no significant difference ($P \leq 0.05$) between May plant heights measured in the east plot at different levels of I within any given species (Table 65). In August, the average height of buffaloberry (*S. argentea*) at I level 1 was significantly less than the measured heights at the 3 higher I levels but the August heights between I levels within the other species were not significantly different. The heights of all species increased from May to August in all I treatments. Mean heights ranged from 1.99 ft to 2.81 in May, and from 2.24 ft to 3.53 ft in August for the 3-leaf sumac (*R. trilobata*) ft and buffaloberry, respectively, but buffaloberry exhibited heights greater than 3.8 ft at I levels 3 and 4 (Table 65).

Table 65. Average† measured height (feet) of six plant species at four different drip irrigation (I) levels in the east plot of study area in May and August; NMSU Agricultural Science Center at Farmington, NM. 2011.

		I Level, total gals / plant				
Species	**Month**	**3.0**	**71.7**	**109.3**	**154.9**	**Mean**
Rhus trilobata	May	2.03	2.14	1.85	1.92	1.99
	August	2.23	2.36	2.08	2.27	2.24
Chamaebatiaria millefolium	May	2.87 (9)	2.85	2.48	2.79	2.75
	August	3.37 (9)	3.24	3.32	3.36	3.32
Fallugia paradoxa	May	2.03 (5)	2.09 (9)	1.95 (9)	2.04 (6)	2.03
	August	2.57 (5)	3.42 (9)	2.99 (9)	3.31 (6)	3.07
Prunus besseyi	May	2.04	2.32	2.16	2.19	2.18
	August	2.41	2.63	2.47	2.61	2.53
Rosa woodsii	May	2.25	2.40	2.47	2.74	2.47
	August	2.36	2.50	2.64	2.98	2.62
Shepherdia argentea	May	2.28	3.11 (8)	2.85 (8)	2.98 (8)	2.81
	August	2.68 b	3.73 a (8)	3.84 a (8)	3.88 a (8)	3.53

† Numbers in parentheses represent the number of replications used in calculating that mean value, all other values represent the mean of 10 replications. Values in a row followed by the same letter are not significantly different than each other based on ANOVA at the 0.05 level of significance. The absence of letters indicates no significant difference between values within a row.

Unlike height, which did not vary considerably between I levels or even between species or time in the east plot, CA did show a response to I level in some species and did increase substantially from May to August in most species (Table 66). Canopy areas of sandchherry (*P. besseyi*), fernbush (*C. millefolium*), Apache plume (*F. paradoxa*), and buffaloberry, for example, doubled, or nearly doubled between May and August at the higher I levels. Generally, August CA was greater at irrigated plots (I levels 2, 3, and 4) than at the no irrigation plot (I level 1), but in 3-leaf sumac and fernbush, there was no distinct relationship between CA and I (Table 66).

Table 66. Average† measured canopy area (ft^2) of six plant species at four different drip irrigation (I) levels in the east plot of study area in May and August; NMSU Agricultural Science Center at Farmington, NM. 2011.

		I Level, total gals / plant				
Species	**Month**	**3.0**	**71.7**	**109.3**	**154.9**	**Mean**
Rhus trilobata	May	10.2	9.2	11.9	10.2	10.4
	August	12.2 bc	11.3 c	15.9 a	14.7 ab	13.5
Prunus besseyi	May	3.7 b	7.6 a	6.9 a	7.7 a	6.5
	August	7.0 c	12.4 b	12.6 b	17.4 a	12.4
Chamaebatiaria millefolium	May	6.7 (9)	5.4	5.9	5.7	5.9
	August	12.0 (9)	9.7	11.7	10.6	11.0
Rosa woodsii	May	7.2	6.1	6.9	8.0	7.1
	August	7.9 b	7.6 b	10.3 a	11.2 a	9.3
Fallugia paradoxa	May	6.5 (5)	5.8 (9)	4.7 (9)	5.6 (6)	5.7
	August	7.0 (5)	10.2 (9)	9.6 (9)	10.0 (6)	9.2
Shepherdia argentea	May	3.1	4.5 (8)	4.0 (8)	3.5 (8)	3.8
	August	4.1 b	8.5 a (8)	8.6 a (8)	8.2 a (8)	7.4

† Numbers in parentheses represent the number of replications used in calculating that mean value, all other values represent the mean of 10 replications. Values in a row followed by the same letter are not significantly different than each other based on ANOVA at the 0.05 level of significance. The absence of letters indicates no significant difference between values within a row.

The mortality of plants, as indicted by the number of replications shown for Apache plume and buffaloberry in Table 65 and Table 66, and desert willow in Table 63 and Table 64 was caused by trunk girdling by cutworms when the plants were very small prior to initiation of irrigation treatments.

Summary and conclusions

This research study will be continued in 2012. Conclusions as to survival and growth of the species in the long term cannot be drawn at this time. Preliminary findings indicate that all species in the study seem capable of surviving in the short term with very limited supplemental irrigation after establishment.

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

Funds provided by the USDA and Kansas State University

Dan Smeal, Mick O'Neill, Joe Ward, and Margaret West

Abstract

This was the second year of a study 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. There was a trend of increasing yield with irrigation, which ranged from 15.5 to 28.5 inches, but statistically significant linear regressions between these two variables were exhibited by only two of the six varieties; Sitro and Flash. Adverse effects of bird feeding activity, gopher damage, and winterkill masked the irrigation treatment effects on canola seed yield in 2011.

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 on September 2, 2010 in a plot area 100 feet wide by 160 feet long. The plot area (which had been disk-harrowed previously) was fertilized on September 1, 2010 with ammonium sulfate (20-0-0) and monoammonium phosphate (11-52-0) at total N and P2O5 rates of 87 and 79 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 in 68-inch wide beds at a row spacing of 11 inches (6 rows per bed) in plot lengths of 20 feet at a seeding rate of 0.25 ounces per bed (6.0 lbs/acre) with a small-plot cone seeder. Three irrigation lines, set up on September 3 after planting, were used to apply uniform irrigation for seed germination and establishment. The initial irrigation (1.6 inches) was applied on September 3 and the entire plot area was irrigated uniformly about every 3 to 5 days up through October 4 (Table 67). Irrigation treatments were initiated on October 15. The initial spring irrigation treatment was applied on April 13, 2011 and treatments continued through July 6, 2011 (Table 67). The plots were harvested on July 26, 2011 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 67. Calculated reference ET (ETRS) and average irrigation depths applied to winter canola varieties with the sprinkler line source; NMSU Agricultural Science Center at Farmington, NM, 2011.

		Average Irrigation Treatment (inches)[†]					
	ET_{RS}	Distance from SLS (feet)					
Date	(in)	36.8	31.2	25.5	19.8	14.2	8.6
9/03/10	0.34[‡]	1.60	1.60	1.60	1.60	1.60	1.60
9/07/10	1.34	0.35	0.35	0.35	0.35	0.35	0.35
9/12/10	1.29	0.45	0.47	0.46	0.45	0.45	0.46
9/16/10	1.02	0.55	0.55	0.57	0.57	0.58	0.57
9/21/10	1.54	0.30	0.30	0.29	0.29	0.29	0.29
9/27/10	1.23	0.95	0.90	0.90	0.93	0.98	1.05
10/04/10	1.78	0.99	1.00	1.03	1.04	1.07	1.05
10/15/10	2.30	0.20	0.28	0.35	0.46	0.59	0.71
4/13/11	22.82	0.56	0.62	0.73	0.90	1.08	1.28
4/18/11	1.57	0.35	0.47	0.61	0.75	0.92	1.10
4/20/11	0.65	0.18	0.27	0.36	0.47	0.58	0.68
5/02/11	3.06	0.20	0.34	0.45	0.59	0.75	0.87
5/06/11	1.14	0.18	0.28	0.39	0.49	0.64	0.78
5/13/11	2.49	0.33	0.52	0.65	0.83	1.00	1.07
5/23/11	3.08	0.26	0.40	0.57	0.68	0.77	0.96
5/27/11	1.40	0.31	0.38	0.49	0.66	0.81	1.06
5/31/11	1.94	0.24	0.30	0.39	0.52	0.71	0.92
6/03/11	1.50	0.17	0.25	0.38	0.52	0.66	0.78

	Average Irrigation Treatment (inches)†						
	ET_{RS}	Distance from SLS (feet)					
Date	(in)	36.8	31.2	25.5	19.8	14.2	8.6
6/07/11	1.90	0.22	0.34	0.47	0.61	0.76	0.89
6/10/11	1.25	0.29	0.44	0.57	0.69	0.79	0.87
6/15/11	1.93	0.12	0.16	0.21	0.26	0.32	0.35
6/17/11	0.96	0.22	0.26	0.34	0.46	0.57	0.74
6/21/11	1.70	0.28	0.41	0.48	0.54	0.57	0.63
6/23/11	0.72	0.25	0.33	0.46	0.59	0.76	0.92
6/27/11	1.97	0.25	0.35	0.45	0.57	0.67	0.76
6/30/11	1.48	0.03	0.10	0.26	0.39	0.45	0.46
7/06/11	2.66	0.35	0.42	0.50	0.58	0.66	0.70
Totals	**65.1**	**10.2**	**12.1**	**14.3**	**16.8**	**19.4**	**21.9**

† Irrigation values represent the average of two plots equidistant (but on opposite sides) from the SLS.
‡ Reference ET from planting (5/2) to first irrigation on 5/3.

Results and discussion

Total irrigation applied to the plots from planting (5/2/2010) to harvest (7/26/2011) ranged from a high of 21.9 in at the plots closest to the SLS (8.6 ft) to a low of 12.7 in at the plots farthest (36.8 ft) from the SLS (Table 67). An additional 5.89 in of precipitation occurred during this same time period. Reference ET (ET_{RS}) totaled 65.1 inches but 22.8 inches of this was calculated from October 15, 2010 through April 13, 2011, a period of relative dormancy.

Several factors adversely affected canola seed production during the 2010 – 2011 growing season. Seed germination and seedling emergence seemed uniform and normal but plant stands were significantly reduced during the winter due to hard freezes and pocket gopher damage (Figure 11). The east side of the study plot sustained the most damage with estimated stand reductions ranging from near zero in some plots to more than 50% in others (Table 68). Two cold fronts that dropped temperatures below zero, one in early January and another in early February, may have contributed to freeze kill. About 50% of total stand reduction in some plots were caused by mound building, and feeding on plant roots or foliage by pocket gophers (Table 68). Feeding activity by birds also reduced seed yields below potential (Figure 12).

Figure 11. Example of winterkill (left) and gopher mound damage (right) in canola; NMSU Agricultural Science Center – Farmington, NM. 2011.

Figure 12. Example of bird damage in canola plot; NMSU Agricultural Science Center – Farmington, NM. 2011.

Table 68. Approximate stand loss (%) of winter canola in the east side of the line-source irrigation study at Farmington ASC. The first number (or single number) within a table cell represents the total estimated percent stand loss. The second number indicates apparent (%) loss due to gopher mounds and is included in the total stand loss; NMSU Agricultural Science Center at Farmington, NM. 2011.

Variety	Estimated Stand Loss (%) — Distance from Sprinkler Line (feet)					
	36.8	31.2	25.5	19.8	14.2	8.6
Sitro	25	12	8	5	2	5
Safran	50	17 (3)	2	2	3 (1)	1
Hybristar	40 (20)	30 (12)	20 (10)	55 (15)	20 (2)	30 (4)
Hybrisurf	50 (15)	28 (8)	18	7	12	55
Flash	55 (10)	15 (5)	2	2	4	6
Virginia	20 (5)	10 (3)	8 (3)	20 (5)	10	28

Because of these yield-limiting factors, canola seed yields were erratic and much lower than expected based on comparisons with production data from previous years at the study site. While there was a general trend of increasing yield with increasing water applied, statistically significant, positive relationships between these variables were exhibited by only two of the six varieties; Sitro and Flash. Sitro produced the greatest yield of 1500 lbs/acre at an irrigation level of 27.5 in while Virginia tended to produce the lowest yields at most irrigation levels (Figure 13).

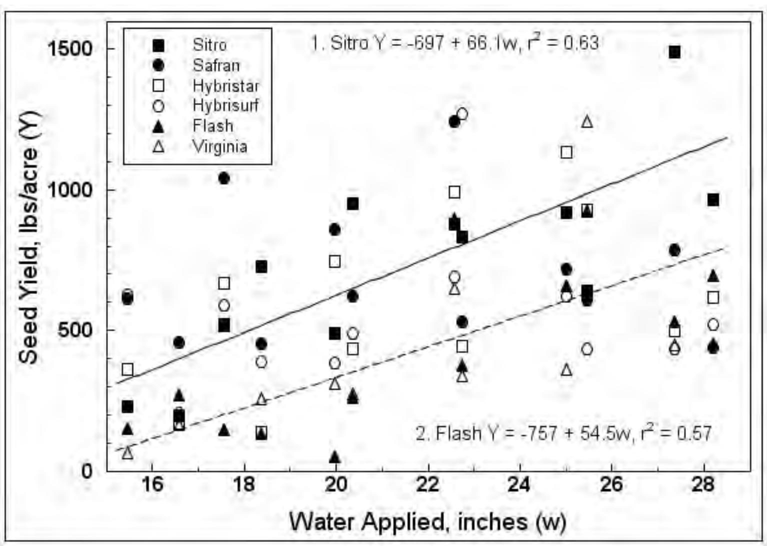

Figure 13. Seed yields (adjusted to 10% moisture content) of six winter canola cultivars as related to total water applied from planting (09/02/2010) to harvest (07/26/11) and where applicable, best fit regression lines describing the relationships. Water applied includes 5.89 in of precipitation; NMSU Agricultural Science Center at Farmington, NM. 2011.

Summary and conclusions

Winter canola responded positively to increased irrigation but yields were reduced by a variety of factors. Winter canola yields from previous studies at the ASCF, including those from variety trials conducted over the past few years, have exceeded 4000 lbs/acre. In 2010, Sitro and Safran were the two highest yielding varieties in variety trials and in an irrigation study, Sitro produced the second highest yield of more than 2700 lbs/acre at an irrigation level of 30 inches. Irrigation studies of canola using a line source design are somewhat difficult due to the effect water stress has on the maturation rate of the crop. This effect, coupled with variability in the maturation rate between varieties creates some problems in deciding the optimum harvest time for the study plots. Some pods may be fully mature and shatter easily before or during harvest, while others may be immature and not shatter during harvesting. The sprinkler line-source design, while it conserves space and provides a continuous gradient of irrigation treatments, may not be the best design for studying the irrigation requirements of canola because of this maturation variability.

New Mexico Plants for Pollinators Project

Tessa Grasswitz, Dan Smeal, Dave Dreesen, Keith White, Alex Taylor, Margaret West, Christen Begay, Joe Ward

Introduction

In recent years, sharp declines in honeybee populations due to Colony Collapse Disorder have led to financial hardship for beekeepers and increased costs for growers of various crops who rent hives for pollination services. Research indicates that wild native bees can often fill the 'pollination gap' when honeybees are scarce, and there is increasing interest amongst farmers and home gardeners in growing flowering plants that will help sustain our native bees, honeybees, and other beneficial insects.

Federal cost-share programs now exist to help farmers establish such plantings (e.g. the NRCS's 'EQIP' programs), but until recently, little guidance has been available on the best plants to use in New Mexico. A pilot project was started in 2010 at the Los Lunas Agricultural Science Center to help meet this need by assessing more than 80 species of (mostly native) plants for their survival, ease of cultivation and ability to attract and retain beneficial insects. In 2011, similar plantings were established at NMSU's Farmington ASC and at two additional sites (Tucumcari and Vado) to compare the performance of the plants in different parts of the state. The ultimate aim of the project is to produce a robust list of recommended 'pollinator plants' for use in New Mexico.

The 2011 plantings were established relatively late in the season, but sufficient species bloomed to attract an impressive diversity of native bees, predatory wasps and other beneficial insects. Two collections were made of the insect fauna at the Farmington site in 2011, and while these specimens are still being processed, they include some taxa that have not been found at the other sites. Further monthly collections are planned for 2012.

Objectives

- Evaluate the survival, ease of cultivation, and ability to attract and retain beneficial insects of several species of (mostly native) flowering plants in northwestern New Mexico

Material and methods

More than 100 species of plants were planted in four, 220 foot long rows on July 7, 2011. A single drip tape was laid on the soil surface in each row and it was covered with a 3 foot wide weed barrier prior to planting. The drip system was then used to wet the soil for planting. Holes were punched in the weed barrier at an in-row spacing of about 1 foot on each side of the drip tubing and seedlings were transplanted into the holes. A total of 1081 individual plants were transplanted and the number of individual plants per species varied (Table 69).

A 5.5 hour irrigation with the drip system was applied on the day after planting (7/8) and the plants were irrigated an average of twice per week afterward at an average rate of 2 hours and 45 minutes per irrigation (5.5 hours/week).

Table 69. Plant species and number of individuals planted (on 7/8/2011), and inventoried for survival on 8/13/2011 in the plants for pollination plot. Asterisks(*) to right of counts on 8/15 indicate at least some plants of this species were flowering at this time; NMSU Agricultural Science Center at Farmington, NM. 2011.

Species Name	Common Name	Number of Plants 7/8	Number of Plants 8/15
Annuals			
Cleome serrulata	Rocky Mountain beeplant	18	**12** *
Collinsia heterophylla	purple Chinese houses	9	**6** *
Monarda citriodora	lemon beebalm	18	18 *
Gilia capitata	bluehead gilia	18	14 *
Verbesina encelioides	golden crownbeard	6	6 *
Baileya multiradiata	desert marigold	22	22 *
Thymophylla pentachaeta	fiveneedle pricklyleaf	18	18 *
Anthriscus cerefolium	garden chervil	12	6
Lesquerella gordonii	Gordon's bladderpod	12	11 *
Mimulus luteus	seep monkeyflower	6	5
Mimulus guttatus	seep monkeyflower	6	6 *
Cosmos bipinnatus	garden cosmos	11	11 *
Trifolium alexandrinum	Egyptian clover (berseem clover)	16	16 *
Ocimum basilicum	basil	11	10 *
Ammi majus	large bullwort	18	18 *
Helianthus petiolaris	prairie sunflower	8	8 *
Trifolium hybridum	alsike clover	16	16 *
Trifolium hirtum	rose clover (hykon)	10	10 *
Melilotus officinalis	yellow sweetclover	18	18
Tithonia rotundifolia	clavel de muerto	12	11
Coreopsis tinctoria	golden tickseed	18	18 *
Anethum graveolens	dill	14	14 *
Trifolium resupinatum	reversed clover (nitro persian)	17	17 *
Cosmos sulphureus	sulphur cosmos	6	6 *
Melilotus officinalis	white sweetclover	16	16
Oenothera albicaulis	whitest evening primrose	8	7 *
Monarda pectinata	pony beebalm	4	3 *
Lasthenia glabrata	yellowray goldfields	5	1
Machaeranthera bigelovii	Bigelow's tansyaster	12	12
Delphenium sp.		5	0

Species Name	Common Name	Number of Plants 7/8	8/15
Phacelia integrifolia	gypsum phacelia	6	5
Cosmos parviflorus	southwestern cosmos	6	5 *
Trifolium incarnatum	crimson clover	8	8 *
Layia platyglossa	coastal tidytips	12	9 *
Perennials			
Sphaeralcea ambigua	desert globemallow (Orange)	12	12 *
Thelesperma filifolium	stiff greenthread	18	18 *
Symphyotrichum laeve var. *geyeri*	Geyer's aster	24	24
Origanum marjorana	sweet marjoram	11	8
Origanum vulgare	oregano	7	7
Heliomeris multiflora var. *multiflora*	showy goldeneye	24	24 *
Rudbeckia hirta	blackeyed Susan	23	24 *
Penstemon strictus	Rocky Mountain penstemon	24	24
Ratibida columnifera	upright prairie coneflower	23	23 *
Penstemon eatonii	firecracker penstemon	23	23
Monarda fistulosa	wild bergamot	17	17
Ratibida columnifera	mexican hat	24	24 *
Trifolium repens	white clover (Dutch)	24	15
Gaillardia aristata	common gaillardia	18	18
Psilostrophe cooperi	whitestem paperflower	13	4
Sphaeralcea ambigua	desert globemallow (Multi)	6	6 *
Melampodium leucanthum	plains blackfoot	6	6 *
Verbena stricta	hoary verbena	10	10 *
Origanum laevigatum	ornamental oregano	3	1
Liatris aspera	tall blazing star	4	3
Agastache rupestris	threadleaf giant hyssop	6	6 *
Agastache cana	mosquito plant	4	4
Scutellaria lateriflora	blue skullcap	6	6 *
Verbena macdougalii	Mac Dougal verbena	10	10 *
Salvia apiana	white sage	4	3
Epilobium canum	hummingbird trumpet	4	4
Leptosiphon nuttallii	Nuttall's linanthus	4	4 *
Scrophularia lanceolata	lanceleaf figwort	3	3
Hypericum ascyron	great St. Johnswort	4	4
Allium stellatum	autumn onion	4	4
Linum lewisii	Lewis flax	4	3
Linum perenne	blue flax	5	5
Erigeron pulcherrimus	basin fleabane	4	4
Pycnanthemum verticillatum var. *pilosum*	whorled mountainmint	5	5
Sphaeralcea parviflora	smallflower globemallow	6	6

Species Name	Common Name	Number of Plants 7/8	8/15
Achillea millefolium	common yarrow	16	15
Coreopsis lanceolata	lanceleaf tickseed	24	24
Dalea candida	white prairie clover	12	12
Zinnia grandiflora	Rocky Mountain zinnia	10	9
Gaillardia pulchella	firewheel	22	22 *
Salvia officinalis	kitchen sage	16	16
Foeniculum vulgare var. *azoricum*	sweet fennel	11	11 *
Trifolium pratense	red clover (double cut)	16	16
Trifolium fragiferum	strawberry clover (Palestine)	16	16
Trifolium repens	white clover (New Zealand)	16	16 *
Silphium integrifolium	wholeleaf rosinweed	3	3
Symphyotrichum oblongifolium	aromatic aster	4	4
Symphyotrichum ericoides	white heath aster	4	4
Eupatorium purpureum	sweetscented joe pye weed	3	2
Symphyotrichum sericeum	western silver aster	4	4
Xylorhiza tortifolia	Mojave woodyaster	6	6 *
Gaillardia pinnatafida	red dome blanketflower	6	6 *
Eupatorium altissimum	tall thoroughwort	5	5
Xylorhiza venusta	charming woodyaster	3	3
Thelesperma subnudum	Navajo tea	4	3 *
Solidago petiolaris	downy ragged goldenrod	3	3
Solidago nemoralis	gray goldenrod	5	5
Silphium laciniatum	compassplant	5	5
Machaeranthera pinnatifida	lacy tansyaster	11	11 *
Symphyotrichum novae-angliae	New England aster	5	5
Dalea cylindriceps	Andean prairie clover	4	4
Pycnanthemum tenuifolium	narrowleaf mountainmint	6	6
Salvia arizonica	desert indigo sage	3	2 *
Sphaeralcea laxa	caliche globemallow	4	4 *
Lesquerella fendleri	Fendler's bladderpod	3	1
Rudbeckia subtomentosa	sweet coneflower	5	5
Heterotheca camporum	lemonyellow false goldenaster	5	5 *
Scrophularia californica	California figwort	4	4
Thermopsis divaricarpa	spreadfruit goldenbanner	3	3
Lotus rigidus	shrubby deervetch	3	2
Penstemon fendleri	Fendler's penstemon	12	12
Eriogonum ovalifolium (robust form)	cushion buckwheat	6	4
Penstemon virgatus	upright blue beardtongue	4	4

Results and discussion

Most of the plants in the pollinator study survived and grew well. A plant inventory taken on 8/15, about a month after planting showed a mortality of greater than 50% for only six of the 107 species. Of these six, only *Delphinium* sp. had no live individuals on 8/15 (Table 69). Most of the annuals, and about a third of the perennials were in flower one month after planting (Table 69). This research study will continue in 2012.

Literature cited

Albuquerque Bernalillo County Water Utility Authority. 2009. Rebates - Outdoor. Online. http://www.abcwua.org/content/view/123/199/ (verified 01 Feb. 2011).

Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. Irrig. Drain. Paper 56. Food and Agriculture Organization (FAO) U.N. Rome.

Arenofsky, J. 2010. Valley fever blowin' on a hotter wind. The Daily Climate - A publication of Environmental Health Sciences. Online. http://wwwp.dailyclimate.org/tdc-newsroom/valley-fever/Valley-Fever-blowin2019-on-a-hotter-wind (posted 6 Oct. 2010, verified 6 Oct. 2010)

Belin, A., C. Bokum, and F. Titus. 2002. Taking charge of our water destiny: A water management policy guide for New Mexico in the 21st century. Cottonwood Printing, Albuquerque.

Bernstein, L., and L.E. Francois. 1973. Comparison of drip, furrow, and sprinkler irrigation. Soil Sci. 115:73-86.

Camp, C.R. 1998. Subsurface drip irrigation: A review. Trans. A.S.A.E. 41(5):1353-1367.

Clow, D. W., 2010: Changes in the timing of snowmelt and streamflow in Colorado: A response to recent warming. Online. J. Climate, 23:2293–2306. doi: 10.1175/2009JCLI2951.1

CoStat 6. 2001. Statistical software. CoHort. Monterey, CA

Engelbert, E.A., and A.F. Scheuring (eds.) 1984. Water Scarcity. Impacts on western agriculture. Univ. Calif. Press, Berkeley.

Guido, Z. 2008. Mountain Snowpack in the West and Southwest. Southwest Climate Change Network. Online. http://www.southwestclimatechange.org/impacts/water/snowpack (posted 15 Sept. 2008, verified 6 Oct. 2010).

Hanks, R.J., J.Keller, V.P. Rasmussen, and G.D. Wilson. 1976. Line source sprinkler for continuous variable irrigation-crop production studies. Soil Sci. Soc. Am. J. 40:426-429.

Lansford, R.R., J.W. Hernandez, G. Bruner, C. Lightfoot, J. Costello, and B.J. Creel. 1988. Water supply and demand for New Mexico, 1985-2030 Resource Data Base. Misc. Rep. No. 18. New Mexico Water Resources Res. Inst. Las Cruces.

Majewski, M.S. and P.D. Capel. 1996. Pesticides in the Atmosphere: Distribution, Trends, and Governing Factors. CRC Press, Boca Raton, FL

New Mexico Climate Center. http://weather.nmsu.edu/ (verified 24 Feb. 2012).

NMSU ASCF, 2005-2010. New Mexico State University Agricultural Science Center at Farmington Annual Reports. Online. http://aces.nmsu.edu/aes/farm/projects--results.html. (verified 2 Nov. 2010).

Office of the State Engineer. 2009. Roof-reliant landscaping: Rainwater harvesting with cistern systems in New Mexico. Online. http://www.ose.state.nm.us/wucp_RoofReliantLandscaping.html (verified 15 Mar. 2011)

Powers, M. 2009. Effects of global warming on snowpack in the Colorado River Basin. Worcester Polytechnic Institute - Electronic Projects Collection 4/30/2009. Online. http://www.wpi.edu/Pubs/E-project/Available/E-project-043009-125733/unrestricted/EffectsOfGlobalWarmingOnSnowpackInTheColoradoRiverBasin.pdf (verified 6 Oct. 2010).

Sammis, T. 1980. Comparison of sprinkler, trickle, subsurface, and furrow irrigation methods for row crops. Agron. J. 72:701-704.

Santa Fe County, 2010. Ordinance No. 2003-6. Online. http://www.santafecounty.org/userfiles/Water%20Harvesting%20Ordinance.pdf (verified, 20 Oct. 2010).

Service, R.F., 2004. As the West Goes Dry. Science 303:1124-1127.

Smajstrla, A.G., B.J. Boman, D.Z. Haman, D.J. Pitts, and F.S. Zazueta. 1997. Field evaluation of microirrigation water application. Bull. 265.Univ. Fla. Coop. Ext. Svc. Gainesville

Strzepek, K.M., 1998. Assessment of climate-change impacts on the water resources of the western United States. Proceedings of the Rocky Mountain/Great Basin Regional Climate-Change Workshop, February 16-18, 1998, Salt Lake City, Utah.

Vickers, A. 2001. Handbook of water use and conservation: homes, landscapes, businesses, industries, farms. WaterPlow Press, Amherst, MA.

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

Kevin Lombard, Bernd Maier, and Mick O'Neill

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 70) and 15 table/raisin cultivars (Table 71) 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 70. Table grape cultivars, their parents, and source of parents grown in the experimental vineyard; NMSU Agricultural Science Center at Farmington, NM. 2011.

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
Himrod	T-9	American: (Ontario x Sultanina)	Cornell University, Geneva Statn.	White

Common Name	Code	Parentage	Origin	Color
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 71. 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. 2011.

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
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

Common Name	Code	Parentage	Origin	Color
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 72). 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 72. Rootstock Trial scions and rootstock grown in the experimental vineyard; NMSU Agricultural Science Center at Farmington, NM. 2011.

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
	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 vineyard 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.

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: 4/18, 4/24, 5/02, 5/12, 5/20, 5/27, 6/21, 8/01, and 8/17. Growth stages for the rootstock trial were made on the same dates.

A spring killing frost was recorded on May 2, 2011 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.

Grapes were harvested when the seed appeared dark brown. We also attempted to harvest when ˚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 (˚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 PROC MIXED.

Results

Table grape study

Visible freeze damage was observed in half of the entries and ranged from 8% of vines impacted for Swenson Red to 75% in Himrod (Table 73). Although there were 6 cultivars appearing to have no visible signs of frost damage from the May 2 event (e.g. 0%), these cultivars produced no grapes indicating primary bud damage had occurred in the spring or further back during the winter. Many of these vines had died back to the ground. These 6 cultivars (Black Rose, Centennial, Christmas Rose, Crimson, Flame Seedless, Red Globe, and Superior Seedless) have been perennial poor performers and were removed from the study altogether in October. E-L rankings taken during the growing season (Figure 14) indicated that growth of Glenora, Himrod, Interlaken, Marquis, Reliance, Swenson Red and Vanessa recovered from secondary buds (Figure 14). Swenson Red produced on 100% of vines. Himrod had low yields and was not harvested in 2011. Harvest dates ranged from 8/26 for Swenson Red to 9/23 for Glenora (Table 73). Soluble solids were lowest for Vanessa (19.4) and highest for Glenora (24.6) – a function of the harvest date. There was no difference in juice pH which ranged from 3.3-3.4. Swenson Red appears to be well adapted to high elevation sites. Vanessa, Glenora and Reliance also have potential.

Table 73. Freeze damage on new growth of table grapes planted in 2007 measured after May 2 freeze event; NMSU Agricultural Science Center at Farmington, NM. 2011.

Cultivar	Freeze Damage (%)	Date of Harvest	Number Vines Harvested (%)	# Clusters per vine	Cluster Weight per Vine (g)	Soluble Solids (˚Brix)	Juice pH
Black Rose	0e	NH	NH	NH	NH	NH	NH
Centennial	8e	NH	NH	NH	NH	NH	NH
Christmas Rose	0e	NH	NH	NH	NH	NH	NH
Crimson	0e	NH	NH	NH	NH	NH	NH
Flame Seedless	0e	NH	NH	NH	NH	NH	NH
Glenora	67abc	9/23	75	6c	264cd	24.6a	3.4a
Himrod	75ab	8/29	NH	NH	NH	NH	NH
Interlaken	58bc	9/09	83	4c	160d	22.2b	3.3a
Marquis	60abc	NH	NH	NH	NH	NH	NH
Red Globe	0e	NH	NH	NH	NH	NH	NH
Reliance	83a	9/12	83	14b	562bc	20.9bc	3.4a
Saturn	17de	9/02	NH	NH	NH	NH	NH
Superior Seedless	0e	NH	NH	NH	NH	NH	NH
Swenson Red	8e	8/26	100	25a	1047a	20.9bc	3.3a
Vanessa	40cd	9/02	75	11bc	689b	19.4c	3.3a
LSD	29			7	356	2.2	NS
F Value	10.33			11.94	8.36	5.05	1.69
Pr>F	<0.0001			<0.0001	<0.0001	0.0022	0.1727

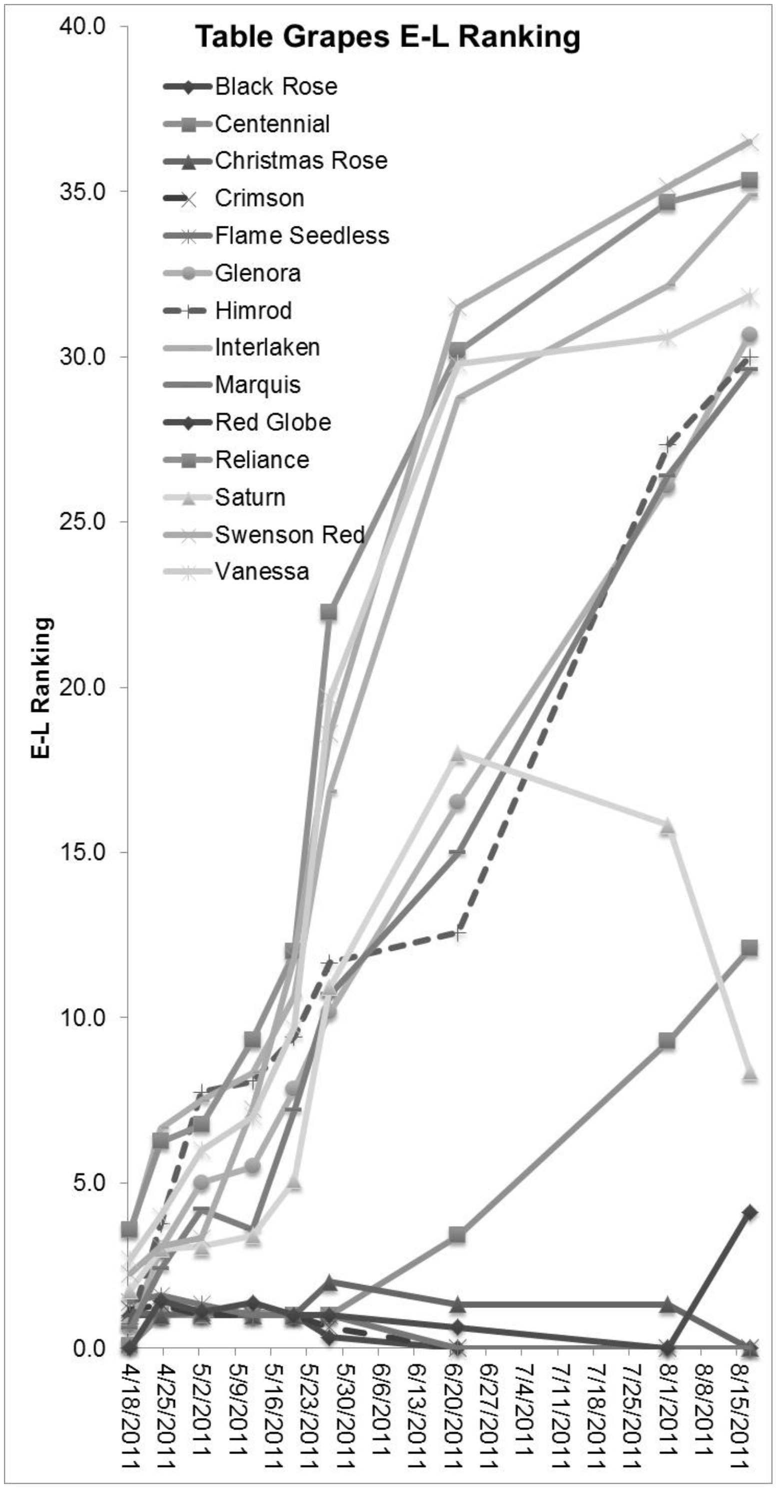

Figure 14. Modified E-L ranking for table grape cultivars grown on their own roots. Grapes were planted in 2007; NMSU Agricultural Science Center at Farmington, NM. 2011.

2007-Planted Red and White Wine Grape Varieties

Among the red wine grape cultivars, visible freeze damage measured directly after the May 2nd freeze event ranged from 4% in Regent to 58% in Baco Noir (*P*<0.0001;Table 74). The true measure of whether these vines recovered is indicated in the last E-L measurement (Table 74 and Figure 15). Values in the high 20's and low 30's indicate that a crop was produced in Baco Noir, Kozma, Leon Millot, and to a lesser extent Regent. Baco Noir produced on 100% of planted vines; 96% for Leon Millot, and 79% for Kozma (Table 75) indicating that these vines are capable of producing a crop on secondary buds. The remaining reds (Agria, Malbec, Pinot Noir, Refosco, Sangiovese, and Zinfandel failed to produce a measurable crop or no crop at all.

Of the harvested vines, Baco Noir produced on average 36 smallish clusters per vine followed by Leon Millot (27) and Kozma (17.5), an increase from 2010 (Table 75). Cluster weights per vine were highest in Leon Millot (1158 g) being large clusters. In 2011 Baco Noir, harvested August 29 (two weeks earlier than in 2010), had the highest sugar content (23˚Brix) (Table 75). Juice pH ranged from 2.9 to 3.1 (Table 75).

Among the white wine grape cultivars, visible freeze damage measured after the May 2nd spring frost ranged from 0% (Vidal Blanc) to 52% in Valvin Muscat (*P*<0.0001; Table 74). The last E-L measurement indicates that all but Muller Thurgau, Sauvignon Blanc, and Viognier were able to produce a crop (Table 74 and Figure 15). These three entries have not borne grapes to any measurable quantity since record keeping started in 2009 (Table 75). The remaining entries, Chardonel, Seyval Blanc, Siegfried, Traminette, Valvin Muscat and Vidal Blanc had greater than 71% of their vines bear fruit in 2011. Of the harvested white wine vines, Seyval Blanc produced nearly 40 clusters per vine followed by Siegfried (27), Vidal Blanc (23), Traminette (20) and Valvin Muscat (18) and Chardonel (15) (Table 75). Cluster weights per vine were highest in Seyval Blanc (1820 g) and lowest in Valvin Muscat (503 g). In 2011, Chardonel had the highest sugar content (22.3˚ Brix) followed by Valvin Muscat (20.8 ˚Brix) (Table 75). We could have left the grapes on the vine longer in order to try to boost the sugar content but our last harvest date was 9/29, pushing toward the first fall frost which occurred on October 08. Juice pH ranged from 2.9 to 3.4 (Table 75).

Table 74. Mortality, freeze damage, and chlorosis characteristics of wine grapes planted in 2007. Note: Higher E-L measurement equates to fruiting; NMSU Agricultural Science Center at Farmington, NM. 2011.

Cultivar	Freeze Damage (%)	Last E-L 8/17/2011
Red		
Agria	0d	9f
Baco Noir	58a	36a
Kozma	13cd	32ab
Leon Millot	38b	35a
Malbec	0cd	11ef
Pinot Noir	17c	22cd
Refosco	0cd	18de
Regent	4cd	27bc
Sangiovese	0d	8f
Zinfandel	5cd	12ef
LSD	17	7
F Value	10.89	17.52
Pr>F	<0.0001	<0.0001
White		
Chardonel	4c	32a
Müller-Thurgau	0c	13bc
Sauvignon Blanc	13bc	11c
Seyval Blanc	5bc	32a
Siegfried	21b	34a
Traminette	0c	31a
Valvin Muscat	52a	28a
Vidal Blanc	0c	33a
Viognier	0c	18b
LSD	15	6
F Value	9.75	17.93
Pr>F	<0.0001	<0.0001

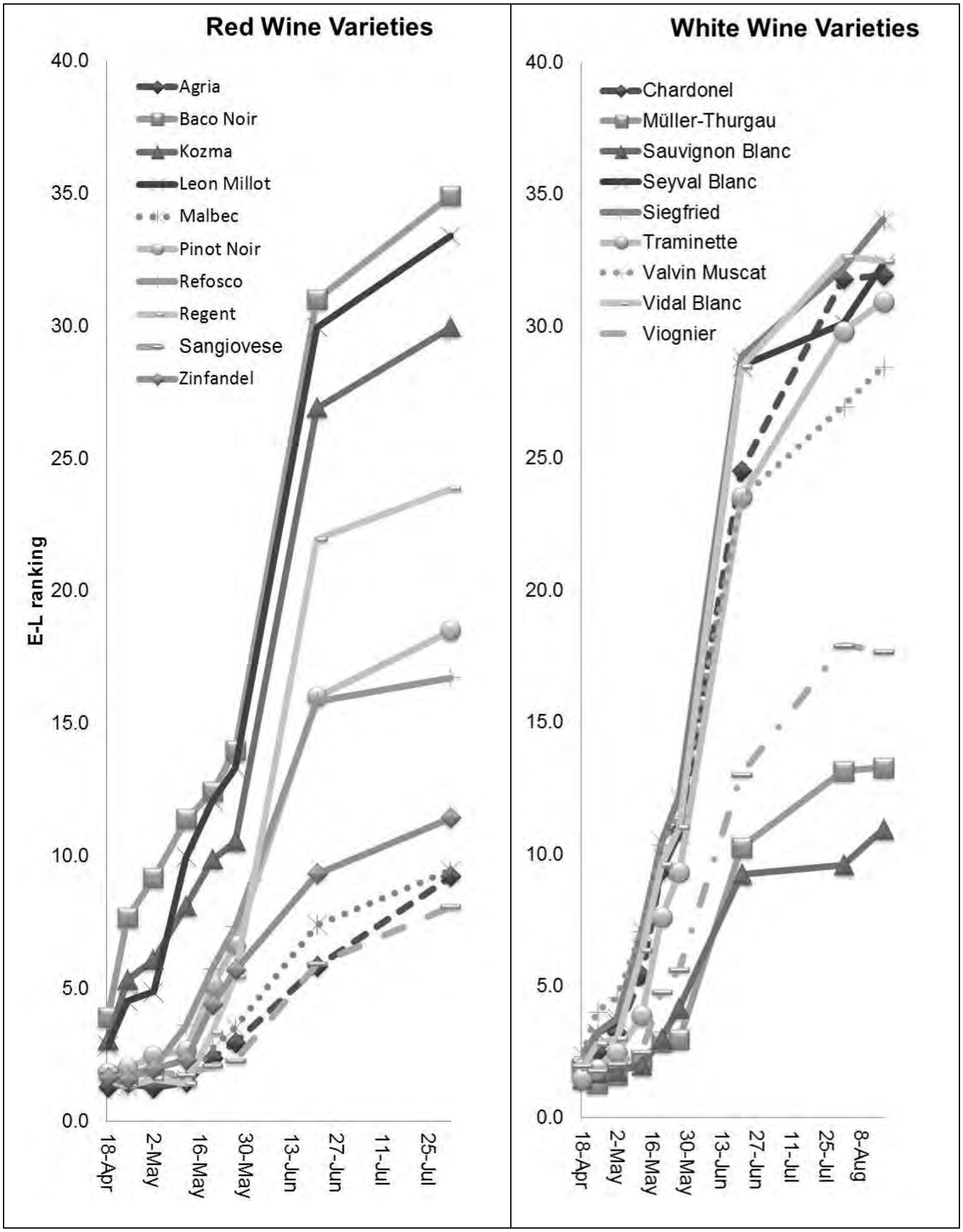

Figure 15. Modified E-L ranking for red wine (A) and white wine (B) cultivars grown on their own roots; NMSU Agricultural Science Center at Farmington, NM. 2011.

Table 75. Harvest data for wine grapes planted on their own roots in 2007; NMSU Agricultural Science Center at Farmington, NM. 2011.

Cultivar	Harvest Date	Number Vines Harvested out of 24 vines planted (%)	# Clusters Harvested per Vine	Cluster Weight per Vine (g)	Soluble Solids (˚Brix)	Juice pH
Red						
Agria	NH†	NH	NH	NH	NH	NH
Baco Noir	8/29	100	36.4a	1108a	23.4a	3.1b
Kozma	9/07	79	17.5c	685b	21.6bc	3.1b
Leon Millot	8/26	96	27.2b	1158a	22.8ab	3.5a
Malbec	NH	NH	NH	NH	NH	NH
Pinot Noir	9/07	29	3.1d	166b	19.8cd	3.4ab
Refosco	9/23	46	6.8d	427b	20.3cd	3.3ab
Regent	8/31	67	4.5d	649b	19.2d	2.9c
Sangiovese	NH	NH	NH	NH	NH	NH
Zinfandel	9/07	33	7.9cd	790ab	19.7cd	3.2b
LSD			9.3	0.51	2.4	0.25
F Value			19.5	3.95	4.89	5.54
Pr>F			<0.0001	0.0014	0.0002	<0.0001
White						
Chardonel	8/31	88	15d	914bc	22.3a	3.0cd
Müller-Thurgau	NH	NH	NH	NH	NH	NH
Sauvignon Blanc	NH	NH	NH	NH	NH	NH
Seyval Blanc	9/29	71	39.5a	1820a	20.5b	3.2b
Siegfried	9/09	100	27.3b	751cd	19.9bc	3.1c
Traminette	9/07	92	20.1bcd	781bcd	19.9bc	2.9e
Valvin Muscat	9/23	75	17.6cd	503d	20.8b	3.4a
Vidal Blanc	9/12	100	23.0bc	1104b	18.9c	3.0de
Viognier	NH	NH	NH	NH	NH	NH
LSD			7.6	350	1.3	0.1
F Value			9.57	11.2	6.65	28.6
Pr>F			<0.0001	<0.0001	<0.0001	<0.0001

† NH = Not Harvested

2008-planted rootstock trial

Evaluations will be included in an upcoming NMSU Research Report

San Juan County vineyard temperature monitoring

The coldest winter temperatures in 2011 were recorded on January. The NMSU-ASC vineyard was the warmest site (-5.7° F) followed by the Wines of the San Juan vineyard (-11.7° F) while the Wilsey vineyard north of Aztec was the coldest (-20° F). Previously mentioned, a spring killing frost was recorded in the NMSU-ASC Farmington Vineyard which killed back vines that had budded. In 2011, several vines were lost at the ASC-Farmington and at Wines of the San Juan. No data is available for the Wilsey vineyard. Site selection in regards to freeze events remains one critical factor in grape establishment and long-term survivability.

Conclusion

Table grapes

Table grapes showing the most promise for our high elevation site are Swenson Red, Glenora, Vanessa, and, Reliance. Himrod and Interlaken also have some potential from prior year's evaluations but did not yield well in 2011. Marquis remains questionable. Several new entries will be planted in 2012.

Red and white wine grapes grown on their own roots

Among the red wine grapes, Baco Noir, Kozma and Leon Millot continue to yield despite cold winters and the May 2 spring freeze. Unlike previous years, Agria failed to recover from the May 2 freeze. Regent continued to produce although this was minimal and needs further evaluation. Remaining reds Zinfandel, Pinot Noir, and Refosco also remain questionable but remain in the evaluation for at least another year. Malbec and Sangiovese failed again and were removed from the trial along with Agria. Baco Noir is a French American Hybrid, Kozma is a *vinifera* cultivar from Hungary, and 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 71% of their vines in the trial yield grapes in 2011. Viognier, Muller-Thurgau, and Sauvignon Blanc did not perform in 2011 and were removed from the study. 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* from 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.

Several new entries will be planted in 2012.

Rootstock Trial

A report of broader depth will be released in 2012 describing performance of the Rootstock Trial.

San Juan County vineyard 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, 2010 and May 2, 2011, it is not feasible to assume the risk of growing susceptible grape cultivars.

The data reported here should still be viewed as general. As we have measured, several microclimates and differing soil types dictate the need for preliminary research before sites are developed into commercial vineyards. Readers are highly encouraged to contact the State Viticulturist, (Bernd Maier), local county extension agents or the author for assistance in site and cultivar selection in San Juan County.

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.

Literature cited

Alimova, N. and J. M. Lillywhite, 2006: New Mexico vineyard growers' survey: Results and implications. NMSU, Las Cruces.

Coombe, B.G. 1995. Adoption of a system for identifying grapevine growth stages. Australian Journal of Grape and Wine. 1: 104-110.

O'Neill, M.K., R.N. Arnold, D. Smeal, T. Jim, R. Heyduck, M. West, C.K. Owen, Z. Williams, K.D. Kohler, M. Begay, C. Begay-Serna, K. Lombard, J. Tomko, and N. Pryor. 2005. Thirty-ninth annual progress report for 2005. NMSU Agricultural Science Center at Farmington.

O'Neill, M.K., R.N. Arnold, D. Smeal, T. Jim, R. Heyduck, M. West, C.K. Owen, J. Ward, K.D. Kohler, S. Stone, K. Lombard, N. Begay, and J. Joe. 2008. Forty second annual progress report for 2008. NMSU Agricultural Science Center at Farmington.

Schepers, J.S., T.M. Blackmer, and D.D. Francis. 1998. Chlorophyll meter method for estimating nitrogen content in plant tissue, p. 129-134. In: Y.P. Kalra (ed.). Handbook of Reference Methods for Plant Analysis. CRC Press, Boca Raton, FL.

Yamamoto, A., T. Nakamura, J.J. Adu-Gyamfi, and M. Saigusa. 2002. Relationship between chlorophyll content in leaves of sorghum and pigeonpea determined by extraction method and by chlorophyll meter (SPAD-502). Journal of Plant Nutrition. 25: 2295-2301.

Hops (*Humulus lupulus*) Evaluation

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

Kevin Lombard, John Henning, Ram Acharya, Robert Heyduck, and Mick O'Neill

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 (kg/ha) 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).

The 2008 and 2009 planted rows (rows one and two) were harvested in 2011. The New Mexico Native hops (Row 3) is still establishing. Hops were harvested by hand on two occasions in early September 2011 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

For the third straight year of yield evaluations, Cascade was highest followed by Crystal, and Newport. (Table 76). The 2009 planted row was added to the evaluations. Nugget, Horizon, and Galena all had modest yields. The trial remains unfertilized except by using a compost top dressing in an effort to examine cultivars under minimal input to gain an unbiased evaluation under experimental conditions. 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).

Hops from Europe (Hallertauer, Fuggle, Saaz) continue to show poor growth on our high pH soils and dry conditions. These cultivars should be avoided.

Table 76. Average yield per plant for 2008 and 2009 planted hops; NMSU Agricultural Science Center at Farmington, NM. 2009-2011.

Cultivar	Ave Fresh Weight (g)	Yield (kg/ha)
Cascade	293.3a	878a
Centennial	0.0d	0
Columbia	9.0d	27
Crystal	180.8b	541b
Fuggle	0.8d	2d
Galena	47.8cd	127cd
Hallertauer	0.0d	0d
Horizon	65.6c	181c
Newport	97.5c	292c
Northern Brewer	0.0d	0d
Nugget	96.9c	290c
Saaz	0.0d	0d
Sterling	7.5d	22d
LSD	0.06	172
F Value	20.82	20.61
Pr>F	<0.0001	<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.

References

Fix, G. 1999. Principles of Brewing Science: A Study of Serious Brewing Issues. Brewers Publications, Boulder, Colorado.

O'Neill, M.K., R.N. Arnold, D. Smeal, T. Jim, R. Heyduck, M. West, C.K. Owen, Z. Williams, K.D. Kohler, M. Begay, C. Begay-Serna, K. Lombard, J. Tomko, and N. Pryor. 2005. Thirty-ninth annual progress report for 2005. NMSU Agricultural Science Center at Farmington.

Schepers, J.S., T.M. Blackmer, and D.D. Francis. 1998. Chlorophyll meter method for estimating nitrogen content in plant tissue, p. 129-134. In: Y.P. Kalra (ed.). Handbook of Reference Methods for Plant Analysis. CRC Press, Boca Raton, FL.

Ward, I. 2009. 2009 North American harvest: Hops stabilize, but barley production decreases. The New Brewer. 26: 30-37.

Yamamoto, A., T. Nakamura, J.J. Adu-Gyamfi, and M. Saigusa. 2002. Relationship between chlorophyll content in leaves of sorghum and pigeonpea determined by extraction method and by chlorophyll meter (SPAD-502). Journal of Plant Nutrition. 25: 2295-2301.

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 Dustin Thomas, Jaime G. Vela, and India Ornelas

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 assisted with data gathering and networking activities. The focus group portion of the study was confined to areas adjacent to the Navajo Nation. The final two focus group sessions took place on 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 77. The questions were projected onto a wall so that participants could follow the moderator.

Each focus group session took 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 77. Gardening and Health Themed Focus Group Questions; NMSU Agricultural Science Center at Farmington, NM. 2011.

Questions
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. Does your chapter talk about diabetes at their meetings?
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

Transcripts for all seven focus group sessions were compiled into one document and coded according to themes and sub-themes that emerged. The final report is nearing completion and will be submitted to the Navajo Nation Human Research Review Board for approval before being published in this document.

A spin-off project has resulted in collaboration with NMSU-ASC Farmington and Diné College (more below).

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, Stefan Sutherin, Dan Smeal and Rolston St. Hilaire

Background and justification

It is not difficult to imagine in today's technology driven world that a web-based demonstration site could effectively demonstrate water conserving practices. Grant funds are being sought to enhance the Center for Landscape Water Conservation "*Demonstration*" site and online clearing house of information. A beta version is now online at: http://www.xericenter.com. We have endeavored to use every web-based platform available to reach as broad a swath of the population as possible. Users of any age, background, or attention span can see how a low-water-use yard looks, how it "works", and how to build one for themselves. We focused on the demonstration, the visuals – What does it look like? What does the maintenance look like? How do I go about building it? Users appreciation for our hands-on, demonstration-type methods are seen in the analytics of our Youtube videos – of the 40 videos we filmed in demonstration gardens a year ago, 4,300 of the 11,000 views were of the video, "How to Set up your Drip Irrigation System". *This is significant given the fact that only a few dozen visitors attended a live field day event at the ASC-Farmington demonstrating the same technologies in 2011*! On iTunes U, our demonstration garden tours are quite popular, with the highest number of ticks marked for *each* and *every one*. We recently organized and posted our still photos on Picasa. Our new Facebook page is now set up and ready for user discussions and photos of their projects. All of our associated sites are linked together – The Center for Landscape Water Conservation at www.xericenter.com, www.youtube.com/xericenter, www.facebook.com/xericenter, picasaweb.google.com/xericenter, and iTunes U on the NMSU channel under Southwest Yard and Garden. An iOS app will soon deliver appropriate plant information to consumers. A QR Code will drive smartphone users to our website. All of these together will drive user traffic and user adoption of water-wise landscape practices.

We need to continue to build relevant demonstration materials applicable to Northwest NM and Southwest CO residents – videos of demonstration gardens in additional NM climate zones, encouragement of Facebook user projects and discussions, and further app development and updates. We would like to enhance this feature and the site needs continued development. The objective of the Center for Landscape Water Conservation is to become a single clearinghouse of information and/or information transfer with *integrated* services to strengthen educational and extension outreach related to urban water conservation topics in the urban landscape. The following end-users are targeted: 1) homeowners, 2) city and private landscapers, city planners, and park managers 3) county extension agents, and 4) students and adolescents.

The justifications for establishing the Center for Landscape Water Conservation are defined by 1) The need to disseminate water conservation information to homeowners, landscape professionals, and students of the Upper Colorado basin who may be unfamiliar with New Mexico's and Southwest Colorado'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) Given the cost constraints of establishing a physical demonstration center, the Center for Landscape Water Conservation will take advantage of more cost effective information technologies for information, training, and educational outreach services of information dissemination.

The methods employed involve continued consolidation of NMSU, state, county and non-profit websites dealing with xeriscaping, urban irrigation and other landscape water conservation topics, 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 indicating the locations of xeriscaping demonstration sites and wholesale/retail outlets for drip irrigation supplies and drought adapted plant material enhances the site. Undergraduate students from NMSU and San Juan College continue to participate in the Center's construction.

Master's candidate Stefan Sutherin continues to make huge contributions to the project and oversees all day-to- day activities. She is evaluating outcomes using a variety of quantitative and qualitative methods. The Center for Landscape Water Conservation is being evaluated using Google Analytics which tracks the numbers of visitors, predominant end-user, and the popularity of individual topics which range from appropriate plant material usage to using smart irrigation controllers to managing irrigation systems. Feedback through online surveys will assess ease of usability and satisfaction in deliverables. Outcomes will be published as a thesis and in a peer reviewed scientific journal.

Program and anticipated water management benefits

Considering that marketing efforts for the site have included staffing a booth at the annual NM Xeriscape Council Expo with >10,000 persons in attendance, this would approximate 1% of the total NM urban population. As reviewed by Lockett (2000): Studies have shown that between 40 and 60% of the water supply in residential areas is used for lawn and garden watering; a typical single family residence uses approximately 340,200 L of water each year for landscape areas; the average family of four uses 23,134 L of water per summer month on turfgrass maintenance alone.

Previous research has demonstrated that implementing the principles of xeriscaping would allow the homeowner to reduce water use by 20 to 80% (as reviewed by Lockett, 2002).

Considering New Mexico alone, the population in towns exceeding 15,000 is approximately 1,069,848 (Brinkhoff, 2011).

Considering if one NM household would conservatively reduce landscape irrigation by 20%, the total estimated water savings would be approximately 68,040 L/year.

Considering if 10,000 households were impacted by the proposed activities, water reductions would be estimated as 680 million L of water saved/year.

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 and evaluation

Demonstrating sources of information for urban water conservation

1. Continue to coalesce existing websites including ULWCCC (http://ulwccc.nmsu.edu/) Rolston St. Hilaire (http://landscape.nmsu.edu/), elements of the State Climatology (http://weather.nmsu.edu), UTEP Chihuahuan Desert Gardens (http://museum.utep.edu/chih/gardens/gardens.htm), Office of the State Engineer (http://www.ose.state.nm.us/index.html), NM Xeriscape Council (http://www.xeriscapenm.com/), NMSU Agricultural Science Center at Farmington Xeriscape website and demonstration garden site (http://aces.nmsu.edu/aes/farm/xeriscape-plant-specimen.html), NM Irrigation Center (http://aces.nmsu.edu/aes/irrigation/) among other websites hosted on the NMSU ACES server.
2. Create web links to NMSU Cooperative Extension fact sheets related to urban landscape topics.
3. Create web links to information developed by the investigators and cooperators.

Content and integrated services related to virtual demonstration of urban water conservation

1. Continue developing multimedia content which could include interactive garden tours, an iOS app for iPhone, iPod, iPad and Android, animation or other interactive feature.
2. Continue adding locations of regional Xeriscape demonstration sites to enable users to find ideas and information. Map locations in *Google Maps*.

3. Continue uploading locations of regional supply outlets specializing in drip irrigation, rain water catchment, drought tolerant and native plant material. Map locations in *Google Maps*.

4. Continue to edit and upload streaming videos of archived Southwest Yard and Garden emphasizing xeriscaping and irrigation topics.

5. Continue to upload instructional materials accessible to cooperative extension agents and educators like:

6. Downloadable videos, dvd or power point presentation on urban landscape topics.

7. Downloadable diagrams or posters requested from a searchable list of topics that could be printed from NMSU and loaned or printed from off-campus sites.

8. Continue modifying databases of all topics linked to a searchable *Google* index.

Evaluate the Center's functionality – measuring impact

1. Post-Development: Final online survey to be split into three distinct surveys to encourage response.

   a. Sample: Real users on the site. There will be three survey sets for each of the two login sides (public and private) of the site; 50 users/survey; 150 for each of the public and login sides of the site; n=300. For online surveys and polls, users will use their own computers on their own time, though deadlines will be given for each poll/survey response. In the event we do not receive back at least three responses, the poll will be reissued to additional participants. Three to five responses per poll/survey are required.

   b. Incentive: None. Short surveys are anonymous and will take minimal time to encourage response.

2. Google Analytics will indicate number of site visitors, number of visits on site specific topics, and end-user background.

3. Outcomes of valuations and questionnaires will be published in *HortTechnology*.

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 16, Figure 17, Figure 18, and Figure 19 shows screen shots of the site.

Extension outputs

Website development is mostly complete with a few outstanding tasks still in-work. Since 2008, when the original grant proposal was written, the way people access information has changed dramatically. No longer will a static educational website do the job the grant writer proposed, which is to affect people's behavior regarding the use of water in home landscapes. A host of other, more interactive, media have to be harnessed and shared. We think of the Center for Landscape Water Conservation as a bicycle wheel, with the website being the hub and "spokes" pointing to/from the affiliated sites. Status follows.

Online presence

1. www.xericenter.com – This is the primary website. We are in the process of adding tags to the content and implementing an upgraded search function to provide better search capabilities on the site. Both have been on the list for quite some time, but are major tasks for our student programmers so were deferred to the end. The tags are about 80% complete on the public side of the site and still need to be implemented on the private side. One of the outcomes of various testing was the search function was inadequate – we knew that, but our thoughts were validated in testing. We also have several minor navigation and design fixes.

2. www.youtube.com/xericenter -- We posted 40 videos of four narrated garden tours in late-December 2010. Without any marketing, we are at 12,500 views for all and about 5200 views just for Dan Smeal's "How to set up a drip irrigation system" video. Not huge numbers in youtube-land, but respectable given that we haven't marketed it at all.

3. iTunes U – The same 40 videos are available for download on NMSU's channel. Apple has terrible analytics, so we don't have numbers. Our videos have the highest ratings, so we know they are being downloaded; we just don't have perspective on demand. Supposedly, Apple is working on providing better analytics.

4. www.picasaweb.com/xericenter -- We have four albums of still photos of the garden tours, one album of each garden. Most, but not all, of the plants are labeled. We need to follow-up with the curators to get captions for the un-captioned plants.

5. www.facebook.com/xericenter -- We recently posted a Facebook page that I need to start adding something to on a weekly basis in order to gain traffic. The intent is for user friends to interact and share projects and experience.

6. Southwest Plant Selector (SW Plants) app for Apple mobile devices (iPhone, iPod, iPad) is currently in-development by NMSU Media Dept. We partnered with the NM Office of the State Engineer to adapt its recently-developed Interactive Plant List (http://wuc.ose.state.nm.us/Plants/) to an iOS app format. This database of about 750 plants holds the most commonly-available xeric plants for NM. If you would like to see the prototype, let me know. We took it on an iPad to the NM Xeriscape Expo in Albuquerque on

Saturday Feb 25, 2012 to get a feel for receptiveness and, Wow – great enthusiasm! Many of the photos were of lower quality for iPad display, so we was also able to line up volunteers to provide better-quality photos (I emphasize "volunteers" because we did not have to ask – the business owners volunteered their time and photos). We tentatively plan a late-March/early-April launch and a 1.1 version with upgraded photos in June, but it will depend on how we can work through the queue in the Media Dept. We got a good price, but they work us in. We will beta test it before launch with 10-20 selected participants.

7. We have "shared" all the above sites where possible to boost cross-traffic.

Research outputs

Ms. Sutherin 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" (Appendix 1) of adoption by users, and evaluate the content, usability, interactivity, marketability of the site which will in part involve research with human subjects 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, Rolston St. Hilaire, Brenda Seevers, and Dawn Vanleewen). Specific study status:

1. Two very small Likert-type surveys completed to get top-level perspective from users both in the very beginning to assess the overall site design and after fixes generated by the usability studies (#2 below).

2. A series of hands-on user/usability exercises were conducted last summer (2011), using a group of 12 participants, which resulted in programming fixes, menu organization changes, and navigation fixes.

3. In mid-March 2012, at least one, maybe two additional usability exercises will be conducted with 5 users for each, to check out the tags, new search, and answer lingering navigation questions.

4. A larger, 60+, survey using the top-level Likert survey will be planned for late-March to get a final read on the overall site design, navigation, and usability.

5. We use Google Analytics to assess site activity. We have done no marketing yet because we don't want to turn off users with an incomplete site, so our numbers remain low. However, our traffic numbers have generally increased over the past year for new users and those users are staying on the site longer.

6. As stated above, our videos attract quite a bit of attention on their own, so I expect a significant boost once we undertake a concerted marketing effort. We have ordered 6 floor banner stands for pilot testing/placement around the state (nurseries, libraries, etc). We generated a QR Code for smartphones which will be added to our existing banner artwork (and other materials) and will take users to our youtube channel url.

7. We have gotten only positive feedback (unsolicited email) on the website and the videos.
8. The short-term goal of the project per the Logic Model (Appendix 1), for Homeowners is:
    a. "Users use one-stop access to immediately usable info for their landscaping decisions and implementation.
    b. Users use access to master gardeners and other community members for specific questions.
    c. Users use central resource for related events, activities, and destinations.
    d. Users trade ideas and upload their project photos".
9. The short-term goal of the project per the Logic Model, for Industry Professionals is:
    a. "Educators and outreach professionals use site to coordinate message and resources.
    b. Professional users use the site as a primary resource for information and info exchange".
10. Though the original Logic Model refers to one-stop, the concept of a hub and spokes is consistent with that concept
11. By the end of 2012, we hope the project will be hitting the medium-term goals which are, for Homeowners:
    a. Continually expanding user base; site traffic (quantity and quality) increasing.
    b. Users interact with site as intended.
    c. Users apply site info as intended and use best landscape practices on their properties.
12. …and for industry professionals:
    a. Outreach and education has a coordinated message and reaches intended audience.
    b. Users interact with site as intended, use the collaborative tools, share and upload new info and resources; active user base is expanding.
    c. Academics use the site to ID and target research activities to specific end-user knowledge gaps, per survey and analytics results.

13. As soon as the website is complete (after the final usability study), we will start more actively marketing it to both homeowners and industry professionals. We should get a good boost from the app launch. In fact, we probably got more visibility from one day at the Expo showing the app around than we have from the past two years sitting in a booth!

14. Academic status: Ms. Sutherin plans to graduate 12/12, this December.

Literature cited

Brinkhoff, T. 2011. USA: New Mexico City Population. Accessed Jan 8, 2011: http://www.citypopulation.de/USA-NewMexico.html

Lockett, L. 2000. Assessing public opinion on water conservation and water conserving landscapes in the semiarid southwestern United States. MSc thesis. Texas Tech University.

Lockett, L., T. Montague, C. McKenney, and D. Auld. 2002. Assessing public opinion on water conservation and water conserving landscapes in the semiarid southwestern United States. HortTechnology. 12: 392-396.

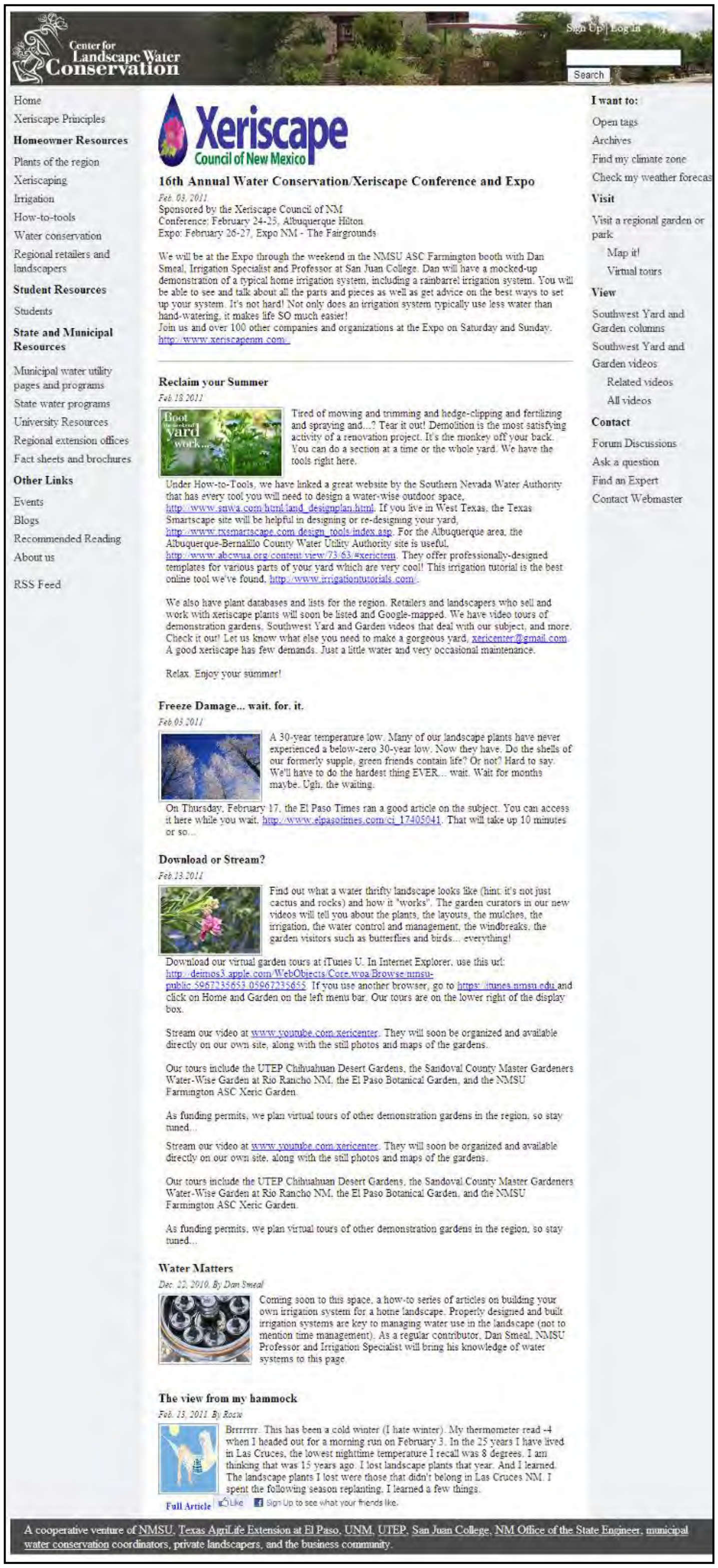

Figure 16. Screen shot of Home Page of the Center for Landscape Water Conservation; NMSU Agricultural Science Center at Farmington, NM. 2011.

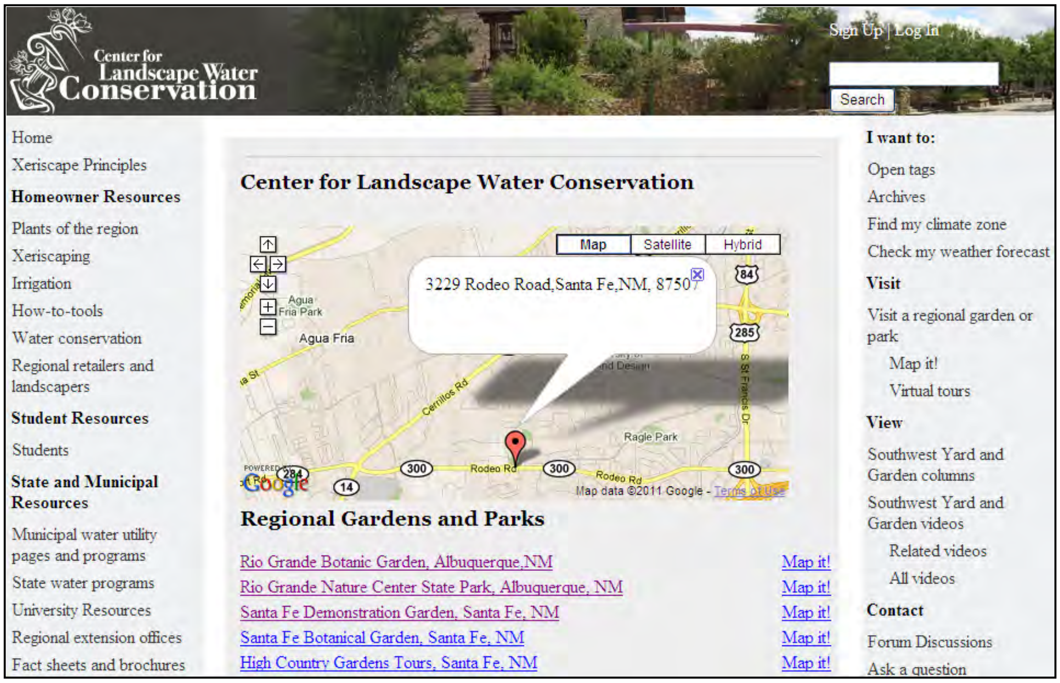

Figure 17. Screen shot of locations of demonstration gardens practicing water conserving practices. Google-Maps is integrated into the website to direct web users to these locations; NMSU Agricultural Science Center at Farmington, NM. 2011.

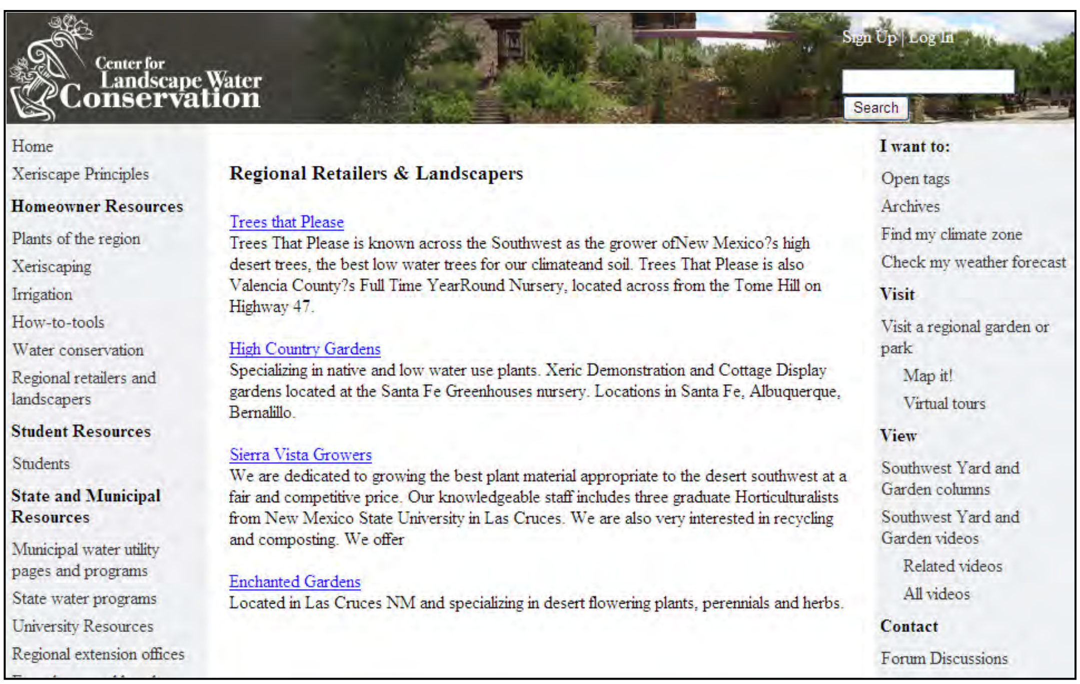

Figure 18. Screen shot of Regional Retailers and Landscapers specializing in water conserving plant material and services; NMSU Agricultural Science Center at Farmington, NM. 2011.

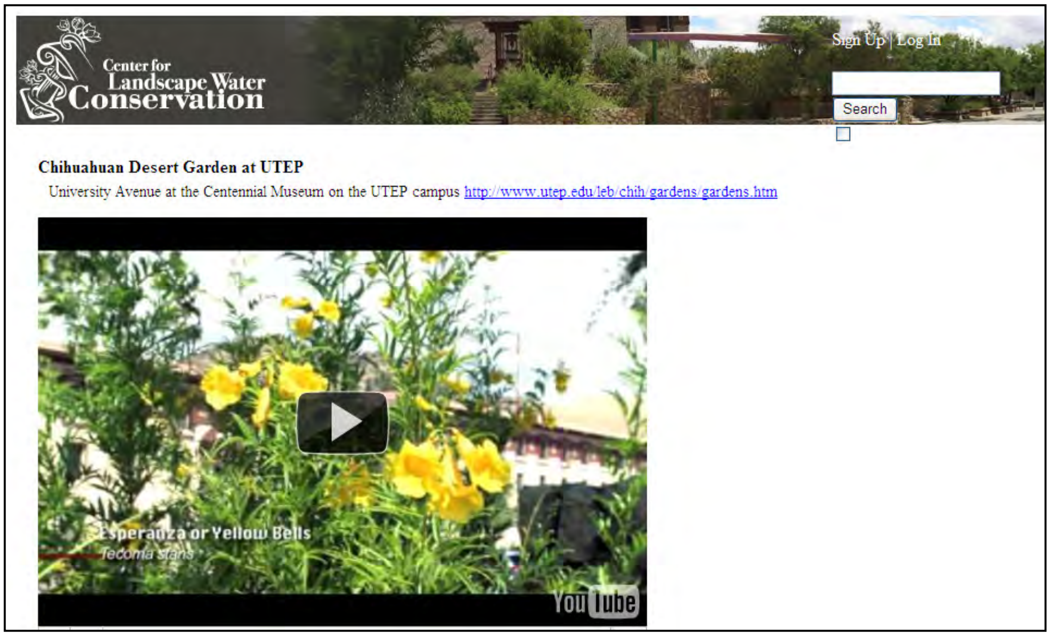

Figure 19. Video/virtual tour of Xeriscape demonstration garden; NMSU Agricultural Science Center at Farmington, NM. 2011.

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

Executive summary

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, 2) legal risks, 3) financial risks, 4) marketing risks, and 5) intangible risks such as cultural insensitivity leading to objections to commercialization of native herbs, the appropriation of indigenous knowledge and cultural property by non-traditional commercial enterprises. We conducted a risk management educational program to help socially-disadvantaged growers manage risks associated with collecting, producing, and marketing native medicinal herbs of the US Southwest. Risk management subjects include: product diversification, market outlook, marketing strategies, direct markets, and value-added enterprises. Project delivery consisted of: 1) Two intensive training programs, one each in Farmington, NM and Albuquerque, NM. The results of the workshop was to assist grower participants on understanding basic risk management and empower entrepreneurship and promote networking with established herb growers/processers. 2) An online tutorial, and 3) Educational DVDs. Audience emphasis was targeted at small-scale, limited-resource, and socially-disadvantaged farmers. The topics covered during the workshops included presentations on cultural sensitivity and understanding the need to balance culture and commerce; entrepreneurship; identification of potential herb species to fit specific markets; growing, harvesting and value-added production methods and associated risks and risk management options; understanding unique risks associated with quality control and marketing herbs; and develop financial management plans as they pertain to financial risk management. Post workshop follow-up occurred 6-10 months after workshops. Results indicated that about 5 participants began the process of applying risk management principles. Respondents indicated that the workshop series improved their interest and understanding of managing risks associated with growing southwestern medicinal herbs.

An agricultural renaissance is underway among small-scale traditional, socially-disadvantaged farmers and ranchers across the Southwestern US, especially within Native American tribes. This renewal of agricultural traditions among Indo-Hispano cultures has led to an interest in the cultivation of traditional and alternative crops and a revival of traditional folkways, including natural healing methods and herbalism. Greater interest in NM is spurring a demand for native medicinal herbs and herbal products. The collection or cultivation of Southwestern medicinal herbs (SWH), their value-added production and the entrepreneurial and marketing aspects of these niche crops present both opportunities and special risks that other agricultural enterprises may not have.

New Mexico clients, especially along the Rio Grande corridor, referencing SWH production and use of these alternative crops as part of an overall specialty crop production program on small acreages prompted early work which focused on production techniques, yield and market potential (Falk et al., 1999; Kleitz et al., 1999; Kleitz et al., 2008). Interest continued to remain steady with the emergence of educational and development programs clustered around alternative health care, indigenous foods for diabetes and obesity control, ethnobotany, and multiple-use crops for both natural dyes and medicine. For example, a special herbal memorial/symposium held in New Mexico in 2009 to honor Michael Moore, renowned Southwest native herbalist and educator, was attended by over two hundred herbalists and growers. The memorial included herb identification walks, educational programs on growing, processing, marketing and using native medicinal herbs. The high level of attendance, including Native American and Hispanic grower/herbalists, confirmed not only the demand for information about native herbs and herb enterprises, but illustrated the vast number of Southwest native medicinal herb species and their potential as cultural, health, and economic resources for socially-disadvantaged growers. The development of production and marketing information for traditional growers and entrepreneurs, both Native American and Hispanic, and the management of risks associated with the development of value-added native medicinal herb products would help meet this increased interest and producer demand.

Introduction

This project created a risk management education program to assist specialty crop growers in identifying and understanding risks associated with native medicinal herbs of the American Southwestern US. 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. Coupled closely with such educational programs are both formal and informal efforts to safeguard tribal knowledge, protect indigenous cultural and intellectual property rights, and reinforce tribal sovereignty. The potential problems of exploitation, commoditization, over-harvesting, and the commercialization of

what to some indigenous cultures view as sacred or ceremonial plants, are unique to the development of indigenous medicinal herbs, regardless of the region of the country.

Using the successful training and tutorial format developed through the 2008 RME Asian medicinal herbs specialty crop program, a similar program was modeled after it for the topic of Southwestern native medicinal herbs. While the two programs superficially appeared similar, the SWH training program dealt with entirely different herb species, a unique and significantly different set of risks, targeting a different audience. The program was tailored to meet the particular needs and objectives of socially-disadvantaged grower/entrepreneurs. The project also sought to educate non-natives on the importance of balancing culture and commerce.

The project had three parts 1) Workshops and workbook development, 2) Online tutorial development, and 3) Educational DVD development. Post workshop evaluations took place between September and December.

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

Workshops and 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.

Two live two-day workshops were conducted on December 7-8, 2010 (Farmington, NM) and March 4-5, 2011 (Albuquerque, NM). The sites were selected for accessibility and proximity to tribes and traditional growers in neighboring states. The workshops were intended to instruct participants in basic risk management principles, help familiarize them with the above-mentioned risks as they pertain to SW medicinal herb production and value-added product development, provide tools to assist them in financial management as it pertains to financial risk management, assist them in framing native SW herb enterprises in proper cultural context, and introduce them to the recognition of the concept of "intangible" assets and liabilities.

Most importantly, we expected the trainings to engender entrepreneurship and help socially-disadvantaged growers/value-added entrepreneurs to network with other entrepreneurs to develop entrepreneurial skills.

Participants were asked to register in advance although at-the-door registration was accepted. 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 second workshop was held March 4 and 5, 2011 at the NMSU Distant Education Center. The registration fee was lowered to $40. Additional speakers covered value-added products. The Financial Risk session was eliminated to allow for more discussion time. Financial risk was weaved into other sessions.

Topics included: product diversification, market outlook, marketing strategies, direct markets, and value-added enterprises. Each module was presented by an influential player in the medicinal herb industry and multiple levels from small-scale to large scale were represented (Table 78). Whether collected from native stands, or cultivated expressly for the purpose of commercialization, cultural sensitivity and the importance of a cultural context was emphasized to workshop participants who were considering native medicinal herbs of the Southwest and Mountain West as alternative crops. A member of the Navajo Nation covered this topic of balancing culture and commerce. The results-oriented nature of the program encouraged participants to apply what they learned directly to their farm enterprise.

Table 78. The December 7-8, 2010 workshop schedule; NMSU Agricultural Science Center at Farmington, NM. 2011.

Day 1: (8:30am-4:30pm) **Topic**	**Presenter**	**Affiliation**
Introduction to Risk Management	Charles Martin	NMSU-ASC Alcalde
Balancing Culture and Commerce	Carmelita Topaha	San Juan College
Herbal Entrepreneurship	Bill Quiroga	President and CEO of Native American Botanics
Value-Added Herb Products	Roundtable discussion	NM growers and processors
Day 2: (8:30am-4:30pm)		
Herb Marketing	Jackie Greenfield	Gaia Herbs, Brevard, NC
Financial Risk Management	Charles Martin	NMSU-ASC Alcalde
Herb Production Models	Amy Brown and Steve Heil	NM herb producers

Online tutorial

The training sessions in Albuquerque were recorded via Centra by Sonja Jo Serna (Information Technology, College of Agricultural, Consumer and Environmental Sciences) and placed as modules online at the following web address: http://aces.nmsu.edu/southwestherbs/. The purpose is to make the content of the risk management topics available to interested growers long after the actual workshops have ended. Screenshots are shown in Figure 20 and Figure 21.

Educational DVDs

Four educational DVDs of the entire Albuquerque workshop were produced by the NMSU University Communications and Marketing Services Media Productions unit (Figure 22). At least 12 hours of recording time was logged excluding editing time. The DVDs serve as an archive of the speaker presentations and workshop content and are organized according to the workshop agenda. The DVDs are available to workshop attendees by request and will also be made available through the online tutorial website. Copies will be sent to the NMSU library, Risk Management Education library and other repositories of agricultural related information.

Figure 20. Screenshot of the online tutorial found at http://aces.nmsu.edu/southwestherbs/ NMSU Agricultural Science Center at Farmington, NM. 2011.

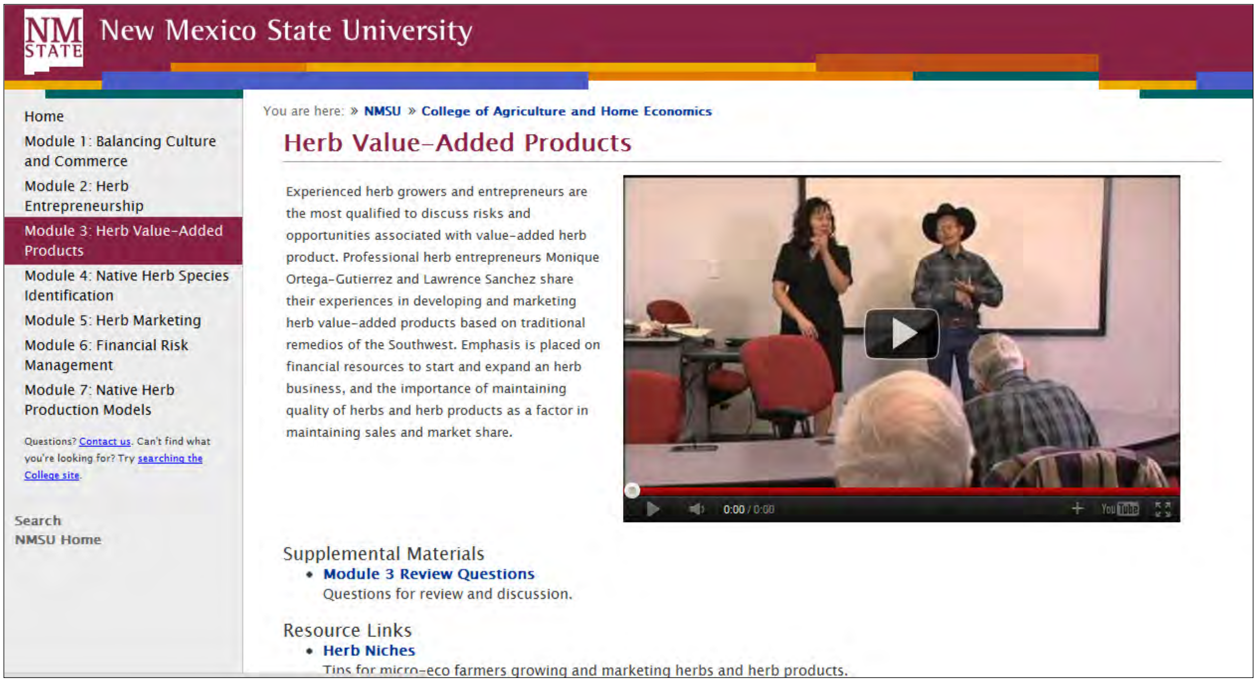

Figure 21. Screenshot of the online tutorial found at http://aces.nmsu.edu/southwestherbs/. NMSU Agricultural Science Center at Farmington, NM. 2011.

Figure 22. DVD case and disc artwork by Mike A. Ferrales, NMSU University Communications and Marketing Services Media Productions; NMSU Agricultural Science Center at Farmington, NM. 2011.

Post workshop follow-up survey

The goals of the post workshop follow-up were to 1) evaluate the number of participants who actually followed up with developing a risk management plan, 2) evaluate the level (scale) of a growers' operation, 3) assess the number of participants coming from socially disadvantaged groups. The participants were recruited during two workshops held December 7-8, 2010 and March 4-5, 2011.

Participants that agreed to be re-contacted (n=37) signed consent forms at that time. The survey was located online at Zoomerang (http://www.zoomerang.com/). A link to the survey instrument will be emailed to participants for self-administering. Participants that did not have access to the internet - indicated on consent forms – had surveys delivered by an interviewer over the phone. NMSU Institutional Review Board approved the survey methodology. The survey instrument is in Table 79.

Results

Only 17 participants of the 37 that agreed to be contacted filled out the online survey. Of these, about 5 started to implement some components of developing a risk management plan (Table 80). One person used the results to guide their future enterprise.

Questions 13-17 (Table 81) were directed toward all respondents – those that had started a risk management plan and those that had not. Overall, interest was high in SWH and respondents indicated mostly positive outcomes from the workshops in better understanding the risks and pitfalls of growing or attempting to grow SWH. One respondent stated that they were "Looking at growing herbs from a more business-like perspective, vs. just romanticizing about it". This was a recurrent theme from the questions 13-16. From question 17, barriers and gaps in information included the need for cooperatives and less "heavy duty" business planning information.

Of the respondents, 13 indicated experience growing other specialty horticultural crops (Table 82). Three indicated no experience growing any crop. None of the respondents were deriving more than half of the income from crop production. On respondent indicated that ¼ to ½ of their income was derived from commercial production of any crop.

From Table 83, only 1 respondent identified themselves as Native American while 4 identified themselves as Hispanic or Latino. The vast majority of participants were Anglo. Expectations on delivering the material to underserved populations of growers were not met even though the Farmington workshop was conducted near the Navajo Nation with fliers being distributed to Navajo extension agents and cooperators.

Table 79. Post workshop follow-up survey; NMSU Agricultural Science Center at Farmington, NM. 2011.

Post Workshop Follow-up Survey
1. Which steps of the risk management plan have you put into action? • None. STOP AND PROCEED TO QUESTION #13. • As a grower, I have assessed my production and financial circumstances. I am considering growing Southwestern medicinal herbs and have assessed the cost of production and financial risks. Production risks include long turn-around time to produce a harvestable product, especially for perennial herbs. Financial risks include investing money up-front for specialized plants and equipment. • I have identified production and financial risks and started to develop a business plan. • I have developed a risk management plan but have not implemented it yet. • I have implemented my plan and am now growing and marketing Southwestern herbs. • I have evaluated my results (outcomes) and I am using the results to guide my future enterprise. Other, please specify

Post Workshop Follow-up Survey

2. Have you identified your potential market?
   - Yes
   - No
3. What is/are the market(s) you have identified?
4. Have you obtained any Southwestern herb seeds to fit the market you have identified?
   - Yes
   - No
5. Which Southwestern herb seeds and/or propagation material (e.g. cuttings) have you obtained?
6. Are you having success at propagating and growing the seed/material you obtained?
   - Yes
   - No
7. Describe how successful you are at growing the herbs you selected.
8. Are you wildcrafting (harvesting from a naturalized area) Southwestern medicinal herbs to sell?
   - Yes
   - No
9. Which Southwestern herbs are you wildcrafting to sell? (Please list):
10. Have you balanced cultural sensitivity with the Southwestern herbs you have selected?
    - Yes
    - No. Please explain.
11. What information from the workshop helped you in making decisions about which herb species to obtain seed for?
12. What are the markets you sell to? (Check all that apply)
    - I am not selling herbs.
    - I sell the raw, unprocessed herb locally at a farmer's market.
    - I sell the raw, unprocessed herb to a company for processing.
    - I do my own herb processing and sell locally.
    - I sell directly through a catalog/internet.
    - I sell through a distributor and/or broker.
    - I direct market to retail outlets like coops, health food stores and/other retail outlet(s).
    - Other. What other potential companies or persons have you contacted regarding buying herbs?
13. How has your interest in Southwestern herbs changed as a result of the training?
14. What information from the training program did you find most useful?
15. What information from the training have you applied to your operation?
16. What information from the training program did you find least useful?
17. What gaps or information are still needed to help you make decisions about growing Southwestern herbs?
18. How would you describe yourself as a grower?
    - I do not have any experience but am considering it.
    - I have experience growing agricultural crops but only as a hobby or for personal use, not commercially as a cash generating activity. Examples of agricultural crops can include fruits, vegetables, herbs, hay, grains, ornamentals, etc.).
    - I am an experienced commercial grower of other crops (e.g. vegetables) but I have never grown Southwestern herbs.
    - I am already commercially growing and/or wildcrafting Southwestern medicinal herbs.
    - Other. Please describe.
19. No matter what you are growing e.g., fruit, vegetables, herbs, hay, or other agricultural crop) or the size of your land under production, how would you describe your growing operation in terms of household-income generating activity?
    - Personal or hobby use (I derive all of my income from anything other than growing).
    - Part time income generated (less than one quarter of my household income is generated as a grower).
    - Between 1/4 and 1/2 of my household income is generated by growing.
    - Over half but not all of my household income is generated by growing.
    - I derive all of my household income by growing crops.
    - Other (Please describe).
20. Ethnic Category. I am:
    - Hispanic or Latino
    - Not Hispanic or Latino
21. Racial Categories. I am:
    - American Indian/Alaska Native
    - Asian
    - Native Hawaiian or Other Pacific Islander
    - Black or African American
    - White
    - More Than One Race

Table 80. Questions that were relevant to participants who indicated that they had put some of the information presented to use. Participants who had not put the information to use were asked to proceed to question #13; NMSU Agricultural Science Center at Farmington, NM. 2011.

Relevant Participant Questions (1 - 12)	No. of Respondents	% of Total
1. Which steps of the risk management plan have you put into action?		
• None. STOP AND PROCEED TO QUESTION #13.	8	47%
• As a grower, I have assessed my production and financial circumstances. I am considering growing Southwestern medicinal herbs and have assessed the cost of production and financial risks. Production risks include long turn-around time to produce a harvestable product, especially for perennial herbs. Financial risks include investing money up-front for specialized plants and equipment.	1	6%
• I have identified production and financial risks and started to develop a business plan.	1	6%
• I have developed a risk management plan but have not implemented it yet.	0	0%
• I have implemented my plan and am now growing and marketing Southwestern herbs.	1	6%
• I have evaluated my results (outcomes) and I am using the results to guide my future enterprise.	1	6%
• Other, please specify	5	29%
o "I did assess production and financial risks. As much as I would like to proceed the upstart costs in relation to the chances of success were overwhelming"		
o "Because of the duties of my present job, I have not had time to do anything."		
o "I have not assessed the risks, but am not growing medicinal herbs"		
o "I am developing and making a line of tincture blends, but am not currently able to grow my own herbs."		
o "This year I worked on solving irrigation problems, and mostly grew stuff for personal consumption."		
Total	17	100%
2. Have you identified your potential market?		
• Yes	8	80%
• No	2	20%
Total	10	100%
3. What is/are the market(s) you have identified?		
• "Farmer's markets in Aztec, Farmington, and Durango".		
• "Native residents and students around Fort Lewis College".		
• "Individuals at grower market and retail nurseries".		
• "Vitality Works, Albuquerque Gaia Herbs, Brevard NC my own online marketing website, Willow Creek Herb Farm".		
• "Local herb businesses, farmer's market sales, national herb businesses".		
• "Wholesale and retail tea-bagged herb--wholesale to coops, natural food stores, high end gift shops, and culturally-specific (Navajo) shopping centers".		
• "People looking naturopathic alternatives to synthetic drugs, starting with family, friends, co-workers; and developing a word-of-mouth approach".		
• "The farmers' market that I manage in my town".		
4. Have you obtained any Southwestern herb seeds to fit the market you have identified?		
• Yes	5	45%
• No	6	55%
Total	11	100%
5. Which Southwestern herb seeds and/or propagation material (e.g. cuttings) have you obtained?		

Relevant Participant Questions (1 - 12)	No. of Respondents	% of Total
• "I continue to grow small plants to sell at growers market that include Yerba mansa, showy milkweed, datura, creosote bush, horehound, golden rod, cota", mullien, agave, and various non-native species.		
• "Echinacea, yerba del manso, firewheel and overlapping Midwest prairie species".		
• "Seed: Osha, Prodigiosa. Manso plants".		
• "Greenthread seeds".		
• "Yerba mansa, cota".		
6. Are you having success at propagating and growing the seed/material you obtained?		
• Yes	5	56%
• No	4	44%
Total	9	100%
7. Describe how successful you are at growing the Southwestern herb seed/material you obtained. Please describe.		
• "Seed propagation is mixed".		
• "Seeds are germinated in a controlled greenhouse environment".		
• "Still in the initial soil preparation/ layout/infrastructure phase (greenhouse, irrigation, machinery acquisition)".		
• "Manso is easy but slow. Prodigiosa is easy from seed and division. Osha is an ongoing experiment with fresh seed planted in fall".		
• "Half ton dry harvested 2010".		
• "None".		
• "Haven't tried".		
• "I have transplanted yerba mansa into a cultivated bed near my house. I have not worked with cota yet".		
8. Are you wildcrafting (harvesting from a naturalized area) Southwestern medicinal herbs to sell?		
• Yes	2	20%
• No	8	80%
Total	10	100%
9. Which Southwestern herbs are you wildcrafting to sell? (Please list):		
• "Does not apply to me".		
• "I collect some of the seed from wild native plants to germinate".		
• "Goldenrod".		
• "Mullein, Prodigiosa, manso (plants)"		
• "None".		
• ".None".		
• "Yerba mansa".		
10. Have you balanced cultural sensitivity with the Southwestern herbs you have selected?		
• Yes	3	30%
• No	2	20%
• Please explain.	5	50%
o "Does not apply to me".		
o "Not applicable in my Midwestern situation".		
o "I know the cultural or historic uses in this area as well as scientific".		
11. What information from the workshop helped you in making decisions about which herb species to obtain seed for?		
• "Does not apply to me".		
• "We are working on a business plan".		
• "There were some that after being introduced to now include in my inventory".		
• "1) Networking with other growers, esp. Bill Quiroga 2) introduction to aeroponic production by Bill Quiroga. 3) Strengths/opportunities chart presented by Bill Quiroga 4) the importance of a business plan before		

Relevant Participant Questions (1 - 12)	No. of Respondents	% of Total
investing. As a result I held off on buying a new compact tractor because I realized I couldn't make it pay for itself. Maybe a good used one, or working with neighbors”.		
• “Cultural data in the handouts gave me a good sense of what would grow well from seed”.		
• “Most would apply”.		
• “I didn’t get to see much of the workshop”.		
12. What are the markets you sell to? (Check all that apply)		
• I am not selling herbs.	6	67%
• I sell the raw, unprocessed herb locally at a farmer’s market.	1	11%
• I sell the raw, unprocessed herb to a company for processing.	1	11%
• I do my own herb processing and sell locally.	2	22%
• I sell directly through a catalog/internet.	1	11%
• I sell through a distributor and/or broker.	1	11%
• I direct market to retail outlets like coops, health food stores and/other retail outlet(s).	2	22%
• Other. What other potential companies or persons have you contacted regarding buying herbs?	2	22%
o “I sell live herb plants to individuals and nurseries”.		

Table 81. Participants who had not put the information to use were asked to proceed to question #13 in order to assess general interest in growing southwestern medicinal herbs. Their responses are grouped with those that answered questions 1-12; NMSU Agricultural Science Center at Farmington, NM. 2011.

Relevant Participants Questions (13 – 17)
13. How has your interest in Southwestern herbs changed as a result of the training? (15 Responses)
• “I need to do more research”.
• “It has grown but I haven't started my planting yet”.
• “I want to work to bring product to the campus at Fort Lewis College”.
• “My interest has increased but I am disappointed that I was unable to start a farm production as I had hoped”
• “I realize the importance of grower cooperatives instead of marketing to wholesalers/brokers. I want to bring this information to Midwestern tribes in Wisconsin, Illinois and Iowa”.
• “I have become even more interested in exploring pooling/cooperating/associating to build direct local markets”.
• “No, my interest has not changed, just put on the back burner”.
• “Increased”.
• “I suppose what I saw of the workshop was interesting and looked like a sound idea”.
• “The seminar was very informative; although I studied herbalism in Florida I was not aware of many local southwestern herbs. The seminar expanded my herb ‘database’ so-to-speak”.
• “A great deal. Wish I had more time to focus on right now”.
• “I have always been interested in and used herbs personally and for my patients”.
• “It has enhanced my interest and desire to learn more and grow my own herbs”.
• “Looking at growing herbs form a more business-like perspective, vs. just romanticizing about it”.
• “I have more awareness of SW herbs. I went to the training with no background in herbs. I wish to become a market gardener and wanted to find out about herbs as a possible crop”.
14. What information from the training program did you find most useful? (16 Responses)
• “Marketing opportunities”.

Relevant Participants Questions (13 – 17)

- “Other growers experiences”.
- “Marketing and risk information”.
- “I was able to logically investigate a dream more fully to see if it would work”.
- “All of Bill Quiroga's presentation 2) aeroponics production maybe could be used for outdoor production (pea gravel lined beds?)”.
- “Steve H.'s concentration on a single herb and a few value added products”.
- “All of the material was of interest. Hearing the struggles of all the growers was an inspiration. What we do is not easy”.
- “The Gaia Herbs presentation was the most straight forward and useful: specifically the info on quality control and FDA regulations”.
- “Identification tips”.
- “I only saw the part with the wholesalers/buyers of small scale product”.
- “The presenters were all very knowledgeable; I learned that starting a business isn't as difficult as I thought it could be”.
- “Most of it. Especially the personal experiences”.
- “Risk management”.
- “All of it but I really connected with the lecture ‘Commerce verses Culture’”.
- “The part about identifying your market and working backwards from the selling point to the choice of what to grow. The info from Jackie Greenfield of Gaia Herbs was really helpful”.
- “Just learning about the most popular SW herbs. I had no knowledge of them before I attended the workshop”.

15. What information from the training have you applied to your operation? (15 Responses)
    - “Market research”.
    - “None yet”.
    - “No operation but all of it will be relevant”.
    - “Only some of the investigation techniques”.
    - “I did a cost/benefit evaluation of farm equipment. I investigated getting a loan from a local bank. Actually, bank loans for businesses are very reasonable nowadays, the labor, time, and delay on return of investment (3-5 years for some herbs) is currently the biggest obstacle”.
    - “Confirmed my sense that I should responsibly collect and market seed from many of the SW med. herb plants”.
    - “We have incorporated plants in landscapes that have the potential to be used for homeopathy. But we have not gone beyond that”.
    - “Quality Control info”.
    - “None”.
    - “None”.
    - “None”.
    - “It has helped me to evaluate and plan better instead of planting something I like and then winding up with a weed”.
    - “Growing process”.
    - “Testing a variety of herbs vs. just one or two”.
    - “N/A”.
16. What information from the training program did you find least useful? (12 Responses)
    - “None that I can think of”.
    - “N/A”.
    - “N/A”.
    - “The mystical uses of herbs”.
    - “Jackie Greenfields information because the wholesale prices are so low and the standards/criteria are so high”.
    - “Bill's presentation was useful but too long”.
    - “Don’t remember”.
    - “The parts I didn’t get to see”.
    - “None”.
    - “All was great”.
    - “The heavy duty business plan stuff...it was over my head so I didn't get how to utilize the information in

Relevant Participants Questions (13 – 17)
my business”.
• “Although growing most of these herbs doesn't seem to be practical as part of a mixed fruit, vegetable, culinary herb and cut flower small market garden operation, I still liked learning about them. I didn't find any information ‘least useful’”.
17. What gaps or information are still needed to help you make decisions about growing Southwestern herbs? (13 Responses)
• “Local cooperatives”.
• “N/A”.
• “Land access, securing land access, contracts”.
• “The gap between the funds I have and those I would need to farm”.
• “Info about specialized equipment/machinery and sources/distributors to a better grower/cooperator network here in the Midwest”.
• “There is always a gap between local and regional markets supporting local/regional growers”.
• “There are no gaps, just the lack of time, and until I can retire, nothing will happen”.
• “Don’t know yet”.
• “Probably need to see the entire presentation”.
• “I do not have any reliable help to care for my fields, so I am leery of too many and too big projects. I have a profession and also travel to teach and give treatments”.
• “N/A”.
• “More basic business planning”.
• “N/A”.

Table 82. General questions (18 and 19) not related to SWH to assess growing and scale of operation; NMSU Agricultural Science Center at Farmington, NM. 2011.

Relevant Participants Questions (18 and 19)	No. of Respondents	% of Total
18. How would you describe yourself as a grower?		
• I do not have any experience but am considering it.	3	19%
• I have experience growing agricultural crops but only as a hobby or for personal use, not commercially as a cash generating activity. Examples of agricultural crops can include fruits, vegetables, herbs, hay, grains, ornamentals, etc.).	1	6%
• I am an experienced commercial grower of other crops (e.g. vegetables) but I have never grown Southwestern herbs.	5	31%
• I am already commercially growing and/or wildcrafting Southwestern medicinal herbs.	2	12%
• Other. Please describe.	5	31%
o “Experience growing but not commercially”.		
o “Answers to previous questions describe my growing”.		
o “Have 25 + years in commercial growing, but it is with non-native/non-medicinal herbs”.		
o “I work with SW medicinals as well as ag”.		
o “I have a very small potted garden each summer on my patio”.		
Total	16	100%
19. No matter what you are growing (e.g., fruit, vegetables, herbs, hay, or other agricultural crop) or the size of your land under production, how would you describe your growing operation in terms of household-income generating activity?		
• Personal or hobby use (I derive all of my income from anything other than growing).	6	40%
• Part time income generated (less than one quarter of my household income is generated as a grower).	5	33%
• Between ¼ and ½ of my household income is generated by growing.	1	7%

Relevant Participants Questions (18 and 19)	No. of Respondents	% of Total
• Over half but not all of my household income is generated by growing.	0	0%
• I derive all of my household income by growing crops.	0	0%
• Other (Please describe).	3	20%
o "My income does not come from the selling of anything, just my salary in the NM Education system".		
o "I get paid to work on a farm not my own".		
o "Depends on the year, how well fruit and crops do, but very little of my income".		
o Really more personal use or for my patients.		
Total	15	100%

Table 83. Questions (20 and 21) on ethnic and racial categories; NMSU Agricultural Science Center at Farmington, NM. 2011

Relevant Participant Questions (20 and 21)	No. of Respondents	% of Total
20. Ethnic Category. I am:		
• Hispanic or Latino	4	25%
• Not Hispanic or Latino	12	75%
Total	16	100%
21. Racial Categories. I am:		
• American Indian/Alaska Native	1	7%
• Asian	0	0%
• Native Hawaiian or Other Pacific Islander	0	0%
• Black or African American	0	0%
• White	13	87%
• More Than One Race	1	7%
Total	15	100%

Conclusion

Of the 37 participants who agreed to be re-contacted, 17 completed the post workshop follow-up survey online. The low number of survey respondents and the fact that almost half of those that did respond (47%) had not undertaken any steps toward developing a risk management plan indicate that most of the participants were interested in the topic but were not well positioned to implement growing herbs on any scale. In fact, of the respondents, none indicated greater than half of their income as farm generated. This is not surprising of small scale producers as typically, other sources of income are needed to support a household.

Qualitative descriptions indicate that time and resources were issues in progressing with commercial production of southwestern medicinal herbs. Others indicated that they were progressing with growing herbs commercially to support a portion of their income. Some responses included:

- "I did assess production and financial risks. As much as I would like to proceed the upstart costs in relation to the chances of success were overwhelming"

- “Because of the duties of my present job, I have not had time to do anything.”

Those that had assessed their market indicated that a local farmer’s market was the preferred transaction channel for selling SWH. About half of the respondents (45%) who began the process of assessing risks had identified specific herb species to grow. Five out of nine respondents indicated that they were having success at growing their own herbs from seed. Few respondents, only 2, were wildcrafting.

Responses were overall positive concerning the content of the workshops. Some commented that the sessions were too long. The business plan material was too complex for one respondent who commented that “The heavy duty business plan stuff...it was over my head so I didn't get how to utilize the information in my business”. Gaps in the information concerning SWH included agronomic barriers, like access to land, time and a need for simplified business planning.

The low number of underserved Native American growers is an indication that SWH represent a grey area for groups like the Navajo and clearly more sociological and ethnographical information should be conducted before assuming that any one tribe will embrace commercial production of SWH. Cultural sensitivity to these issues was strongly emphasized during the workshops and an example of a successful operation by Native American Botanics illustrated that some tribes of the Southwest see SWH as an economic generator. Still, we encourage non-native growers to seriously research and respect tribal policy when it comes to considering producing some SWH.

Acknowledgements

This project was funded by the Western Center for Risk Management Education Project number RME-JSL03272. We also wish to acknowledge the NMSU Agricultural Experiment Station

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 groTM, 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 23). 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 23. Grow-box experiment located at San Juan College; NMSU Agricultural Science Center at Farmington, NM. 2011.

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 (kg/ha) 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.

Certified Kitchen/Food Processing Feasibility for Bloomfield, NM – Tracing Transaction Channels between Agricultural Producers and Consumers to Identify Market Bottlenecks

Kevin Lombard and Ram Acharya

Specialty crops such as fresh fruits, vegetables, and herbs offer high potential for greater returns on investment for small holders. Value added products like salsa, jams, juices, baked goods, and herb extracts require post-harvest and processing facilities that are cost prohibitive to small-scale agricultural producers.

The City of Bloomfield, San Juan County, New Mexico is seeking assistance to identify opportunities for local growers to form linkages with produce buyers and food processors in nearby markets. The proposal is connected to the possible refurbishment of a 6,000 square foot facility that once housed the Home Economic program at Bloomfield High school. The request is timely given the results of a recent survey of large and small-scale farming and ranching producers located in San Juan County, NM (Kramer 2009). To summarize:

1. The majority of respondents classified as farmers and market growers expressed that there are opportunities for profitability in the future.
2. Thirty percent of the respondents are interested in diversifying their production and twenty-five percent are interested in developing a value-added products;
3. Trying a specialty crop and utilizing different markets also received a significant level of interest among respondents.

These statistics reveal an openness and desire to learn and apply new information that can be used to strengthen and sustain agricultural operations in Bloomfield and San Juan County. All of these interests can be addressed by research and extension service activities and should receive attention. Any private grower/rancher would be interested to know what product or service has a market demand that is adequate to sustain a commercially viable business. Similarly, any government or non-government agency would be interested to leverage interventions that have the highest potential to increase access to new markets. No business will thrive without addressing a need that has adequate and sustainable demand at commercially viable prices. No institutional kitchen or retail outlet will sustain a ready supply of fresh fruits, vegetables, meats, or dairy without understanding market bottlenecks. To our knowledge, no one has attempted to quantify/qualify transaction channels from farm to consumer table in Bloomfield and beyond.

Scope

The study will be conducted by Drs. Kevin Lombard (Horticulturist, NMSU Agricultural Science Center at Farmington) and Ram Acharya (NMSU Agricultural Economist, Las Cruces, NM). The subsector approach will be employed which allows for qualitative analysis of transaction channels between producers and consumers through interviews with key informants. Subsector analysis has been used by Non-Governmental Organizations such as CARE and ACDI-VOCA

(Karuga, 2003) to identify market opportunities and bottlenecks. This approach requires: 1) review of available documents, 2) focus group - discussion with key informants in a workshop that will include representatives of producer groups; consumer groups that include retailers, restaurants, institutional kitchens, individuals; and state and federal extension/research personnel, 3) field interviews (one-on-one) -will be used to develop case studies which will aid in identifying transaction channels between producers and consumers. Identifying web-based direct marketing of a value added product might also be included in the analysis.

Beneficiaries: Direct beneficiaries will be: 1) Bloomfield, NM growers/ranchers seeking to add value to a raw product they produce and sell directly either themselves or through a cooperative (Currently, most of these producers lack access to a certified kitchen); 2) Consumers seeking to buy Bloomfield value-added products; 3) Regional policy makers seeking to justify economic growth initiatives

References

Karuga, S. 2003. "Eritrea's horticultural subsector analysis and potential business investment opportunities." A report to the Ministry of Agriculture, Rural Enterprise Unit of the Commercial Bank of Eritrea and ACDI/VOCA, February 19, 2003.

Kramer, A. 2009. "San Juan County Agricultural Needs Assessment Analysis." NMSU San Juan County Cooperative Extension report, January 2009.

Navajo Gardening, Nutrition and Community Wellness

Mark Bauer and Kevin Lombard

Specific objectives and activities

This proposal describes a community-based participatory research project to gather community assessment data to plan interventions to promote wellness through gardening and nutrition in the Navajo Nation. The project will reflect close collaboration and cooperation between Diné College faculty, led by PI Mark Bauer and Becky Begay, the Diné College Land Grant Programs, and New Mexico State University, through Co-PI Kevin Lombard. All phases of the project will be guided by a local stakeholders group, to include representation from local youth programs, senior programs, tribal health and agriculture programs and IHS Health Promotions, among others, to ensure that project activities are closely attuned to the culture and people from whom we expect to gain insights that ultimately contribute to effective interventions to increase nutrition and wellness over time within the Navajo Nation. Students trained in research methods through the college's Summer Research Enhancement Program will participate in carrying out the research aims.

Aim 1. To consolidate a community-based advisory group that will serve an essential role in planning and guiding all project activities.

Aim 2. To conduct a needs assessment of Navajo community members to determine community-based priorities related to gardening, nutrition and wellness among youth, adults and elders. This work will include assessment of level of interest, barriers, priorities, recommended strategies, and methods to elicit community participation in interventions to utilize gardening initiatives to promote wellness.

During the first 3 months of the project the staff will work with the community advisory group to develop an interview protocol following the scope and content recommended. It will include questions in the following areas:

- Attitudes and interest in gardening and learning about nutrition
- Past and current gardening and farming activities, and which family members are involved
- Access to land, water, tools, skills for gardening at home or in the community
- Knowledge of gardening, and its connection to nutrition, family economics
- Nutritional assessment through food frequency questionnaires to see if gardening activity impacts noticeably on nutrition
- Demographic questions about distance from various resources, household size and resources, ages and gender of family members

Students will be recruited and trained through coursework of the Summer Research Enhancement Program, which will also be offered during the academic year to provide the training needs of this project. This previously USDA funded program provides academic coursework in research methods and research practicum activities. They will assist with pilot testing the interview protocols and sampling procedures.

During the remainder of the first year the staff and students will conduct the first 100 interviews, and perform the data entry and data cleaning that will be required. The sample descriptive statistics will be produced to determine whether the sampling procedure is resulting in a sample that is representative of the communities of interest.

During the first six months of the second year, the remaining 50 surveys will be conducted, with any modification of sampling necessary to strive for a sample representative in terms of age, economic status, location, and other key household characteristics noted.

During the final six months of the second year, the full data analysis will be done, and analyzed for factors associated with more or less gardening, and for any nutrition differences that could result from that.

Aim 3. To develop recommendations for intervention strategies based on the findings of the needs assessment.

The community advisory group will meet regularly (at least monthly) to assist with consideration of the findings and compiling recommendations in terms of interventions, content for further extension education and outreach programming, and further research that could be suggested as a result of the findings.

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 - 2011

- The "Wedge Landscape was tentatively approved for installation in 2012.
- Student enrollment remains steady at about 15 students per class.
- The SJC Horticulture Club raised approximately $1000 in proceeds during the second annual Earth Day Plant Sale hosted April 22, 2010.
- Several students are receiving training through the NMSU-ASC Farmington.

Development and Evaluation of Drip Irrigation for Northwest New Mexico

Hybrid Poplar Production under Drip Irrigation in the Four Corners Region

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

Mick O'Neill, Kevin Lombard, and Sam Allen

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 for establishment of an initial trial on 1.1 acres (0.45 ha) at ASC Farmington on May 15, 2002. Sixteen cuttings per clone per plot were planted in a 10 x 10 foot (3 x 3 m) grid spacing. The clone entries were replicated in three blocks for a total of 480 trees.

Irrigation for the current year was started on April 18, 2011 and programmed as prescribed by calculated evapotranspiration (ET) demand. Irrigation was terminated September 30, 2011. Tenth year survival and diameter at breast height (DBH) were determined for all study trees on November 28 and 29, 2011, with tree height determined on December 9, 12-13, 2011. Total crop ET amounted to 49.3 inches while total application plus rainfall was 47.6 inches, for the poplar trees. Clone OP-367 remains the tallest clone, after 10 seasons reaching a mean height of 65.4 feet. Significantly shorter than OP-367 were the clones 49-177 and 311-93 (both ~55 ft in mean height), but these were significantly taller than the remaining 5 clones. OP-367 had the largest mean DBH at 11.0 inches. This was followed by clones 311-93 and 58-280, both with DBH ~9 inches, with the remaining 5 clones of significantly smaller diameter. Maximum wood volume was obtained by OP-367 at 6,758 ft^3/acre and total biomass for OP-367 was 153 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 interest in the production of poplar as a sustainable substitute for aspen currently harvested from the nearby 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 84). These clones were various crosses between *Populus deltoides*, *P. maximowiczii*, *P. nigra*, and *P. trichocarpa*. Procedures for the hybrid poplar production trial are presented in Table 85. Prior to planting, the field was disked, leveled, and spot sprayed with Roundup herbicide. 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 foot (3 x 3 m) grid 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 84. Hybrid poplar clones, their parents, and source of parents grown under drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM. 2002-2011.

Clone	Code	Taxon	Female Parent	Source	Male Parent	Source
Eridano*	1	DM	*P. deltoides*	France	*P. maximowiczii*	Japan
NM-6*	2	NM	*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.

$$KC1 = 3.93\times10^{-1} - 2.58\times10^{-5}(GDD) + 5.39\times10^{-8}(GDD^2) - 8.98\times10^{-12}(GDD^3) \qquad (1)$$

$$KC2 = 3.71\times10^{-1} + 1.38\times10^{-4}(GDD) + 2.95\times10^{-8}(GDD^2) - 8.20\times10^{-12}(GDD^3) \qquad (2)$$

$$KC3 = 5.18\times10^{-1} + 4.57\times10^{-5}(GDD) + 1.19\times10^{-7}(GDD^2) - 2.40\times10^{-11}(GDD^3) \qquad (3)$$

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

where…

KC(year) = Crop coefficient for a given year;

GDD = Growing degree days; and

ET = Evapotranspiration replacement rate (inches).

Irrigation was started on April 18, 2011 and programmed as prescribed by calculated ET demand. Irrigation was terminated September 30, 2011. Calculated ET replacement amounted to 49.3 inches (125.2 cm), and actual irrigation application plus rainfall was 47.6 (120.8 cm).

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 possible leaf chlorosis (Brady and Weil 1999; Havlin et al. 1999). To reduce this prospect, a micronutrient blend was applied (June 24-27, August 1, and September 1, 2011) through the irrigation system.

Diameter at breast height (DBH) was determined on November 28 and 29, 2011, with tree height (Ht) determined on December 9, 12-13, 2011. Wood volume per tree was calculated after Browne (1962) using Equation 3 and scaled to ft^3/acre.

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

where…

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

DBH = Diameter at breast height (inches); and

Ht = Tree Height (feet).

Statistical analysis was carried out using the ANOVA procedure in the CoStat software package version 6.400 (CoHort 2008). Least significant differences were determined at the 0.05 level.

Table 85. Operations and procedures for the 2002-planted hybrid poplar production in the drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operations	Procedures
Varieties:	8 Clones
Planting Date:	May 15, 2002
Planting Rate:	10 x 10 ft (3 x 3 m) spacing (436 trees/acre)
Plot Size:	40 x 40 ft (12.2 x 12.2 m) each containing 16 trees
Fertilization:	Custom blend (25-9-0-0.32Zn-0.1Fe) injected for a total of 50 lbs N per acre (56 kg/ha) divided over three periods: June 24-27, August 1, and September 1, 2011
Fungicide:	None
Herbicide:	None
Insecticide:	None
Rodenticide:	None
Soil Type:	Doak sandy loam
Irrigation:	Surface drip irrigation
Irrigation Commenced:	April 18, 2011
Irrigation Terminated:	September 30, 2011

Results and discussion

Of the 10 *Populus* sp. evaluated (Table 84) 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 (ETc) and water application plus rainfall for tenth year hybrid poplar are presented in Figure 24. 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 49.3 inches (125.2 cm) while total application plus rainfall was 47.6 inches (120.8 cm) for the poplar trees, of which 3.5 inches (8.8 cm) were received as precipitation.

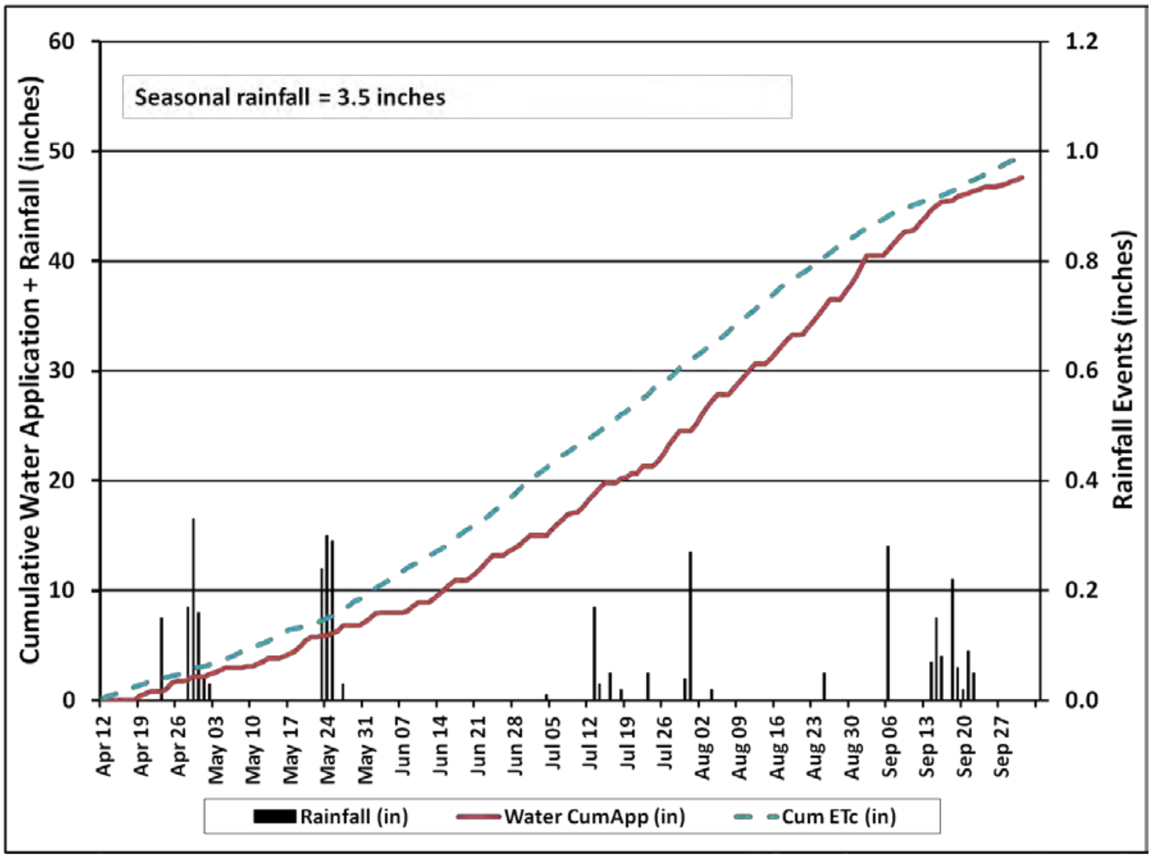

Figure 24. Cumulative evapotranspiration and irrigation plus rainfall for hybrid poplar production under drip irrigation; NMSU Agricultural Science Center at Farmington, NM., 2011.

Growth

Clone OP-367 remains the tallest clone reaching a mean height of 65.4 feet after 10 seasons. Significantly shorter than OP-367 were the clones 49-177 and 311-93, with mean heights of 55.3 and 54.5 feet, respectively. These were significantly taller than the remaining five clones. The shortest clones were 52-225 and Eridano at 43.1 and 40.9 feet, respectively. OP-367 had the largest mean DBH at 11.0 inches. This was followed by clones 311-93 and 58-280 with DBH around 9 inches. The Eridano clone had the smallest mean DBH of 6.1 inches. Maximum wood volume was obtained by OP-367 at 6,758 ft3/acre followed by clones 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 86). Total biomass production to date for OP-367 was 153 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, 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 86. Growth and survival of 8 hybrid poplar clones grown under drip irrigation; NMSU Agricultural Science Center at Farmington, NM. 2011.

Clone	Survival (%)	DBH[†] (in)	DBH (cm)	Height (ft)	Height (m)	Wood Vol. (ft^3/acre)	Wood Vol. (m^3/ha)	Biomass (ton/acre)	Biomass (Mg/ha)
OP-367	100	11.0	28.0	65.4	19.9	6,758	473	153	343
311-93	100	9.1	23.0	54.5	16.6	3,831	268	97	217
58-280	98	9.0	23.0	50.5	15.4	3,456	242	95	214
49-177	90	8.3	21.1	55.3	16.9	3,410	239	80	180
195-529	60	7.3	18.5	49.5	15.1	2,539	178	64	143
NM-6	98	7.1	17.9	49.0	14.9	2,220	155	55	124
52-225	69	7.1	18.0	43.1	13.1	1,917	134	56	126
Eridano	90	6.1	15.5	40.9	12.5	1,449	101	40	90
Mean[‡]	**88**	**8.2**	**20.9**	**51.6**	**15.7**	**3,316**	**232**	**83**	**186**
p>F	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CV%	32.7	17.5	17.5	13.3	13.3	35.5	35.5	36.8	36.8
LSD (0.05)	11.0	0.7	1.9	3.5	1.1	607.4	42.5	15.7	35.3

[†] DBH = Diameter at breast height (~ 4.5 ft; 1.37 m).
[‡] Mean is calculated from 8 clonal entries, each consisting of 3 replications of 16 trees per 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 all characteristics measured during the ten-year growth period, with 311-93 and 58-280 ranking 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 in previous years shifts their means slightly, since dead trees are eliminated from the analysis. Interestingly, the vast majority of these lost trees were in two adjacent plots, towards the north end of the trial, where high soil calcium carbonate has been previously documented (Lombard, 2007).

Another clone of note was PC-06, which, though not included in the analysis (it was planted into existing plots in 2003 as a replacement entry where clone 184-411 had been eliminated), amassed 2,116 ft^3/acre of wood volume and a total biomass of 49 tons/acre (2010 season data), 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 good growth on high pH soils typical of the area. These clones currently exhibit the least chlorosis and greatest growth potential.

Literature cited

Anderson, J.U. 1970. Soils of the San Juan Branch Agricultural Experiment Station. NMSU Agricultural Experiment Station Report 180.

Brady, N.C., and R.R. Weil. 1999. The Nature and Properties of Soils. Prentice Hall, Upper Saddle River, NJ. 881 p.

Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species in British Columbia. British Columbia Forest Service, Forest Surveys and Inventory Division, Victoria, BC, Canada. 105 p.

CoHort. 2008. Users Manual. CoHort Software. Monterey, CA.

Gochis, D.J., and R.H. Cuenca. 2000. Plant water use and crop curves for hybrid poplar. Journal of Irrigation and Drainage Engineering 126:(4)206-214.

Havlin, J.L., J.D. Beaton, S.L. Tisdale, and W.L. Nelson. 1999. Soil Fertility and Fertilizers: An Introduction to Nutrient Management. Prentice Hall, Upper Saddle River, NJ. 499 p.

Johnson, J.D., and K.R. Johnson. 2003. Hybrid poplar genotype affects attack incidence by the poplar-and-willow borer (*Cryptorhynchus lapathi*). Western Journal of Applied Forestry 18:276-280.

Keetch, C.W. 1980. Soil Survey of San Juan County New Mexico: Eastern Part. USDA SCS, USDI BIA and BOR, NMSU Ag. Exp. Stn. 173 p.

Leavengood, S., B.A. Charlton, and J. Dahm. 2001. Hybrid poplar performance 2000. Crop Research in the Klamath Basin. 2000 Annual Report. Oregon State University Agricultural Experiment Station, Corvallis, OR.

Lombard, K.A. 2007. Opportunities and challenges of poplar-based agroforestry in the Four Corners region of New Mexico. Ph.D. dissertation, New Mexico State University, Las Cruces, NM.

Shock, C.C., E.B.G. Feibert, L.D. Saunders, and M. Seddigh. 2002. Initial growth of irrigated hybrid poplar decreased by ground covers. Western Journal of Applied Forestry 17:61-65.

Timmer, V.R. 1985. Response of a hybrid poplar clone to soil acidification and lime. Canadian Journal of Soil Science 65:727-735.

Evaluation of Hybrid Poplar Amended with Composted Biosolids

Kevin Lombard, Mick O'Neill, and Sam Allen

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. A 1.2-acre (0.5-ha) trial was initiated in Spring 2005 to test whether composted biosolids can reduce iron chlorosis in hybrid poplars growing on high pH soils. Plots received a one-time application of 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 in a 12 x 12 foot (3.6 x 3.6 m) grid spacing. Two early chlorosis evaluations showed that poplars cultivated on soil amended with biosolids remained the least chlorotic and compared favorably with the Fe chelate check plots. Initial growth parameters also showed increased biomass rates compared to control plots. For 2011, effects of biosolids on tree growth were not evident, though annual growth was adequate. Average DBH and height were 8.6 inches and 64.6 ft respectively, representing a 3.6% overall increase in DBH and 5.7% overall increase in height since 2010. Average wood volume and biomass were 3,018 ft^3/acre and 60 tons/acre respectively. A lack of treatment differences is understandable given conditions of natural soil turnover since 2005, underwatering, and, most notably, the vigorous growth of clone OP-367 under varied treatments. When viewed as a whole, the use of biosolid-amended soil appears to have been useful in addressing chlorosis issues in the initial stand establishment window, though long-term effects on growth were not observed in 2011. In line with recent USEPA recommendations, the use of biosolids could also be considered for other agricultural land applications, as well as by municipalities seeking alternative waste disposal options in northwestern New Mexico.

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 have periodically been 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 February 21-24, 2005 using a transit and tape measure. Baseline soil samples augured to a depth of 8 inches (20 cm) were taken April 6, 2005 prior to the addition of treatments. Composites of four soil samples from each plot were made and air dried in a greenhouse. Chemical traits of soil and biosolids samples are shown in Table 87.

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 2010). 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 87. Selected chemical traits of soil and biosolids 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
NO_3-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)	3,492.0	4,540.0
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, NM.
† 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, NM).

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 Deere tractor pulled drop-type fertilizer spreader with a capacity of 600 pounds per load (272 kg 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 biosolids 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, and 7 for the 20 ton/acre rate were used. After biosolids applications to Block 1 were completed, the entire block was rototilled to a depth of 5 inches (13 cm) 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 concern 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 88.

Table 88. Operations and procedures for 2005-planted poplars in Biosolids Trial; NMSU Agricultural Science Center at Farmington, NM, 2011.

Operations	Procedures
Variety:	OP-367
Cultivation and Incorporation of Biosolids:	April 6-7, 2005. Composted biosolids spread at 10 ton/acre and 20 ton/acre (22.75 and 45.5 Mg/ha) rate using tractor-pulled fertilizer spreader. Plots rototilled to a depth of 5 inches (13 cm).
Planting Date:	April 27-28, 2005
Planting Rate:	12 x 12 ft (3.6 x 3.6 m) spacing (302 trees/acre)
Plot Size:	48 x 96 ft = 4,608 ft^2 (14.5 x 31 m = 450 m^2) with 32 trees/plot
Treatments (2005):	Control, 10 ton/acre biosolids, 20 ton/acre biosolids, baseline Sprint Fe chelate application (applied annually by hand through 2010)
*Fertilization:	None
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:	April 18, 2011
Irrigation Terminated:	September 30, 2011

*In 2010, UAN-32 applied at 25, 12.5, and 12.5 lbs N/acre on May 26, July 19, and August 18, 2010; Iron chelate hand applied as a soil drench to each tree in Fe treatment plots only (5.55 g/plot applied June 10, 2010). This protocol was followed in previous years as well.

Cuttings of OP-367 were obtained in spring 2005 and planted on moistened soil at 12 x 12 foot (3.6 x 3.6 meter) spacing on April 27-28. Cuttings were placed exactly at a drip emitter, and an iron stake pushed into the ground aided in making 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.

Current-year diameter at breast height (DBH) and tree height (Ht) were determined on November 29, 2011, and January 27, 2012, respectively. Wood volume per tree was calculated after Browne (1962) using Equation 1 below and scaled to ft^3/acre:

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

where…

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

DBH = Diameter at breast height (inches); and

Ht = Height (feet).

Experimental design and statistical analysis

The experiment was a completely randomized block design with two Biosolids 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 6.400 (CoHort 2008). 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). Although the trees were watered several times per week during the summer, mechanical and operational difficulties resulted in significant underwatering. Total calculated ET amounted to 49.3 inches (125.2 cm) while total application plus rainfall was 11.4 inches (28.8 cm). Despite this setback, the study trees exhibited good health throughout the 2011 growing season. Plots were not monitored for Electrical Conductivity (EC), an indicator of soil salinity levels, in 2011, as residual salinity did not appear to be a concern.

There was no significant difference in tree diameter or height among treatments for the 2011 growing season (Table 89). Average DBH was 8.6 inches and average height was 64.6 ft, compared to 8.3 inches and 61.1 ft for 2010, representing a 3.6% overall increase in DBH and 5.7% overall increase in height, respectively. Average wood volume was 3,018 ft^3/acre, and average biomass was 60 tons/acre, reflecting adequate growth, though no differences were seen among treatments. This lack of treatment differences is understandable given conditions of natural soil turnover, underwatering, and, most notably, the vigorous growth of clone OP-367 under varied treatments. When viewed as a whole, the use of biosolid-amended soil appears to have been useful in addressing chlorosis issues in the initial stand establishment window, though long-term effects on growth were not observed in 2011.

Table 89. Selected growth parameters for hybrid poplar amended with composted biosolids; NMSU Agricultural Science Center at Farmington, NM, 2011.

TRT†	DBH‡ (in)	DBH (cm)	Height (ft)	Height (m)	Wood Vol (ft^3/acre)	Wood Vol (m^3/ha)	Biomass (ton/acre)	Biomass (Mg/ha)
Bio-10	8.8	22.3	64.0	19.5	3,042	213	61	138
Bio-20	8.5	21.7	64.0	19.5	2,932	205	58	130
Fe	8.8	22.3	64.6	19.7	3,064	214	61	137
Control	8.4	21.4	65.7	20.0	3,034	212	58	130
Mean	**8.6**	**21.9**	**64.6**	**19.7**	**3,018**	**211**	**60**	**134**
P	0.4959	0.4978	0.7015	0.7034	0.9025	0.9026	0.6593	0.6666
CV%	13.8	13.8	10.9	10.9	26.8	26.8	25.8	25.8
LSD (0.05)	0.6	1.4	3.3	1.0	376.7	26.4	7.2	16.1

† Treatments = Biosolids @ 10 & 20 tons/acre, Fe (Sprint 138), and Control.
‡ DBH = Diameter at breast height (~ 4.5 ft; 1.37 m).
‡ Mean is calculated from 4 replications with 32 trees for each plot.

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 seventh year of this study. A possible reason for the lack of differences seen this year may be attributed to underwatering or to depletion of amended-soil constituents. Moreover, it is possible that clone OP-367 may be too vigorous to show treatment differences in 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 could 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. One caution with the use of biosolids—excessive levels of salinity could develop with repeated applications of biosolids, though this did not appear to be a factor affecting the growth of trees in the current study. Thus, judicious use of biosolids, with proper attention to long-term salinity impacts, should be considered when biosolids are applied to land.

Literature cited

Albuquerque. 2010. Wastewater: Composting [Online]. Available by City of Albuquerque http://www.abcwua.org/content/view/87/75/

Bowman, L., and E. Durham. 2002. A biosolids composting challenge: meeting demand for a peat-free horticultural-grade product. Water and Environmental Management: Journal of the Institution of Water & Environmental Management 16:105-110.

Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species in British Columbia. British Columbia Forest Service, Forest Surveys and Inventory Division, Victoria, BC, Canada. 105 p.

CoHort. 2008. Users Manual. CoHort Software. Monterey, CA.

Committee on Toxicants and Pathogens in Biosolids Applied to Land. 2002. Biosolids Applied to Land. National Research Council, Board on Environmental Studies and Toxicology. Washington, DC.

Gochis, D.J., and R.H. Cuenca. 2000. Plant water use and crop curves for hybrid poplar. Journal of Irrigation and Drainage Engineering 126:(4)206-214.

Iranpour, R., H.H.J. Cox, R.J. Kearney, J.H. Clark, A.B. Pincince, and G.T. Daigger. 2004. Review: Regulations for biosolids land application in U.S. and European Union. Journal of Residuals Science and Technology 1:209-222.

Moral, R., J. Moreno-Caselles, M. Perez-Murcia, and A. Perez-Espinosa. 2002. Improving the micronutrient availability in calcareous soils by sewage sludge amendment. Communications in Soil Science and Plant Analysis 33:3015-3022.

Acknowledgments

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

Mick O'Neill and Sam Allen

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 on 6.8 acres (2.75 ha) on April 27, 2007 in a 12 x 12 foot (3.6 x 3.6 m) grid spacing, and drip irrigated during each growing season at four levels: 70, 80, 120, and 130% of reference poplar evapotranspiration (ET). Survival for the entire planting was 97% after the first year, with tree growth greatest for the 120% irrigation level and wood volume greatest for clone 433. Looking at fifth year results from a 10-year trial, growth patterns between clones and irrigation treatments are shifting slightly from previous years: across irrigation treatments, tree growth was greatest for the 120 and 130% irrigation levels; across clones, greatest wood volume was achieved by clones 433 and 544. It is expected that these patterns will become stabilized in coming 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 calculated to be 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 irrigation regimes.

First year results for multi-year trials (this trial has a planned life of 10 years) are often unreliable and may 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

The trial was established in the spring of 2007 using 4 hybrid clones (433, 544, 910, and 911) that had been the leading producers in the 2005 biomass study. Operations and procedures for the hybrid poplar trial are presented in Table 90. 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 (3.6 x 3.6 m) spacing. Holes were prepared for cuttings using a fabricated metal rebar 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 2,048 trees across a total area of 6.8 acres (2.75 ha). Plot layout and location of irrigation treatments and clones are detailed in Figure 25.

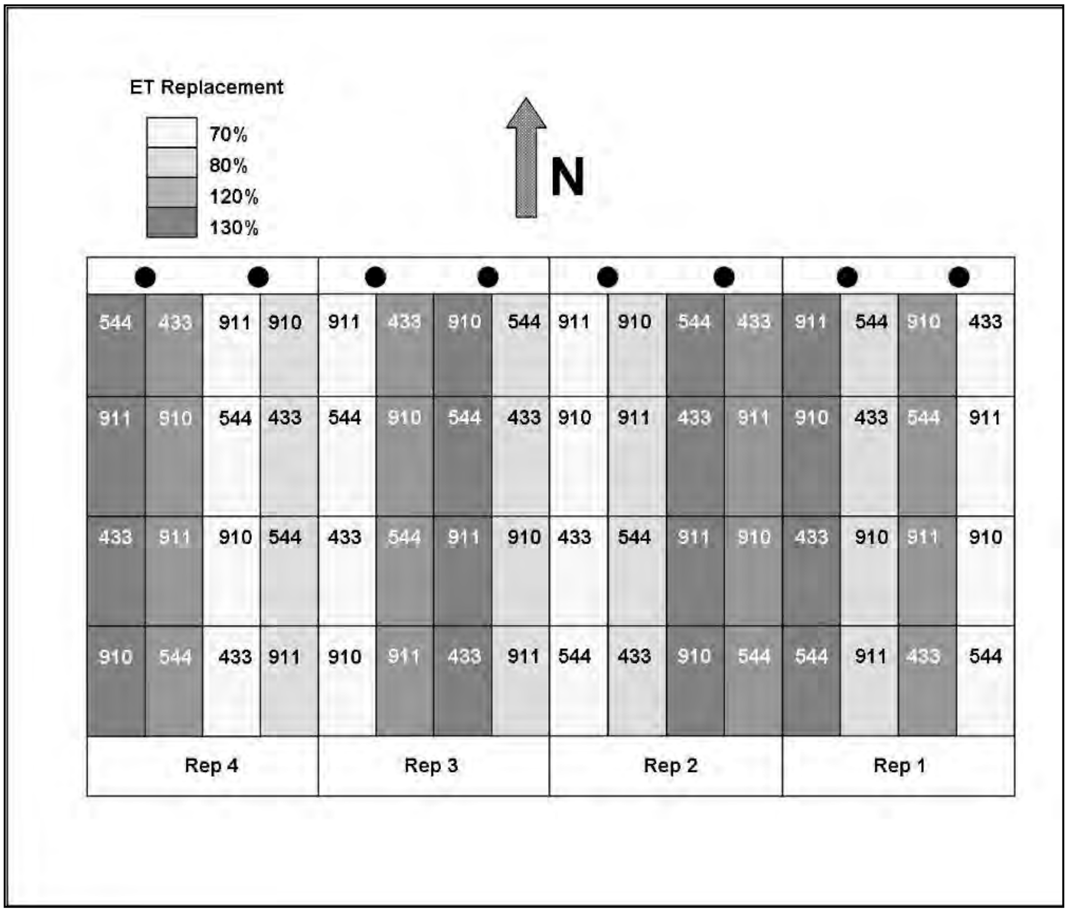

Figure 25. Detailed plot plan of four hybrid poplar clones grown under four irrigation levels. Clones are designated by 3-digit code in each subplot, shaded tones designate whole plot irrigation levels; NMSU Agricultural Science Center at Farmington, NM. 2011.

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.

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

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

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

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

where…

KC(year) = Crop coefficient for a given year;

GDD = Growing degree days; and

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 April 18, 2011 and programmed as prescribed by calculated ET demand. Irrigation was terminated September 30, 2011.

Data collection occurred November 30-December 1, 2011, with survival, DBH and height recorded for the central 12 trees in each experimental unit (subplot=clone within irrigation treatment). Wood volume for each tree was determined after Browne (1962) and scaled to an acre basis, and biomass was calculated on an acre basis. Growth parameters were analyzed using the CoStat ANOVA procedure with mean separation by Fisher’s LSD (CoHort, 2008).

Table 90. Operations and procedures for 2007-planted poplars; NMSU Agricultural Science Center at Farmington, NM. 2011.

Operations	Procedures
Varieties:	4 Clones: 433, 544, 910, 911
Planting Date:	April 27, 2007
Planting Rate:	12 x 12 ft (3.6 x 3.6 m) spacing (303 trees/acre)
Plot Size:	48 x 96 ft = 4,608 ft^2 (14.5 x 31 m = 450 m^2) with 32 trees/plot
Fertilization:	Custom blend (25-9-0-0.32Zn-0.1Fe) injected for a total of 50 lbs N per acre (56 kg/ha) divided over three periods: June 2-7, August 1 and August 30-31, 2011
Fungicide:	None
Herbicide:	Touchdown (glyphosate) 2 qt/ac applied on May 23, 2011
Insecticide:	None
Rodenticide:	None
Soil Type:	Doak sandy loam
Irrigation:	Surface drip irrigation at 4 different rates based on estimated Evapotranspiration (70%, 80%, 120% and 130% of reference ET)
Irrigation Commenced:	April 18, 2011
Irrigation Terminated:	September 30, 2011

Results and discussion

Total ET (at 100% replacement) for the 2011 growing season was calculated at 49.3 inches for fifth year hybrid poplar (Figure 26). For the irrigation treatments, this would mean 34.5, 39.4, 59.1, and 64.0 inches at the 70, 80, 120, and 130% levels, respectively. Actual application plus rainfall (3.47 in.) for the respective treatments was 29.6, 34.0, 42.5, and 46.5 inches, a significant under-application stemming from early-season mechanical problems. In spite of this, overall seasonal growth was deemed to be satisfactory, with significant differences among clonal treatments and irrigation levels less pronounced but largely in line with previous years' results.

Across water treatments, the 120% and 130% irrigation levels showed the greatest growth in diameter (7.2 and 7.1 inches, respectively) and height (45.6 and 47.3 ft, respectively) (Figure 24). Mean wood volume for the irrigation treatments ranged from 736 ft^3/acre for the 70% irrigation level to 1,471 ft^3/acre for the 130% irrigation level, which was not significantly different from the 120% irrigation treatment (1,411 ft^3/acre). The two higher irrigation treatments also yielded the most biomass (39 and 38 tons/acre for 120% and 130% levels, respectively).

Diameter was greatest for clones 433 and 544, both with means of 6.8 inches, followed by clones 910 and 911 with means of 6.3 inches (Table 91). Clone 433 had the greatest mean height, 45.2 feet, significantly taller than all the other entries. Wood volume was also greatest for clone 433, which amassed 1,306 ft^3/acre in 2011, significantly greater than other clones. Biomass was highest for clones 433 and 544, with 35 and 34 tons/acre, respectively. This year, 2011, clone 433 led for height and wood volume and co-led for DBH and biomass. Also, while there is significant interaction between clones and irrigation treatments, and significant under watering may have impacted growth, the 120-130% ET irrigation treatments produced the most growth on average (Figure 27).

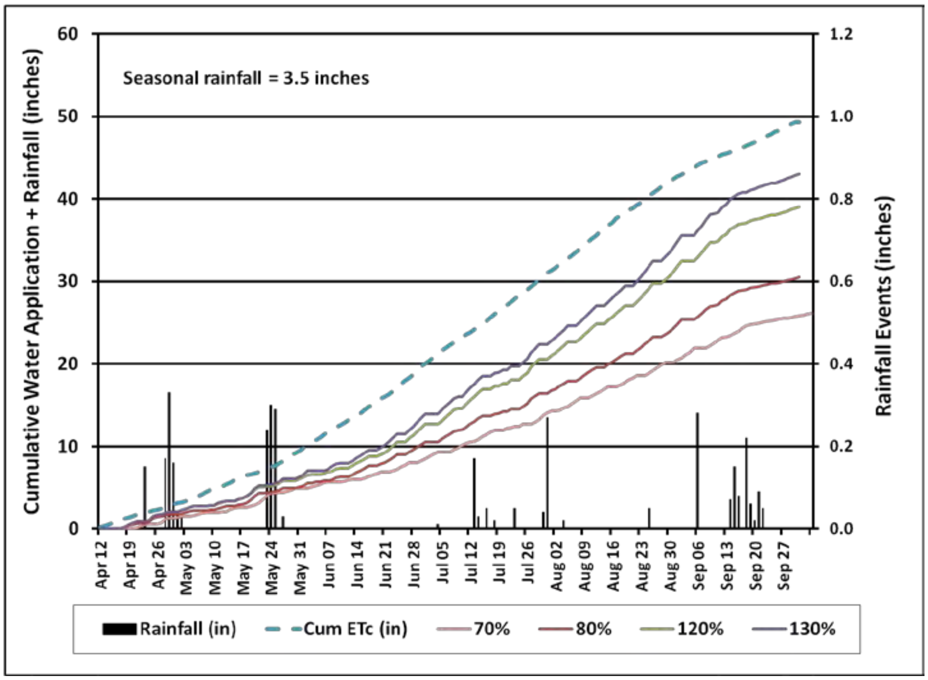

Figure 26. Cumulative evapotranspiration and water application plus rainfall for hybrid poplar water-use trial (2007-planted) grown under drip irrigation trial; NMSU Agricultural Science Center at Farmington, NM. 2011.

Table 91. Mean DBH, height, wood volume, and biomass for four clones grown under four irrigation regimes; NMSU Agricultural Science Center at Farmington, NM. 2011.

Irrigation Factor or Clone	DBH (in)	DBH (cm)	Height (ft)	Height (m)	Wood Vol (ft^3/acre)	Wood Vol (m^3/ha)	Biomass (ton/acre)	Biomass (Mg/ha)
1	5.7	14.6	36.5	11.1	736	52	23	52
2	6.0	15.4	39.0	11.9	862	60	26	58
3	7.2	18.3	45.6	13.9	1,411	99	39	87
4	7.1	18.0	47.3	14.4	1,471	103	38	86
433	6.8	17.2	45.2	13.8	1,306	91	35	78
544	6.8	17.2	42.7	13.0	1,182	83	34	75
911	6.3	15.9	40.0	12.2	992	69	29	64
910	6.3	16.0	40.4	12.3	992	69	28	64
Mean	**6.5**	**16.6**	**42.1**	**12.8**	**1,119**	**78**	**31**	**71**
P (irr.)	0.0001	0.0001	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	0.0001	0.0001
P (interact)	0.0286	0.0290	0.0001	0.0001	0.7952	0.7953	0.0320	0.0320
CV%	15.6	15.6	10.1	10.1	30.0	30.0	29.3	29.3
LSD (0.05) Clone	0.2	0.5	0.9	0.3	68.1	4.8	1.9	4.2
LSD (0.05) Irr.	0.2	0.6	2.1	0.7	106.5	7.5	2.8	6.2

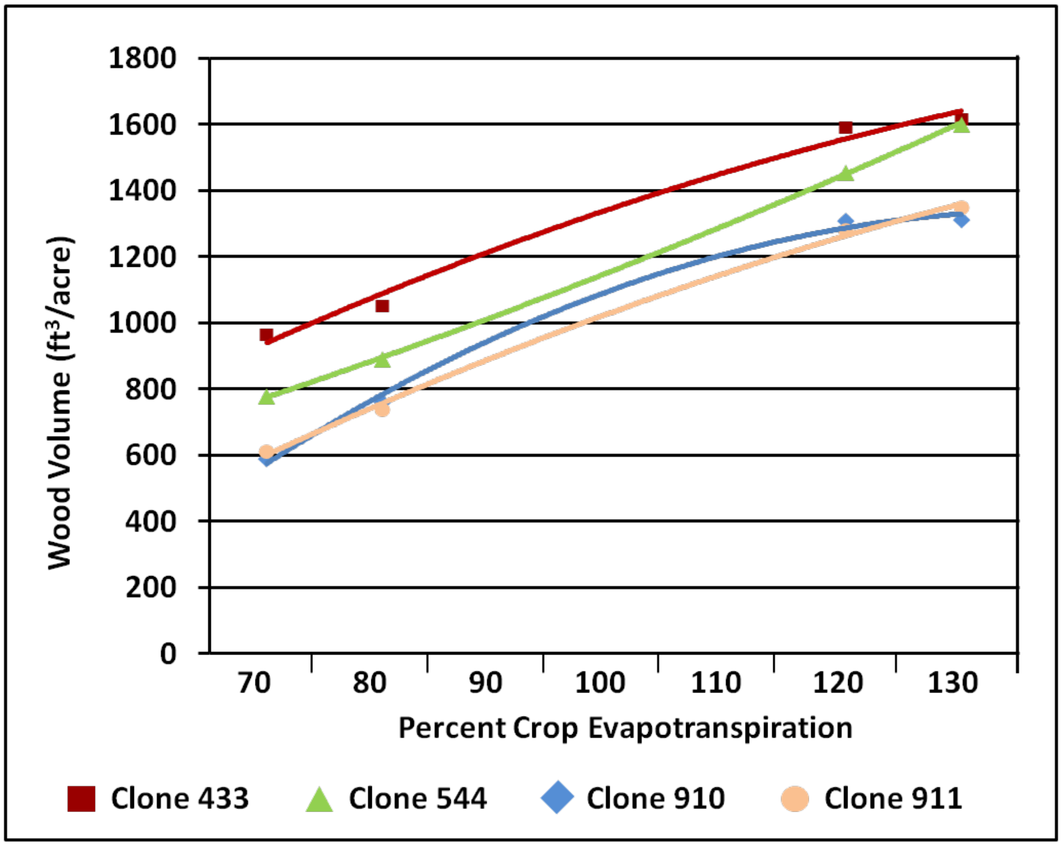

Figure 27. Wood volume for four hybrid poplar clones grown across four irrigation regimes (70, 80, 120, and 130% reference ET); NMSU Agricultural Science Center at Farmington, NM. 2011.

Conclusion

The 120-130% water application levels emerged as statistically similar for 2011, resulting in the most productivity in this trial. Underwatering was a problem but overall tree growth proceeded normally, resulting in less pronounced but observable treatment effects. The clone OP-367 had highest DBH along with Clone 544, and it continued to outperform the other clones with respect to height, wood volume and biomass. It will be interesting to observe these trends in subsequent years of the trial.

Literature cited

Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species in British Columbia. British Columbia Forest Service, Forest Surveys and Inventory Division, Victoria, BC, Canada. 105 p.

CoHort. 2008. Users Manual. CoHort Software. Monterey, CA.

Gochis, D.J., and R.H. Cuenca. 2000. Plant water use and crop curves for hybrid poplar. Journal of Irrigation and Drainage Engineering 126:(4)206-214.

Preliminary Update: Poplar Phytoremediation Project on an Abandoned Oil Refinery Site in Northwestern New Mexico

Mick O'Neill, Sam Allen, and Robert Heyduck

Abstract

Hybrid poplars are gaining in scientific interest for their reported ability to serve as phytoremediation agents for certain types of oil-contaminated soil and groundwater. Given the high density of abandoned oilfields in New Mexico, and environmental regulations requiring the mitigation of these contaminated lands, the potential of poplars to clean up these sites is intriguing. An abandoned oil refinery that had been in operation from 1973 to 1991 was targeted for the current phytoremediation project in spring 2011, following a preliminary phytoremediation study implemented in 2010 using local and hybrid poplars (*Populus* sp.) as well as the xeric species, four-wing saltbush (*Atriplex canescens*). In March 2011, 240 dormant poplar poles, 15-20 feet (4.5-6 m) in length with a 1 to 2-inch (2.5-5 cm) aboveground diameter at breast height (DBH), were planted at the site in four rows along a fence bordering the north boundary. Poles were inserted into groundwater 5 feet (1.5 m) apart with 10 ft (3 m) alleys between rows. Visual observations in April 2011 revealed leaf sprouting, and significant foliar coverage was noted by June 2011. At that time, of the 240 poplar poles planted, only one failed to develop foliage and could be considered dead, representing a 99% survival rate. A season's-end evaluation of 40 sub-sample trees in January 2012 showed on-going high survival. Average DBH was 1.3 inches (3.3 cm), and average aboveground height was 13.8 ft (4.2 m), representing ~8 inches (20 cm) of new growth. Wood volume at this early juncture was estimated to be ~47 ft^3/acre (3.3 m^3/ha). It will be interesting to observe the survival and growth of these poplars in future years, and to determine if they are able to exert a phytoremediatory impact upon petrochemical contaminants in adjacent soil and groundwater as expressed in tissue, soil and water analyses.

Introduction

Hybrid poplars are gaining in scientific interest for their reported ability to serve as phytoremediation agents for certain types of oil-contaminated soil and groundwater (El Gendy et al., 2009; Gordon et al., 1998). Given the high density of abandoned oilfields in New Mexico, and environmental regulations requiring the mitigation of these contaminated lands, the potential of poplars to clean up these sites is intriguing. An abandoned oil refinery that had been in operation from 1973 to 1991 was targeted for the current phytoremediation project in spring 2011. The refinery site, situated along the Kutx Wash north of Bloomfield, NM, had been monitored for several years prior to the present study, for various petrochemical contaminants in soil and groundwater, as part of a long-term monitoring and remediation contract managed by BioTech Remediation (Farmington, NM), a subsidiary of Thriftway Oil Company. The site was selected for the current study due to the high quality of existing groundwater monitoring data, proximity to NSMU Agricultural Science Center, and high levels of soil and groundwater contamination with free product floating on the water table above the site selected for remediation and a significant but lower level of groundwater contamination at the remediation site. The water table at the site is 5-6 feet below the soil surface.

Materials and methods

The site had undergone preliminary phytoremediation evaluations in 2010 using local and hybrid poplars (*Populus* sp.) as well as the xeric species, four-wing saltbush (*Atriplex canescens*). Whips of poplar and bare-rooted specimens of saltbush were planted during April 2010. A drip irrigation system (Figure 28) was established that supplies moderately to severely saline water (TDS 1000 to 2,700 mg/L) from a 1,500-ft well approximately 200 feet from the irrigated area. In March 2011, 240 dormant poplar poles, 15-20 feet (4.5-6 m) in length with a 1 to 2-inch (2.5-5 cm) aboveground diameter at breast height (DBH), were planted at the site along a fence bordering the north boundary (Figure 29). Poles were inserted into groundwater 5 feet (1.5 m) apart with 10 ft (3 m) alleys between rows.

Figure 28. Poplar whips were planted at an abandoned refinery site in Bloomfield, NM. A drip irrigation system was installed which provides water from a 1,500-ft well. Note salt rings under drip line emitters; NMSU Agricultural Science Center at Farmington, NM. 2011.

Results and discussion

Visual observations in April 2011 revealed leaf sprouting, and significant foliar coverage was noted by June 2011 on both the 2010-planted material (Figure 30) and the 2011-planted poplar poles (Figure 31). Of the 240 poplar poles planted, only one failed to develop foliage and could be considered dead by the June 2011 evaluation, representing a 99% survival rate.

A season's-end evaluation of 40 sub-sample trees in January 2012 showed on-going high survival. Average DBH was 1.3 inches (3.3 cm), and average aboveground height was 13.8 ft (4.2 m), representing approximately 8 inches (20 cm) of new growth. Wood volume at this early juncture was estimated to be ~47 ft^3/acre (3.3 m^3/ha).

Figure 29. Sam Allen inserting 20-ft poplar pole into planting hole with groundwater at 5-ft depth; NMSU Agricultural Science Center at Farmington, NM. 2011.

Analysis of the groundwater into which the poles were planted indicated high levels of total dissolved solids (TDS) greater than 4,500 mg/L and concentrations of methyl tertiary butyl ether (MTBE) — a common and pervasive residual contaminant — at nearly 55 µg/L. Gasoline Range Organics (GRO C6-C10) were 0.11 mg/L.

Figure 30. Hybrid poplar whips planted for petroleum phytoremediation during April 2010 produce substantial foliar growth during first half of their second growing season. Note substantial salt accumulation along the drip line; NMSU Agricultural Science Center at Farmington, NM. 2011.

Figure 31. Hybrid poplar poles, 15-20 feet in length, inserted into a 5 ft water table with substantial petroleum product contamination levels, demonstrate satisfactory first season growth during 2011; NMSU Agricultural Science Center at Farmington, NM. 2011.

Conclusion

Given the level of salt and iron in the irrigation water and the groundwater plus the elevated levels of MTBE and GRO C6-C10, it’s a wonder there is a single leaf on the trees and bushes, let alone the excellent foliage produced to date. Initial observations suggest hybrid poplar and four-wing saltbush are capable of substantial initial growth at a petroleum contaminated site with elevated salt loads in the soil and irrigation water. Further work is required to determine the degree of phytoremediation these species are capable of delivering.

Literature cited

El-Gendy, A.S., S. Svingos, D. Brice, J.H. Garretson, and J. Schnoor. 2009. Assessments of the efficacy of a long-term application of a phytoremediation system using hybrid poplar trees at former oil tank farm sites. Water Environment Research 81(5):486-498.

Gordon, M., N. Choe, J. Duffy, G. Ekuan, P. Heilman, I. Muiznieks, M. Ruszaj, B.B. Shurtleff, S. Strand, J. Wilmoth, and L.A. Newman. 1998. Phytoremediation of trichloroethylene with hybrid poplars. Environmental Health Perspectivies 106(4):1001-1004.

Acknowledgments

We would like to thank Mike Beauparlant and John Sandoval of Biotech Remediation, our collaborators on this project, along with Chad Dawson, for their assistance with tree cutting and planting and for site maintenance. Thanks also to Joe Ward for chainsaw work.

Dissemination and Staff Development

Books & Chapter

Waugh, W. J., Glenn, E. P., Charley, P. H., Carroll, M. K., Maxwell, B., O'Neill, M. K. 2011. Helping mother earth heal: Diné College and enhanced natural attenuation research at U.S. Department of Energy uranium processing sites on Navajo Land. In: Burger, J. (Ed.), *Science and Stakeholders: Solutions to Energy and Environmental Issues.* (pp. 119-147). Springer Publ. New York, NY. http://www.springerlink.com/content/978-1-4419-8812-6/#section=945916&page=1.

Publications and Reports

Arnold, R. N., M. K. O'Neill, and D. Smeal. 2011. Pest control in crops grown in northwestern New Mexico, 2003. NMSU Annual Data Report 100-2003. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR100-2003.pdf

Arnold, R. N., M. K. O'Neill, and D. Smeal. 2011. Pest control in crops grown in northwestern New Mexico, 2004. NMSU Annual Data Report 100-2004. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_2004.pdf

Arnold, R. N., M. K. O'Neill, and D. Smeal. 2011. Pest control in crops grown in northwestern New Mexico, 2005. NMSU Annual Data Report 100-2005. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_100_2005.pdf

Arnold, R. N., M. K. O'Neill, and D. Smeal. 2011. Pest control in crops grown in northwestern New Mexico, 2006. NMSU Annual Data Report 100-2006. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_2006.pdf

Arnold, R. N., M. K. O'Neill, and D. Smeal. 2011. Pest control in crops grown in northwestern New Mexico, 2007. NMSU Annual Data Report 100-2007. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_2007.pdf

Arnold, R. N., M. K. O'Neill, and K. A. Lombard. 2011. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Western society of Weed Science. No. 155.

Arnold, R. N. M. K. O'Neill, and K. A. Lombard. 2011. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Proceedings of the Western society of Weed Science. No. 155. ISSN:0091-4487.

Arnold, R. N., M. K. O'Neill, and K.A. Lombard. 2011. Broadleaf weed control in field corn with preemergence herbicides. Western Society of Weed Science Research Report. p.70. ISSN:0090-8142.

Arnold, R. N., M. K. O'Neill, and K. A. Lombard. 2011. Broadleaf weed control in field corn with postemergence herbicides. Western Society of Weed Science Research Report. p.71. ISSN:0090-8142.

Arnold, R.N., M. K. O'Neill, and K. A. Lombard. 2011. Broadleaf weed control in grain sorghum. Western Society of Weed Science Research Report. p.75. ISSN:0090-8142.

Arnold, R. N., M. K. O'Neill, and K.A. Lombard. 2011. Tumble mustard control in winter wheat. Western Society of Weed Science Research Report. p.96. ISSN:0090-8142.

Lauriault, L. M., Ray, I., Pierce, C., Flynn, R. P., O'Neill, M. K., Place, T., Idowu, O. J. 2011. The 2011 New Mexico Alfalfa Variety Test Report. Las Cruces, NM: Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. http://aces.nmsu.edu/pubs/variety_trials/avt11.pdf.

Leinauer, B., Smeal, D. 2011. Turfgrass Irrigation. NMSU CES Guide. (in press)

Lombard, K. A., O'Neill, M. K., Heyduck, R. F., Onken, B. M., Ulery, A. L., Mexal, J., Unc, A. 2011. Composted biosolids as a source of iron for hybrid poplars (*Populus* sp) grown in Northwest New Mexico. Agroforestry Systems, 81(1), 45-56. http://www.springerlink.com/content/v73123244hl383h1/fulltext.pdf.

Lombard, K. A., O'Neill, M. K., Ulery, A. L., Mexal, J., Onken, B., Forster-Cox, S., Sammis, T. W. 2011. Fly ash and composted biosolids as a source of Fe for hybrid poplar: a greenhouse study. *Applied and Environmental Soil Science, 2011*, 11p. http://www.hindawi.com/journals/aess/2011/475185.

Marsalis, M. A., Kirksey, R. E., Contreras-Govea, F., Flynn, R. P., O'Neill, M. K., Lauriault, L. M., Place, M. 2011. *New Mexico 2010 Corn and Sorghum Performance Tests*. Las Cruces, NM: Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. http://aces.nmsu.edu/pubs/variety_trials/10cornsorghum.pdf.

O'Neill, M. K., West, M. M. 2011. In Michael K. O'Neill and Margaret W. West (Ed.), *Forty-fourth Annual Progress Report: 2010 Cropping Season* (vol. 44, pp. 236). Las Cruces, NM: Agricultural Experiment Station and Cooperative Extension Service. New Mexico State University. http://farmingtonsc.nmsu.edu/documents/NMSU%20AnnRpt%202010.pdf.

Smeal, D., Lombard, K. A., West, M.M., O'Neill, M. K., Arnold, R. N. 2011. *Low-Pressure Drip Irrigation for Small Plots and Urban Landscapes* (ed., pp. 16). Las Cruces, NM: Agricultural Experiment Station Research Report. http://aces.nmsu.edu/pubs/research/agmech_eng/rr773.pdf.

Stamm, M., Berrada, A., Buck, J., Cabot, P., Classen, M., Cramer, G., Dooley, S., Godsey, C., Heer, W., Holman, J., Johnson, J., Kochenower, R., Krall, J., Ladd, D., Morre, J., O'Neill, M. K., Pearson, C., Phillips, D., Rife, C., Santra, D., Sidwell, R., Sij, J., Starner, D., Wiebold, W. (in press). Registration of 'Riley' Winter Canola. *To appear in Crop Science*.

Stamm, M., Buck, J., Godsey, C., Heer, W., Holman, J., Johnson, J., Krall, J., O'Neill, M. K., Rife, C., Santra, D., Sij, J., Spradlin, D., Starner, D. 2011. *Riley Canola* (ed., pp. 2p). Manhattan, KS: Kansas State University, Agricultural Experiment Station, and Cooperative Extension Service. http://www.ksre.ksu.edu/library/crpsl2/L929.pdf.

Proceedings

Lombard, K. A., Forster-Cox, S., Huttlinger, K. W., Smeal, D., Beresford, S. A.A., O'Neill, M. K. 2011. Gardens for health: Development of a model diabetes intervention project among an indigenous tribe in northwest New Mexico. Acta Hort. (vol. 911, pp. 311-316). http://www.actahort.org/books/911/911_35.htm.

Abstract, Posters and/or Oral Presentations

Allen, S. C., O'Neill, M. K., Heyduck, R. F., Lombard, K. A., Smeal, D., Arnold, R. N. 2011. Growth performance of hybrid poplar in a semi-arid zone of the Colorado Plateau: a case study of clone OP-367. October 24, 2011. 11th Biennial Conference of Research on the Colorado Plateau. Northern Arizona University, Flagstaff, AZ.

Arnold, R.N. 2011. New forage herbicide overview.2011 Southwest Hay and Forage Conference. January 12-14, Ruidoso, New Mexico

Arnold, R.N. 2011. Bureau of Land Management FFO/Farmington, Mat-28 update and pre-mixes for use on rangeland, January 18, Farmington, New Mexico.

Arnold, R.N. 2011. Navajo Agricultural Products Industry, Annual board meeting, Update of research projects at the ASC, January 28, Farmington, New Mexico.

Arnold, R.N. 2011. Navajo Agricultural Products Industry, Wheat production, February 7, Farmington, New Mexico.

Arnold, R.N. 2011. Navajo Agricultural Products Industry, Alfalfa production, February 11, Farmington, New Mexico.

Arnold, R.N. 2011. Navajo Agricultural Products Industry, Pasture and corn production, February 16, Farmington, New Mexico.

Arnold, R.N. 2011. Navajo Agricultural Products Industry, Dry bean and potato production, February 21, Farmington, New Mexico.

Arnold, R.N. 2011. Navajo Agricultural Products Production update of all crops grown on the Navajo Agricultural Products Industry March 2, Farmington, New Mexico.

Arnold, R. N., M. K. O'Neill and K. A. Lombard, 2011. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. 64th meeting of Western society of Weed Science, March 7-10, Spokane, Washington.

Arnold, R.N. 2011. Re-vegetation of BLM rangelands sites. April 5-6, Fort Collins, Colorado.

Arnold, R.N. New Mexico State University ASC, Advisory Board Meeting for 2011, April 13, Farmington, New Mexico.

Arnold, R.N. 2011. Weed control in corn, alfalfa, dry beans, sugar beets and small grains. University of Wyoming, Colorado State University and University of Nebraska Scottsbluff, Annual Weed Tour. June 20-23. Lingle, Wyoming, Fort Collins, Colorado, and Scottsbluff, Nebraska.

Arnold, R.N. 2011. Native and non-native grass injury, yield and Canada thistle control using Mat-28 and Milestone, October 18-20, Kauai, Hawaii.

Flynn, R. P., Mexal, J., O'Neill, M. K., Lauriault, L. M., Harrington, J. T., Guldan, S. J., Angadi, S., Carrillo, T. 2011. *Abstract - Agricultural Science Centers In New*

Mexico: Challenges and Successes. Madison, WI: ASA-CSSA-SSSA. http://a-c-s.confex.com/crops/2011am/webprogram/Paper67392.html.

Flynn, R. P., Mexal, J., O'Neill, M. K., Lauriault, L. M., Harrington, J. T., Guldan, S. J., Angadi, S., Carrillo, T. 2011. Agricultural Experiment Stations in New Mexico: Challenges and Successes. October 17, 2011. International Annual Meeting, American Society of Agronomy, San Antonio, TX.

Lee, L., Lombard, K. A., Hyder, D. 2011. Society for Advancement of Chicanos and Native Americans in Science (SACNAS) Annual Meeting, Society for Advancement of Chicanos and Native Americans in Science (SACNAS), San Jose, CA, "Evaluating an Asexual Method for propagating Wolfberry (Lycium pallidum)", (October 28, 2011).

Lombard, K. A. Beresford, S., Topaha, C., Thomas, D., Becenti, T., Forster-Cox, S., Smeal, D. 2011. Gardening is a way to improve wellness of indigenous peoples of northwest New Mexico: Focus group results. 11th. Biennial Colorado Plateau Conference, Northern Arizona University, Flagstaff, AZ, Oct. 27, 2011.

O'Neill, M. K., Heyduck, R., Allen, S., Lombard, K. A., Smeal, D., Arnold, R. N. 2011. Hybrid poplar for the Colorado Plateau: NMSU poplar research at Farmington, New Mexico. October 24, 2011. 11th Biennial Conference of Research on the Colorado Plateau. Northern Arizona University, Flagstaff, AZ.

O'Neill, M. K., Heyduck, R., Lombard, K. A., Smeal, D., Arnold, R. N., Hybrid poplar for the Colorado Plateau: NMSU research in Farmington, New Mexico. February 23, 2011. 8th Annual Cottonwood Symposium. Northern Arizona University, Flagstaff, AZ.

O'Neill, M. K., Heyduck, R. F., Allen, S. C., Lombard, K. A., Smeal, D., Arnold, R. N. 2011. Hybrid poplar for the Intermountain West: NMSU poplar research at Farmington, New Mexico. November 16, 2011. W-2128, Western Regional Collaborative Project for Microirrigation Research: Reducing barriers to adoption of microirrigation. Annual Meeting. Las Cruces, NM.

Smeal, D., Lombard, K. A., O'Neill, M. K., Arnold, R. N. 2011. Microirrigation on the Colorado Plateau: research at NMSU's Agricultural Science Center, Farmington, NM. 11th Biennial Conference of Research on the Colorado Plateau, Flagstaff, AZ. Oct. 24, 2011.

Smeal, D., M.K. O'Neill, M. K. 2011. Drip emitter evaluations at substandard head. W-2128 Annual Meeting. USDA Western Regional Collaborative Project for Microirrigation Research: Reducing barriers to adoption of microirrigation. Las Cruces, NM. Nov. 16, 2011 (presented by M.K. O'Neill).

Smeal, D. (Presenter & Author). 2011. Water Outlook/ Current and Future Challenges. Western SARE Conference. Innovations in Sustainability: Techniques for New Mexico Agriculture. Farmington, NM. Dec. 1, 2011.

Smeal, D. (Presenter & Author). 2011. Introduction to Drip Irrigation. Efficient Irrigation Equipment Workshop, La Plata Electric Assoc., Inc., Durango, CO. Nov. 10, 2011.

Smeal, D. (Presenter & Author). 2011. Irrigation research at the Farmington ASC. Rotary Club Meeting, Rotary Club, Farmington, NM. July 28, 2011.

Smeal, D. (Presenter & Author). Xeriscape Garden Presentation and Tour. Trailblazers Garden Club Meeting, Farmington, NM. June 12, 2011.

Smeal, D. (Presenter & Author). 2011. Research Overview. NMSU- ASC Farmington Advisory Committee Meeting, Farmington, NM. April 13, 2011.

Smeal, D. (Presenter & Author). 2011. Xeriscaping and Drip Irrigation. NMSU Coop. Ext Svc. Master Gardener Program, Farmington, NM. Mar. 18, 2011.

Smeal, D. 2011. Turfgrass Management. NMSU Coop. Ext Svc. Master Gardener Program, Farmington, NM. Mar. 11, 2011.

Smeal, D. 2011. Urban landscape drip irrigation. Home Show, San Juan Homebuilders Association, Farmington, NM, Mar. 5, 2011.

Smeal, D. 2011. Rainwater catchment and small scale drip irrigation demonstration. 16th Water Conservation/ Xeriscape Conference and Expo, Xeriscape Council of New Mexico, Albuquerque, NM, February 26, 2011.

Smeal, D. 2011. Small Scale Drip Irrigation. New Mexico Organic Farming Conference, Farm to Table, Albuquerque, NM, Feb. 19, 2011.

Sutherin, S., Lombard, K. A., St Hilaire, R. 2011. American Society for Horticultural Sciences Annual Meeting, American Society for Horticultural Sciences, Waikoloa, HI, " Establishing a Virtual Urban Landscape Water Conservation Center for New Mexico, West Texas, and Surrounding Areas", (September 12, 2011).

Thomas, D., Lombard, K. A., Hyder, D.,* Becenti, T. 2011. Society for Advancement of Chicanos and Native Americans in Science (SACNAS) Annual Meeting, Society for Advancement of Chicanos and Native Americans in Science (SACNAS), San Jose, CA, "The Grow Box Experiment", (October 28, 2011).

Media Contributions and Non-academic Paper or Reports

Lombard, K.A. (PI) and C. Martin. 2011. Audio/Video Production, Southwest Medicinal Herb

Production and Marketing. (December 2011). A risk management education program 4-disc DVD collection of guest speaker presentations. The work was filmed in Albuquerque on March 4 and 5th and edited by NMSU Agricultural Media Productions. The project was supported by USDA/NIFA Award # 2010-49200-6203.

Lombard, K.A. (PI) and C. Martin. 2011. Audio/Video Production, Risk Management Education in Southwest Medicinal Herbs. An online tutorial created from audio and video recordings of the Southwest Medicinal Herb workshops. The project was supported by USDA/NIFA Award # 2010-49200-6203. http://aces.nmsu.edu/southwestherbs.

Lombard, K.A. (PI), S. Sutherin, D. Smeal, R. St. Hilaire and others. 2011. YouTube Videos,

Xericenter.com. 40 YouTube videos on statewide demonstration gardens have been produced. The project is supported by the Rio Grande Basin Initiative. http://www.xericenter.com/main.php.

Lombard, K. A. 2011. Sustainable San Juan December 2011 Meeting, Sustainable San Juan,

Aztec, NM, "Hops in the Four Corners?". (December 12, 2011).

Lombard, K. A., Maier, B., Heil, S., Arnold, D. 2011. Western Sustainable Agriculture Research and Education (WSARE) Workshop, Farmington, NM, "Opportunities and challenges for specialty horticulture crops in the Four Corners Region: A panel discussion". (December 1, 2011).

Lombard, K. A. 2011. Integrated Land Management Workshop, Colorado State.

University Cooperative Extension Service, Arriola, CO, "Opportunities and Challenges for Viticulture in the 4-Corners" (March 22, 2011).

Lombard. K.A. 2011. Risk Management Education in Southwest Medicinal Herbs .

Workshop. Nature of participation: Moderated sessions. Albuquerque, NM. (March. 4-5, 2011).

Smeal, D. 2011. YouTube Videos, (5 short videos showing the xeriscape demonstration garden at NMSU's ASC at Farmington. A drip irrigation set up demonstration is also included). http://www.youtube.com/xericenter.

Meetings

Arnold, R.N. 2011. Bureau of Land Management FFO/Farmington, NM January 18, (presenter and participant)

Arnold, R.N. 2011. Navajo Agricultural Products Industry Farmington, NM February 7, (presenter and participant)

Arnold, R.N. 2011 Southern Rocky Mountain Agricultural Conference Monte Vista, CO February 8-10 (participant)

Arnold, R.N. 2011. Navajo Agricultural Products Industry Farmington, NM February 11 (presenter and participant)

Arnold, R.N. 2011. Navajo Agricultural Products Industry Farmington, NM February 21 (presenter and participant)

Arnold, R.N. 2011. Navajo Agricultural Products Industry Farmington, NM March 2 (presenter, and participant)

Arnold, R.N. 2011. Western Society of Weed Science Spokane, WA March 7-10 (presenter and participant)

Arnold, R.N. 2011. 2011 Spring Training School, CSU Fort Collins, CO April 5-6 (presenter and participant)

Arnold, R.N. 2011. New Mexico State University ASC, Farmington Advisory Conference Farmington, NM April 13 (presenter and participant)

Arnold, R.N. 2011. Colorado State University, University of Wyoming and University of Nebraska Scottsbluff Fort Collin, CO, Lingle, WY and Scottsbluff, NE June 20-23 (presenter and participant)

Arnold, R.N. 2011. New Mexico State University Leadership Tour, Dr. Cynda ClareyFarmington, NM July 25 (presenter and participant)

Arnold, R.N. 2011. Centennial, New Mexico with Carol Cloer Farmington, NM July 27 (participant)

Arnold, R.N. 2011. DuPont Crop Protection and BASF Mountain States Weed Scientists, Review protocols of 2011 Cheyenne, WY September 19-22 (presenter and participant)

Arnold, R.N. 2011. New Mexico State University Ag Experiment Station Superintendents Meeting Corona, NM November 21 (presenter and participant)

Arnold, R.N. 2011. Navajo Agricultural Products Industry San Juan County, NM. Twice a month or more from March to November 2011 (presenter, participant)

Arnold, R.N. 2011. Bureau of Land Management FFO Farmington, NM Once a month for weed committee meetings (presenter and participant)

Arnold, R.N. 2011. BASF, DuPont Crop Protection, Bayer CropScience and Monsanto Farmington, NM Conference calls or meetings throughout 2011 (presenter and participant)

Arnold, R.N. 2011. Western SARE Farmington, NM December 1 (moderator and participant)

Smeal, D. 2011. Western SARE Conference. Innovations in Sustainability: Techniques for New Mexico Agriculture. Western (SARE) Sustainable Agriculture Research and Education, Farmington, NM. Dec. 1, 2011.

Smeal, D. 2011. Research/Writing Presentation, U.S. Dept. Interior, Bureau of Reclamation Grant Writing Training, Dept. Interior, Bureau of Reclamation, Durango, CO. Nov. 15, 2011.

Smeal, D. 2011. Efficient Irrigation Equipment Workshop, La Plata Electric Association, Inc., Durango, CO. Nov. 10, 2011.

Smeal, D. 2011. 11th Biennial Conference of Research on the Colorado Plateau: Cultural and Natural Resource Management on the Colorado Plateau, Northern Arizona University, Flagstaff, AZ. Oct. 24 – 27, 2011.

Smeal, D. 2011. 16th Water Conservation/ Xeriscape Conference, NM Xeriscape Council, Albuquerque, NM. Feb. 24 – 27, 2011.

Smeal, D. 2011. New Mexico Organic Farming Conference, Farm to Table. Albuquerque, NM. Feb. 18 - 19, 2011.

Awards

Jim, Tom. NMSU ACES Off-campus ‘Distinguished Staff Award’. April 15, 2011.

Proposals and Grants

Gutierrez, Paul, Michael Hensley, Michael Morgan, Rex E Kirksey, Michael K O'Neill. Botswana Sustainable Agriculture Initiative. Sponsoring Organization: Siemens Corp and others. Requested funds to be determined .... (pending)

O'Neill, Michael K, Cibils, Andres F, Scholljegerdes, Eric J, St Hilaire, Rolston. Intensifying Fodder Production Systems for Improved Livelihoods of Smallholder Farmers in the Sahel. Sponsoring Organization: US Agency for International Development – Mali.
Five-year project, (pending) $5,207,000

O'Neill, Michael K, Lombard, Kevin A, Angelo Tomedi, Maimbo Malesu, Ramni Jamnadass. Rainwater Harvesting for Agroforestry Production and Community

Health. Sponsoring Organization: Bill and Malinda Gates Foundation, Grand Challenges Explorations Round 8. Eighteen-month project, (pending) ... $100,000.

Sattler, A. and R.N. Arnold, et al. 2010-2011. Sandia National Laboratory and United States Department of Energy. Desalinization of Coal Bed Methane Produced Water for Rangeland Grass Production .... (pending).

Grants Received

Arnold, Richard N. (PI)
Chemical Weed Control Hatch Project, State of New Mexico Allocation $5,000
Extension Plant Science Allocation.. $2,500

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.

Corporation Support
BASF $4,800
Bayer Crop Sciences $5,000
Dupont Crop Protection $4,000
Monsanto $4,000
Total $17,800

Lombard, Kevin A. (PI)
Viticulture and Specialty Horticulture
Hatch Project, State of New Mexico Allocation $5,000

Externally Received Awards and ongoing Research Support

Lombard, K. A. 2011. Internal Award - I2011-30 - Bridges/Mentor. Sponsoring Organization.
NIH Funded. (May 1, 2011 - December 31, 2011) $1,080

Lombard, K. A., 2011. Navajo Gardening, Nutrition and Community Wellness Surveys.
Sponsoring Organization: Diné College, Sponsoring Organization
USDA, Funded. (09/01/2011 -08/31/2012) $13,771

Lombard, K.A., and R. Acharya. Gift. Certified Kitchen/Food Processing Feasibility for Bloomfield, NM – Tracing Transaction Channels between Agricultural Producers and Consumers to Identify Market Bottlenecks. Sponsoring Organization Is: San Juan Economic Development $5,000

Lombard, K. A. and S. Beresford. 2011. Internal Award. Gardens for Health Enhancements, Crownpoint, NM. Sponsoring Organization Is: NIH/U-54. 2011 support $20,223

Lombard, K.A. 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. 2011 support $7,500

Lombard, K.A. and C. Martin. 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. 2011 support $32,000
Total $185,775

O'Neill, Michael K. (PI)
Drip Irrigation in the Four Corners
Hatch Project, State of New Mexico Allocation $5,000
Extension Plant Science Allocation....... $2,500
Total $7,500

Smeal, Daniel (PI)
Appropriate Water Conservation Technologies for Small Farms and Urban Landscapes
Hatch Project, State of New Mexico Allocation $5,000

Proposal Submitted in 2011 and Pending Review

O'Neill, M.K. (Principal), K.A. Lombard, K. Bachman. Infant Nutrition Enhancement through Agroforestry in Drought Prone Eastern Kenya. Currently Under Review.$100,000

Lombard, K. A. (Principal), S.A.A. Beresford, I. Ornelas, J. Jim,M. Bauer, D. Smeal. Where Health and Horticulture Intersect: A Navajo Wellness Collaboration., Sponsoring Organization: NMSU/FHCRC U54 .... $359, 839

Proposals Submitted but not Accepted

Lombard, K. A. (Principal), Acharya, R. (Co-Principal), Uchanski, M. E. (Co-Principal), Larsen, M. D. (Other), Sponsored Research, Is Farm/Ranch to Kitchen Direct Marketing Feasible in San Juan County, NM?, Sponsoring Organization: Winrock International. Institute for Agricultural Development....... $23,946

Lombard, K. A. (Principal), St Hilaire, R. (Co-Principal), Smeal, D. (Co-Principal), Sponsored Research, Enhancing the Center for Landscape Water Conservation, Sponsoring Organization: US Department of the Interior Bureau of Reclamation, Sponsoring Organization Is: Federal....... $37,500

Lombard, K.A., S.A.A. Beresford. Where Health and Horticulture Intersect: A Navajo Wellness Collaboration. Sponsoring Organization: NMSU/FHCRC U54 .... $782,612

O'Neill, M. K., Lombard, K. A. Rainwater Harvesting for Agroforestry Production and Community Health. Sponsoring Organization: US Agency for International Development.
(07/01/2011 – 12/31/2011) $10,000

O'Neill, M. K., Lombard, K. A. Seed to Wheel Advanced Biofuel: A Rural Energy Case Study in Experiental Learning. Sponsoring Organization: US Department of Agriculture/Cooperative State Research, Education, and Extension Service. Award (09/09/2009 – 09/09/2011)... $56,249

Stringam, B., Seevers, B. S., O'Neill, M. K. Enhancing Water Harvesting to Benefit Rural Communities of Rwanda. Sponsoring Organization: USDA/NIFA-International Science and Education., Current Status: Not Funded. (09/01/2011 – 12/31/2013).$149,550

Stories from the Popular Press

Farmington Science Center boosts Four Corners agriculture

Poplar trees, corn and canola are among the plants being raised at the Farmington Agricultural Science Center.

Farmington Science Center boosts Four Corners agriculture

By Jane Moorman

New Mexico State University's Farmington Agricultural Science Center is helping to turn the Four Corners region green through agricultural, environmental and economic development.

"As the only agricultural research facility in the state that is on the western side of the Continental Divide, we have 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," said Rick Arnold, Western Society of Weed Science 2010 Fellow and superintendent of the center.

NMSU's faculty at the center, which is located on 254 acres leased from the Navajo Nation, has assisted the Navajo Agricultural Products Industry in turning the semi-arid high plateau of the northeastern Navajo Nation into a major agricultural producer. In the past eight years, annual net returns have been about $5 million.

Farming 58,000 acres in a variety of crops, including alfalfa, potatoes, pinto beans, corn and wheat, NAPI has 110 year-round employees, and up to 300 employees during the growing season. It contributes approximately $200 million to the Four Corners region annually through direct procurements and pass-through purchasing. Additionally, the company contributes about $2 million to the Navajo Nation, including funding for scholarships and educational opportunities.

"We conduct variety tests of crops to help determine which hybrid will grow in our environment," Arnold said. "This information helps NAPI and area crop producers decide what to raise."

Through the years, Farmington ASC has conducted trials and agronomic research in a variety of crops, and that research has produced results for growers. Since the mid-1960s, average county yield of alfalfa has increased from three to more than five tons per acre; corn has gone from 55 to 154 bushels per acre; and wheat has jumped from 35 to 110 bushels per acre.

Recent variety research has been conducted on alfalfa, corn, dry beans, potatoes, canola, onions, pasture grass, winter wheat, spring oats, grapes, hops, medicinal herbs, hybrid poplar trees and landscape tree species, as well as irrigation water-use studies on tomatoes, chile, sweet corn and canola.

Variety trials are not all that Farmington's researchers do. Located in an area with annual precipitation of 8.19 inches, it is crucial that agricultural irrigation operations be as efficient as possible.

Since 1983, NMSU college professor Dan Smeal has performed water-related research to determine water use/production functions of the primary crops in the area. The research has determined consumptive use indexes and efficient water application strategies on crops including tomato, chile, potatoes, winter and spring grains, beans, corn, alfalfa, pasture and buffalo gourd.

Smeal has studied and demonstrated ways for small-area gardeners, who must transport water, to raise produce with a low-cost, low-pressure drip irrigation system.

"It is so simple," Smeal said of the gravity-driven system that requires a reservoir six feet above ground level, distribution pipe and emitters, all of which can be very basic or extravagant depending on funds.

"This system was created for farms with limited water resources in underdeveloped countries, such as Africa and India, to help them grow crops in an efficient way. People wishing to raise a garden in the remote areas of the Navajo Reservation face similar conditions," he said. "The system can also be used to distribute water to gardens from elevated rainwater catchment collectors."

The research determined how much water was needed for optimal production of chile and tomatoes.

Smeal is the project leader on the xeriscape research and demonstration garden where he has collected data on plant specimen water requirements. More than

Above: Farm hand Latisha Yazzie inspects grapes grown in a grape variety trial.

Right: Professor Rick Arnold tells field day guests about the outcome of an herbicide variety trial.

100 plant species receive water through a micro-irrigation system at four different rates – no water, 20 percent, 40 percent and 60 percent of reference evapotranspiration.

Residents and visitors to the Four Corner region can take a self-guided walking tour of the garden to help make plant selections for their own gardens and yards. Groups such as Master Gardeners and the Native Plant Society have visited.

Farmington ASC has played a key role in improving the success of revegetation on disturbed land from oil and gas exploration and transmission in the San Juan Basin, one of the most prolific gas-producing regions of the United States.

The Bureau of Land Management, which regulates how the land is treated after drilling is completed, turned to Arnold for help in developing a mix of native and non-native grasses that are adapted to the soil and climate of the region. The plants had to germinate and be established while using the produced water from the coal bed methane gas well sites.

The grass mix Arnold suggested to the BLM includes Arriba western wheatgrass, Hy Crest crested wheatgrass, bottlebrush squirreltail, Paloma Indian ricegrass, San Luis slender wheatgrass and some four-wing saltbush. Once the grass mix was determined it was tested on six well sites. BLM has established specifications regarding the quantity of each type of grass required at each disturbed site.

Looking to the future, Farmington ASC is conducting a wide range of research. The center 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 they are best adapted.

"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 recent years, the science center has also collaborated with the University of Nebraska, Kansas State University and Sustainable Oils, LLC, in renewable energy research on oilseed crops, such as sunflowers, canola and camelina for oil content, crop yield and weed management.

In 2002, Mick O'Neill, NMSU agronomist, began biomass research on hybrid poplar adaptations to the Four Corners region. Collaborative hybrid poplar research has been with Oregon State University, Washington State University, Greenwood Resources and ZeaChem.

Potential uses of the wood range from home use on the Navajo reservation to wood fiber as excelsior for cooling pads or soil conservation blankets placed along road cuts. The wood can be used as a biofuel, either as co-fired fuel for the Four Corners power plants or in a cellulosic conversion process to make ethanol.

NAPI has planted two 100-acre plots of the trees to see what will develop economically when the trees mature.

One role of the center is to explore alternative crops for the area. Horticulturalist Kevin Lombard, in collaboration with NMSU viticulturalist Bernd Maier and Bruce Reisch of Cornell University, has initiated wine and table grape research to examine cultivars for high elevation sites and comparison of similar cultivars at other statewide locations.

Hops research has been established in collaboration with the U.S. Department of Agriculture Hops Germplasm Center in Corvallis, Ore.; Todd Bates of Taos; Three Rivers Brewery in Farmington; and other brewers in Durango, Colo., to address Four Corners brewer needs.

Additional projects at Farmington ASC include horticulture therapy using gardens to address a regional diabetes problem, a Southwest and Chinese medicinal herb study for potential niche market productions, and a Rio Grande Basin Initiative project to develop educational materials and a website to address urban water conservation needs. ■

Garden project sprouts on harsh Navajo lands

Moorman, Jane and distributed to Associated Press. 2011. Garden project sprouts on harsh Navajo lands. Albuquerque Journal and others. Website:.An article featuring Dr. Lombard's involvement with the Gardens for Health project.

NMSU Garden for Health project strives to return gardening into Navajo lifestyle Share

Date: 2011-06-28
Writer: Jane Moorman, 505-249-0527, jmoorman@nmsu.edu

NMSU Tribal Extension agent Jesse Jim, left, and Alysse Pablo, lab assistant at NMSU Agricultural Science Center in Farmington, work on the irrigation system at the Garden for Health demonstration garden in Crownpoint. (NMSU photo by Jane Moorman)

CROWNPOINT, N.M. On a mesa in Crownpoint, overlooking the sun-parched, wind-blown land of the Navajo Nation, a garden is sprouting. New Mexico State University's Tribal Extension and the Agricultural Science Center of Farmington is helping the Crownpoint Boys and Girls Club to raise a garden as a demonstration of the Garden for Health project.

The Garden for Health project is introducing gardening back into the Navajo lifestyle to improve wellness. Gardening for sustenance and as a hobby has been lost across the United States, not just in the Navajo Nation. However, the loss of traditional lifestyle activities, such as gardening, and the introduction of processed foods have had a greater negative impact on the health of the indigenous people.

"Diabetes is a serious health problem in the Navajo Nation," said Kevin Lombard, NMSU College of Agricultural, Consumer and Environmental Sciences horticulturalist in Farmington. "There is a correlation between diabetes and associated cardiovascular disease with the lack of fresh vegetables and fruit in a person's diet." Scientific evidence indicates that diabetes among all groups, not just the Navajo, is largely a result of shifting lifestyles to include a reduction in consuming fruit and vegetables, and exercise habits. Studies show that individuals with diabetes are more likely to be sedentary and are more likely to suffer premature death related to cardiovascular disease than their non-diabetic counterparts.

"A huge concern is the number of children, adolescents, and young adults who are receiving diagnoses of diabetes," Lombard and colleague Sue Foster-Cox of the College of Health and Social Services' Department of Health wrote in an article entitled "Diabetes on the Navajo Nation: What role can gardening and agriculture extension play to reduce it?" The article appears in Rural and Remote Health, an international electronic journal of rural and remote health research, education, practice and policy. Dan Smeal and Mick O'Neill, of the Farmington science center, also contributed.

In the article, the authors reviewed the contributing factors to the lack of fresh vegetables in the Navajo diet, such as poverty and remoteness of communities on the reservation, where it is difficult to purchase fresh produce. The article proposed gardening as a source for fresh vegetables and fruit to improve diets. It also explained how drip irrigation and hoop houses could help gardens survive in the harsh climate of the Four Corners region.

“Gardening can help. Nutritious fruits and vegetables can be produced closer to home in an individual or community setting,” Lombard said. “This would increase consumption, enable physical activity in daily gardening practices, and raise rural household income by eliminating some grocery purchases while providing the potential to sell excess produce in a farmers’ market approach.”

Funds to promote the Garden for Health concept to the Navajos have been provided by the U-54 Partnership for the Advancement of Cancer Research partnership between the National Cancer Institute, the Fred Hutchinson Cancer Research Center and NMSU.

“During the first year of the funding we focused on networking with key people on and adjacent to the eastern portion of the Navajo Nation to assess deficiencies and avoid duplication of efforts,” Lombard said. Representatives from various agencies and organizations working to address the diabetes issue were among those polled. “The second year, we conducted focus group surveys to determine the grass roots interest and perceptions about gardening among the Navajos,” he said.

The elders, who were surveyed, remembered gardening as part of the lifestyle in the past. They mentioned that their parents and grandparents actively gardened and that it was a tradition at one time, but is no longer widely practiced. “A large percentage of all who were surveyed wanted to get back into the practice of gardening; some mentioned they were not sure how to go about it,” Lombard said. “They realized that while gardening seems simple, there is a level of knowledge that comes from experience. They said they have lost that knowledge and asked for technical assistance.”

One of the first groups to ask for assistance is the Crownpoint Boys and Girls Club. Kristen Willie, coordinator of the club’s programs, said the club has had a garden for about five years, but last year no plants grew. Willie asked advice from Jesse Jim, NMSU Tribal Extension agent, who has worked with the club providing nutritional education to the youth. “Jesse offered to help and she contacted Kevin for his assistance,” she said.

The expertise provided by NMSU included installing a low-pressure, low-cost drip irrigation system, that Smeal has researched at the Farmington Agricultural Science Center. The system is ideal for small gardens located in remote areas where water needs to be transported, a reality for many Navajo Nation residents. The design includes a 50-gallon tank, mounted six feet above the ground, where water is stored then released through irrigation lines to drip emitters at each plant. Delivering water directly to the plants eliminates wasting water and decreases the growth of weeds. The watering system and the use of low-cost hoop houses to extend the growing season were introduced in the Rural and Remote Health article as ways to help gardeners have success.

Youth from the boys and girls club helped prepare the garden’s soil, and planted the vegetables. The youth have learned about the importance of eating vegetables and fruits during Jim’s weekly nutrition and cooking class. “We want to show the kids that the produce they see at the grocery store can be grown in their backyard,” Jim said. “Also, how the corn we use in our traditional foods is raised. We planted one row of white corn for the kneel-down bread, one row of blue corn for the blue corn mush and one row of yellow for general eating. We also planted other vegetables including tomatoes and melons. The garden is also a demonstration to the community on how families can grow vegetables. Willie said the youth proudly show their parents that the plants have sprouted. “The parents are interested in the garden,” she said. “Maybe they will see that they too can raise a garden.”

In addition to modern irrigation and growing season extending technologies, Jim said, “There should be a balance between western and traditional gardening practices. Area elders in Crownpoint are willing to assist youth in learning about traditional Navajo gardening practices.” The project has already sparked the interest of Alysse Pablo, a lab assistant at the Farmington science center. The 22-year-old resident of

White Rock, which is located 30 miles from Crownpoint, says she remembers raising a garden when she was younger, but lack of rain caused her family to stop farming.

“With a secure source of water, or water that is hauled, this drip irrigation system would allow us to garden even if we don’t get rain,” she said while working on the Crownpoint garden’s system. “I could see how this could help the people in our community. It would be nice for people to have gardens or at least one at the chapter house where they could receive produce after it’s harvested.” The nearest grocery store to White Rock is in Crownpoint. While the store has fresh produce, Pablo said few of her chapter house members buy it. “Hardly anyone has running water or electricity to keep the vegetables cool, and they spoil. It would be nice to have gardens nearby so they could have vine ripened vegetables.”

To read the article “Diabetes on the Navajo Nation: What role can gardening and agriculture extension play to reduce it?” go to http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=640
To learn more about the low-pressure, low-cost drip irrigation system, go to
http://www.youtube.com/nmsuaces#p/u/35/AZaZht8eDRc

Piedra Vista remembers Kyler Beaty

By Jenny Kane The Daily Times Posted: 05/05/2011 12:11:00 AM MDT

FARMINGTON — It's young. It's sturdy. It's lively. It's perfect.

Close friends and family gathered around a recently planted honey locust sapling Wednesday in a ceremony to honor the life of Kyler Beaty, a Piedra Vista student who died in a car accident last June. The tree, a gift from his former workplace, was a gesture to provide closure to those who knew him — and shade to those who never got the chance. "I don't usually have a loss for words, but today I'm a little shaky," said Beaty's grandfather, Rick Arnold.

Beaty was a 17-year-old senior known for his athleticism and gregarious nature. He was on his way from football practice to work when he crashed his pickup truck into a dump truck that summer morning. He was unresponsive when paramedics arrived. Despite his life cut short, Beaty will be eternalized with the tree.

The tree, a slender but tall addition to the landscaping just behind Beaty's high school, was chosen by a handful of the teens co-workers from the New Mexico State University Agricultural Science Center. Not only did he work with them during his summers as a teenager, but many of them remember him as a child because his grandfather, Arnold, introduced him to the place. Arnold is now the supervisor of the center. "If he knew what he needed, he'd gather everything, and he'd do it," said Arnold, who started bringing his grandson to work when he was about 7.

"He would go all over the place and see who was doing what," said center professor Mick O'Neill, who spearheaded the project. "He just had this energy that was all over the place. He thought it was his farm."

The center became something of an educational playground for Beaty as a child, said colleagues who knew him as a preteen. He learned how to turn bolts the right way, how to ride a tractor and how to catch prairie dogs at the center. "He wouldn't want to go home at night, though everyone else would," O'Neill said.

"He was always smiling," said the center's self-proclaimed fix-it-man, Kenny Kohler.

It was that positive energy and liveliness that his coworkers wanted to embody in a memorial, and they agreed the perfect solution would be a tree. "It's a hardy tree. It's a strong tree, and that's how he was," said Dan Smeal, another science center professor. The tree is planted outside of the football locker room, where Beaty walked to and from football practice on a daily basis. "I thought it was just a perfect form of dedication," said Dennis Simonson, Beaty's best friend. Simonson was one of the individuals to shovel dirt into a space that was kept for a memorial plaque in Beaty's name. The tree eventually will be partnered with a picnic bench where students can visit, study or simply enjoy life.

Reducing our carbon footprint: From our kitchen to Three Rivers Brewery

http://www.sanjuanregional.com/upload/docs/About%20Us/Publications/Quarterly-Spring-2011.pdf

Reducing Our Carbon Footprint: From Our Kitchen to Three Rivers Brewery

How San Juan Regional Medical Center's composting efforts help create a favorite local ale.

Hundreds of pounds of food waste are being saved from going to the landfill each week, thanks to a partnership between San Juan Regional Medical Center and researchers at the New Mexico State University Agricultural Science Center located about 10 miles south of Farmington. It's all part of the many efforts being made at the hospital to reduce waste and increase environmental awareness through its 'Green Team' initiatives.

Food waste generated through the cooking process at the hospital was piling up when, a few years ago, a hospital employee approached the NMSU science center with the idea of using the unused kitchen produce to establish a composting program.

"We would collect the produce daily and bring it to work with us and deposit it in a pile, where it would begin the decomposition process," says NMSU science center

Continued on page 12 >>>

12

employee Curtis Owen, who continues these efforts begun by his colleague, Rob Heyduck, and picks up around 50 to 100 pounds of food waste three times a week. "With the aid of occasionally stirring it and adding leaves and other dry matter, the food waste gradually breaks down into a nice organic compost that is used mainly by Dr. Kevin Lombard with his horticulture projects."

Dr. Lombard adds the compost to soil used in grape and hops trials at the science center, seeing added benefits such as an increase in organic matter and improved soil moisture-holding capacity. The compost is used to fertilize the crops from mid May to early June, including Dr. Lombard's hops which are eventually given to Three Rivers Brewery in downtown Farmington, New Mexico, and used to produce a local favorite: **Aggie's Ale.**

Two weeks' worth of food waste from San Juan Regional Medical Center. The food waste is put into piles, where it is stirred and dried matter is added to assist with the decomposition phase. It is watered and 'turned' for three to six months before being used as organic fertilizer in Dr. Lombard's projects.

Dr. Kevin Lombard is shown checking on his wine grapes—which are also among his many horticulture projects at the NMSU Agriculture Science Center.

Dr. Lombard's hops trials at the New Mexico State Agricultural Science Center are shown here in their dormant phase. He uses our compost to fertilize the soil during the summer and—once harvested—the hops are given to Three Rivers Brewery in downtown Farmington, where they make a special brew called Aggie's Ale.

Summer interns take gardening to a new level

http://www.sanjuancollege.edu/documents/PR/Communicator/2011/Communicator_Sep-Oct_2011.pdf

september/october 2011
volume 31, issue 5

san juan college

communicator

san juan college's community news and events

inside this issue

Summer Interns Take Gardening to a New Level

San Juan College horticulture students Jason Thomas and Aiessa Wages got the chance of a lifetime, working as summer interns in the prestigious Filoli Estate Garden.

Competing against students from major universities nationwide, Thomas and Wages were two of five students selected to participate in the 10-week internship. The focus at Filoli is to preserve and maintain the historic gardens and estate as they were in the 1970's.

Filoli is a country house set on 600 acres in Woodside, California, about 30 miles south of San Francisco. The property was established in the early 1900's and includes 17 acres of formal gardens. It is a historic site of the National Trust for Historic Preservation and one of the finest remaining country estates of the early 20th century. The property remains one of the premier gardens on the west coast with over 60,000 visitors annually. They have the largest apple and pear fruit tree collection in North America. Movies and television episodes including *The Game*, *The Joy Luck Club*, and *Nash Bridges*, among others, have been filmed there.

"This is a tremendous privilege to participate in an internship of this caliber," says Kevin Lombard, assistant professor of Horticulture at San Juan College and New Mexico State University. "This also speaks volumes to the talent and excellent students we have at San Juan College."

Lombard worked on staff at Filoli from 1995 until 1998. "Part of the duty of a good instructor is to help expose students to potential internship opportunities that will benefit them down the road," he says.

Both Thomas and Wages agree that they learned a great deal about gardening, and especially learned a lot about themselves.

"The internship at Filoli has really allowed me to learn more about myself outside of my normal routine," Thomas says. "The entire educational experience has been one that I fully appreciate. From the broad-based program at San Juan College to working at the NMSU Agricultural Science Center to the Filoli internship, I'm grateful for all of these opportunities."

Thomas and Wages joined three other students for the intense 10-week program beginning in June and ending mid August. Each intern is assigned a lead horticulturist as well as an assistant, to act as a mentor throughout the program.

The 17-acre garden is divided into five distinct areas. These include four separate garden areas as well as a greenhouse.

"The goal of the program is to expose the interns to two weeks of estate gardening practices in each of the garden's five areas, Lombard says. "Their study includes planting, mowing, gardening and plant propagation, with an academic component in each of these areas as well."

All students interning at Filoli live with a host family in the area during their stay. Filoli works with area families to match the intern with a compatible family adding to the whole experience.

Both Thomas and Wages are from Aztec. Thomas just completed his first year working toward an Associate of Applied Science degree in horticulture at San Juan College. Wages received her AAS degree in horticulture from San Juan College in May. Both students are active in the San Juan College Horticulture club.

"This internship provided a unique opportunity that will no doubt prove beneficial in their careers, but one that also expanded their personal horizons," Lombard says.

By Carrie Thompson

Pictured above: Aiessa Wages, SJC horticulture program graduate, trims hedges at the prestigious Filoli Estate Garden, located in Woodside, Calif.
Pictured left: SJC horticulture students Jason Thomas and Aiessa Wages participated in a 10-week internship, where they had the opportunity to work alongside a lead horticulturist to learn about estate gardening.

the san juan college
communicator
Published Bimonthly by MARKETING AND PUBLIC RELATIONS, 566-3265
Michael Tacha, Interim President

Linda Baker, Editor • Rhonda Schaefer, Managing Editor • Linda Kaleta, Designer

AWARD Fellows at New Mexico State University

http://awardfellowships.org/news-and-events/award-news/318-award-fellows-at-new-mexico-state-university.html

AWARD
African Women in Agricultural Research and Development

search...

Home ▸ News & Events ▸ AWARD News ▸

AWARD News

AWARD Fellows at New Mexico State University

"Lifechanging" is how four AWARD Fellows describe their recent experience at New Mexico State University (NMSU) as the first participants in the prestigious, newly created Service Learning for Women (SLW) program.

The four participants were:

- **Chikondi Precious Chabvuta**, 2010 AWARD Fellow, an environmental scientist, who is the Gender Coordinator with the Farmers' Union of Malawi. Chabvuta has conducted pioneering work with eco-sanitation, teaching women in urban slums how to convert human waste into valuable, effective fertilizer.
- **Meaza Melkamu Abawari**, 2010 AWARD Fellow, Food Security and Economic Growth Program Manager and a focal person for natural-resource management with Food for the Hungry in Ethiopia.
- **Anabela da Piedade Manhiça**, 2010 AWARD Fellow, Senior Researcher and Head of the Technology Transfer Department at the Agricultural Research Institute of Mozambique. A livestock veterinarian, Manhiça is researching technology transfer, with a special emphasis on animal nutrition.
- **Esther Wamono**, 2009 AWARD Fellow, a nutrition officer with UNICEF, who works with women and children in the Karamoja region, a conflict zone in northeastern Uganda.

Read more about their experiences.

To view a photo gallery of the trip, visit the NMSU photo gallery.

Launched in September by NMSU and AWARD, the SLW program was aimed at empowering women from developing countries to achieve their highest potential and be catalysts for change.

NMSU chose four African women agricultural scientists to participate. They took part in a four-week (Sept. 12-Oct. 7) cross-cultural exchange at the university, with studies focusing on agricultural extension and leadership skills. The women attended classes and workshops, worked with mentors in their respective disciplines, met with state agricultural leaders, visited current agriculture and extension programs, and presented their experiences to local groups.

The program is the initiative of New Mexico philanthropist Linda Stout. Stout, whose grandparents were New Mexico homesteaders and parents were farmers, shares the African agriculturalists' passion. "My youth was spent breathing the dry-land dust and hoping for rain and a good crop. My main farming job was driving tractors and grain trucks," says Stout. "My vision in doing NMSU Service Learning for Women is that we will nurture and empower women who are already courageously pursuing careers in the agricultural sciences to reach their full leadership potential."

Vicki's Picks

Building science leadership in Africa - BecA-ILRI Hub Annual Letter

The BecA Hub Annual Letter offers are review of the progress made in building science research capacity and shares research news. The letter mentions partnerships BecA has entered into, including one with AWARD.

Read the paper here.

USAID's new gender policy

USAID revealed a new updated Policy on Gender Equality and Female Empowerment which provides guidance on pursuing more effective, evidence-based investments in gender equality and female empowerment.

FAO and Farming First launch new interactive infographic

The United Nations Food and Agriculture Organization (FAO) and Farming First have just launched a new interactive infographic entitled "The Female Face of Farming." The infographic consists of 17 individually-designed graphics, each of which tells a part of this important story. Each graphic can be tweeted and/or embedded for use in presentations or blog posts.

View the full infographic.

Happy International Women's Day

This year, the Bill & Melinda Gates foundation is updating their guidance document for potential grantees and partners wishing to work with them in

As AWARD Fellows, these women have already been identified as leaders. Their participation in the NMSU-SLW program will allow them to not only expand their knowledge and research capabilities, but to network with others in agricultural research and extension leadership roles.

The SLW placements are given to women who have rarely had the opportunity to gain an international perspective, and are based on their potential to positively affect the lives of rural women in their respective countries, with whom they work.

"We are extremely proud of these four outstanding women who have such a passion for the rural poor," said AWARD Director Vicki Wilde. "They exemplify the spirit of AWARD. We are deeply grateful to Linda Stout and NMSU for creating this opportunity, which will undoubtedly bear measurable results for years to come."

For more information about NMSU Service Learning for Women, visit the NMSU website.

the Agricultural Development program.

The attached document, which they are calling an 'orientation' document, outlines why they believe gender-responsive agricultural programs will sustain greater impact for poverty reduction and nutrition outcomes and some of the steps they expect grantees to take to design and implement these programs.

Specifically they ask all grantees to:

To view a photo gallery of the trip, visit http://aces.nmsu.edu/slw/photos-2011.html

To read more about the NMSU-SLW program, visit http://aces.nmsu.edu/slw/about.html

The Power of One

http://awardfellowships.org/component/zoo/item/the-power-of-one.html

The Power of One

AWARD
African Women in Agricultural Research and Development

Home ▸ The Power of One

The Power of One

on Thursday, 03 November 2011.

Ethiopian AWARD Fellow Meaza Melkamu Abawari describes Linda Stout this way: "She is professional, beautiful, intelligent, talented, well-organized, passionate, and has an eye that sees what God sees."

I hope you're asking, "Who is this Linda Stout?"—because I want to tell you about her.

A long-time social justice advocate, author, and New Mexico State University (NMSU) alumna, Linda shows what one visionary person can accomplish. She made possible the newly established Service Learning for Women (SLW) program at NMSU's College of Agricultural, Consumer and Environmental Sciences. Inspired by Kenya's late Nobel laureate, Wangari Maathai, Linda decided to do something for African women in agriculture. Specifically, she wanted to create broader learning opportunities that would empower African women to achieve their highest potential. I think Linda puts it best, "The real heart of SLW is empowering women to be agents of positive change."

We are thrilled that our project was chosen as the first SLW beneficiary, giving four AWARD Fellows the opportunity to spend four weeks in New Mexico to study adaptive extension and leadership. They also met agricultural leaders throughout the state and visited agriculture and extension programs. Through it all, they were mentored by the College of Agriculture, Consumer and Environmental Sciences faculty.

Now back home, the women are already sharing about the impact of their experience.

> *"I am changed for good. I can never be the same person again. I am empowered and a change agent."*

2010 AWARD Fellow Meaza Melkamu Abawari, Program Officer, Food for the Hungry in Ethiopia, MSc in Agriculture (Horticulture), Haromaya University

> *"Africa has powerful women, but they are not empowered. Being an empowered woman means taking responsibility to see others become empowered as well, so we are now left with a huge responsibility to change other peoples' lives."*

2010 AWARD Fellow Chikondi Precious Chabvuta, Gender Coordinator, Farmers Union of Malawi, BSc in Environmental Science from the University of Malawi's Bunda College of Agriculture

The origins of SLW grew out of conversations in very different parts of the world. On the back porch of a mutual friend in Nairobi, I happened to meet Mick O'Neill, a professor and José Fernandez Memorial Chair in Crop Production at the NMSU Agricultural Science Center. He asked me to tell him more about AWARD. A few months later, Mark Gladden, Director of Development at the college, introduced Mick to Linda, who talked about her idea of creating a scholarship program at NMSU. The rest is history and a wonderful new relationship for AWARD.

Though many people developed and implemented this new program, Linda is its heart and soul. She helped design the program specifics, selected the participants, provided them a "home away from home", and introduced them to NMSU's educational benefits, as well as the local culture.

I am inspired by this woman who decided that she could—and would—do something in which she believes. Her commitment shows the impact that one woman can have, and how one individual donor can complement the support of large foundations and agencies. Such innovation enables AWARD to leverage the talent of African women agricultural scientists to better address Africa's food security issues. We welcome more opportunities like this.

We would like to express our deep gratitude to Linda, Mick, Mark, Dr. Brenda Seevers, Program Coordinator and Professor at the College of ACES, and Connie Padilla, Assistant Program Coordinator, as well as program mentors Kari Bachman, Thomas J. Dormody, Sue Forester-Cox, April Ulery, and Stephanie Walker. Our sincere thanks also go to all the others at NMSU and the community who made such a difference in these young women's lives.

Vicki Wilde, Director
CGIAR Gender & Diversity Program and
African Women in Agricultural Research and Development (AWARD)

Note: Primary funding for the NMSU SLW was provided by Linda Stout. Additional support was provided by the José Fernandez Memorial Chair in Crop Production and the College of Agriculture, Consumer and Environmental Sciences.

http://awardfellowships.org/component/zoo/item/the-power-of-one.html[3/29/2012 1:01:33 PM]

More about the AWARD Fellows who participated in the NMSU Service Learning for Women program: http://awardfellowships.org/images/stories/award/web_q&a_with_fellows_nmsu_post_trip.pdf.

To read more about the NMSU-SLW program, visit http://aces.nmsu.edu/slw/about.html

Activities Hosted by 2011 Jose Fernandez Chair

http://aces.nmsu.edu/aes/fernandezchair

Service Learning for Women (SLW) and African Women in Agricultural Research and Development (AWARD) programs

O'Neill, M.K. Advisor and Committee Member. Partially funded by the Jose Fernandez Chair (http://aces.nmsu.edu/aes/fernandezchair/service-learning-for-wom.html), the NMSU College of Agricultural, Consumer and Environmental Sciences, Service Learn for Women (http://aces.nmsu.edu/slw) hosted four women from Ethiopia, Uganda, Malawi, and Mozambique for a month-long series of workshops on Extension methodologies. The educational exchange was in collaboration with CGIAR program for African Women in Agricultural Research and Development (http://awardfellowships.org). In addition to on-campus classwork, the women met with President Barbara Couture and Provost Wendy Wilkins. They also visited farmers in the Las Cruces, Farmington, and Alcalde areas. Off-hour recreation brought them to their first Aggies football game, a visit it White Sands National Monument, and many evening meals with NMSU ACES faculty. The four SLW-AWARD fellows finished their service learning experience by presenting their experiences in a seminar to ACES faculty, staff, and students.

The four participants were:

- Chikondi Precious Chabvuta, 2010 AWARD Fellow, an environmental scientist, who is the Gender Coordinator with the Farmers' Union of Malawi. Chabvuta has conducted pioneering work with eco-sanitation, teaching women in urban slums how to convert human waste into valuable, effective fertilizer.
- Meaza Melkamu Abawari, 2010 AWARD Fellow, Food Security and Economic Growth Program Manager and a focal person for natural-resource management with Food for the Hungry in Ethiopia.
- Anabela da Piedade Manhiça, 2010 AWARD Fellow, Senior Researcher and Head of the Technology Transfer Department at the Agricultural Research Institute of Mozambique. A livestock veterinarian, Manhiça is researching technology transfer, with a special emphasis on animal nutrition.
- Esther Wamono, 2009 AWARD Fellow, a nutrition officer with UNICEF, who works with women and children in the Karamoja region, a conflict zone in northeastern Uganda.

Stories of their life changing experiences at NMSU can be found at:

http://awardfellowships.org/news-and-events/award-news/318-award-fellows-at-new-mexico-state-university.html.

http://awardfellowships.org/component/zoo/item/the-power-of-one.html

Summer Internships

The Jose Fernandez Chair supported three summer internships conducted at NMSU's Agricultural Science Center at Farmington (http://aces.nmsu.edu/aes/fernandezchair/internship.html). The educational program provided the students with an opportunity to assist faculty and staff on their specific research projects. The interns rotated their educational experience every two weeks between xeric and small farm drip irrigation, grape and medicinal plants, hybrid poplar and crop variety trials, weed management, and water conservation projects. Coupled with the rotation, the interns were required to carry out a research project of their choice and present a report at the end of the program.

The stipend-based internships were awarded to three Navajo students;

- Justina Harvey is a horticulture student from San Juan College. Her SJC Advisor is Dr. Kevin Lombard. Research Project: *Evaluation of hybrid poplar tree diameter growth rates under four irrigation treatments*
- Faith Benally, an environmental sciences student at Diné College is advised by Dr. Marnie Carroll. Research Project: *Growth evaluation of native xeric landscape species.*
- Zena Archie, also an environmental science student, is with the NMSU Plant and Environmental Sciences department where Dr. April Ulery is her Adviser. Research Project: *Evaluation of growth and development of winter canola for northwestern New Mexico.*