New Mexico State University

2012 Annual Progress Report

New Mexico Centennial Edition (1912-2012)

Agricultural Science Center At Farmington
April 2013

Forty-sixth
Annual Progress Report
For 2012
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 Superintendent, College Professor	Curtis K. Owen Research Assistant
Michael K. O'Neill Professor	Jonah Joe Research Technician
Dan Smeal College Professor	Joseph Ward Research Technician
Kevin Lombard Assistant Professor	Kenneth D. Kohler Farm/Ranch Laborer
Tom Jim Farm/Ranch Superintendent	Nathan Begay Farm/Ranch Laborer
Samuel Allen Ag. Research Scientist	Dallen Begay Farm/Ranch Laborer
Margaret M. West Research Specialist	Sue Stone Assoc. Administrative Asst.
Curtis K. Owen Research Assistant	

Temporary Employees

2012 Student Employees

Aiessa Wages Technician	Angela Grubbs Research Technician
Jason Thomas Lab Assistant	Seth Fulfer JFC[†] – Intern, Lab Assistant

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

Cover: Overview of drip-irrigated flower beds in a multi-locational Alternate Pollinator Trial. Locations include Farmington, Los Lunas, Tucumcari, and Vado (photo by Mick O’Neill). Centennial Field Day presentation about the Hops Trial (lower right) by Dr. Kevin Lombard with Hybrid Poplar Trial in background (photo by Aiessa Wages).

2012 ASC Advisory Committee

Bart Wilsey
Chairman

Karl Garling
Vice Chairman

Tsosie Lewis

Leonard Scott

Anthony Valdez

Jeannie Benally

Mark Bentley

Frank Blackmer

Lynn Blancett

Jean Brown

Carol Cloer

Albert Davis

Doug Docktor

Bill Eaton

Elbert Hamlin

Charlie Joe

Bob Krakow

Robert Lake

Vicky Lake

Jim Lukow

Thomas Montoya

Lewis Montoya

Craig Painter

Lawrence Stock

Mandy Valesquez

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 Physicist
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 Preparatory 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	Interim 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	Assistant 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
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

Anderson Tyler	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 Representative

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 Projects Manager
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

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
Brian Olson	Technical 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, Superintendent and College Professor – Weed Control Specialist
Mick O'Neill, Professor – Agronomist
Dan Smeal, College Professor – Irrigation Specialist
Kevin Lombard, Assistant Professor – Horticulturalist

Dedication

This 2012 Annual Progress Report is fondly dedicated to our friend and colleague:

Kenneth D. Kohler

Kenny first came to NMSU's Agricultural Science Center at Farmington on July 27, 1998, as a Farm/Ranch Laborer. From the beginning, he demonstrated his ability and willingness to perform many tasks at the Center.

He assisted Curtis Owen in field preparation, irrigation, and harvesting of field crop variety trials, such as alfalfa, beans, canola, corn, oats, onions and wheat. Additionally, he was a master at mechanical repair and building of equipment. He built all sorts of things and participated in many projects, e.g., agricultural machinery retrofits, office and building maintenance, and general equipment repair. Not only would Ken complete the project but would always do an exemplary job.

Kenny is a man that always delivered a great job and had a great sense of humor. He was a pleasure to work with and being around him was always fun. Kenny was a great asset to the ASC Farmington and NMSU, and his presence will be missed by all the faculty and staff.

We wish Kenny good luck and fun in his retirement years! Kenneth Kohler retired from service with NMSU's ASC Farmington on November 30, 2012.

New Mexico State Centennial 1912 – 2012

NMSU's Agricultural Science at Farmington Celebrates the New Mexico State Centennial 1912 - 2012.

Margaret M. West

The ASC Farmington 'Field Day' was registered with the state Centennial Committee as an Official Centennial Event in December 2011. The NM Centennial Event was held on Friday, July 20, 2012 at the ASC Farmington site. Nearly 300 event participants received a tour of the current Center's research, a BBQ luncheon and had the opportunity to visit with the agricultural industry partners, sponsors, and faculty. Additionally, NM Centennial posters and literature were available to event participants. The NMSU ASC Farmington posters researched and created for the NM Centennial Official Event can be viewed at http://farmingtonsc.nmsu.edu/new-mexico-centennial.html.

Thank you to all contributors of the 2012 New Mexico Centennial ASC Farmington Official Centennial 'Field Day' event.

Executive Summary

Adaptive field crops research is concerned with the identification of crops varieties that perform well in the Four Corners region. On-station trials this year included alfalfa (3 tests), canola (2), corn (3), and winter wheat (1). The 2009-planted alfalfa test consisted of 24 varieties and the 2012-planted alfalfa trial had 22 varieties from private seed companies and NMSU. In the 2012 growing season for the 2009-planted variety trial, 20 entries yielded over 10 dry tons per acre for the 4 cuttings compared to a New Mexico state average of 5.5 dry tons per acre. The highest yielding entry was 4S417 from Mycogen Seed with a total yield of 12.1 dry tons per acre. At a farm gate sales price of $256 per ton of hay (National Agricultural Statistics for New Mexico – 2012), this would represent a sales price of $3,098 per acre. The average yield for the 24 varieties in 2012 was 10.7 tons per acre and the 3-year average (2010-2012) was 9.6 tons per acre, both substantially greater that the average alfalfa yield of 5.5 tons per acre for New Mexico in 2012.

With the current interest in biofuels as alternate sources of energy as outlined in the USDA/USDOE 1 Billion Ton Report, 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 coordinated through the Kansas State University. The highest producing variety of the 45 entries tested in 2012, MH07J14, had a yield of 5,324 lb/acre or $1,473 per acre at the average 2012 price of $0.27 per pound (National Agricultural Statistics for New Mexico – 2011). The trial mean yield of 4,231 lb/acre was substantially greater than the national average of 1,416 lb/acre, continuing to demonstrate the high yields obtained at ASC-Farmington.

The Early Season corn variety trials with a total of 10 entries had an average yield of 193 bu/ac. The highest yielding entry in this trial was PO636HR from Pioneer Hi-Bred International with a total yield of 249 bu/acre. There were 3 of the 10 entries that had grain yields greater than 200 bu/ac, representing approximately $1,440/acre at $7.20/bu for the state (National Agricultural Statistics for New Mexico – 2012).

In 2012, there were two Roundup Ready alfalfa trials, three broadleaf weed control trials in corn, and one broadleaf weed control trial in grain sorghum at ASC-Farmington. Total yield of alfalfa cut on a 30 day schedule and comparing Headline SC application to no Headline application showed a significant increase in alfalfa production using Headline SC between cuttings of approximately 0.52 t/ac. A common corn hybrid, Pioneer PO636HR, was used across the three broadleaf weed control trials. Averaged across all three trials, the mean yield in the treated plots was 287 bu/ac compared to the untreated plots which had a mean yield of 50 bu/ac. In the grain sorghum trial, yields were 91 to 118 bu/ac higher in the herbicide treated plots as compared to the weedy check.

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 eleventh year at the science center. 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. A study was initiated to evaluate the performance selected drip irrigation point source emitters at water pressures less than those specified or recommended by the emitter manufacturer or dealer. In 2012, the study identified several emitters that exhibit acceptable Application Uniformities (> 0.90) along a relatively short lateral (80 feet) at both the Manufacturers Suggested Operational Pressure and at very low pressure. 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. The results of this study to date indicate that several (mostly native) plant species can be established in disturbed, wind-blown soils after one season of weekly irrigations using a drip irrigation system. These results, coupled with the results from the low pressure performance test of drip emitters, could be married in designing tank irrigation systems for establishing plantings for soil stabilization at remote sites.

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, two *vinifera* scion grafted to nine rootstock planted in 2008, three selections from the Cornell grape breeding program, and six Riesling varieties planted in 2009. Many *Vits vinifera* entries yielding in lower locations of the state did not do well in Farmington mainly because of winter kill and spring frosts. French-American and North American hybrid grapevines and *V. vinifera* cultivars from Northern Europe appear to have greater adaptability to high elevation intermountain sites. Once established, sugar to acid appears well balanced and shows the region has potential to produce favorable wines.

The horticulture program used the New Mexico State Engineer's Office online database of New Mexico landscape plants to create a mobile plant selector application (app) for Apple iPhone™ and iPad™. The Southwest Plant Selector was released on iTunes™ on June 29, 2012. The app was downloaded 1,145 times in the first two months after release and received 4- and 5-star ratings and positive reviews during that period.

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 11 seasons, the clone OP-367 remained the tallest entry reaching a mean height of 69 feet. OP-367 also had the largest mean DBH at 11.5 inches and maximum wood volume of 7,861 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 (50.8 ft), Wood Volume (1,881 ft^3/acre), and total aboveground biomass (47 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, 2013

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 2012 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 2012. 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 2012 growing season had 192 days of above freezing temperatures and was above the 44-year average of 162.3 days free of freezing temperatures (Table 3). 2012 was the second longest growing season recorded in 44 years with the longest being 1977 with 193 days. The freeze-free period was from April 16 through October 25 (Table 3).

During 2012, the temperature conditions were above normal compared to the 44 year average. The annual mean temperature of 54.4 ºF for 2012 was 1.7 ºF higher than the 44 year mean of 52.7 ºF (Table 5).The annual mean temperature was 0.7 ºF less than the highest year occurring in 2003 which had an annual mean temperature of 55.1 ºF. The annual mean temperature for 2012 was 4.4 ºF greater than the lowest year of 50.0 ºF occurring in 1975. The mean monthly temperatures in 2012 were higher than average for every month of the year except February (Table 5).

A below average 3.70 inches of precipitation was recorded in 2012. This was the second driest year recorded in 44 years with the driest year occurring in 1976 with 3.57 inches of precipitation. The wettest month was July which received 1.07 inches and was 0.24 inches greater than the 44 year monthly average of 0.83 inches. April and June were especially dry when only 0.01 inches of precipitation were recorded in each month. All months except July and December were below average in monthly precipitation (Table 4).

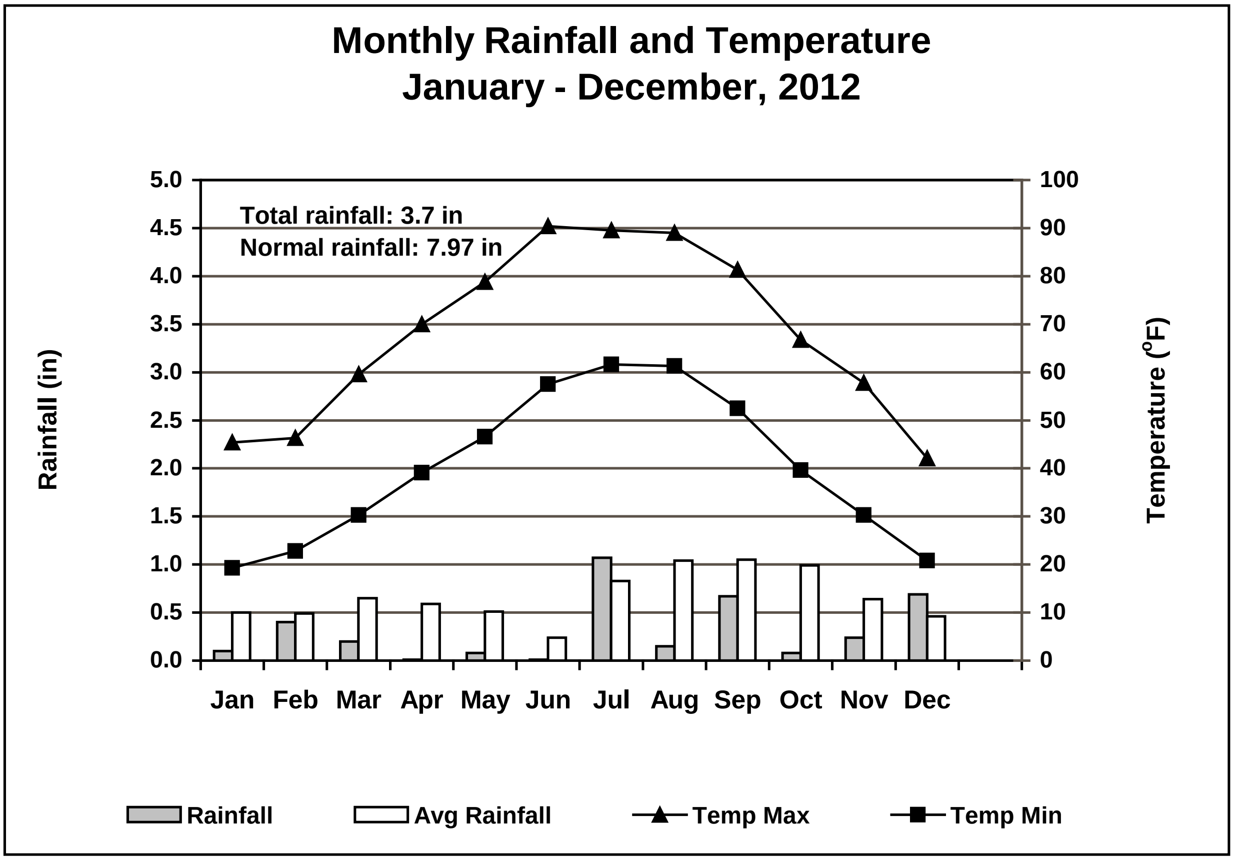

Figure 1. **Monthly and average precipitation (in), monthly maximum and minimum temperatures (ºF). NMSU Agricultural Science Center at Farmington, NM. 2012.**

Table 1. Mean daily climatological data. NMSU Agricultural Science Center at Farmington, NM. January through December 2012.

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	45.4	19.3	32.4	53.0	7.0	0.10	65	99		260
February	46.3	22.8	34.6	59.0	16.0	0.40	78	110		333
March	59.6	30.3	45.0	73.0	13.0	0.20	84	114		458
April	70.0	39.1	54.6	85.0	25.0	0.01	84	116	8.78	544
May	78.8	46.6	62.7	87.0	37.0	0.08	73	99	12.29	656
June	90.4	57.5	74.0	98.0	45.0	0.01	62	89	14.45	706
July	89.5	61.6	75.6	97.0	57.0	1.07	50	72	11.80	601
August	89.0	61.3	75.2	95.0	55.0	0.15	52	76	11.35	551
September	81.3	52.5	66.9	90.0	45.0	0.67	46	73	8.88	491
October	66.7	39.6	54.7	83.0	24.0	0.08	63	90	7.48	415
November	57.8	30.3	44.1	70.0	16.0	0.24	60	79		303
December	42.1	20.8	31.5	60.0	5.0	0.69	64	94		244
Total	**819.9**	**481.7**	**650.8**	**950.0**	**303.0**	**3.7**	**781.0**	**1111.0**	**71.9**	**5562**
Mean	**68.3**	**40.1**	**54.2**	**79.2**	**25.3**	**0.3**	**65.1**	**92.6**	**10.3**	**464**

Freeze-Free Period
Last Spring reading of 32 ºF or below: April 16 (27 ºF)
First Fall reading of 32 ºF or below: October 25 (27 ºF)
Number of freeze-free days: 192
Killing Freeze-Free Period
Last Spring reading of 28 ºF or below: April 16 (27 ºF)
First Fall reading killing freeze: October 25 (27 ºF)
Number of freeze free days: 192

Table 2. Forty-four year average monthly weather conditions. NMSU Agriculture Science Center at Farmington, NM. 1969 – 2012.

Month	Precip-tation (in)	Mean Temperature Maximum (ºF)	Mean Temperature Minimum (ºF)	Extreme Temperature Maximum (ºF)	Year Recorded	Extreme Temperature Minimum (ºF)	Year Recorded
January	0.50	41	19	66	2000	-18	1971
February	0.49	48	24	70	1986	-14	1989
March	0.65	57	30	82	2004	3	2002
April	0.59	66	36	86	1992	16	1979
May	0.51	76	45	97	2000	23	1975
June	0.24	87	54	100	1981-1990-1994	32	1999
July	0.83	91	61	103	1989,90,03,05	43	1969
August	1.04	88	59	99	1969,70,83,02	41	1980
September	1.05	80	51	97	1995	28	1971-1999
October	0.99	68	40	88	2010	15	1989
November	0.64	53	28	75	1999-2001	1	1976
December	0.46	43	20	67	1999	-16	1990
Total	**7.97**						
Mean	**0.66**	**66.4**	**38.9**				

Table 3. Freeze dates and number of freeze-free days. NMSU Agricultural Science Center at Farmington, NM. 1969 – 2012.

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****

	–––– Less than or equal to 32 ºF ––––			–––––– Less than or equal to 28 ºF ––––––		
Date	**Last Spring Freeze (date)**	**First Fall Freeze (date)**	**Freeze-free Period (days)**	**Last Spring Killing Freeze (date)**	**First Fall Killing Freeze (date)**	**Killing Freeze-free Period (days)**
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
2012	Apr 16	Oct 25	192	Apr 16	Oct 25	192
Mean	**May 03**	**Oct 13**	**162.3**	**Apr 21**	**Oct 21**	**183.0**

* Earliest date (or shortest freeze-free period) of 44 years.
** Latest date (or longest freeze-free period) of 44 years.

Table 4. Mean monthly precipitation (in). NMSU Agricultural Science Center at Farmington, NM. 1969 – 2012.

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
2012	0.10	0.40	0.20	0.01	0.08	0.01	1.07	0.15	0.67	0.08	0.24	0.69	3.70
Mean	0.50	0.49	0.65	0.59	0.51	0.24	0.83	1.04	1.05	0.99	0.64	0.46	7.97

* 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 – 2012.

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**
2012	32	35	45	55	63	74	76	75	67	55	44	32	**54.4**
Mean	**30.1**	**36.1**	**43.2**	**51.0**	**60.3**	**70.2**	**75.8**	**73.7**	**65.9**	**53.7**	**40.8**	**31.4**	**52.7**

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

Table 6. Summary of monthly average maximum temperature (ºF). NMSU Agricultural Science Center at Farmington, NM. 1969 – 2012.

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**
2012	45	46	60	70	79	90	90	89	81	70	58	42	**68.3**
Mean	**41.1**	**47.9**	**57.0**	**65.8**	**75.9**	**86.5**	**91.1**	**88.1**	**80.4**	**67.6**	**53.3**	**42.5**	**66.4**

Table 7. Summary of monthly average of the minimum temperature (ºF). NMSU Agricultural Science Center at Farmington, NM. 1969 – 2012.

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**
2012	19	23	30	39	47	58	62	61	53	40	30	21	**40.3**
Mean	**19.1**	**24.1**	**29.5**	**35.9**	**44.8**	**53.6**	**60.5**	**59.3**	**51.3**	**39.7**	**28.4**	**20.2**	**38.9**

Table 8. Highest temperatures (ºF). NMSU Agricultural Science Center at Farmington, NM. 1969 – 2012.

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
2012	53	59	73	85	87	98	97	95	90	83	70	60	79.2
Mean	**54.3**	**62.4**	**71.8**	**79.5**	**87.6**	**96.0**	**98.0**	**95.3**	**90.4**	**81.0**	**67.8**	**56.1**	**78.3**
Maximum	**66**	**70**	**82**	**86**	**97**	**100**	**103**	**99**	**97**	**88**	**75**	**67**	
Year	**2000**	**1986**	**2004**	**1992**	**2000**	**1981**	**1989**	**1969**	**1995**	**2010**	**1999**	**1999**	
						1990	**1990**	**1970**			**2001**		
						1994	**2003**	**1983**					
							2005	**2002**					

Table 9. Lowest temperatures (ºF). NMSU Agricultural Science Center at Farmington, NM. 1969 – 2012.

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**
2012	7	16	13	25	37	45	57	55	45	24	16	5	**28.8**
Mean	**4.1**	**8.9**	**15.7**	**22.9**	**31.6**	**41.2**	**52.7**	**51.9**	**37.7**	**24.7**	**12.7**	**5.0**	**25.8**
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 – 2012.

	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**
2012	31	29	20	6	0	0	0	5	17	28	**136**	0	0	0	**0**
Mean	**29.5**	**24.6**	**20.0**	**9.6**	**1.3**	**0**	**0.2**	**5.7**	**21.1**	**29.3**	**141**	**1**	**0.2**	**0.3**	**1.2**
Total	**1298**	**1082**	**889**	**422**	**57**	**1**	**10**	**250**	**929**	**1287**	**6225**	**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 – 2012.

	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**
2012	0	5	2	1	0	**8**	0	0	**0**
Mean	**0.1**	**3.0**	**7.5**	**2.1**	**0.0**	**12.7**	**0.1**	**0.8**	**0.8**
Total	**3**	**131**	**330**	**91**	**2**	**557**	**3**	**33**	**36**

Table 12. Mean daily evaporation (inches per day). NMSU Agricultural Science Center at Farmington, NM. 1972 – 2012.

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**
2012		0.293	0.396	0.482	0.381	0.366	0.296	0.241		**0.351**
Mean	**0.226**	**0.276**	**0.352**	**0.439**	**0.420**	**0.362**	**0.287**	**0.200**	**0.154**	**0.336**
Years	**1**	**36**	**41**	**42**	**42**	**42**	**42**	**41**	**3**	**42**

Table 13. Mean monthly evaporation (inches per month). NMSU Agricultural Science Center at Farmington, NM. 1972 – 2012.

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**
2012	8.78	12.29	14.45	11.80	11.35	8.88	7.48	**75.03**
Mean	**8.18**	**10.83**	**13.17**	**13.01**	**11.20**	**8.58**	**6.00**	**68.73**
Years	**34**	**40**	**41**	**41**	**41**	**41**	**37**	**41**

Table 14. Wind movement in miles per day (MPD) at 6 inch height above evaporation pan. NMSU Agricultural Science Center at Farmington, NM. 1980 – 2012.

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	
2012	65	78	84	84	73	62	50	52	46	63	60	64	**64.5**
Mean (MPD)	**62.8**	**71.8**	**83.8**	**85.7**	**73.8**	**66.9**	**61.8**	**58.8**	**56.0**	**59.3**	**64.9**	**60.3**	**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 – 2012.

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**
2012	99	110	114	116	99	89	72	76	73	90	79	94	**92.6**
Mean (MPD)	**111.9**	**127.6**	**143.9**	**153.6**	**135.0**	**119.2**	**108.0**	**102.3**	**104.4**	**105.1**	**109.2**	**109.2**	**119.4**
Mean (MPH)	**4.7**	**5.3**	**6.0**	**6.4**	**5.6**	**5.0**	**4.5**	**4.3**	**4.3**	**4.4**	**4.5**	**4.5**	**5.0**

Table 16. Mean daily solar radiation (Langleys). NMSU Agricultural Science Center at Farmington, NM. 1977 – 2012.

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**
2012	260	333	458	544	656	706	601	551	491	415	303	244	5,562	**464.0**
Mean	**219.6**	**294.6**	**411.7**	**524.8**	**606.2**	**650.5**	**635.7**	**572.0**	**484.8**	**362.4**	**253.4**	**199.9**	**5,216**	**434.6**

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 – 2012. (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**

Year	May	Jun	Jul	Aug	Sep	**May - Sep**	**Ist Freeze Date**	**Total to 1st Frost (32 ºF)**
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**
2012	459	650	729	722	514	**3,074**	**Oct 25**	**3,343**
Mean	**404**	**578**	**714**	**691**	**486**	**2,873**	**Oct 13**	**2,973**
Accum-mulation	**404**	**982**	**1,696**	**2,387**	**2,873**			

*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 2012.

Month	Mean High	Mean Low	Mean*	Extreme High	Extreme Low
January	34.7	30.7	32.7	40.8	25.0
February	41.6	34.1	37.9	51.9	29.1
March	54.3	40.6	47.5	64.4	33.9
April	66.1	49.3	57.7	76.9	39.6
May	77.9	59.6	68.8	87.7	48.5
June	88.9	70.4	79.7	96.1	62.5
July	95.4	77.6	86.5	100.9	68.9
August	92.7	73.9	83.3	98.7	66.7
September	83.2	65.6	74.4	92.9	55.9
October	66.5	51.6	59.1	78.7	41.1
November	48.6	39.0	43.8	59.4	31.6
December	36.3	31.6	34.0	45.4	25.4
Mean	**65.2**	**51.9**	**58.6**	**74.5**	**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 – 2012.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1976	-	-	-	-	-	-	-	-	88.9	69.2	56.8	38.8	**63.4**
1977	31.8	49.8	56.2	79.1	88.3	106.6	109.7	102.9	92.6	74.1	53.3	42.6	**73.9**
1978	37.0	42.8	53.7	75.5	82.0	100.7	106.0	102.2	91.2	73.3	53.9	36.3	**71.2**
1979	35.7	40.8	53.9	68.4	81.6	92.2	99.2	98.4	93.4	75.0	49.8	38.9	**68.9**
1980	46.2	52.5	59.8	68.4	80.8	94.2	102.3	96.8	85.3	70.0	54.8	49.0	**71.7**
1981	47.6	49.9	57.6	73.9	79.3	88.5	92.8	89.7	81.2	65.6	52.0	38.1	**68.0**
1982	33.9	38.9	51.0	62.7	78.5	89.4	96.0	94.0	82.8	67.7	50.1	39.6	**65.4**
1983	34.9	44.8	51.4	59.8	73.8	81.4	90.5	92.7	82.6	66.0	47.4	37.1	**63.5**
1984	32.5	38.5	52.4	59.3	77.0	84.7	92.6	94.7	85.6	59.6	51.1	38.7	**63.9**
1985	35.5	39.9	54.1	65.2	81.4	93.3	100.4	96.2	83.3	69.5	49.6	37.0	**67.1**
1986	41.6	47.1	58.6	64.3	77.9	88.9	92.4	95.9	78.9	63.1	45.9	37.0	**66.0**
1987	32.2	41.9	47.1	62.4	77.0	88.6	93.7	91.5	82.4	70.9	50.9	40.9	**65.0**
1988	34.6	42.7	57.1	66.3	77.3	89.2	94.0	92.5	82.6	71.0	50.2	34.4	**66.0**
1989	31.1	38.7	57.2	67.8	77.3	86.6	94.6	90.6	82.3	67.8	49.7	37.0	**65.1**
1990	34.5	39.5	55.5	65.8	75.4	87.1	91.3	88.6	83.0	67.5	49.8	34.8	**64.4**
1991	33.5	42.1	51.9	66.1	76.6	86.4	95.3	95.3	85.6	70.1	46.4	37.6	**65.6**
1992	34.8	43.8	55.3	68.5	77.5	86.1	90.4	90.9	83.3	70.9	44.4	31.4	**64.8**
1993	36.8	42.4	53.7	66.0	78.9	85.9	94.8	88.4	80.2	64.2	42.5	33.7	**64.0**
1994	34.7	38.3	57.4	65.8	76.6	89.7	94.5	94.1	84.3	63.2	42.5	33.9	**64.6**
1995	34.5	48.9	55.9	60.9	69.5	83.7	91.0	92.3	-	63.9	51.7	39.9	**64.7**
1996	36.1	46.9	56.6	68.3	83.5	89.4	94.6	86.4	78.5	64.3	53.1	34.9	**61.9**
1997	33.6	41.3	54.8	58.3	73.0	-	-	91.0	83.8	65.5	47.4	32.6	**63.9**
1998	33.6	40.6	51.1	62.2	80.4	89.2	95.6	92.0	85.3	65.0	46.5	34.8	**64.7**
1999	35.6	42.5	56.1	61.9	71.2	87.0	90.7	85.0	78.7	65.1	50.5	35.2	**63.3**
2000	36.5	43.8	51.7	67.1	79.0	87.8	92.4	90.4	80.0	62.4	38.1	34.5	**63.6**
2001	29.9	37.3	51.4	64.9	78.0	88.0	92.5	89.7	83.7	66.8	52.1	34.1	**64.0**
2002	32.4	37.6	52.3	69.5	79.1	90.7	95.5	90.5	80.1	63.3	46.0	34.6	**64.3**
2003	37.5	41.3	52.0	66.0	75.9	86.8	96.1	95.1	81.4	68.8	46.2	35.9	**65.3**
2004	31.4	35.5	60.3	65.8	80.6	85.8	91.6	92.5	81.2	64.3	46.5	32.3	**64.0**
2005	38.5	43.8	54.9	68.6	81.9	88.8	101.2	92.6	81.6	63.2	47.6	35.6	**66.5**
2006	37.1	44.1	53.9	71.9	82.6	93.8	96.3	92.4	78.6	62.2	50.9	33.4	**66.4**
2007	29.8	40.4	57.2	68.2	80.4	91.6	101.1	98.9	87.8	67.1	53.5	33.4	**66.9**
2008	29.9	34.7	53.3	64.1	74.9	88.4	96.6	93.0	84.2	66.0	49.3	35.3	**64.1**
2009	32.3	39.8	54.3	63.3	78.9	84.0	97.5	93.2	84.7	62.1	45.8	29.4	**63.8**
2010	28.3	37.9	49.5	63.2	73.0	85.2	92.0	85.6	76.8	65.6	45.6	40.2	**61.9**
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**
2012	32.2	32.2	52.5	66.5	77.5	87.8	92.2	89.9	82.1	65.0	49.3	36.4	**63.6**
Mean	**34.7**	**41.6**	**54.3**	**66.1**	**77.9**	**88.9**	**95.4**	**92.7**	**83.2**	**66.5**	**48.6**	**36.3**	**65.2**

Table 20. Mean low soil temperature (ºF) four inches below surface. NMSU Agricultural Science Center at Farmington, NM. 1976 – 2012.

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**
2012	29.8	29.8	41.7	55.8	65.0	75.6	77.6	79.4	69.8	54.3	40.9	31.5	**54.3**
Mean	**30.7**	**34.1**	**40.6**	**49.3**	**59.6**	**70.4**	**76.0**	**73.9**	**65.6**	**51.6**	**39.0**	**31.6**	**51.9**

Table 21. Soil high temperature (ºF) extremes, four inches below surface. NMSU Agricultural Science Center at Farmington, NM. 1976 – 2012.

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**
2012	38	38	66	77	82	94	96	93	90	76	57	48	**71.3**
Mean	**40.8**	**51.9**	**64.4**	**76.9**	**87.7**	**96.1**	**100.9**	**98.7**	**92.9**	**78.7**	**59.4**	**45.4**	**74.5**

Table 22. Soil low temperature (ºF) extremes, four inches below surface. NMSU Agricultural Science Center at Farmington, NM. 1976 – 2012.

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**
2012	24	31	32	46	58	69	68	71	60	38	32	19	**45.7**
Mean	**25.0**	**29.1**	**33.9**	**39.6**	**48.5**	**62.5**	**68.9**	**66.7**	**55.9**	**41.1**	**31.6**	**25.4**	**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 2012-Planted Alfalfa Variety Trial

Michael O'Neill, Curtis Owen, Kenneth Kohler, and Margaret M. West

Abstract

The 2012 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 22 varieties (Table 23) from public varieties and private seed companies. The 2012 mean seasonal total yield for this trial was 3.98 ton/acre (Table 24). The highest yielding entry of 4.41 ton/acre was MagnaGraze, an entry from Dairyland Seed. The lowest yielding entry of 3.56 ton/acre was DG4210, an entry from CPS. There were no significant differences in yield at the 95% probability level between the entries within this trial. The third cut yielded the highest with a mean of 1.35 ton/acre, while the first cutting was the lowest yielding cut with a mean of 1.28 ton/acre (Table 24).

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 2012-Planted Alfalfa Variety Trial was planted at the Agriculture Science Center at Farmington on May 9, 2012. The trial consisted of 22 varieties (Table 23) 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 23. Procedures for the 2012-planted Alfalfa Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2012.

Operation	Procedure
Number of Entries:	Twenty-Two
Check Entries:	Dona Ana, Archer III, Wilson, NM Common, African Common, Ranger, Mountaineer 2.0, Lahontan, Zia and Malone
Planting Date:	May 9, 2012
Planting Rate:	20 lb/acre
Plot Design:	Complete randomized block with four replications
Plot Size:	Six 8-inch rows, 16 ft. long
Cutting Date:	Three cutting dates: July 13, August 14 and October 3, 2012
Fertilization:	Pre-plant Fertilizer applied on March 6, 2012 at 200 lb of 5-26-30-10 zinc sulfate e.g. N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 20 lb/acre
Herbicide:	Raptor applied at 6 oz/acre on June 5, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Solid set pipe, watered as needed; generally 4 to 5 hours 3 times per week; 44 inches applied including precipitation
Results and Discussion:	Yield and other characteristics are presented in Table 24.

Dry fertilizer was applied pre-plant on March 6, 2012 at the rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 20 lb/acre. During the 2011 growing season, there were three cutting dates; July 13, August 14, and October 3, 2012. 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 select plots to determine dry matter percent.

Results and discussion

Yield results for the 2012 growing season of the 2012-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. 2012 was the first year to obtain harvest data from this trial as it was planted in May of 2012.

2012 mean seasonal total yield for this trial was 3.98 ton/acre (Table 24). The highest yielding entry of 4.41 ton/acre was MagnaGraze, an entry from Dairyland Seed. The lowest yielding entry of 3.56 ton/acre was DG4210, an entry from CPS. There were no significant differences in yield at the 95% probability level between the entries within this trial. The third cut yielded the highest with a mean of 1.35 ton/acre, while the first cutting was the lowest yielding cut with a mean of 1.28 ton/acre (Table 24).

Table 24. Forage yield of the 2012-planted Alfalfa Variety Trial. NMSU Agriculture Science Center at Farmington, NM. 2012.

Variety	Company	––––––– Yield dry ton/acre ––––––––			
		Cut-1	Cut-2	Cut-3	Total
MagnaGraze	Dairyland Seed	1.50	1.54	1.37	4.41
Zia	Roswell Seed	1.40	1.39	1.54	4.33
Dona Ana	Roswell Seed	1.33	1.38	1.59	4.30
Gunner	Croplan	1.40	1.48	1.41	4.29
Lahontan	Public	1.42	1.39	1.40	4.21
Mountaineer 2.0	Croplan	1.29	1.41	1.48	4.19
HybriForce Mesa	Dairyland Seed	1.26	1.46	1.35	4.07
WL440HQ	W-L Research	1.16	1.36	1.52	4.04
Ranger	Public	1.41	1.44	1.15	4.00
GrandStand	CPS	1.30	1.35	1.29	3.94
NM Common	Roswell Seed	1.32	1.26	1.36	3.94
MagnaGraze II	Dairyland Seed	1.34	1.37	1.21	3.92
African Common	Roswell Seed	1.14	1.26	1.50	3.90
Archer III	America's Alfalfa	1.19	1.39	1.32	3.90
WL354HQ	W-L Research	1.27	1.26	1.35	3.88
Malone	Roswell Seed	1.19	1.18	1.50	3.86
Wilson	Roswell Seed	1.11	1.24	1.51	3.85
Creeping Crown, Exp	Dairyland Seed	1.33	1.32	1.18	3.83
WL363HQ	W-L Research	1.23	1.32	1.22	3.77
54VR03	Pioneer Hi-Bred Int.	1.30	1.33	1.12	3.75
Arrowhead II	Dairyland Seed	1.24	1.17	1.24	3.65
DG4210	CPS	1.13	1.26	1.17	3.56
Mean		**1.28**	**1.34**	**1.35**	**3.98**
LSD (0.05)		0.38	0.36	0.31	0.93
CV (%)		21.00	19.00	16.40	16.40
P Value		0.8992	0.9343	0.0725	0.9685
Significance		ns	ns	ns	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

Michael O'Neill, Curtis Owen, Kenneth 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 25) from public varieties and private seed companies. Mean seasonal total yield for this trial in 2012 was 10.73 ton/acre (Table 26). The highest yielding entry of 12.1 ton/acre was 4S417 an entry from Mycogen Seed. The lowest yielding entry of 9.57 ton/acre was African Common from Roswell Seed. 4S417, the highest yielding entry, was not significantly higher in seasonal total yield over the next top eleven entries at the 95% probability level. There were no significant differences in the second highest yielding entry Mountaineer 2.0 and the next 14 highest yielding entries. The first cut yielded the highest with a mean of 3.75 ton/acre, while the fourth cutting was the lowest yielding with a mean of 1.71 ton/acre (Table 26).

The highest yielding entries over a three year period from 2010 through 2012 were Lahontan a check entry, and 4S417, an entry from Mycogen Seed and Mountaineer 2.0, also a check entry from Croplan Genetics with an average yield of 10.32, 10.26 and 10.26 ton/acre respectively. The lowest yielding entry over a three year period was Wilson, from Roswell Seed, with an average of 8.99 ton/acre. The average yield over a three year period of all entries was 9.58 ton/acre (Table 27).

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 25) 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 25. Procedures for the 2009-planted Alfalfa Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2012.

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 5, July 12, August 16 and October 2, 2012
Fertilization:	Pre-plant Fertilizer applied on March 6, 2012 at 200 lb of 5-26-30-10 zinc sulfate e.g. N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 20 lb/acre
Herbicide:	Raptor applied at 6 oz/acre on February 29, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Solid set pipe, watered as needed; generally 2 hours 3 times per week; 66 inches applied including precipitation
Results and Discussion:	Yield and other characteristics are presented in Table 26

Dry fertilizer was applied pre-plant on March 6, 2012 at the rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 20 lb/acre. The plot area was chemically treated with the herbicide Raptor at a rate of 6 ounces per acre on February 29, 2012 using a tractor mounted spray rig.

During the 2012 growing season, there were four cutting dates; June 5, July 12, August 16, and October 2, 2012. 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 select plots to determine dry matter percent.

Results and discussion

Yield results for the 2012 growing season of the 2009-planted Alfalfa Variety Trial are presented in Table 26. Yield for each cut, along with the seasonal total yield, are shown for each entry as dry ton/acre. 2012 was the third year to obtain harvest data from this trial as it was planted in August of 2009.

Mean seasonal total yield for this trial in 2012 was 10.73 ton/acre (Table 26). The highest yielding entry of 12.1 ton/acre was 4S417 an entry from Mycogen Seed. The lowest yielding entry of 9.57 ton/acre was African Common from Roswell Seed.

4S417, the highest yielding entry, was not significantly higher in seasonal total yield over the next top eleven entries at the 95% probability level. There were no significant differences in the second highest yielding entry Mountaineer 2.0 and the next 14 highest yielding entries. The first cut yielded the highest with a mean of 3.75 ton/acre, while the fourth cutting was the lowest yielding with a mean of 1.71 ton/acre (Table 26).

The highest yielding entries over a three year period from 2010 through 2012 were Lahontan a check entry, and 4S417, an entry from Mycogen Seed and Mountaineer 2.0, also a check entry from Croplan Genetics with an average yield of 10.32, 10.26 and 10.26 ton/acre respectively. The lowest yielding entry over a three year period was Wilson, from Roswell Seed, with an average of 8.99 ton/acre. The average yield over a three year period of all entries was 9.58 ton/acre (Table 27).

Table 26. Forage yield of the 2009-planted Alfalfa Variety Trial. NMSU Agriculture Science Center at Farmington, NM. 2012.

Variety	Company	---------- Yield dry ton/acre ----------				
		Cut-1	Cut-2	Cut-3	Cut-4	Total
4S417	Mycogen Seed	4.53	3.30	2.34	1.93	12.10
Mountaineer 2.0	Croplan Genetics	3.96	3.30	2.35	2.03	11.63
HybriForce 2400	Dairyland Seed	4.00	3.35	2.28	1.95	11.58
Artesian Sunrise	Croplan Genetics	4.13	3.32	2.18	1.92	11.54
SW435	S&W Seed	4.02	3.40	2.22	1.89	11.53
HybriForce 2420/wet	Dairyland Seed	3.79	3.38	2.24	1.90	11.31
Lahontan	Check	3.74	3.38	2.30	1.84	11.26
Malone	Roswell Seed	3.97	3.16	2.30	1.77	11.21
63Q105	Syngenta Seeds	4.11	3.11	2.19	1.75	11.14
WL440HQ	W-L Research	3.79	3.04	2.20	1.84	10.87
AmeriStand 201+Z	America's Alfalfa	3.77	3.22	2.16	1.71	10.86
Dura 843	Croplan Genetics	3.81	3.09	2.17	1.78	10.85
Rugged	Producers Choice Seeds	3.63	3.16	2.20	1.69	10.68
Maxi-Graze GT	Croplan Genetics	3.73	3.06	2.11	1.73	10.63
SW6330	S&W Seed	3.77	3.06	1.92	1.69	10.43
Dona Ana	Roswell Seed	3.76	3.06	1.98	1.58	10.39
Ranger	Check	3.24	3.27	2.14	1.60	10.24
6422Q	Syngenta Seeds	3.78	3.08	1.94	1.39	10.19
LegenDairy 5.0	Croplan Genetics	3.49	3.06	2.08	1.50	10.13
NM Common	Roswell Seed	3.61	2.87	1.99	1.54	10.02
Velvet	Producers Choice Seeds	3.33	2.99	2.03	1.63	9.98
WL363HQ	W-L Research	3.27	3.04	1.98	1.46	9.74
Wilson	Roswell Seed	3.41	2.75	1.96	1.55	9.66
African Common	Roswell Seed	3.33	2.92	1.90	1.42	9.57
Mean		**3.75**	**3.14**	**2.13**	**1.71**	**10.73**
LSD (0.05)		0.84	0.33	0.27	0.30	1.28
CV (%)		16.00	7.50	9.00	12.50	8.50
P Value		0.1819	0.0088	0.0090	0.0004	0.0031
Significance		ns	**	**	***	**

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

Table 27. Three-year forage yield of the 2009-planted Alfalfa Variety Trial. NMSU Agriculture Science Center at Farmington, NM. 2010-2012.

Variety	Company	––––––– Yield dry ton/acre ––––––––			
		2010	2011	2012	3 Yr Avg.
Lahontan	Check	9.57	10.12	11.26	10.32
4S417	Mycogen Seed	9.41	9.75	12.10	10.26
Mountaineer 2.0	Croplan Genetics	9.27	9.42	11.63	10.26
HybriForce 2400	Dairyland Seed	9.25	9.40	11.58	10.08
SW435	S&W Seed	8.96	9.62	11.53	10.04
HybriForce 2420/wet	Dairyland Seed	9.39	8.96	11.31	9.83
Artesian Sunrise	Croplan Genetics	8.86	9.32	11.54	9.76
Dura 843	Croplan Genetics	9.17	8.90	10.85	9.73
63Q105	Syngenta Seeds	8.97	9.06	11.14	9.69
Malone	Roswell Seed	9.00	8.96	11.21	9.62
AmeriStand 201+Z	America's Alfalfa	8.63	9.29	10.86	9.59
WL440HQ	W-L Research	8.51	9.41	10.87	9.56
Dona Ana	Roswell Seed	8.95	8.95	10.39	9.45
NM Common	Roswell Seed	8.92	8.89	10.02	9.35
Rugged	Producers Choice Seeds	9.21	8.54	10.68	9.35
LegenDairy 5.0	Croplan Genetics	8.80	8.91	10.13	9.35
SW6330	S&W Seed	9.08	8.60	10.43	9.33
Ranger	Check	8.72	8.94	10.24	9.30
Maxi-Graze GT	Croplan Genetics	8.75	8.90	10.63	9.28
Velvet	Producers Choice Seeds	9.04	8.53	9.98	9.23
African Common	Roswell Seed	8.57	8.79	9.57	9.21
WL363HQ	W-L Research	8.75	8.54	9.74	9.14
6422Q	Syngenta Seeds	8.26	8.95	10.19	9.11
Wilson	Roswell Seed	8.38	8.76	9.66	8.99
Mean		**8.93**	**9.06**	**10.73**	**9.58**
LSD (0.05)		0.78	0.87	1.28	0.71
CV (%)		6.24	6.83	8.50	5.30
P Value		0.1390	0.0469	0.0031	0.0034
Significance		ns	*	**	**

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

Alfalfa – Penatron and Thoro-Gro Treated Alfalfa Trial

Michael O'Neill, Curtis Owen, Kenneth Kohler, and Wes Richens

Abstract

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

Treatments of Penatron and Thoro-Gro were each applied to the alfalfa plots with a four gallon backpack sprayer. Each product was mixed with water in the backpack sprayer and applied. The products were applied at a one and two (split) application schedule. The first application of each product was made in April before irrigation began on the alfalfa. The second application was made after the first cutting had been made and before little new growth had occurred. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on April 4, 2012 (Table 28). Penatron was also applied to the split application plots at a rate of one gallon per acre on June 11, 2012 Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on April 5,2012. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 11, 2012

Yield results for the 2012 growing season of The Penatron and Thoro-Gro treated Alfalfa Trial are presented in Table 29. Yield for each cut, along with the seasonal total yield, are shown for each entry as dry ton/acre. Total mean yield of the five treatments of this trial was a total of 11.68 ton/acre for cuts 1, 2, 3, & 4. The check treatment had the top yield of 11.98 ton/acre. There were no significant differences in yield at the 95% probability level between the five treatments for individual cuts or for total yield (Table 29).

Introduction

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

Objective

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

Materials and methods

The alfalfa variety Legend from Arkansas Valley Seed Co. was planted as outside border rows for the 2009-Planted Alfalfa Variety Trial. These border rows were used to conduct the Penatron and Thoro-Gro treated Alfalfa Trial. The alfalfa was planted at the Agriculture Science Center at Farmington on August 26, 2009 (Table 28). The trial at Farmington was established in a randomized block design with four replications. Individual plots were six 8-inch rows by 16 feet long (64 ft^2). Planting rate was 20 lb/acre. The planter used was a Kincaid 6-row cone seeder equipped with discs that closed the seed trench directly after the seeds were dropped in the small furrow opening at a depth of about 0.25 inches.

Treatments of Penatron and Thoro-Gro were each applied to the alfalfa plots with a four gallon backpack sprayer. Each product was mixed with water in the backpack sprayer and applied. The products were applied at a one and two (split) application schedule. The first application of each product was made in April before irrigation began on the alfalfa. The second application was made after the first cutting had been made and before little new growth had occurred. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on April 4, 2012. Penatron was also applied to the split application plots at a rate of one gallon per acre on June 11, 2012. Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on April 5, 2012. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 11, 2012.

Table 28. Procedures for the Penatron and Thoro-Gro Treatment Alfalfa Trial; NMSU Agricultural Science Center at Farmington, NM. 2012.

Operation	Procedure
Number of Treatments:	Five: (1) Penetron applied once at a rate of 1 gallon per acre, 04/04/12 (2) Penetron applied twice at a rate of 1 gallon per acre at each application, 04/04/12, and 06/11/12. (3) Thoro-Gro applied once at the rate of 0.1 gallon per acre, 04/04/12. (4) Thoro-Gro applied twice at the rate of 0.1 gallon per acre at each application 04/04/12, and 06/11/12. (5) a check plot with no application
Planting Date:	August 26, 2009
Planting Rate:	20 lb/acre

Operation	**Procedure**
Plot Design:	Complete randomized block with four replications
Plot Size:	Six 8-inch rows, 16 ft long
Harvest Date:	Four cutting dates: June 5, July 12, August 16 and October 2, 2012
Fertilization:	Pre-plant Fertilizer applied on March 6, 2012 at 200 lb of 5-26-30-10 zinc sulfate e.g. N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 20 lb/acre
Herbicide:	Raptor applied at 6 oz/acre on February 29, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Solid set pipe, watered as needed; generally 2 hours 3 times per week; 66 inches applied including precipitation
Results and Discussion:	Yield and other characteristics are presented in Table 29.

Dry fertilizer was applied pre-plant on March 6, 2012 at the rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 20 lb/acre.

The plot area was chemically treated with the herbicide Raptor at a rate of 6 ounces per acre on February 29, 2012 using a tractor mounted spray rig.

During the 2012 growing season, there were four cutting dates; June 5, July 12, August 16, and October 2, 2012. 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 of the plots to determine dry matter percent.

Results and discussion

Yield results for the 2012 growing season of The Penatron and Thoro-Gro treated Alfalfa Trial are presented in Table 29. Yield for each cut, along with the seasonal total yield, are shown for each entry as dry ton/acre. Total mean yield of the five treatments of this trial was a total of 11.68 ton/acre for cuts 1, 2, 3, & 4. The check treatment had the top yield of 11.98 ton/acre. There were no significant differences in yield at the 95% probability level between the five treatments for individual cuts or for the total (Table 29).

Table 29. Forage yield of the Penatron and Thoro-Gro Alfalfa Trial. NMSU Agriculture Science Center at Farmington, NM. 2012.

Treatment	# Appli-cations	Total Product Applied	Cut-1	Cut 2	Cut-3	Cut-4	Total
			––––––––––– (tons/A)			–––––––––––	4 cuts
Check	0	0	4.31	3.50	2.28	1.89	11.98
Penatron	1	1 gal/a	4.23	3.48	2.32	1.87	11.90
Thorogro	2	0.2 gal/a	4.41	3.29	2.12	1.87	11.69
Penatron	2	2 gal/a	4.11	3.27	2.22	1.84	11.44
Thorogro	1	0.1 gal/a	4.00	3.35	2.10	1.94	11.39
Mean			**4.21**	**3.38**	**2.21**	**1.88**	**11.68**
LSD (0.05)			0.74	0.54	0.38	0.20	1.26
CV (%)			11.40	10.40	11.30	7.04	7.01
P Value			0.77	0.83	0.66	0.86	0.79
Significance			ns	ns	ns	ns	ns

Canola – 2012 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 45 entries of canola from public and private sources. The trial was planted September 8, 2011 and harvested July 17, 2012 (Table 30). Mean yield of this trial was 4230.5 lb/acre (Table 31). The highest yielding entry, at 5323.5 lb/acre, was MH07J14. The lowest yielding entry at 3196.0 lb/acre, was DKW41-10. There were no significant differences in yield between the top yielding variety and the next fifteen varieties. The moisture content averaged 8.9 % for the 45 entries. The average test weight was 50.2 lb/bu. The average plant height was 43.7 inches (Table 31). Ulura had the tallest height of 48.7 inches. The shortest entry was DKW41-10 at 36.3 inches (Table 31). The mean 50% flowering date was April 18.

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 8, 2011 (Table 30). The trial consisted of 45 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 30. Procedures for the Winter Canola Hybrid and Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2010-2012.

Operation	Procedure
Number of Entries:	Forty-five
Planting Date:	September 8, 2011
Planting Rate:	5 lb/acre
Plot Design:	Randomized block with three replications
Plot Size:	Six 10-in rows, 20 ft long
Harvest Date:	July 17, 2012
Fertilization:	N 100 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 14 lb/acre
Herbicide:	None, hand weeded in March
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from September 9 through October 19, 2011; and April 4 through June 24, 2012. 29.0 inches irrigation water applied and 4.5 inches of precipitation for a total of 33.53 inches total water
Results and Discussion:	Yield and other characteristics are presented in Table 31.

Dry fertilizer was applied on August 11, 2011 prior to planting and land preparation at a rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 14 lb/acre. During the growing season, 90 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 9 through October 19, 2011; and April 4 through June 24, 2012. Twenty-nine inches irrigation water was applied and 4.5 inches of precipitation fell from September 2011 through June 2012 for a total of 33.5 inches total water.

Plots were harvested on July 17, 2012 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 31. Yields of all entries were adjusted to a uniform 10% moisture content.

Mean yield of this trial was 4230.5 lb/acre (Table 31). The highest yielding entry, at 5323.5 lb/acre, was MH07J14. The lowest yielding entry at 3196.0 lb/acre, was DKW41-10. There were no significant differences in yield between the top yielding variety and the next fifteen varieties. The moisture content averaged 8.9 % for the 45 entries. The average test weight was 50.2 lb/bu. The average plant height was 43.7 inches (Table 31). Ulura had the tallest height of 48.7 inches. The shortest entry was DKW41-10 at 36.3 inches (Table 31). The mean 50% flowering date was April 18.

There were eight common varieties for the Winter Canola Hybrid and Variety Trials 2009 through 2012. Table 32 shows their comparison in pounds per acre by year and the four year mean for each variety.

Table 31. Yield and other characteristics for the Winter Canola Hybrid and Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2010-2012.

Variety or Selection	Yield	Moisture Content	Test Weight	Plant Height	50% Flower	Fall Plant Stand	Winter Kill
	(lb/acre)	(%)	(lb/bu)	(in)	(date)	(%)	(%)
MH07J14	5323.5	8.4	50.8	46.0	20-Apr	100.0	0.0
Dynastie	5240.0	9.1	49.8	44.0	18-Apr	100.0	0.0
Hybrirock	5148.8	8.3	50.8	45.3	18-Apr	100.0	0.0
Safran	5025.7	9.6	51.1	41.7	19-Apr	90.0	0.0
MH09H19	4948.0	8.4	50.5	47.3	18-Apr	100.0	0.0
NPZ 0903	4835.1	7.9	49.4	43.0	15-Apr	100.0	0.0
HPZ 1005	4807.8	8.8	51.2	44.7	17-Apr	100.0	0.0
WRH 350	4768.3	8.6	50.7	43.7	18-Apr	100.0	0.0
Visby	4749.7	7.8	50.1	42.3	17-Apr	100.0	0.0
Sitro	4725.3	11.0	49.2	43.0	18-Apr	100.0	0.0
46W94	4546.5	8.6	49.9	44.0	17-Apr	100.0	0.0
Hornet	4532.7	9.2	50.3	46.0	19-Apr	100.0	0.0
TCI806	4440.6	8.2	50.7	45.3	17-Apr	100.0	0.0
06.U1WC.1	4431.7	8.5	51.2	42.0	18-Apr	100.0	0.0
Riley	4429.2	8.5	49.6	42.7	18-Apr	100.0	0.0
MH06E10	4357.3	8.8	51.0	46.0	18-Apr	100.0	0.0
Flash	4331.7	9.2	49.4	44.7	18-Apr	100.0	0.0
KS 4428	4310.8	8.0	50.4	48.0	20-Apr	100.0	0.0
TCI805	4273.5	8.9	50.2	46.7	20-Apr	100.0	0.0
Baldur	4263.9	8.4	51.3	44.0	17-Apr	100.0	0.0
46W99	4255.9	9.7	50.8	43.7	18-Apr	100.0	0.0
Amanda	4209.5	8.6	51.1	46.3	20-Apr	100.0	0.0
HPX-7341	4205.4	8.2	50.9	44.0	20-Apr	100.0	0.0
KS 4083	4161.1	8.4	50.9	47.7	20-Apr	100.0	0.0
Wichita	4156.2	8.0	50.9	43.7	20-Apr	100.0	0.0
Chrome	4135.2	10.9	50.1	43.0	19-Apr	83.0	0.0
KS 4564	4091.6	8.4	51.1	43.3	17-Apr	100.0	0.0
Hyclass 154W	4065.9	7.9	51.0	46.3	18-Apr	100.0	0.0

Variety or Selection	Yield	Moisture Content	Test Weight	Plant Height	50% Flower	Fall Plant Stand	Winter Kill
	(lb/acre)	(%)	(lb/bu)	(in)	(date)	(%)	(%)
Rumba	4039.0	9.5	50.0	45.0	16-Apr	100.0	0.0
Rossini	4024.8	9.2	48.7	42.7	14-Apr	100.0	0.0
VSX-3	4002.1	9.2	49.0	37.3	18-Apr	100.0	0.0
Hyclass 115W	3971.4	8.3	50.2	39.3	18-Apr	100.0	0.0
Kiowa	3946.6	9.9	50.6	47.0	19-Apr	100.0	0.0
DKW44-10	3914.7	8.2	50.4	39.0	19-Apr	100.0	0.0
Virginia	3910.3	8.6	49.8	42.3	18-Apr	100.0	0.0
DKW47-15	3839.3	8.9	49.2	44.3	19-Apr	100.0	0.0
05.U1.5.6.33	3836.2	9.3	49.6	44.3	20-Apr	100.0	0.0
Durola	3798.4	9.1	50.2	44.3	20-Apr	100.0	0.0
Hyclass 125W	3666.6	8.6	49.5	44.3	18-Apr	100.0	0.0
Claremore	3576.3	10.1	50.6	41.3	25-Apr	100.0	0.0
DKW46-15	3548.0	8.4	49.4	40.0	21-Apr	100.0	0.0
Ulura	3487.5	8.7	49.8	48.7	17-Apr	100.0	0.0
Sumner	3432.5	8.8	50.6	40.7	17-Apr	100.0	0.0
HPX-7228	3411.9	9.1	48.0	41.7	17-Apr	100.0	0.0
DKW41-10	3196.0	10.8	50.1	36.3	15-Apr	100.0	0.0
Mean	**4230.5**	**8.9**	**50.2**	**43.7**	**18-Apr**	**99.4**	**0.0**
LSD .05	977.3	1.6	1.6	3.1			
CV %	14.2	11.6	2.0	4.4			
P	0.0015	0.0189	0.0227	<0.0001			
significant	**	*	*	***			

Yields adjusted to 10 % moisture

Table 32. Four-year grain yield of Winter Canola Hybrid and Variety Trial; NMSU Agriculture Science Center at Farmington, NM. 2009-2012.

Variety	2009	2010	2011	2012	4 year
	(lb/acre)				
Sitro	5166.0	4458.5	3106.9	4725.3	4364.2
Safran	4043.1	4118.2	3437.4	5025.7	4156.1
Flash	5716.7	3190.6	3382.0	4331.7	4155.3
Visby	4362.8	3439.2	2839.0	4749.7	3847.7
Virginia	4381.6	3407.8	2685.3	3910.3	3596.2
Baldur	4725.6	2492.7	2783.4	4263.9	3566.4
Wichita	4726.1	2541.4	2430.5	4156.2	3463.6
Sumner	2681.2	2469.3	2131.4	3432.5	2678.6
Mean	**4475.4**	**3264.7**	**2849.5**	**4324.4**	**3728.5**

Canola – 2012 Winter Canola Roundup Ready Variety Trial

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

Abstract

The Winter Canola Roundup Ready Variety Trial was conducted 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 made up of Roundup ready hybrids from DeKalb Seed. The trial consisted of four entries of Roundup ready canola. The trial was planted September 8, 2011 and harvested July 9, 2012 (Table 33). Mean yield of this trial was 4210.7 lb/acre (Table 34). The highest yielding entry, at 4617.9 lb/acre, was DKW 46-15. The lowest yielding entry at 3641.6 lb/acre, was DKW41-10. There were no significant differences in yield between the four varieties. The moisture content averaged 8.0 % for the 4 entries. The average test weight was 50.1 lb/bu. The average plant height was 39.4 inches (Table 34). DKW 47-15 had the tallest height of 42.8 inches. The shortest entry was DKW41-10 at 35.5 inches (Table 34). The mean 50% flowering date was April 17. The weed control was very effective using the Roundup Power Max a rate of 16 ounces per acre to control mustard.

Introduction

The Winter Canola Roundup Ready Variety Trial was conducted to help determine which entries would perform best in the area they are tested. The entries were provided by Dekalb Seeds from the Monsanto Company.

Objectives

- Test winter canola roundup ready varieties and hybrids on grain yield and yield components.
- Determine the effectiveness of spraying round up on the weed population within the sprayed areas.
- 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 Roundup Ready Variety Trial was planted at the Agriculture Science Center at Farmington, on September 8, 2011 (Table 33). The trial consisted of four entries of Roundup Ready winter canola from Dekalb Seed from the Monsanto Company. The trial at Farmington was established in a randomized block design with four 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 33. Procedures for the Winter Canola Roundup Ready Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2011-2012.

Operation	Procedure
Number of Entries:	Four
Planting Date:	September 8, 2011
Planting Rate:	5 lb/acre
Plot Design:	Randomized block with three replications
Plot Size:	Six 10-in rows, 20 ft long
Harvest Date:	July 9, 2012
Fertilization:	N 100 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 14 lb/acre
Herbicide:	Roundup Power Max, 16 oz/acre applied on March 9, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from September 9 through October 19, 2011; and April 4 through June 24, 2012. 29.0 inches irrigation water applied and 4.5 inches of precipitation for a total of 33.53 inches total water
Results and Discussion:	Yield and other characteristics are presented in Table 34.

Dry fertilizer was applied on August 11, 2011 prior to planting and land preparation at a rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 14 lb/acre. During the growing season, 90 lb/acre of liquid nitrogen fertilizer was applied through the irrigation water.

The plot area was treated with Roundup Power Max herbicide on March 9, 2012 at a rate of 16 ounces per acre to control mustard.

This trial was grown under a center pivot irrigation system and was watered from September 9 through October 19, 2011; and April 4 through June 24, 2012. Twenty-nine inches irrigation water was applied and 4.5 inches of precipitation fell from September 2011 through June 2012 for a total of 33.5 inches total water.

Plots were harvested on July 9, 2012 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 weed control was very effective using the Roundup Power Max a rate of 16 ounces per acre to control mustard.

Yield results and other data collected in this trial are presented in Table 34. Yields of all entries were adjusted to a uniform 10% moisture content.

Mean yield of this trial was 4210.7 lb/acre (Table 34). The highest yielding entry, at 4617.9 lb/acre, was DKW 46-15. The lowest yielding entry at 3641.6 lb/acre, was DKW41-10. There were no significant differences in yield between the four varieties. The moisture content averaged 8.0 % for the 4 entries. The average test weight was 50.1 lb/bu. The average plant height was 39.4 inches (Table 34). DKW 47-15 had the tallest height of 42.8 inches. The shortest entry was DKW41-10 at 35.5 inches (Table 34). The mean 50% flowering date was April 17.

Table 34. Yield and other characteristics for the Winter Canola Roundup Ready Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2011-2012.

Variety or Selection	Yield	Moisture Content	Test Weight	Plant Height	50 % Flower	Fall Plant Stand	Winter Kill
	(lb/acre)	(%)	(lb/bu)	(in)	(date)	(%)	(%)
DKW 46-15	4617.9	7.3	49.1	40.3	20-Apr	100.0	0.0
DKW 47-15	4428.0	7.8	50.6	42.8	18-Apr	100.0	0.0
DKW 44-10	4155.5	8.4	50.1	39.0	19-Apr	100.0	0.0
DKW 41-10	3641.6	8.4	50.7	35.5	14-Apr	100.0	0.0
Mean	**4210.7**	**8.0**	**50.1**	**39.4**	**17-Apr**	**100.0**	**0.0**
LSD .05	1110.2	0.7	0.9	3.5			
CV %	16.5	5.7	1.1	5.6			
P	0.2811	0.0222	0.0125	0.0078			
significant	ns	*	*	**			

Yields adjusted to 10 % moisture

Corn – Early Season Corn Hybrid and Variety Trial

Michael O'Neill, Curtis Owen, Kenneth 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. Ten hybrids of early season corn were planted in a randomized block design with three replications on the Agriculture Science Center at Farmington on May 15, 2012 and harvested November 5, 2012. (Table 35) Mean yield of this trial (Table 36) was 193.4 bu/acre. The highest yielding entry, at 249.1 bu/acre, was the hybrid PO636HR from Pioneer Hi-Bred International, Inc. There was no significant difference in yield between entries at the 95% probability level due to large differences between replications The lowest yielding hybrid, at 158.1 bu/acre was 9669S from Triumph Seed Co. Inc. The test weights averaged 57.6 lb/bu (Table 36).

The weed control from the Bicep Lite II Mag along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season. 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

Ten hybrids of early season corn were planted in a randomized block design with three replications on the Agriculture Science Center at Farmington on May 15, 2012 (Table 35). Plots were planted using cone seeders that fit on John Deere 71 flex planters. Individual plots were four 30-in. rows by 20 feet. long. Planting rate was approximately 40,000 seeds/acre and all hybrids were planted at the same rate.

Table 35. Procedures for the Early Season Corn Hybrid and Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2012.

Operation	Procedure
Number of Entries:	Ten
Planting Date:	May 15, 2012
Planting Rate:	40,000 seeds per acre (46 seeds per 20 ft row)
Plot Design:	Randomized block with three replications
Plot Size:	Four 30-in rows by 20 ft long
Harvest Date:	November 5, 2012
Fertilization:	N 254 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre, 10 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Bicep Lite II Mag applied on May 21, 2012; 1 qt/acre Prowl H_2O and 5 oz/acre Status applied on June 12, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 16 through September 21, 2012; Irrigation water applied: 32.6 inches Total water received including precipitation: 34.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 36.

Dry fertilizer was applied prior to planting on March 6, 2012 at the rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 10 lb/acre. Nitrogen fertilizer was applied 11 times during the growing season through the irrigation water for a total of 244 lb/acre. Total nitrogen received was 254 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Bicep Lite II Mag (1.5 qt/acre) to prevent weed infestation. The active ingredients of Bicep Lite II Mag are S-metolachor (1.4 lb ai/acre) and Atrazine (1.2 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 6 days after planting on May 21, 2012. 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 12, 2012. Irrigation water was applied immediately after the herbicide application.

This trial was grown under a center pivot irrigation system and was watered from May 16 through September 21, 2012. During the growing season, 34.6 inches of irrigation water and precipitation was received.

The plots were harvested November 5, 2012 using a 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 potatoes in 2010 and was fallow in 2011.

Results and discussion

Yield results and other data collected from this trial are presented in Table 36. 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 36) was 193.4 bu/acre. The highest yielding entry, at 249.1 bu/acre, was the hybrid PO636HR from Pioneer Hi-Bred International, Inc. There was no significant difference in yield between entries at the 95% probability level due to large differences between replications. The lowest yielding hybrid, at 158.1 bu/acre was 9669S from Triumph Seed Co. Inc. The test weights averaged 57.6 lb/bu (Table 36).

Stand counts at the end of the growing season averaged 34,756 plants/acre (Table 36). The plant heights averaged 108.2 inches (9.0 feet) and ranged from 101 to 118 inches. The moisture content of the grain at harvest averaged 10.4 % and ranged from 9.0 % to 11.4 % (Table 36).

The weed control from the Bicep Lite II Mag along with the Status and Prowl H_2O application was good with very few weeds present at the end of the growing season. Very little hand weeding was done.

Table 36. Grain yield and other attributes of the Early Season Corn Hybrid and Variety Trial. NMSU Agriculture Science Center at Farmington, NM. 2012.

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)
PO636HR	Pioneer*	249.1	58.4	10.3	118	55	73.0	0	35,154	106
P0193HR	Pioneer*	222.5	56.3	10.8	103	41	72.7	0	35,154	101
9946S	Triumph**	210.0	57.7	9.8	108	52	73.0	0	33,014	100
TRX22114R	Triumph**	193.9	57.4	11.4	106	50	73.0	0	34,542	100
36V75	Pioneer*	190.7	56.3	11.4	104	50	73.3	0	35,307	102
9811X	Triumph**	186.0	59.5	10.2	115	56	72.0	0	35,612	98
P9690HR	Pioneer*	185.3	55.5	9.0	107	50	70.3	0	36,529	96
5502S	Triumph**	171.2	57.5	10.8	111	58	73.0	0	35,154	102
3212X	Triumph**	167.1	58.8	10.7	109	53	73.0	0	35,765	102
9669S	Triumph**	158.1	58.1	9.9	101	47	74.0	0	31,333	96
Mean		**193.4**	**57.6**	**10.4**	**108.2**	**51.156**	**72.7**	**0**	**34,756**	**100.3**
LSD (0.05)		17.1	1.9	10.0	7.6	12.5			6.9	
CV (%)		57.0	1.9	1.8	14.1	11.0			4140.9	
P Value		0.0931	0.0069	0.2197	0.3308	0.1628			0.3688	
significant		ns	**	ns	ns	ns			ns	

Yields adjusted to 15.5% moisture and 56 lb/bu.
*Pioneer Hi-Bred International, Inc.
**Triumph Seed Co. Inc.

Corn – Penatron and Thoro-Gro Treated Corn Hybrid Trial

Michael O'Neill, Curtis Owen, Kenneth Kohler, and Margaret M. West

Abstract

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

Treatments of Penatron and Thoro-Gro were each applied to the corn plots with a four gallon backpack sprayer. Each product was mixed with water in the backpack sprayer and applied. The products were applied at a one and two (split) application schedule. The first application of each product was made in May before seed emergence. The second application was made in June when the corn was about six inches in height. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on May 23, 2012. Penatron was also applied to the split application plots at a rate of one gallon per acre on June 7, 2012. Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on May 23, 2012. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 7, 2012.

Plant growth was variable within this trial from unknown factors and yields were less than desirable. Mean yield of this trial was 136.8 bu/acre (Table 38). The highest yielding treatment, at 164.6 bu/acre, was the treatment Penatron applied once at a rate of one gallon per 10 acres. There was no significant difference in yield between treatments at the 95% probability level. The lowest yielding hybrid, at 119.8 bu/acre was Penatron applied twice at a rate of one gallon per 10 acres for each application. The test weights averaged 56.1 lb/bu (Table 38). Stand counts at the end of the growing season averaged 25,421 plants/acre (Table 38). The plant heights averaged 98.2 inches (8.16 feet) and ranged from 96 to 100 inches. The moisture content of the grain at harvest averaged 9.4 % and ranged from 9.1 % to 9.7 % (Table 38).

Introduction

The Penatron and Thoro-Gro Treated Corn Trial is a collaborated effort between New Mexico State University Agriculture Science Center at Farmington and S.C.A.L.E. Ag Services represented by Wes Richens. The purpose of the experiment was to see how Penatron and Thoro-Gro applied at different rates on the soil and crop would affect corn yield compared with a check entry of the same variety. Penatron and Thoro-Gro are both natural crop enhancers that when applied to the soil and/or crop may increase production. Penatron, a product from Maz-Zee S.A. International, is an organic liquid soil conditioner. Thoro-Gro, a product from

S.C.A.L.E. Ag Services, is “a spore based (Dormant Live Liquid Bio-Stimulant) made from a fermented biomass and other natural accruing growth enhancers.”

Objective

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

Materials and methods

The corn hybrid NK N34N-3111 from Syngenta was planted in a randomized block design with three replications on the Agriculture Science Center at Farmington on May 15, 2012 (Table 37). Plots were planted with a pair of John Deere 71 flex planters. Individual plots were four 30-in. rows by 20 ft. long. Planting rate was approximately 30,000 seeds/acre.

Treatments of Penatron and Thoro-Gro were each applied to the corn plots with a four gallon backpack sprayer. Each product was mixed with water in the backpack sprayer and applied. The products were applied at a one and two (split) application schedule. The first application of each product was made in May before seed emergence. The second application was made in June when the corn was about six inches in height. Penatron was applied to the single application plots and to the split application plots at a rate of one gallon per acre on May 23, 2012. Penatron was also applied to the split application plots at a rate of one gallon per acre on June 7, 2012. Thoro-Gro was applied to the single application plots and to the split application plots at a rate of 0.1 gallon per acre on May 23, 2012. Thoro-Gro was applied again to the split application plots at a rate of 0.1 gallon per acre on June 7, 2012.

Table 37. Procedures for the Penatron and Thoro-Gro treated Trial; NMSU Agricultural Science Center at Farmington, NM. 2012.

Operation	Procedure
Number of Treatments:	Five: (1) Penetron applied once at a rate of 1 gallon per acre, 05/23/12 (2) Penetron applied twice at a rate of 1 gallon per acre at each application, 05/23/12, and 06/07/12. (3) Thoro-Gro applied once at the rate of 0.1 gallon per acre, 05/23/12. (4) Thoro-Gro applied twice at the rate of 0.1 gallon per acre at each application 05/23/12, and 06/07/12. (5) a check plot with no application
Planting Date:	May 15, 2012
Planting Rate:	30,000 seeds per acre
Plot Design:	Randomized block with three replications
Plot Size:	Four 30-in rows by 20 ft long
Harvest Date:	November 6, 2012

Operation	Procedure
Fertilization:	N 254 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre, 10 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Bicep Lite II Mag applied on May 21, 2012; 1 qt/acre Prowl H_2O and 5 oz/acre Status applied on June 12, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 16 through September 21, 2012; Irrigation water applied: 32.6 inches Total water received including precipitation: 34.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 38.

Dry fertilizer was applied prior to planting on March 6, 2012 at the rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 10 lb/acre. Nitrogen fertilizer was applied 11 times during the growing season through the irrigation water for a total of 244 lb/acre. Total nitrogen received was 254 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Bicep Lite II Mag (1.5 qt/acre) to prevent weed infestation. The active ingredients of Bicep Lite II Mag are S-metolachor (1.4 lb ai/acre) and Atrazine (1.2 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 6 days after planting on May 21, 2012. 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 12, 2012. Irrigation water was applied immediately after the herbicide application.

This trial was grown under a center pivot irrigation system and was watered from May 16 through September 21, 2012. During the growing season, 34.6 inches of irrigation water and precipitation was received.

The plots were harvested November 6, 2012 using a 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 potatoes in 2010 and was fallow in 2011.

Results and discussion

Yield results and other data collected from this trial are presented in Table 38. 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.

Plant growth was variable within this trial from unknown factors and yields were less than desirable. Mean yield of this trial (Table 38) was 136.8 bu/acre. The highest yielding treatment, at 164.6 bu/acre, was the treatment Penatron applied once at a rate of one gallon per 10 acres. There was no significant difference in yield between treatments at the 95% probability level. The lowest yielding hybrid, at 119.8 bu/acre was Penatron applied twice at a rate of one gallon per 10 acres for each application. The test weights averaged 56.1 lb/bu (Table 38). Stand counts at the end of the growing season averaged 25,421 plants/acre (Table 38). The plant heights averaged 98.2 inches (8.16 feet) and ranged from 96 to 100 inches. The moisture content of the grain at harvest averaged 9.4 % and ranged from 9.1 % to 9.7 % (Table 38).

The weed control from the Bicep Lite II Mag along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season. Very little hand weeding was done.

Table 38. Grain yield and other attributes of the Penatron and Thoro-Gro treated Trial. NMSU Agriculture Science Center at Farmington, NM. 2012.

Treatment	# Appli-cations	Total Product Applied	Grain Yield (bu/A)	Test Weight (lb/bu)	Moisture Content (%)	Plant Height (in)	Ear Height (in)	Days to Silk (# days)	Lodge (%)	Plant Pop. (#/acre)
Penatron 1X	1	1 gal/10a	164.6	56.3	9.1	100	48	73.0	0	25,849
Check	0	0	146.5	56.5	9.7	97	45	73.0	0	26,002
ThoroGro 1X	1	0.1gal/10a	126.9	56.1	9.5	100	47	73.0	0	25,390
ThoroGro 2X	2	0.2gal/10a	126.0	56.1	9.4	98	47	73.0	0	24,625
Penatron 2X	2	2 gal/10a	119.8	55.6	9.3	96	44	73.0	0	25,237
Mean			**136.8**	**56.1**	**9.4**	**98.2**	**46.2**	**73.0**	**0**	**25,421**
LSD (0.05)			48.5	1.4	0.5	10.6	6.2			3,669
CV (%)			18.8	1.3	2.7	5.8	7.1			8
P Value			0.2762	0.5797	0.2285	0.8707	0.5850			0.9111
significant			ns	ns	ns	ns	ns			ns

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

Corn – Forage Corn Hybrid and Variety Trial

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

Abstract

The Forage Corn Hybrid and Variety Trial is part of a statewide entry fee program in which seed companies wishing to test their hybrids pay an entry fee to help with the cost of running the test. Three hybrids of forage corn were planted in a randomized block design with three replications on the Agriculture Science Center at Farmington on May 15, 2012 and harvested September 25, 2012 (Table 39). The highest yielding entry during the 2012 growing season was CX12117 from Dyna-Gro with a total yield of 25.9 wet (green) ton/acre. The lowest yielding entry in the 2012 growing season was D58VP30 from Dyna-Gro with a total yield of 19.2 wet (green) ton/acre. The mean yield of all 3 entries in the 2012 growing season was 21.7 ton/acre wet (green) (Table 40). The mean moisture content at harvest was 54.0% wet weight. The mean plant height was 112 inches. The mean days to 50% silk was 77 days. The mean plants/acre was 39,301 (Table 40). CX12117 from Dyna-Gro had the highest production of milk per acre with 24,763 lb milk/acre. The mean of all 3 entries of milk production per acre was 21,977 lb milk/acre (Table 41).

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 three replications on the Agriculture Science Center at Farmington on May 15, 2012 (Table 39). Plots were planted using cone seeders that fit on John Deere 71 flex planters. Individual plots were four 30 in. rows by 20 ft. long. Planting rate was approximately 40,000 seeds/acre and all hybrids were planted at the same rate.

Table 39. Procedures for the Forage Corn Hybrid and Variety Trial. NMSU Agricultural Science Center at Farmington, NM. 2012.

Operation	Procedure
Number of Entries:	Three
Planting Date:	May 15, 2012
Planting Rate:	40,000 seeds per acre (46 seeds per 20 ft row)
Plot Design:	Randomized block with three replications
Plot Size:	Four 30-in rows by 20 ft long
Harvest Date:	September 25, 2012
Fertilization:	N 254 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre, 10 lb/acre zinc sulfate
Herbicide:	1.5 qt/acre of Bicep Lite II Mag applied on May 21, 2012; 1 qt/acre Prowl H_2O and 5 oz/acre Status applied on June 12, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered as needed from May 16 through September 21, 2012; Irrigation water applied: 32.6 inches Total water received including precipitation: 34.6 inches.
Results and Discussion:	Yield and other characteristics are presented in Table 40.

Dry fertilizer was applied prior to planting on March 6, 2012 at the rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 10 lb/acre. Nitrogen fertilizer was applied 11 times during the growing season through the irrigation water for a total of 244 lb/acre. Total nitrogen received was 254 lb/acre (including the dry fertilizer).

The plot area was chemically treated with the herbicide Bicep Lite II Mag (1.5 qt/acre) to prevent weed infestation. The active ingredients of Bicep Lite II Mag are S-metolachor (1.4 lb ai/acre) and Atrazine (1.2 lb ai/acre). A pull behind sprayer was used to apply the herbicides. The plots were sprayed 6 days after planting on May 21, 2012. 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 12, 2012. Irrigation water was applied immediately after the herbicide application.

This trial was grown under a center pivot irrigation system and was watered from May 16 through September 21, 2012. During the growing season, 34.6 inches of irrigation water and precipitation was received.

The previous crop grown on this plot was potatoes in 2010 and was fallow in 2011.

The plots were harvested for forage September 25, 2012 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 40. Chemical analysis data for forage quality is presented in Table 41.

The highest yielding entry during the 2012 growing season was CX12117 from Dyna-Gro with a total yield of 25.9 wet (green) ton/acre. The lowest yielding entry in the 2012 growing season was D58VP30 from Dyna-Gro with a total yield of 19.2 ton/acre wet (green). The mean yield of all 3 entries in the 2012 growing season was 21.7 ton/acre wet (green) (Table 40). The mean moisture content at harvest was 54.0% wet weight. The mean plant height was 112 inches. The mean days to 50% silk was 77 days. The mean plants/acre was 39,301 (Table 40). CX12117from Dyna-Gro had the highest production of milk per acre with 24,763 lb milk/acre. The mean of all 3 entries of milk production per acre was 21,977 lb milk/acre (Table 41).

The weed control from the Bicep Lite II Mag along with the Status and Prowl H2O application was good with very few weeds present at the end of the growing season. Very little hand weeding was done.

Table 40. Forage yield (dry and green) and other attributes of the Forage Corn Hybrid and Variety Trial. NMSU Agriculture Science Center at Farmington, NM. 2012.

Hybrid or Selection	Source	Forage Dry	Forage Wet	Wet Weight	Plant Pop.	Plant Height	Ear Height	Days to Silk	Relative Maturity
		––– (ton/acre) –––		(%)	–– (plants/acre) ––		(in)	# days	#days
CX12117	Dyna-Gro	10.3	25.9	60.4	39,494	116.0	55.0	77	117
D56VP24	Dyna-Gro	9.2	20.0	51.4	39,494	106.0	49.0	78	116
D58VP30	Dyna-Gro	9.6	19.2	50.2	38,914	114.0	51.0	77	118
Mean		**9.7**	**21.7**	**54.0**	**39,301**	**112.0**	**51.7**	**77**	**117**
LSD (0.05)		20.1	25.3	8.4	23.8	2.9	3.9		
CV (%)		4.4	12.5	10.2	21,190	7.3	4.5		
P Value		0.8012	0.3605	0.0921	0.9961	0.0400	0.0494		
significant		ns	ns	ns	ns	*	*		

Table 41. 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. 2012.

Hybrid or Selection	Source	Forage Dry (ton/acre)	CP (%)	NDF (%)	NDFD 48hr (%)	Starch (%)	Ash (%)	Fat DM (%)	Milk/ ton (lb/ton)	Milk/ acre (lb/acre)
CX12117	Dyna-Gro	10.3	7.9	44.3	57.2	31.4	5.8	2.5	2,733.6	24,762.7
D56VP24	Dyna-Gro	9.2	7.1	46.0	58.1	32.8	5.7	2.4	2,525.1	20,812.3
D58VP30	Dyna-Gro	9.6	7.4	47.7	58.0	31.4	5.2	2.1	2,428.5	20,356.3
Mean		**9.7**	**7.5**	**46.0**	**57.8**	**31.9**	**5.6**	**2.3**	**2,562.4**	**21,977.1**
LSD (0.05)		20.1	6.9	6.8	2.3	6.2	7.9	7.1	2.1	20.4
CV (%)		4.4	1.2	7.1	3.1	4.5	1.0	0.4	124.6	10,153.9
P Value		0.80	0.31	0.48	0.70	0.65	0.33	0.14	0.01	0.48
Significant		ns	ns	ns	ns	ns	ns	ns	**	ns

Winter Wheat – Southern Regional Winter Wheat Performance Nursery

Michael O'Neill, Curtis Owen, Kenneth Kohler, and Margaret M. West

Abstract

The Southern Regional Performance Nursery is a winter wheat trial grown collaboratively in various southern and western states and the results compiled by the University of Nebraska at Lincoln and distributed to all cooperators growing this nursery. Forty-four entries were planted in a randomized block design with four replications on the Agriculture Science Center at Farmington on September 16, 2011 and harvested July 30 through August 1, 2012 (Table 42). Mean yield of this trial was 82.3 bu/acre (Table 43). The highest yielding entry at 105.1 bu/acre was a CO07W245. 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 27.2 bu/acre was Kharkof, a check variety. The tallest entry in this trial at 43.8 inches was Kharkof, a check variety. The shortest entry in height at 27.5 inches was T175. The mean moisture content of all the entries was 9.2% and ranged from 8.4 to 9.8% (Table 43). Bushel weights ranged from 54.1 to 58.5 lb/bu and the mean was 56.6 lb/bu for all entries (Table 43).

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 16, 2011 (Table 42). The nursery consisted of 44 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-in. 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 42. Procedures for the Southern Regional Winter Wheat Performance Nursery. NMSU Agricultural Science Center at Farmington, NM. 2012.

Operation	Procedure
Number of Entries:	Forty-four
Check Entries:	TAM-107, Scout 66, Kharkof, Fuller,
Planting Date:	September 16, 2011
Planting Rate:	100 lb/acre
Plot Design:	Randomized block with four replications
Plot Size:	Six 10-in rows, 20 ft long
Harvest Date:	July 30 through August 1, 2012
Fertilization:	N 100 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 14 lb/acre
Herbicide:	Lo Vol 6 Ester weed killer 0.5 pt/acre and Clarity 0.125 pt/acre applied on March 14, 2012
Insecticide:	None
Soil Type:	Doak fine sandy loam
Irrigation:	Center pivot, watered from September 17 through October 19, 2011 and from April 4 through June 24, 2012 as needed, 29.0 in. of irrigation water and 4.5 in. of precipitation for total received water of 33.5 in. for 2011-2012 growing season.
Results and Discussion:	Yield and other characteristics are presented in Table 43.

Dry fertilizer was applied on August 11, 2011 prior to planting and land preparation at a rate of N 10 lb/acre, P_2O_5 52 lb/acre, K_2O 60 lb/acre and zinc sulfate 14 lb/acre. During the growing season, 90 lb/acre of liquid nitrogen fertilizer was applied through the irrigation water.

The plot area was chemically treated with the herbicide Lo Vol 6 Ester weed killer at a rate of 0.5 pt/acre and Clarity at a rate of 0.125 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.) The active ingredient of Clarity is Dicamba (0.05 lb/acre). A pull behind sprayer was used to apply the herbicide post-emergence on March 14, 2012.

This trial was grown under a center pivot irrigation system and was watered from September 17 through October 19, 2011 and from April 4 through June 24, 2012. During the growing season, 29.0 inches of water was applied along with 4.5 inches of precipitation for a total amount of received water of 33.5 inches.

Plots were harvested July 30 through August 1, 2012. A John Deere 4420 combine equipped with a special gathering box and weigh scale was used to harvest the plots. Samples were taken for yield, moisture content, and bushel weight.

Results and discussion

The weed control from the Lo Vol 6 Ester and Clarity weed killer was good. Very little hand weeding was necessary.

Yield results and other data collected in this trial are presented in Table 43. Yields of all entries were adjusted to a uniform 14% moisture content and a 60-lb bushel.

Mean yield of this trial was 82.3 bu/acre (Table 43). The highest yielding entry at 105.1 bu/acre was CO07W245. 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 27.2 bu/acre was Kharkof, a check variety. The tallest entry in this trial at 43.8 inches was Kharkof, a check variety. The shortest entry in height at 27.5 inches was T175. The mean moisture content of all the entries was 9.2% and ranged from 8.4 to 9.8% (Table 43). Bushel weights ranged from 54.1 to 58.5 lb/bu and the mean was 56.6 lb/bu for all entries (Table 43).

Table 43. Winter wheat grain yield and other characteristics of the Southern Regional Performance Nursery. NMSU Agriculture Science Center at Farmington, NM. 2012.

Variety or Selection	Putative Market Class	Grain Yield (bu/acre)	Grain Yield (kg/ha)	Moisture Content (%)	Test Wt (lb/bu)	Plant Ht (in)	Heading Date (date)
CO07W245	HWW	105.1	7077.3	9.6	57.9	34.0	9-May
CO07W722-F5	HWW	102.3	6893.6	8.7	56.4	31.3	5-May
TX07A001505	HRW	101.3	6824.0	9.4	57.5	35.0	6-May
OK08707W	HWW	100.1	6739.8	9.8	57.7	32.8	9-May
T167	HRW	99.0	6670.0	9.3	57.2	34.0	7-May
TX06V7266	HRW	98.8	6656.8	9.4	57.0	30.5	7-May
TX08V7173	HRW	96.0	6470.2	9.3	58.4	35.5	7-May
CO05W111	HWW	94.5	6368.5	9.5	56.9	35.8	13-May
T175	HRW	91.6	6173.7	9.1	55.6	27.5	7-May
TX03A0563-07AZHR247	HRW	91.4	6153.7	9.8	58.1	30.5	4-May
TX08V7313	HRW	91.2	6140.8	9.3	57.9	37.3	10-May
OK07214	HRW	90.6	6101.5	9.6	57.3	32.0	8-May
TX07V7327	HRW	90.1	6067.2	9.7	56.3	35.5	10-May
OK08229	HRW	89.4	6022.9	9.5	57.2	32.5	6-May
KS030975-CF-3	HRW	88.8	5982.3	9.3	56.4	30.8	7-May
BL11001	HRW	88.4	5956.9	9.6	55.4	28.8	7-May
BL11002	HRW	87.9	5922.0	9.8	56.2	34.0	6-May
TAM 107	HRW	85.4	5755.9	9.1	57.2	32.8	5-May
NW09627	HWW	84.7	5703.8	9.3	56.3	34.8	5-May
LCH08-80	HRW	84.4	5686.1	8.5	56.1	33.8	10-May
Substitute 1	HRW	83.3	5610.1	9.3	56.6	32.0	5-May
OK08328	HRW	82.9	5586.8	8.8	55.4	31.8	10-May

Variety or Selection	**Putative Market Class**	**Grain Yield (bu/acre)**	**Grain Yield (kg/ha)**	**Moisture Content (%)**	**Test Wt (lb/bu)**	**Plant Ht (in)**	**Heading Date (date)**
HV9W07-1942	HRW	82.8	5576.3	9.8	56.9	33.0	6-May
TX08A001128	HRW	82.2	5538.3	9.4	58.1	31.5	7-May
Fuller	HRW	81.3	5478.8	8.7	56.2	30.5	4-May
T179	HRW	81.0	5457.9	8.6	54.1	34.3	10-May
HV9W07-1784	HRW	80.7	5439.6	8.5	55.2	29.5	6-May
OCW00S063S-1B	HRW	79.4	5350.7	9.5	55.9	30.8	9-May
Substitute 2	HRW	78.3	5272.7	8.4	56.2	35.3	5-May
NE06430	HRW	78.0	5257.2	8.7	55.9	34.0	3-May
TX08A001249	HRW	78.0	5254.9	9.1	57.8	33.5	4-May
HV9W07-1028	HRW	77.7	5233.3	9.6	55.7	35.3	7-May
NE09517	HRW	77.6	5228.8	9.1	57.1	33.5	9-May
T185	HRW	76.8	5171.0	8.4	55.1	30.3	7-May
OK09634	HRW	76.2	5132.6	9.5	56.1	30.3	6-May
KS020638-M-5	HRW	75.4	5077.9	9.1	57.3	31.0	8-May
KS020665-M-3	HRW	75.2	5068.3	8.8	55.1	32.0	7-May
LCH08-12	HRW	70.8	4770.7	9.3	54.8	30.0	7-May
KS07HW5-1-1-5	HWW	69.9	4709.0	9.5	58.5	35.0	7-May
KS020319-7-3	HRW	65.6	4421.6	8.8	55.4	33.3	7-May
KS07HW5-1-1-3	HWW	63.9	4306.7	8.8	57.1	33.5	7-May
KS07HW5-1-1-4	HWW	59.6	4012.9	8.6	57.5	35.5	7-May
Scout 66	HRW	56.4	3796.3	9.5	56.9	39.0	1-May
Kharkof	HRW	27.2	1834.1	9.1	55.3	43.8	14-May
Mean		**82.3**	**5544.4**	**9.2**	**56.6**	**33.1**	**7-May**
CV (%)		15.8	15.8	7.7	1.6	8.1	
LSD .05%		18.1	1222.1	1.0	1.3	3.8	
P Value		<0.0001	<0.0001	0.1	<0.0001	<0.0001	
Significance		***	***	ns	***	***	

Yield 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 spring-seeded alfalfa tolerance and yield to applied selected herbicides.

Materials and methods

In 2012, 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 0.3 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 feet wide by 30 feet 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 14. Preemergence treatments were applied on May 15 and immediately incorporated with 0.75 inch of sprinkler applied water. Soils had a maximum and minimum temperature of 76 and 60 degrees F. Postemergence treatments were applied on June 12 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 85 and 70 degrees F. One late postemergence treatment of Roundup powermax was applied on June 26 when seedling alfalfa was in the 5th to 6th trifoliate leaf stage and weeds were 4 to 6 inches tall. Air temperature maximum and minimum during this postemergence application was 92 and 81 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 12. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 26. Postemergence treatments were rated for crop injury and weed control on July 26. Alfalfa was harvested with an Almaco self-propelled plot harvester on August 21. 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 44 and Table 45. On June 12, both Sharpen and Warrant applied preemergence at 2.5 and 48 oz/A caused crop injury ratings of 9 and 7, respectively (Table 44). 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 (Table 44). On July 26, Roundup powermax plus AMS applied postemergence at 44 plus 48 oz/A on June 26 at the 5th to 6th trifoliate leaf stage caused an injury rating (stunting) of 3. On July 26 all treatments except the weedy check and Raptor plus Select max plus MSO plus AMS applied postemergence at 5 plus 9 plus 24 plus 48 oz/A gave good to excellent control of all broadleaf weeds (Table 45).

Yield and protein content

Results of yield, protein content, and relative feed values are given in Table 46. The weedy check had the highest yield during the first cutting of 2.6 t/A. The weedy check had the lowest protein content among treatments at 17.1. There was no significant difference among treatments for relative feed value (Table 46).

Table 44. Control of annual broadleaf weeds with preemergence herbicides in spring-seeded Roundup Ready alfalfa, June 12, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments	Rate (oz/A)	Crop Injury[a] (%)	Weed Control[a,b] Amare	Amabl	Solni	Saskr	Cheal
			---------------	%	---------------		
Sharpen	2.5	9	91	92	89	43	98
Warrant	48	7	99	99	95	43	94
Weedy check		0	0	0	0	0	0
LSD 0.05		3	4	3	3	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 45. Control of annual broadleaf weeds with preemergence, preemergence followed by sequential postemergence, and postemergence herbicides in spring-seeded Roundup Ready alfalfa, July 26, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments[a]	Rate (oz/A)	Crop Injury[c] (%)	Weed Control[c,d] Amare	Amabl	Solni	Saskr	Cheal
			%				
Roundup powermax+AMS	22+48	0	95	98	100	95	87
Roundup powermax+AMS[b]	44+48	3	100	100	100	99	100
Sharpen/roundup powermax+AMS	2.5/22+48	7	85	100	100	86	100
Raptor+select max+MSO+AMS	5+9+24+48	0	100	100	100	82	100
Butyrac+roundup powermax+AMS	64+22+48	0	100	100	100	100	100
Raptor+roundup powermax+MSO+AMS	5+22+24+48	0	100	98	100	97	98
Pursuit+roundup powermax+MSO+AMS	4+22+24+48	0	100	100	100	98	100
Prowl H20+roundup powermax+AMS	32+22+48	0	100	100	100	91	94
Roundup powermax+select max+MSO+AMS	22+9+24+48	0	87	100	100	98	97
Warrant/roundup powermax+AMS	48/22+48	2	100	100	100	97	100
Warrant+roundup powermax+AMS	48+22+48	0	98	100	100	98	86
Raptor+prowl H20+MSO+AMS	6+32+24+48	0	100	100	100	99	100
Pursuit+ prowlH20+MSO+AMS	6+32+24+48	0	100	100	100	97	100
Raptor+prowl H20+ roundup powermax+MSO+AMS	6+32+22+24+48	0	100	100	100	100	100
Pursuit+ prowl H20+ roundup powermax+MSO+AMS	6+32+22+24+48	0	100	100	100	98	100
Weedy check		0	0	0	0	0	0
LSD 0.05		1	4	1	1	3	2

[a] First treatment applied preemergence followed by a sequential postemergence treatment and AMS (ammonium sulfate), MSO (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 46. 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 21, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments[a]	Rate	Yield[c]	RFV[d]	Protein Content
	(oz/A)	(t/A)	(no.)	(%)
Roundup powermax+AMS	22+48	2.1	177	22.9
Roundup powermax+AMS[b]	44+48	2.1	195	22.9
Sharpen/roundup powermax+AMS	2.5/22+48	2.0	171	19.3
Raptor+select max+MSO+AMS	5+9+24+48	2.3	171	19.6
Butyrac+roundup powermax+AMS	64+22+48	2.2	167	19.0
Raptor+roundup powermax+MSO+AMS	5+22+24+48	2.1	169	21.3
Pursuit+roundup powermax+MSO+AMS	4+22+24+48	2.1	168	21.3
Prowl H20+roundup powermax+AMS	32+22+3 48	2.1	171	20.3
Roundup powermax+select max+MSO+AMS	22+9+24+48	2.2	187	20.8
Warrant/roundup powermax+AMS	48/22+48	2.2	165	19.2
Warrant+roundup powermax+AMS	48+22+48	2.1	160	20.2
Raptor+prowl H20+MSO+AMS	6+32+24+48	2.0	165	20.0
Pursuit+ prowl H20+MSO+AMS	6+32+24+48	2.2	160	19.7
Raptor+prowl H20+ roundup powermax+MSO+AMS	6+32+22+24+48	2.0	173	20.8
Pursuit+ prowl H20+ roundup powermax+MSO+AMS	6+32+22+24+48	2.1	177	21.7
Weedy check		2.6	159	17.1
LSD 0.05		ns	ns	3

[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.
[d] RFV denotes relative feed value.

BASF Headline SC Applications for Established Roundup Ready Alfalfa Production

Introduction

Headline SC a fungicide was introduced by BASF to help growers control diseases and improve overall plant health. Headline is fast-acting and delivers a high level of activity on more than 50 major diseases that can threaten yield and crop quality. Headline helps prevent diseases and provides protection for more than 90 crops. Field trials were conducted to evaluate Headline applications to established Roundup Ready alfalfa and yield potential at two different cutting schedules.

Objective

- Determine Headline SC potential as a plant health fungicide applied in between cuttings at two different cutting schedules on alfalfa yield and quality.

Materials and methods

In 2012, a field experiment was conducted at Farmington, New Mexico to evaluate the response of Headline fungicide applied to established alfalfa (DeKalb DKA41-18RR) in between cuttings and to evaluate Headline SC potential to increase yield and quality at two different cutting schedules. 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 two-way randomized block ANOVA with eight replications. Treatments were with or without headline applied between cuttings and alfalfa cutting schedule. Individual plots were 4 feet wide by 26 feet long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 35 psi. Table 47 will indicate Headline SC application dates and cutting schedules. Alfalfa was harvested with an Almaco self-propelled plot harvester. A grab sample from each cutting was taken from each plot to determine protein content and relative feed value. A two-way randomized block ANOVA was used to determine statistical differences among treatment mean at P=0.05.

Results and discussion

Headline application, yield, protein and relative feed value

Alfalfa did show a significant yield response to Headline SC plus NIS applied at 6 plus 12 oz/A to alfalfa between the 6th and 8th inch height range between the 2nd and 3rd cuttings. Further results show that alfalfa for maximum production should be cut on a 30 day schedule as compared to a 35 day schedule. Total yield of alfalfa cut on a 30 day schedule and comparing Headline SC application to no Headline application showed a significant increase in alfalfa production using Headline SC between cuttings of approximately 0.52 t/A (Table 48 and Table 49).

Table 47. Headline SC application dates and cutting schedule of DKA41-18RR Roundup Ready alfalfa NMSU Agricultural Science Center at Farmington; NM. 2012.

Cutting	Headline SC application at 6 oz/A when alfalfa was 6-8 inch in height[a]	Cutting schedule in days	Date Headline SC applied at 6 oz/A to 6-8 inch alfalfa, 2012	Cutting date, 2012
1	none	35		6-6
2	none	70		7-11
3	none	105		8-15
4	none	140		9-20
1	none	30		6-1
2	none	60		7-1
3	none	90		8-1
4	none	120		9-1
1	6	35	4-12	6-6
2	6	70	6-15	7-11
3	6	105	7-23	8-15
4	6	140	8-27	9-20
1	6	30	4-12	6-1
2	6	60	6-11	7-1
3	6	90	7-9	8-1
4	6	120	8-14	9-1

[a] Headline SC was applied with an NIS at 12 oz/A.

Table 48. Yield of Roundup Ready alfalfa applied with or without Headline SC at different cutting schedules (Cut 1 and Cut 2). NMSU Agricultural Science Center at Farmington, NM. 2012.

Headline SC[a]	Cutting Schedule	Yield Cut 1	Protein	RFV[b]	Yield Cut 2	Protein	RFV[b]
(oz/A)	(days)	(t/A)	(%)	(No.)	(t/A)	(%)	(no.)
None	35	2.90	17.56	156	2.40	21.33	161
None	30	2.97	17.98	165	2.45	22.93	156
6	35	3.21	16.40	153	2.56	21.21	162
6	30	2.97	18.20	168	2.58	22.80	155
Headline SC		ns	ns	ns	0.10	ns	ns
Cutting schedule		ns	0.80	6	ns	0.67	6
Headline by cutting schedule		ns	ns	ns	ns	ns	ns

[a] Headline SC was applied with an NIS at 12 oz/A.
[b] RFV denotes relative feed value.

Table 49. Yield of Roundup Ready alfalfa applied with or without Headline SC at different cutting schedules (Cut 3 and Cut 4). NMSU Agricultural Science Center at Farmington, NM. 2012.

Headline SC[a]	Cutting Schedule	Yield Cut 3	Protein	RFV[b]	Yield Cut 4	Protein	RFV[b]
(oz/A)	(days)	(t/A)	(%)	(No.)	(t/A)	(%)	(no.)
None	35	1.86	21.71	162	1.28	23.20	8.44
None	30	2.07	21.94	160	1.62	23.51	9.11
6	35	2.02	21.79	167	1.36	23.13	9.15
6	30	2.32	22.45	164	1.76	24.41	9.63
Headline SC		0.08	ns	ns	ns	ns	0.06
Cutting schedule		0.08	ns	ns	0.11	0.53	0.06
Headline by cutting schedule		ns	ns	ns	ns	ns	ns

[a] Headline SC was applied with an NIS at 12 oz/A.
[b] RFV denotes relative feed value.

BASF Broadleaf Weed Control in Field Corn with Preemergence Followed by Sequential Postemergence Herbicides with or without Headline SC, Headline AMP, and Priaxor Applied alone or in Combination.

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. Headline SC, Headline AMP or Priaxor were added to some postemergence herbicides applied alone or in combination to determine if there would be an increase in corn production.

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 with or without Headline SC, Headline AMP or Priaxor applied alone or in combination.

Materials and methods

In 2012, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO636HR) and annual broadleaf weeds to preemergence followed by sequential late postemergence herbicides with or without Headline SC, Headline AMP or Priaxor applied alone or in combination. Soils were a Doak silt loam with a pH of 7.4 and an organic matter content of less than 0.3 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 8. Preemergence herbicides were applied on May 9 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soils had a maximum and minimum temperature of 74 and 61 degrees F. Postemergence treatments were applied on June 15, when field corn was in the 5th to 6th stage and weeds were small (less than 4 inches). Air temperature maximum and minimum during postemergence applications was 89 and 57 degrees F. Headline SC, Headline AMP and Priaxor were added to postemergence herbicides alone or in combination on June 15, and without herbicides on July 24. 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 11. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 16. Stand counts were made on June 11 by counting individual plants per 10 feet of the third row of each plot. Field corn was harvested on October 30, 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 and there were no significant differences among treatments for stand count (Table 50). On June 11, all preemergence treatments gave excellent control of redroot and prostrate pigweed, black nightshade and common lambsquarters. Russian thistle control was poor with Zidua applied at 1.5 oz/A (Table 50). On July 16, all treatments except the weedy check and Roundup powermax plus NIS plus AMS applied alone postemergence at 22 plus 10 plus 80 oz/A gave excellent control of redroot and prostrate pigweed and common lambsquarters. Black nightshade control was excellent with all treatments, except the weedy check, Roundup powermax plus NIS plus AMS applied postemergence alone at 22 plus 10 plus 80 oz/A and Zidua plus Verdict applied preemergence at 1.5 plus 12 oz/A followed by a sequential postemergence treatment of Roundup powermax plus NIS plus AMS applied at 22 plus 10 plus 80 oz/A. Russian thistle control was poor with Zidua applied preemergence at 1.5 oz/A, followed by a sequential treatment of Roundup powermax plus NIS plus AMS applied at 22 plus 10 plus 80 oz/A and Roundup powermax plus NIS plus AMS applied postemergence alone at 22 plus 10 plus 80 (Table 51).

Crop yields

Yields are given in Table 51. Yields were 206 to 268 bu/A higher in the treated plots as compared to the weedy check. The addition of Headline SC to Verdict applied preemergence at 12 oz/A, followed the sequential postemergence treatment of Roundup power max plus NIS plus AMS applied at 22 plus 10 plus 80 oz/A in combination with Headline SC applied at 6 oz/A and followed by a postemergence treatment of Headline AMP plus NIS applied at 10 plus 10 oz/A at the R-1 silk stage had the highest yield of 312 bu/A (Table 51).

Table 50. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 11, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments	Rate (oz/A)	Stand Count (no.)	Crop Injury[a] (%)	Weed Control[a,b] Amare	Amabl	Solni	Saskr	Cheal
				(%)				
Gmax lite	40	22	0	99	100	100	96	100
Verdict	12	24	0	100	100	100	96	100
Verdict	12	23	0	100	99	100	99	99
Verdict	12	23	0	100	100	100	98	99
Verdict	12	24	0	99	99	100	99	100
Zidua	1.5	25	0	99	99	98	33	100
Zidua+verdict	1.5+12	23	0	100	100	100	99	100
Zidua	1.5	22	0	99	99	98	40	99
Zidua	1.5	23	0	99	100	99	43	99
Zidua+verdict	1.5+12	24		100	100	100	100	100
Weedy check		23	0	0	0	0	0	0
LSD 0.05		ns		1	1	1	5	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 with or without Headline SC, Headline AMP and Priaxor applied alone or in combination in field corn on July 16, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments[a]	Rate (oz/A)	Weed Control[e,f] Amare	Amabl	Solni	Saskr	Cheal	Yield (bu/A)
		%					
Roundup powermax+NIS+AMS	22+10+80	71	69	80	36	77	250
Gmax lite/roundup powermax+NIS+AMS	40/22+10+80	100	100	100	96	100	281
Verdict/roundup powermax+NIS+AMS	12/22+10+80	100	100	100	98	99	294
Verdict/roundup powermax+NIS+AMS/ headline AMP+NIS[b]	12/22+10+80/10 +10	99	99	99	98	100	290
Verdict/roundup powermax+NIS+AMS+ priaxor/headline AMP+NIS[c]	12/22+10+80+ 4/10+10	100	99	99	97	99	295
Verdict/roundup powermax+NIS+AMS/ headline SC+NIS/headline AMP+NIS[d]	12/22+10+80/6+ 10/10+10	100	99	100	97	100	312
Zidua/roundup powermax+NIS+AMS	1.5/22+10+80	99	100	100	60	99	269
Zidua+Verdict/roundup powermax+NIS+AMS	1.5+12/22+10+80	99	100	77	98	100	290
Zidua/roundup powermax+NIS+AMS+ priaxor/headline AMP+NIS[c]	1.5/22+10+80+ 4/10+10	100	99	100	52	99	271
Zidua/roundup powermax+NIS+AMS/ headline SC+NIS/headline AMP+NIS[d]	1.5/22+10+80/6+ 10/10+10	99	100	99	48	100	280
Zidua+Verdict/roundup powermax+NIS+AMS/ headline AMP+NIS[b]	1.5/22+10+80/10 +10	100	100	100	98	100	311
Weedy check		0	0	0	0	0	44
LSD 0.05		1	2	18	5	3	14

[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] Headline AMP plus NIS applied with herbicide treatment on June 15.
[c] Priaxor applied with herbicide treatment on June 15, Headline AMP plus NIS applied alone on July 24 at R-1 silk.
[d] Headline SC applied with herbicide treatment on June 15, Headline AMP Plus NIS applied alone on July 24 at R-1 silk.
[e] Based on a visual scale from 0-100, where 0 = no control or crop injury and 100 = dead plants.
[f] 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 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 2012, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO636HR) 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 0.3 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 8. Preemergence herbicides were applied on May 9 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soil had a maximum and minimum temperature of 74 and 61 degrees F. Postemergence treatments were applied on June 12, when field corn was in the 3rd to 5th leaf stage and weeds were small (less than 2 inches). Air temperature maximum and minimum during postemergence applications was 84 and 50 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 12. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 12. Stand counts were made on June 12 by counting individual plants per 10 feet of the third row of each plot. Field corn was harvested on October 30, 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. There was no crop injury and there were no significant differences among treatments for stand count (Table 52). On June 12, all preemergence treatments gave excellent control of prostrate pigweed, black nightshade, and common lambsquarters. Verdict and Sharpen applied preemergence at 12, 15 and 2.5 oz/A gave poor control of Russian thistle (Table 52). All preemergence and preemergence followed by sequential postemergence treatments gave excellent control of redroot and prostrate pigweed, black nightshade, Russian thistle, and common lambsquarters (Table 53).

Crop yields

Yields are given in Table 53. Yields were 217 to 256 bu/A higher in the herbicide treated plots as compared to the weedy check (Table 53).

Table 52. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 12, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments	Rate (oz/A)	Stand Count (no.)	Crop Injury[a] (%)	Weed Control[a,b] Amare (%)	Amabl	Solni	Saskr	Cheal
Corvus+atrazine	3+16	23	0	100	100	100	100	100
Balance flexx+atrazine	3+16	25	0	100	100	100	100	100
Lumax	48	23	0	100	100	100	100	100
Harness xtra	48	25	0	100	100	100	100	100
Verdict	15	24	0	99	100	100	83	100
Verdict	12	25	0	99	98	100	77	100
G-max lite	48	23	0	100	100	100	98	98
Sharpen	2.5	24	0	98	98	98	84	98
Weedy check		24	0	0	0	0	0	0
LSD 0.05		ns		1	1	1	5	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 12, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments[a]	Rate (oz/A)	Weed Control[b,c] Amare (%)	Amabl	Solni	Saskr	Cheal	Yield (bu/A)
Corvus+atrazine/laudis +MSO+AMS	3+16/3+38+40	100	100	100	100	100	281
Corvus+atrazine/ignite+AMS	3+16/22+48	100	100	100	100	100	272
Corvus+atrazine/roundup powermax+AMS	3+16/22+48	100	100	100	100	100	296
Corvus+atrazine/capreno +COC+AMS	3+16/3+38+40	100	100	100	100	100	297
Balance flexx+atrazine/laudis+MSO +AMS	3+16/3+38+40	100	100	100	100	100	304
Balance flex +atrazine/ignite+AMS	3+16/22+48	100	100	100	100	100	289
Balance flex +atrazine/Roundup powermax+AMS	3+16/22+48	100	100	100	100	100	276
Balance flex +atrazine/capreno+COC +AMS	3+16/3+38+40	100	100	100	100	100	278
Lumax/touchdown total +AMS	48/24+40	100	100	100	100	100	296
Lumax/Halex GT+NIS+AMS	48/58+10+40	100	100	100	100	100	286
Harness xtra/roundup powermax+AMS	48/22+40	100	100	100	100	100	283
Verdict/status+AMS	15/2.5+40	97	100	100	96	100	273
Verdict/status+AMS	12/2.5+40	98	98	100	96	100	282
G-max lite/status+AMS	48/2.5+40	100	99	100	96	100	290
Sharpen/status+AMS	2.5/2.5+40	98	100	100	96	100	265
Weedy check		0	0	0	0	0	48
LSD 0.05		1	1	1	1	1	20

[a] First treatment applied preemergence then a slash followed by a sequential postemergence treatment, MSO, COC, NIS, and AMS denotes 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 2012, a field experiment was conducted at Farmington, New Mexico to evaluate the response of field corn (Pioneer PO636HR) 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 0.3 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 8. Preemergence herbicides were applied on May 9 and immediately incorporated with 0.75 inch of sprinkler-applied water. Soil had a maximum and minimum temperature of 74 and 61 degrees F. Postemergence treatments were applied on June 12, when field corn was in the 3rd to 5th leaf stage and weeds were small (less than 2 inches). Air temperature maximum and minimum during postemergence application were 84 and 50 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 12. Preemergence followed by sequential postemergence treatments were rated visually for weed control on July 12. Stand counts were made on June 12 by counting individual plants per 10 feet of the third row of each plot. Field corn was harvested on October 29, 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 54. Weed control evaluations are given in Table 54 and Table 55. There was no crop injury and there were no significant differences among treatments for stand count 10. On June 12, all preemergence treatments gave excellent control of redroot and prostrate pigweed, black nightshade, and common lambsquarters. Zemax applied preemergence at 64 oz/A gave poor control of Russian thistle (Table 54). On July 12, all treatments except the weedy check gave excellent control of redroot and prostrate pigweed, black nightshade, and common lambsquarters. Zemax applied preemergence at 64 oz/A and Zemax applied preemergence at 64 oz/A followed by a sequential postemergence treatment of Roundup powermax plus NIS+AMS at 22 plus 10 plus 80 oz/A gave poor control of Russian thistle (Table 55).

Crop yields

Yields are given in Table 55. Yields were192 to 233 bu/A higher in the herbicide treated plots as compared to the weedy check (Table 55).

Table 54. Control of annual broadleaf weeds with preemergence herbicides in field corn on June 12, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments	Rate	Stand Count	Crop Injury[a]	Amare	Amabl	Solni	Saskr	Cheal
				––––––––– Weed Control[a,b] –––––––––				
	(oz/A)	(no.)	(%)	–––––––––––––– (%) ––––––––––––––				
Rimsulfuron+isoxaflutole +breakfree ATZ	1.2+0.8 +48	24	0	100	100	100	100	100
Rimsulfuron+isoxaflutole +breakfree ATZ	1.0+0.67 +64	23	0	100	100	100	100	100
Rimsulfuron+isoxaflutole +cinch ATZ	1.0+0.67 +64	25	0	100	100	100	100	100
Corvus	5.6	24	0	100	100	100	100	100
Corvus+atrazine	5.6+32	25	0	100	100	100	100	100
Zemax	64	24	0	100	100	100	45	100
Weedy check		24	0	0	0	0	0	0
LSD 0.05		ns		1	1	1	3	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 field corn on July 12, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments[a]	Rate (oz/A)	Weed Control[b,c] Amare	Amabl	Solni	Saskr	Cheal	Yield (bu/A)
		––––––––	––––––––	%	––––––––	––––––––	
Rimsulfuron+isoxaflutole+ breakfree ATZ	1.2+0.8+48	100	100	100	100	100	273
Rimsulfuron+isoxaflutole+ breakfree ATZ	1.0+0.67+64	100	100	100	100	100	273
Rimsulfuron+isoxaflutole+ cinch ATZ	1.0+0.67+64	100	100	100	99	100	291
Corvus	5.6	100	100	100	100	100	280
Corvus+atrazine	5.6+32	100	100	100	100	100	289
Zemax	64	99	100	100	43	100	252
Rimsulfuron+isoxaflutole+ breakfree ATZ/roundup powermax+NIS+AMS	1.0+0.67+ 64/22+10+80	100	100	100	100	100	284
Rimsulfuron+isoxaflutole+ cinch ATZ/roundup powermax+NIS+AMS	1.0+0.67+ 64/22+10+80	100	100	100	100	100	290
Corvus/roundup powermax+NIS+AMS	5.6/22+10+80	100	100	100	100	100	293
Corvus+atrazine/roundup powermax+NIS+AMS	5.6+32/22+10+ 80	100	100	100	100	100	284
Zemax/roundup powermax+NIS+AMS	64/22+10+80	100	100	100	68	100	274
Weedy check		0	0	0	0	0	60
LSD 0.05		1	1	1	2	1	17

[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 2012, a field experiment was conducted at Farmington, New Mexico to evaluate the response of grain sorghum (Pioneer, DKS 44-20) 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 0.3 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 29. Preemergence treatments were applied on May 30 and immediately incorporated with 0.75 inch of sprinkler applied water. Soil temperature maximum and minimum during application were 81 and 66 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 89 and 63 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 26. Preemergence followed by a sequential postemergence treatment were evaluated for weed control on July 26. Grain sorghum was harvested on November 14, by combining the center four 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 56. Weed control evaluations are given in Table 56 and Table 57. There were no crop injury symptoms from any of the treatments for both rating periods. On June 26, all treatments except the weedy check gave excellent control of redroot and prostrate pigweed, black nightshade, Russian thistle and common lambsquarters (Table 56). On July 26, all treatments except the weedy check gave excellent control of redroot and prostrate pigweed, black nightshade and common lambsquarters. Russian thistle control was good with the preemergence application of Guardsman max applied at 48 oz/A (Table 57).

Crop yields

Yields are given in Table 57. Yields were 91 to 118 bu/A higher in the herbicide treated plots as compared to the weedy check.

Table 56. Control of annual broadleaf weeds with preemergence herbicides in grain sorghum on June 26, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments	Rate (oz/A)	Crop Injurya (%)	Weed Control[a,b] Amare (%)	Amabl	Solni	Saskr	Cheal
Guardsman max	48	0	99	99	100	98	100
Cinch ATZ	48	0	100	99	100	97	100
Atrazine	32	0	99	99	100	97	100
Weedy check		0	0	0	0	0	0
LSD 0.05		ns	1	1	1	3	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 57. Control of annual broadleaf weeds with preemergence followed by sequential postemergence herbicides in grain sorghum on July 26, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Treatments[a]	Rate (oz/A)	Weed Control[b] Amare	Amabl	Solni	Saskr	Cheal	Yield
		(%)					(bu/A)
Huskie+atrazine+AMS	13+16+16	100	100	100	100	100	127
Huskie+atrazine+AMS	16+16+16	100	100	100	100	100	118
Huskie+AMS	13+16	98	97	100	96	100	124
Atrazine+buctril	16+16	100	100	100	100	100	119
Huskie+atrazine+AMS	16+16+32	100	100	100	100	100	129
Huskie+atrazine+AMS	10+16+32	100	100	100	100	100	129
Guardsman max	48	100	100	100	89	100	126
Guardsman max/Huskie+AMS	48/13+16	100	100	100	100	100	134
Cinch ATZ	48	100	100	100	100	100	126
Cinch ATZ/Huskie+AMS	48/13+16	100	100	100	100	100	145
Atrazine/Huskie+AMS	32/13+16	100	100	100	100	100	144
Weedy check		0	0	0	0	0	27
LSD 0.05		1	1	1	1	1	20

[a] First treatment applied preemergence followed by a slash then a sequential postemergence treatment, AMS denotes ammonium sulfate.
[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.

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 five (in Farmington, 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 the pathogenic fungus *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 2012 progress of these studies.

Climate data and reference ET

In addition to weather data recorded manually from the National Weather Service station; air temperature, relative humidity, solar radiation, wind speed and direction, and precipitation are recorded with an automated Campbell Scientific, Inc. Model CR10 weather station (Figure 2) at the ASCF. These data were used to calculate ET_{REF} using a Hargreaves-Samani (H-S) equation (ET_{HS}), a standardized Penman-Monteith (P-M) grass reference equation (ET_{OS}), and a P-M alfalfa reference (ET_{RS}) equation (Allen, et al. 1998). The P-M equations are also referred to as ET_{SHORT} (grass) and ET_{TALL} (alfalfa) and are the accepted 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 P-M equations require temperature, humidity, solar radiation, and wind data to calculate ET_{REF} while the H-S equation requires only temperature data. Hourly and daily summaries of these weather data are available from the NMCC website (http://weather.nmsu.edu).

In 2012, cumulative ET_{RS}, ET_{OS} and ET_{HS} at the ASCF research site totaled 86, 62, and 54 inches, respectively (Figure 3). During most of the active growing season (April 15 to September 15), daily ET_{RS}, ET_{OS}, and ET_{HS} averaged 0.34, 0.25, and 0.24 inch, respectively (Figure 4) and from June 1 through mid-July, average daily ET_{RS}, ET_{OS}, and ET_{HS} values were 0.38, 0.29, and 0.27 inch, respectively. These averages were below normal for this peak ET period due to cool and cloudy conditions during the first two weeks of July (Figure 4).

Figure 2. Automated New Mexico Climate Center (NMCC) weather station; NMSU Agricultural Science Center at Farmington, NM. 2012.

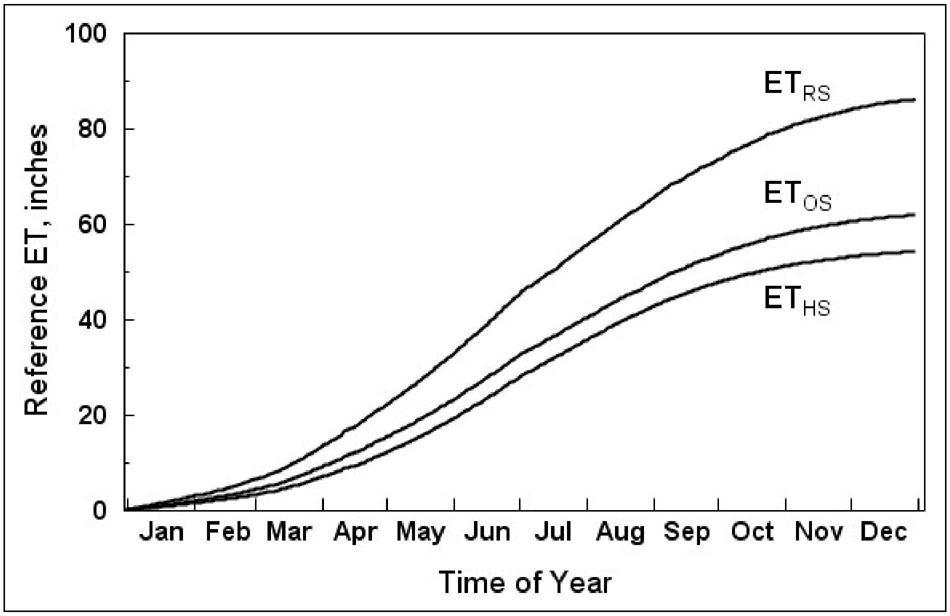

Figure 3. Cumulative 2012 reference ET computed with standardized Penman-Monteith alfalfa (ET_{RS}) and grass (ET_{OS}) equations and Hargreaves-Samani (ET_{HS}) equations. NMSU Agricultural Science Center at Farmington, NM. 2012.

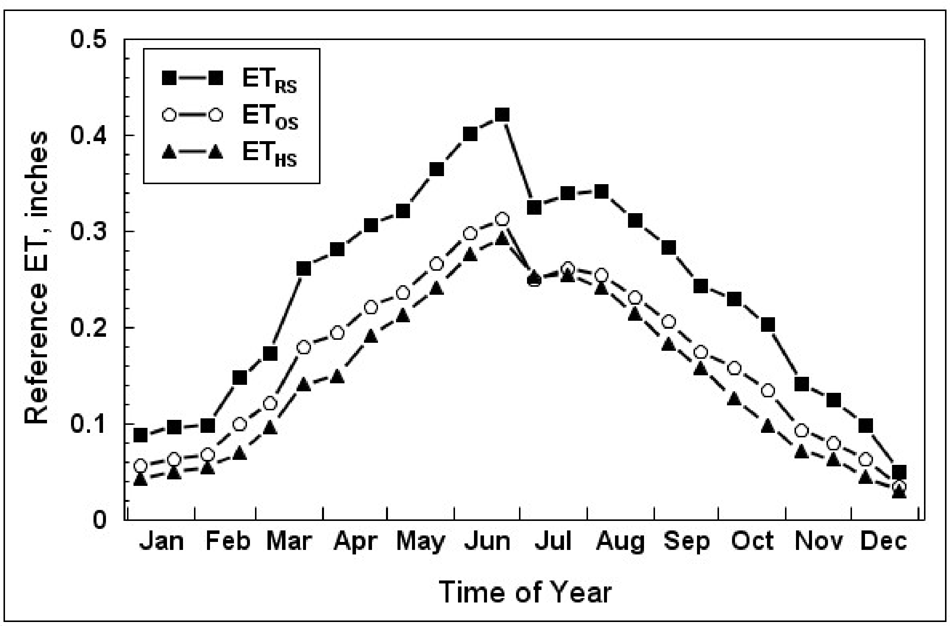

Figure 4. Average daily 2012 reference ET computed with standardized Penman-Monteith alfalfa (ET_{RS}) and grass (ET_{OS}) equations and Hargreaves-Samani (ET_{HS}) equation. Each point on the graph represents the daily average from half-month periods during the year. NMSU Agricultural Science Center at Farmington, NM. 2012.

Xeriscape Demonstration Garden

Dan Smeal, Angi Grubbs, and Joe Ward

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 10th 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. In 2012, the quadrants were irrigated once per week at rates of zero, 4, 8, and 12 gallons of water per plant per week from mid-April to mid-October. Total volumes of water applied per plant through irrigation during the season were 0, 109, 220, and 324 gallons per plant. Only 2.0 inches of rain was received during the irrigation season and only 3.7 inches of precipitation was measured for the entire year making 2012 the 2nd driest year (driest year was 1976 with 3.6 inches) on record since 1969. Nonetheless, many plants survived without supplemental irrigation and most exhibited acceptable quality at low (4 gals/week) and/or medium (8 gals/week) irrigation levels. Irrigation and precipitation records from previous years of this study can be found in the annual reports linked to the ASC – Farmington website (http://aces.nmsu.edu/pubs/research/weather_climate/RR756.pdf). Photos of most of the plants, along with more information on each species, are also linked to this website. A 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. About 50% of all domestic water-use in urban areas of the southwest U.S. during the summer months is used for landscape irrigation. Research studies and surveys have suggested that up to 70% of this water 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 semiarid environment. Research on consumptive use of turfgrass and xeric plants conducted at the ASCF, in fact, indicate that a well-designed xeriscape with 60% canopy coverage can be sustained with less than 20% of the water required for sustaining acceptable quality of a Kentucky bluegrass or fescue 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

General maintenance of the xeriscape demonstration garden was similar in 2012 as in previous years. Detailed description of the plot and methods and materials for previous years can be accessed through links to annual reports at the ASCF web site (http://farmingtonsc.nmsu.edu). Basically, the garden was split into four different quadrants and each quadrant has been irrigated differently with a microirrigation system since 2004. During 2002 and 2003, about 100 species of plants were planted in the garden with at least one individual of each species planted into each of the quadrants. Plants in the NE quadrant have not received irrigation water since 2004 (NE), although the quadrant was flooded by a broken irrigation line in 2010. Each plant in the other three quadrants (low, medium, and high) has received an average irrigation rate of 4, 8 and 12 gallons of water per week, respectively, during the irrigation season (about April 15 through October 15).

In 2012, established plants were trimmed as needed and dead foliage was raked up and deposited in compost piles. Plant labels were cleaned and repaired and a plant inventory was conducted. A new drip irrigation system consisting of 0.700 inch O.D. polyethylene (PE) pipe and point source emitters was installed during June and July. Spaghetti tubing (1/8 inch) was used to deliver water from point source drip emitters installed in the PE pipe to the base of each plant in the irrigated quadrants. A single, pressure compensating emitter provided water to each plant. The 1-gph emitters (Supertif; Drip Store Cat. No. D001) were used in the low (4 gals/week) and medium (8 gals/week) irrigation quadrants while 2-gph emitters (Supertif; Drip Store Cat. No. D002) were used in the high (12 gals/week) irrigation quadrant.

Results and discussion

Drip irrigations were applied weekly between April 13 and October 11, 2012 at rates of 0, 4, 8, and 12 gallons per plant per week (Figure 5). Total volume of irrigation water applied per plant during this time period was 0, 109, 220, and 324 gallons in the no, low, medium, and high irrigation quadrants, respectively (Figure 5). An additional 2.0 inches of precipitation occurred during the same time period

(3.7 inches for the entire year) at the NWS weather station located near the garden site.

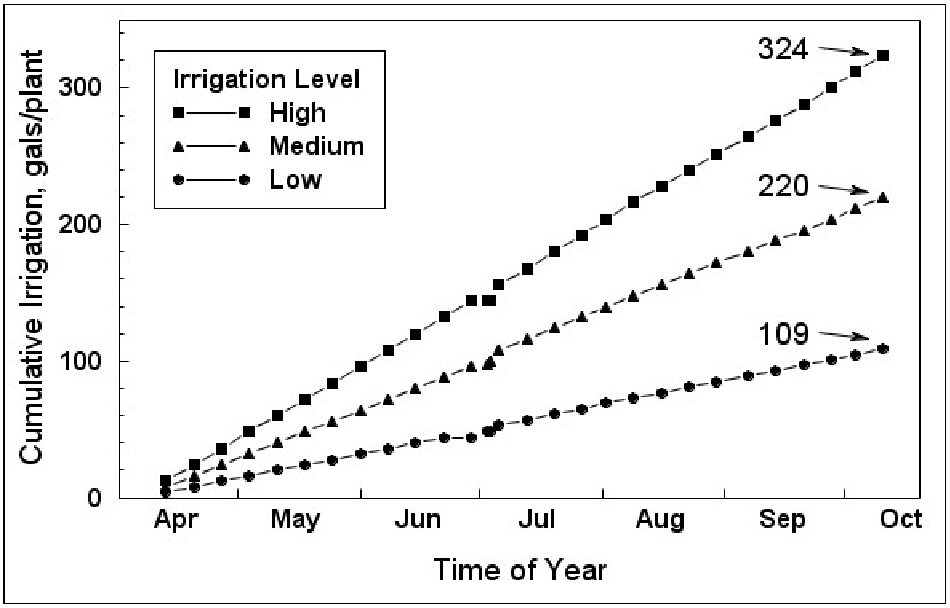

Figure 5. Cumulative irrigation applied to each plant in the drip-irrigated quadrants of the xeriscape demonstration garden. NMSU Agricultural Science Center at Farmington, NM. 2012.

A list of species that were inventoried in the low and medium irrigation plots in 2012, including newly planted species or transplant replacements, is presented in Table 58. Notes are also provided indicating observations, new plantings and whether or not the species has survived in the no irrigation zone, etc.

Of the 126 species planted in the garden since 2003, 108 have survived in at least one quadrant, 70 have survived in both the low and medium irrigation quadrants (Table 58), and 31 have survived and exhibited at least fair quality while surviving on precipitation only.

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. Plant species inventoried in the low (4 gals/week) and medium (8 gals/week) irrigation quadrants in the xeriscape landscape garden in 2012 and list of formerly planted species that were not noted in the garden in 2012 with notes. NMSU Agricultural Science Center at Farmington, NM. 2012.

Species Name	Irrigation Level†		Notes
	Low	Med	
Achillea millefolium (white yarrow)		x	
Achnatherum hymenoides (Indian ricegrass)	x		No I
Agastache foeniculum (blue giant hyssop)	x		
Agastache ruprestris (licorice hyssop)	x	x	
Agave utahensis (Utah agave)	x	x	No I
Amelanchier utahensis (Utah serviceberry)	x	x	No I
Anemopsis californica (yerba mansa)	x	x	
Aquilegia coerulea (blue columbine)		x	Requires shade (new)
Artemisia abrotanum (southernwood)	x	x	Requires med to high I
Artemisia frigida (fringed sagewort)		x	
Artemisia ludoviciana (prairie sagewort)	x	x	
Artemisia nova (black sage)	x	x	
Artemisia tridentata (big sagebrush)	x	x	No I
Asclepias tuberosa (butterfly weed)		x	Only one plant in garden
Berberis fremontii (Fremont barberry)	x	x	No I
Berlandiera lyrata (chocolate flower)	x	x	No I
Brickellia californica (California bricklebush)	x	x	No I
Buddleja davidii (butterfly bush)	x	x	Requires med to high I
Caesalpinia gilliesii (bird of paradise bush)			Probably winterkilled
Callirhoe involucrata (wine cups)	x		Required protection - rabbits
Calylophus berlandieri (Berlandieri sundrops)	x	x	
Campsis radicans (trumpet vine)	x	x	All now in high I
Caragana arborescens (Siberian peashrub)	x	x	No I
Caryopteris clandonensis (blue mist)	x	x	
Centranthus ruber (Jupiter's beard)		x	Requires med to high I
Cerastium tomentosum (snow in summer)	x		Requires partial shade
Cercocarpus ledifolius (curlleaf mtn. mahogany)	x	x	No I
Cercocarpus montanus (true mtn. mahogany)	x		No I
Chamaebatiaria millefolium (fernbush)	x	x	No I
Chilopsis linearis (willow-leaf catalpa)	x	x	No I
Chrysanthemum cinerariaefolium (pyrethrum)		x	One volunteer plant
Chrysothamnus nauseosus (rubber rabbitbrush)	x	x	Requires Low I
Coreopsis lanceolata (lanceleaf coreopsis)	x	xxx	Many volunteers from seed
Cowania mexicana (cliffrose)	x	x	No I
Cylindropuntia imbricata (tree cholla)	x	x	No I

Species Name	Irrigation Level†		Notes
	Low	Med	
Datura metaloides (sacred datura)	x		
Delosperma cooperi (purple iceplant)			Was alive in med. in 2011
Echinacea purpurea (purple coneflower)			Alive in high I only
Eriogonum jamesii (James' buckwheat)	x	x	No I
Euphorbia myrsinites (yellow euphorbia)	x	x	Many volunteers
Fallugia paradoxa (Apache plume)	x	x	No I
Fendlera rupicola (cliff fendlerbush)	x	x	Planted 2009
Forestiera neomexicana (New Mexico olive)	x	x	No I
Gaillardia aristata (blanket flower)	x	x	
Helianthus maximiliani (Maximilian sunflower)	x	x	Requires med to high I
Helichrysum angustifolium (curry plant)	x		
Hesperaloe parviflora (red yucca)	x	x	No I
Hylotelephium telephium (autumn joy sedum)	x	x	Requires Low I
Ipomopsis aggregata (scarlet gilia)		x	
Juniperus scopulorum (Rocky Mountain juniper)	x	x	No I
Kniphofia uvaria (red-hot poker)	x	x	Low quality
Koelreuteria paniculata (goldenrain tree)	x	x	Alive in No I but poor quality
Krascheninnikovia lanata (winterfat)	x	x	
Lavandula sp. (lavender)	x	x	New planting (2012)
Liatris punctata (dotted gayfeather)	x	x	May prefer partial shade
Limonium leptostachyum (statice)	x		Planted in 2009
Linum perenne (perennial blueflax)	x	x	Short lived but reseeds
Lycium pallidum (pale wolfberry)	x	x	Aggressive from rhizomes
Malus sp.(flowering crabapple)	x	x	
Mirabilis multiflora (giant four o'clock)	xx		Short-lived
Nassella tennuissima (threadgrass)		x	Can be aggressive - seed
Nolina microcarpa (beargrass)	x	x	Alive in No I but slow growth
Oenothera missouriensis (Ozark sundrops)	x	?	Requires med to high I
Oenothera organensis (Organ Mtn. eve. primrose)			Alive in No I but no growth
Parthenium incanum (mariola)	x	x	No I
Pascopyrum smithii (western wheatgrass)		x	
Penstemon "abuelitas" (Abuelita penstemon)	xx	x	Short-lived in No I
Penstemon ambiguus (bush penstemon)	x	xxx	No I
Penstemon angustifolia (narrow-leaf beardtongue)	x	x	No I
Penstemon barbatus (scarlet bugler penstemon)	x	xxx	May prefer partial shade
Penstemon eatonii (firecracker penstemon)	x		Only one plant in garden
Penstemon palmeri (Palmer penstemon)	x	x	No I
Penstemon pinifolius (pineleaf penstemon)	xx	x	Requires low I
Penstemon pseudospectabilis (desert penstemon)	?	?	These may be *P. clutei*

Species Name	Irrigation Level†		Notes
	Low	Med	
Penstemon rostriflorus (Bridge penstemon)	x	x	New plantings
Penstemon strictus (Rocky Mountain penstemon)	xxx	xx	Requires low to med I
Penstemon superbus (superb beardtongue)	x	x	New plantings
Peraphyllum ramosissimum (squaw apple)	x		No I but slow growth
Perovskia atriplicifolia (Russian sage)	x	xx	No I but slow growth
Pinus nigra (black pine)	x	x	No I but slow growth
Potentilla fruticosa (native potentilla)	x	x	Requires low to med I
Potentilla thurberii (red cinquefoil)		x	
Prosopis pubescens (screwbean mesquite)	x	x	
Prunus besseyi (western sandcherry)	x	x	Requires low to med I
Prunus domestica ‘Stanley’ (Stanley dwarf prune)	x		
Prunus tomentosa (Nanking cherry)	x	x	New
Psorothamnus scoparius (broom dalea)	x	x	New
Ratibida columnifera (prairie coneflower)			Short-lived (still in High I)
Rhus trilobata (3-leaf sumac)	x	x	No I
Rhus trilobata pilosissima (pubescent squawbush)	x	x	No I
Ribes aureum (golden currant)	x	x	No I but poor quality
Robinia neomexicana (New Mexico locust)	x	x	No I; aggressive - rhizomes
Rosa woodsii (Wood's rose)	x	x	New
Rosmarinus officianalis (upright rosemary)		x	Possible winterkill
Salvia greggii (cherry sage)	x		
Salvia penstemonoides (penstemon sage)		x	
Salvia pinguifolia (rock sage)	x	x	Requires low I
Sedum spurium (dragon’s blood sedum)	x	x	Requires low to med I
Spartium junceum (Spanish broom)			Winterkilled in 2010
Sporobolus wrightii (giant sacaton)	xxx	x	Aggressive - seed
Stachys byzantina (lamb’s ear)		x	Requires med to high I
Syringa vularis (lilac)	x	x	New
Teucrium arogrium (Greek germander)		x	
Verbena macdougalii (western spike verbena)			Probably alive in high I only
Yucca baccata (banana yucca)	x	x	No I
Yucca elata (soaptree yucca)	x	x	No I
Zauschneria californica (hummingbird trumpet)			
Zinnia grandiflora (desert zinnia)	x	x	No I but slow growth
Planted but not noted in garden in 2012			**Notes**
Armeria maritima (seathrift)			Poor survival – year 1
Atriplex confertifolia (shadscale saltbush)			Poor survival – year 1
Chrysanthemum sp. (Crete white)			Short-lived (4-5 years in med)
Delosperma nubigenum (yellow iceplant)			Short-lived
Ephedra viridis (Mormon tea)			Removed – poor quality

Species Name	Irrigation Level[†]		Notes
	Low	Med	
Erysimum (Bowles' mauve) wallflower			Apparent winterkill
Festuca glauca (blue fescue)			Ate by rabbits
Gaura lindheimeri (gaura)			Short-lived
Helianthemum nummularium (sunrose)			Short-lived
Heuchera sanguinea (coral bells)			Short-lived
Lychnis chalcedonica (Maltese cross)			Died after planting
Melampodium leucanthum (blackfoot daisy)			Short-lived
Oenothera caespitosa (tufted eve. primrose)			Short-lived
Oenothera speciosa (Mexican evening primrose)			Short-lived
Salvia greggii var. ‘Navajo Purple’			Died first year – not hardy
Sphaeralcea ambigua (desert globemallow)			Short-lived
Stanleya pinnata (prince’s plume)			Short-lived

[†]The ‘x’ indicates each plant in the respective irrigation quadrant.

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 various water pressures, including those less than specified or recommended by the emitter manufacturer or dealer. In 2011, flow rates and water application uniformities were measured from 20 different point source emitter at heads of 3.5 feet (1.5 psi) and 5.5 feet (2.4 psi). Measured flow rates were 14.8% and 33.6% of specified at these two heads, respectively. Water application uniformity (AU), expressed as 1 – *cv* (where *cv* = standard deviation / mean of measurements was greater than 0.90 for eleven of the twenty emitters. In 2012, flow rate and AU was measured from the same emitters, which were arranged in eight replicates along four separate 80 foot long 0.5 inch laterals (as in 2011), at a pressure of 25 psi. Mean flow rate at 25 psi ranged from 95% to 190% of specified but only three emitters exhibited a flow rate less than specified. The flow rates of 10 of the other 17 were greater than 130% of specified. Only seven emitters exhibited a mean flow rate that deviated from the specified rate by less than 10%. Water AU was greater than 0.90 for 15 of the 20 emitters and two of the 20 exhibited AU less than 0.80.

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. In 2011, the output and application efficiency of various point source drip emitters were evaluated at very low heads (3.5 feet and 5.5 feet) which correspond to pressures of

1.5 and 2.4 psi, respectively. In 2012, the same emitters were evaluated at a pressure of 25 psi for comparison.

Objective

- Measure the water flow rate and evaluate the application uniformity of selected point source drip emitters at 25 psi for comparison with these parameters measured at pressures lower than those specified or recommended by the manufacturers

Materials and methods

This evaluation was conducted in June 2012 to measure the flow rates and water application uniformities (AU) of twenty different models of point source emitters at a lateral inlet pressure of 25 psi. Emitters were inserted into 80 foot long, 0.6 inch ID (nominal ½ inch) polyethylene (PE) drip laterals at a spacing of 24 inches. Eight sets (or replicates) of 5 emitter models were inserted into 4 separate laterals and emitter measurements were taken from each lateral separately. Water was provided to the lateral through a manifold that consisted of a valve, 150 mesh filter, and 25 psi pressure reducer from a high pressure (70-80 psi) irrigation line. Each lateral was hung on a level wire of a sheep fence (2 inch by four inch woven wire) at a height of about 6 inches above ground to facilitate emitter flow rate measurements. Water flow from each emitter on the lateral was caught in a small plastic cup for a timed period. 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 .... (1)

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.

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 evaluations with manufacturer specified flow rates (MSFR) and recommended operating water pressures (MSOP). NMSU Agricultural Science Center at Farmington. NM, 2012.

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	4G	Green Flag NC	4.0	unknown
Orbit 1G	1G	Black Flag NC	1.0	unknown
Orbit 2G	2G	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 25 psi ranged from 0.56 gph from a 0.5 gph, PC, self-cleaning emitter (D079) to 7.15 gph from a 4.0 gph, non PC, flag type emitter (Orbit 4G) (Table 60). These rates were 112.5 and 178.8 % of MSFR, respectively (Table 60). The average FR from all emitters was 139.2 % of MSFR but ranged from 94.9 % (emitter D045) to nearly twice that (emitter D015) of the MSFR (Table 60). Overall, the Katif, PC emitters (D043, D044, and D045) had FR more similar to the MSFR than the other emitters, and measured AU in the 2 gph and 3.3 gph models (D044 and D043, respectively) were greater than 0.91. The D043 emitter exhibited the highest AU of all emitters at 5.5 feet of head during 2011 (Table 60). Other emitters having FR close to MSFR and AU greater than 0.90 at 25 psi were the PC button style emitters (D001, D002, D004, and D006). These emitters also had high AU (>0.90) at the low pressure (2.4 psi) but the measured FR of D001, D002, and D006 were all about 44.5 % of MSFR but the FR of D006 was only 23 % of MSFR (Table 60) at the low head. Self-cleaning, PC emitters (e.g. D079 and D080) had FR similar to MSFR and AU greater than 0.90 at a pressure of 25 psi but did not flow at the low pressure in 2011 (Table 60). These self-cleaning types, as well as anti-drip type emitters, apparently have diaphragms that cut off flow at a minimum threshold pressure.

Table 60. Average flow rates, 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 emitters at a lateral inlet pressure of 25 psi compared to flow rates measured in 2011 at a head of 5.5 feet (2.4 psi). NMSU Agricultural Science Center, Farmington, NM. 2012.

Head	25 psi (2012)			5.5 feet (2011)		
	Flow Rate		Uniformity	Flow Rate		Uniformity
Emitter[b]	(gph)	(% of MSFR)	(1 – *cv*)	(gph)	(% of MSFR)	(1 – *cv*)
D080	1.10	109.6	0.979	-	-	-
D015	1.98	198.0	0.974	0.210	21.0	0.954
D012	1.69	168.6	0.963	0.172	17.2	0.941
D004	3.13	95.0	0.956	0.760	23.0	0.925
D022	3.86	192.9	0.950	0.222	11.1	0.825
D013	3.39	169.4	0.949	0.354	17.7	0.936
D002	2.25	112.3	0.947	0.890	44.5	0.928
D044	2.33	116.4	0.943	1.124	56.2	0.928
D078	5.55	138.7	0.923	2.152	53.8	0.828
D079	0.56	112.5	0.921	-	-	-
Orbit 4G	7.15	178.8	0.918	0.791	19.8	0.957
D043	3.26	98.7	0.913	0.475	14.4	0.956
D001	1.07	106.5	0.909	0.447	44.7	0.946
Orbit 2G	3.33	166.6	0.909	0.435	21.7	0.933
D006	1.07	107.4	0.909	0.442	44.2	0.948
D045	0.95	94.9	0.896	1.018	101.8	0.855
D021	1.80	180.0	0.880	0.075	7.5	0.893
Orbit 1G	1.87	186.8	0.835	0.305	30.5	0.774
D077	2.88	143.9	0.777	0.775	38.8	0.376
D076	1.07	106.8	0.767	0.377	37.7	0.897

[a] Flow rate values represent the mean of eight replications.
[b] Ordered from highest to lowest application uniformity at 25 psi.
- Insufficient data (zero flow from some reps)

For the irrigator that uses both a gravity (i.e. rainwater catchment) and high pressure (i.e. household water tap) system for watering plants when rainwater is exhausted, the ideal emitter is one that has high AU at variable pressure, and a FR at the minimum actual pressure 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. Emitter D004, for example, has an AU of 0.956 and 0.925 and FR of 3.13 and 0.76 gph at high and low pressures, respectively. For optimum growth and yield, 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. 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. If irrigating from a rain barrel at a constant head of 5.5 feet with emitter D004, it would take 1.6 hours to irrigate the chile (1.2 / 0.76) and 3.2 hours (2.4 / 0.76) to irrigate the tomatoes. If high pressure (25 psi) water is used, it would take only 0.38 hours (23 minutes) to water the chile (1.2 / 3.13) and 0.77 hours (46 minutes) to water the tomatoes (2.4 / 3.13). Emitter D015 has very high AU at both high and low pressure (0.974 and 0.954, respectively) but the FR is 1.98 gph, or 198 % of MSFR, at 25 psi and only 0.21 gph, or 21 % of MSFR, at 2.4 psi. At the low pressure FR, it would take 5.7 hours (1.2 / 0.21) and 11.4 hours (2.4 / 0.21) to water the chile and tomatoes, respectively, if irrigating every-other day. If several zones must be watered within the two-day watering cycle, the longer runtimes may prohibit adequate irrigation of the entire garden or field.

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 FR and AU of the selected emitter. This study has identified several emitters that exhibit acceptable AU (> 0.90) along a relatively short lateral (80 feet) at both the MSOP and very low pressure. It has also demonstrated that, irrespective of the operating pressure, actual FR from a given emitter may be quite different from the MSFR. In most cases, measured FR was greater than MSFR at 25 psi and less than MSFR at 2.4 psi (5.5 feet). So, while the baseline data from the results of this study can assist irrigators in selecting appropriate point source drip emitters for their general conditions, for best irrigation management practices, the irrigator should measure the FR and AU of the chosen emitter(s) on site when the system is constructed and operating prior to developing irrigation scheduling programs.

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

Dan Smeal, Joe Ward, and Angi Grubbs

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 have 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 6 and Figure 7). The black pine and bur oak were not included in the study plots but were planted at a spacing of 12 feet in three rows west of the study plots on April 15 and 16.

All 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 opening valves and irrigating for the appropriate runtimes.

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

Where:

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

In late August 2011, water from a broken irrigation line accidentally flooded the east half of the west plot (Figure 6) and west half of the east plot (Figure 7). Subsequently in 2011, and throughout 2012, irrigations were withheld from plants within the flooded sections. In 2012, drip irrigations were applied weekly from April 20 to October 7 in the two sections that had not been flooded. Irrigations were applied uniformly to all (irrigated) plants on April 20 (1 hour) and April 25 (4.8 hours) to check operation of the drip system and perform maintenance and repairs as necessary. Irrigation treatments were initiated on May 2.

Canopy area (CA) and height measurements of all plants were taken in July 2012 to evaluate the effect of irrigation treatment on plant growth. 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. A single factor ANOVA procedure was used to determine drip irrigation treatment effects on CA and height within each species in the two sections that were not flooded with five, single-plant replications. A two factor (drip irrigation level and flood vs. no flood) ANOVA, with 5 single-plant replications, was used to determine if mean CA and mean height were significantly different between the flooded and not flooded sections. Because of some missing data points, the Tukey-Kramer means comparison test was used to separate significantly different means.

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. 2012.

Species (common name)	Species (common name)
Amelanchier spp. (serviceberry)	*Chamaebatiaria millefolium* (fernbush)
Chilopsis linearis (desert willow)	*Fallugia paradoxa* (Apache plume)
Forestiera pubescens (desert olive)	*Pinus nigra* (black pine)
Prunus besseyi (western sandcherry)	*Prunus tomentosa* (Nanking cherry)
Quercus gambelii (gambel oak)	*Quercus macrocarpa* (bur oak)
Rhus trilobata (3-leaf sumac)	*Rosa woodsii* (Woods' rose)
Shepherdia argentea (buffaloberry)	*Syringa vulgaris* (lilac)

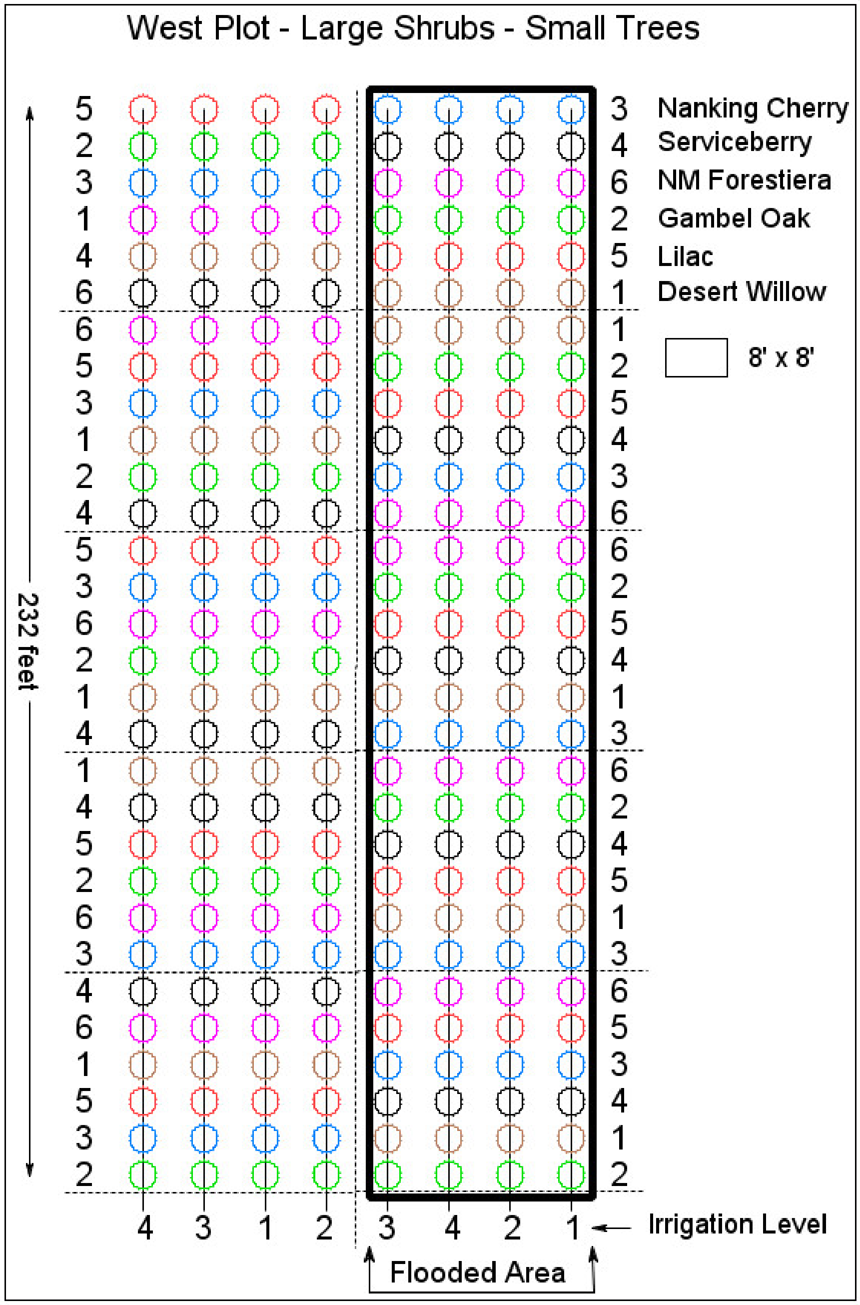

Figure 6. **Diagram of the west plot designed to evaluate effects of drip irrigation level on establishment and growth of large shrubs and small trees for soil stabilization, landscape plantings, etc. NMSU Agricultural Science Center at Farmington, NM. 2012.**

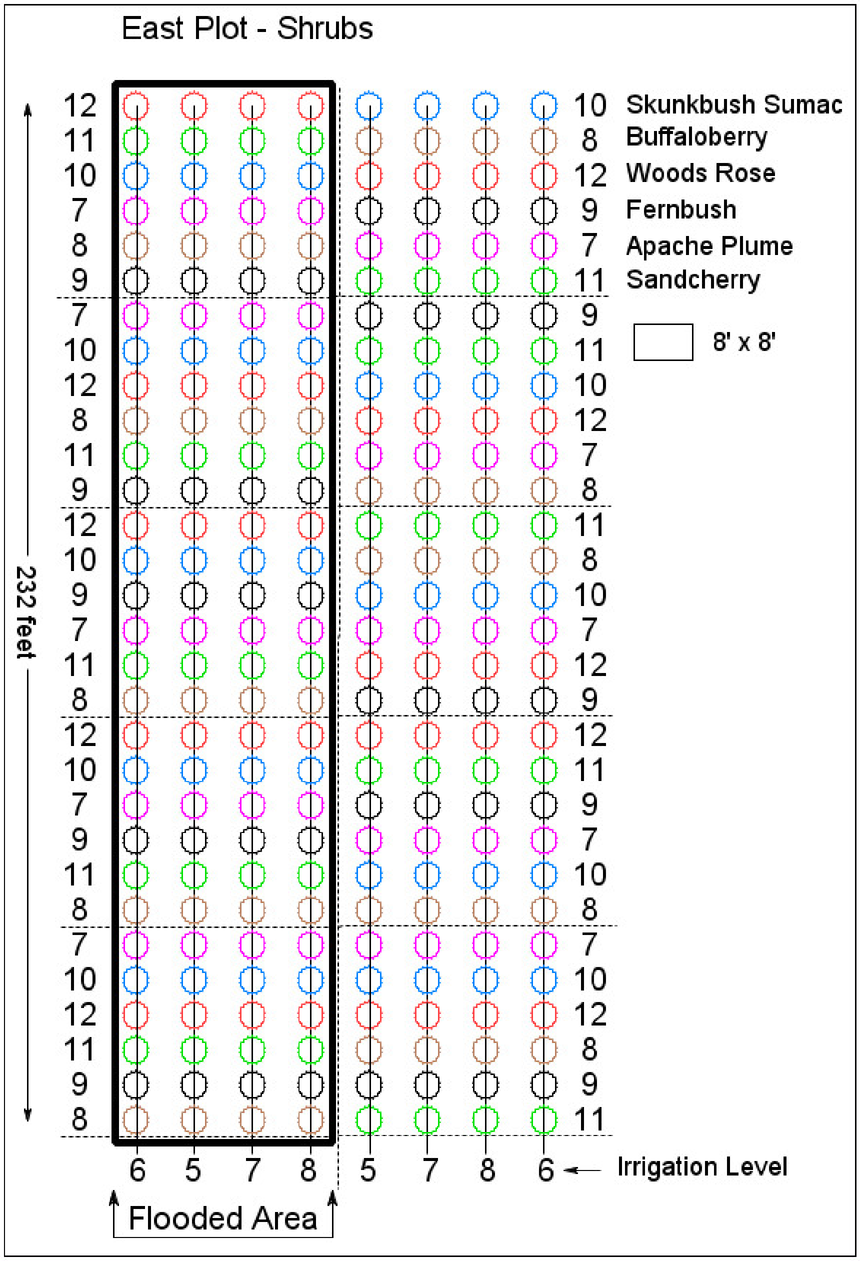

Figure 7. Diagram of the east plot designed to evaluate effects of drip irrigation level on establishment and growth of shrubs for soil stabilization, landscape plantings, etc. NMSU Agricultural Science Center at Farmington, NM. 2012.

Results and discussion

Irrigation (2012)

Starting the last week in May and continuing through the week ending on October 9, weekly irrigations (I) were 0, 2.5, 5.0, and 7.5 gals/plant in the no (1), low (2), medium (3), and high (4) irrigation treatments, respectively (Table 62). Total I applied during the season ranged from zero in the no irrigation plot (and previously flooded plots) to about 175 gals/plant in the high I treatment. An additional 3.7 inches of precipitation occurred during 2012.

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. 2012.

Date	Medium Trees (West Plot)				Shrubs to Small Trees (East Plot)			
	No (1)	Low (2)	Med (3)	High (4)	No (1)	Low (2)	Med (3)	High (4)
	Gallons per Plant							
4/20	0	1.0	1.0	1.0	0	1.0	1.0	1.0
4/25	0	4.8	4.8	4.8	0	3.2	3.2	3.2
5/2	0	2.8	5.1	7.1	0	2.8	5.1	7.1
5/10	0	2.0	4.0	6.0	0	2.0	4.0	6.0
5/17	0	2.3	4.5	6.8	0	2.3	4.5	6.8
5/29	0	2.5	5.0	7.5	0	2.5	5.0	7.5
6/5	0	2.5	5.0	7.5	0	2.5	5.0	7.5
6/12	0	2.5	5.0	7.5	0	2.5	5.0	7.5
6/19	0	2.5	5.0	7.5	0	2.5	5.0	7.5
6/26	0	2.5	5.0	7.5	0	2.5	5.0	7.5
7/3	0	2.5	5.0	7.5	0	2.5	5.0	7.5
7/10	0	2.5	5.0	7.5	0	2.5	5.0	7.5
7/18	0	2.5	5.0	7.5	0	2.5	5.0	7.5
7/25	0	2.5	5.0	7.5	0	2.5	5.0	7.5
8/1	0	2.5	5.0	7.5	0	2.5	5.0	7.5
8/8	0	2.5	5.0	7.5	0	2.5	5.0	7.5
8/15	0	2.5	5.0	7.5	0	2.5	5.0	7.5
8/22	0	2.5	5.0	7.5	0	2.5	5.0	7.5
8/29	0	2.5	5.0	7.5	0	2.5	5.0	7.5
9/4	0	2.5	5.0	7.5	0	2.5	5.0	7.5
9/12	0	2.5	5.0	7.5	0	2.5	5.0	7.5
9/19	0	2.5	5.0	7.5	0	2.5	5.0	7.5
9/26	0	2.5	5.0	7.5	0	2.5	5.0	7.5
10/2	0	2.5	5.0	7.5	0	2.5	5.0	7.5
10/9	0	2.5	5.0	7.5	0	2.5	5.0	7.5
Totals	**0**	**62.9**	**119.4**	**175.7**	**0**	**61.3**	**117.8**	**174.1**

Irrigated only the west side of west plot and east side of east plot due to 2011 flood.

Plant survival (2012)

In the east plot, plant mortality was greatest at 11 of 40 in Apache plume (Table 63) and at 7 of 40 in buffaloberry (Table 64) but it was not related to I level. The trunks of original plantings and replacements of these two species were severed or badly girdled just under the soil surface by cutworms. A single fernbush failed to survive (Table 65) and there was no mortality in sandcherry (Table 66), 3-leaf sumac (Table 67), or Wood's rose (Table 68). In the west plot, five desert willow were evidently killed by cutworms (Table 69) while one specimen each of gambel oak, Nanking cherry, and desert (New Mexico) olive failed to survive (Table 70, Table 72, and Table 73, respectively. Of these, only the death of gambel oak appeared to be related to the lack of water. All lilac and serviceberry plants were alive in August.

Canopy area and height (2012)

The effect of I on plant CA and height varied between species. CA was significantly different between different I levels in only two of the twelve species (western sandcherry and 3-leaf sumac) but a positive linear trend between CA and I was noted in only the flooded sandcherry (Table 66). Plant height was significantly different between I levels in three species (buffaloberry, gambel oak, and desert olive), and in buffaloberry and gambel oak), the shortest mean height was measured in the no irrigation treatment (Table 64 and Table 70, respectively). In the east plot, mean CA and plant height were both significantly greater in the flooded plots than the not-flooded plots in all species, except Apache plume and buffaloberry (Table 63 and Table 64). Buffaloberry CA, but not height was significantly greater in the flooded plots (Table 64). There were no significant differences in either mean CA or mean height between flooded or not-flooded plots in the west plot.

Averaged over all replications, desert olive (also called New Mexico privet or *Forestiera*) exhibited the greatest CA (> 40 ft^2) and the second tallest height (> 5 feet) of all the species (Figure 8 and Figure 9). While a large CA (nearly 40 ft^2) is shown for Wood's rose (Figure 8), it did not provide full cover but included root suckers from the parent plant. The CA of 3-leaf sumac actually had the second greatest full CA of the species at about 38 ft^2 (Figure 8). Desert willow had the tallest mean height (about 5.7 feet) of the 12 species while Apache plume, buffaloberry, and Nanking cherry also had heights greater than 4 feet (Figure 9). Gambel oak and lilac were relatively tall (> 3 feet) but exhibited low CA (10 ft^2 or less).

Table 63. Average canopy area and height of *Fallugia paradoxa* (Apache plume) at four levels of drip irrigation in flooded and non-flooded subplots of shrub/small tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	**No Flood**	**Mean**	**Flood**	**No Flood**	**Mean**
High	18.5 (3)	22.7 (3)	**20.6**	4.39 (3)	4.11 (3)	**4.25**
Medium	22.0	21.0 (4)	**21.5**	4.83	4.52 (4)	**4.68**
Low	31.3 (4)	13.9	**22.6**	5.02 (4)	4.52	**4.77**
No	22.2 (3)	19.3 (2)	**20.8**	4.56 (3)	4.67 (2)	**4.62**
Mean	**23.5**	**19.2**	**21.4**	**4.70**	**4.46**	**4.58**

† Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
ANOVA indicated no significant differences in canopy areas or plant heights between different irrigation levels in neither the flooded or dry (no flood) plots.

Table 64. Average canopy area and height of *Shepherdia argentea* (buffaloberry) at four levels of drip irrigation in flooded and non-flooded subplots of shrub/small tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	**No Flood**	**Mean**	**Flood**	**No Flood**	**Mean**
High	20.4 (4)	14.9 (3)	**17.7**	5.38 (4)	4.50 (3) ab	**4.94**
Medium	20.7 (4)	15.9 (4)	**18.3**	5.54 (4)	4.81 (4) a	**5.18**
Low	24.0 (4)	9.6 (4)	**16.8**	5.50 (4)	4.08 (4) ab	**4.79**
No	11.6	10.4	**11.0**	3.94	3.75 b	**3.85**
Mean	**19.2 a**	**12.7 b**	**15.6 ***	**5.09**	**4.29 ***	**4.69**

† Values represent the average of 5 replications unless otherwise noted by number in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 65. Average canopy area and height of *Chamaebatiaria millefolium* (fernbush) at four levels of drip irrigation in flooded and non-flooded subplots of shrub/small tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	28.5	19.3	**23.9**	4.61	3.78	**4.20**
Medium	31.2	20.5	**25.9**	4.25	3.72	**3.99**
Low	25.4	11.5	**18.5**	4.10	3.40	**3.75**
No	30.8	23.2 (4)	**27.0**	4.17	4.04 (4)	**4.11**
Mean	**29.0 a**	**18.6 b**	**23.8 *** **	**4.28 a**	**3.74 b**	**4.01 *** **

† Values represent the average of 5 replications unless otherwise noted by number in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 66. Average canopy area and height of *Prunus besseyi* (western sandcherry) at four levels of drip irrigation in flooded and non-flooded subplots of shrub/small tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	39.6 a	28.8 a	**34.2**	3.30	2.87	**3.09**
Medium	35.8 ab	22.1 ab	**29.0**	3.40	2.78	**3.09**
Low	32.3 ab	17.7 b	**25.0**	3.48	2.62	**3.05**
No	24.8 b	24.6 ab	**24.7**	2.92	2.98	**2.95**
Mean	**33.1 a ***	**23.3 b ***	**28.2 *** **	**3.28 a**	**2.81 b**	**3.04 ** **

† Values represent the average of 5 replications unless otherwise noted by number in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 67. Average canopy area and height of *Rhus trilobata* (3-leaf sumac) at four levels of drip irrigation in flooded and non-flooded subplots of shrub/small tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	39.6	32.9 ab	**36.3**	3.65	3.18	**3.42**
Medium	40.0	41.0 a	**40.5**	3.65	3.24	**3.45**
Low	45.8	18.3 b	**32.1**	4.15	2.80	**3.48**
No	42.4	35.8 a	**39.1**	3.65	3.65	**3.65**
Mean	**42.0 a**	**32.0 b ****	**37.0 ****	**3.78 a**	**3.22 b**	**3.50 ****

† Values represent the average of 5 replications unless otherwise noted by number in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 68. Average canopy area and height of *Rosa woodsii* (Wood's rose) at four levels of drip irrigation in flooded and non-flooded subplots of shrub/small tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	49.7	40.9	**45.3**	4.05	4.10	**4.08**
Medium	49.1	33.1	**41.1**	4.33	3.78	**4.06**
Low	47.9	23.1	**35.5**	4.48	3.04	**3.76**
No	35.5	29.2	**32.4**	4.23	3.65	**3.94**
Mean	**45.6 a**	**31.6 b**	**38.6 ****	**4.27 a**	**3.64 b**	**3.96 ***

† Values represent the average of 5 replications unless otherwise noted by number in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 69. Average canopy area and height of *Chilopsis linearis (desert willow)* at four levels of drip irrigation in flooded and non-flooded subplots of medium tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	31.1	30.4	**30.8**	5.62	5.38	**5.50**
Medium	29.6	28.5 (4)	**29.1**	5.63	5.71 (4)	**5.67**
Low	27.0	35.0 (4)	**31.0**	5.07	6.13 (4)	**5.60**
No	17.5 (3)	26.6 (4)	**22.1**	5.39 (3)	5.94 (4)	**5.67**
Mean	**26.3**	**30.1**	**28.2**	**5.43**	**5.79**	**5.61**

† Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
ANOVA indicated no significant differences in canopy areas or plant heights between different irrigation levels in neither the flooded or dry (no flood) plots.

Table 70. Average canopy area and height of *Quercus gambelii* (Gambel oak) at four levels of drip irrigation in flooded and non-flooded subplots of medium tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	8.24	5.14	**6.69**	3.95	3.13 ab	**3.54**
Medium	6.24	6.56	**6.40**	3.83	4.32 a	**4.08**
Low	6.62	4.60	**5.61**	3.82	3.05 ab	**3.44**
No	2.73 (4)	4.32	**3.53**	2.46 (4)	2.48 b	**2.47**
Mean	**5.96**	**5.16**	**5.56**	**3.52**	**3.25 ***	**3.38**

† Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 71. Average canopy area and height of *Syringa vulgaris* (Lilac) at four levels of drip irrigation in flooded and non-flooded subplots of medium tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	9.8	8.7	**9.3**	2.98	3.15	**3.07**
Medium	11.1	12.6	**11.9**	3.54	3.43	**3.49**
Low	8.2	13.1	**10.7**	3.00	4.03	**3.52**
No	7.0	7.9	**7.5**	3.12	3.00	**3.06**
Mean	**9.0**	**10.6**	**9.8**	**3.16**	**3.40**	**3.28**

† Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
ANOVA indicated no significant differences in canopy areas or plant heights between different irrigation levels in neither the flooded or dry (no flood) plots.

Table 72. Average canopy area and height of *Prunus tomentosa* (Nanking cherry) at four levels of drip irrigation in flooded and non-flooded subplots of medium tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	23.4	20.2	**21.8**	4.37	3.86	**4.12**
Medium	21.9	20.8	**21.4**	4.35	4.28	**4.32**
Low	19.6	20.5 (4)	**20.1**	4.53	4.73 (4)	**4.63**
No	17.1	17.7	**17.4**	4.30	4.00	**4.15**
Mean	**20.5**	**19.8**	**20.2**	**4.39**	**4.22**	**4.30**

† Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
ANOVA indicated no significant differences in canopy areas or plant heights between different irrigation levels in neither the flooded or dry (no flood) plots.

Table 73. Average canopy area and height of *Forestiera pubescens* (desert olive) at four levels of drip irrigation in flooded and non-flooded subplots of medium tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	45.0	43.8	**44.4**	6.26 a	5.93	**6.10**
Medium	50.0	41.4 (4)	**45.7**	5.10 b	5.56 (4)	**5.33**
Low	38.4	47.3	**42.9**	5.87 ab	5.20	**5.54**
No	37.7	32.1	**34.9**	5.60 ab	4.92	**5.26**
Mean	**42.8**	**41.2**	**42.0**	**5.71 ***	**5.40**	**5.56**

[†] Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
Means followed by the same letter in a column (irrigation level) or row (flood vs. no flood) are not significantly different from each other (5 % level) based on ANOVA and the Tukey-Kramer mean separation test. The absence of letters indicates no significant difference between means in a column or row.

Table 74. Average canopy area and height of *Amelanchier spp.* (serviceberry) at four levels of drip irrigation in flooded and non-flooded subplots of medium tree study plot. NMSU Agricultural Science Center at Farmington, NM. 2012.

Irrigation (gal/plant)	Canopy Area (ft^2)			Height (ft)		
	Flood	No Flood	Mean	Flood	No Flood	Mean
High	14.8	10.2	**12.5**	2.88	2.40	**2.64**
Medium	9.8	11.7	**10.8**	2.83	2.45	**2.64**
Low	14.1	14.6	**14.4**	2.52	2.65	**2.59**
No	10.7	11.3	**11.0**	2.28	2.57	**2.43**
Mean	**12.4**	**12.0**	**12.2**	**2.63**	**2.52**	**2.57**

[†] Values represent the average of 5 replications unless otherwise noted by numbers in parentheses.
ANOVA indicated no significant differences in canopy areas or plant heights between different irrigation levels in neither the flooded or dry (no flood) plots.

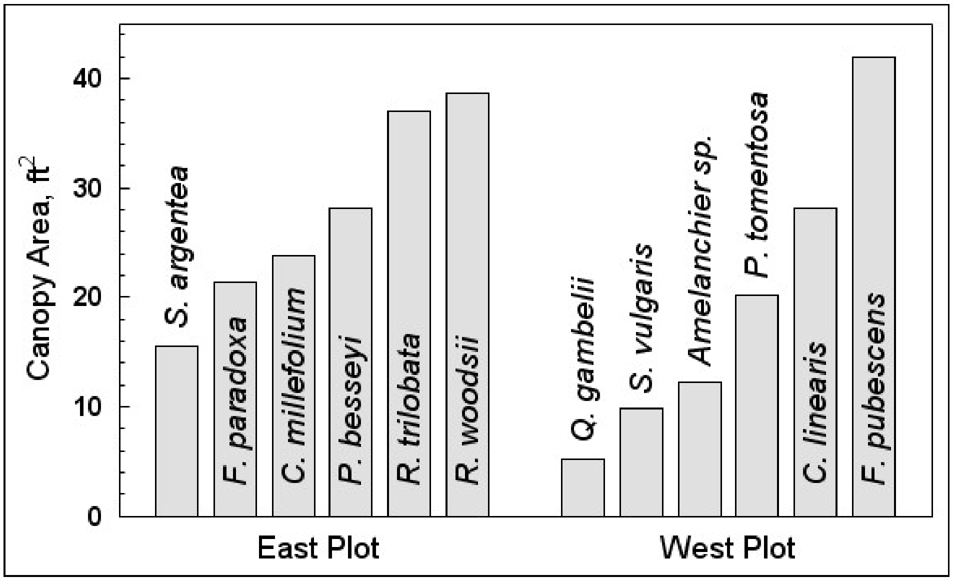

Figure 8. **Average canopy area of twelve xeric-adapted plant species included in the study to evaluate establishment and growth at various drip irrigation levels. Unless otherwise indicated in the plant survival discussion, each average represents the mean measurements from 40 plants among all irrigation levels. NMSU Agricultural Science Center at Farmington, NM. 2012.**

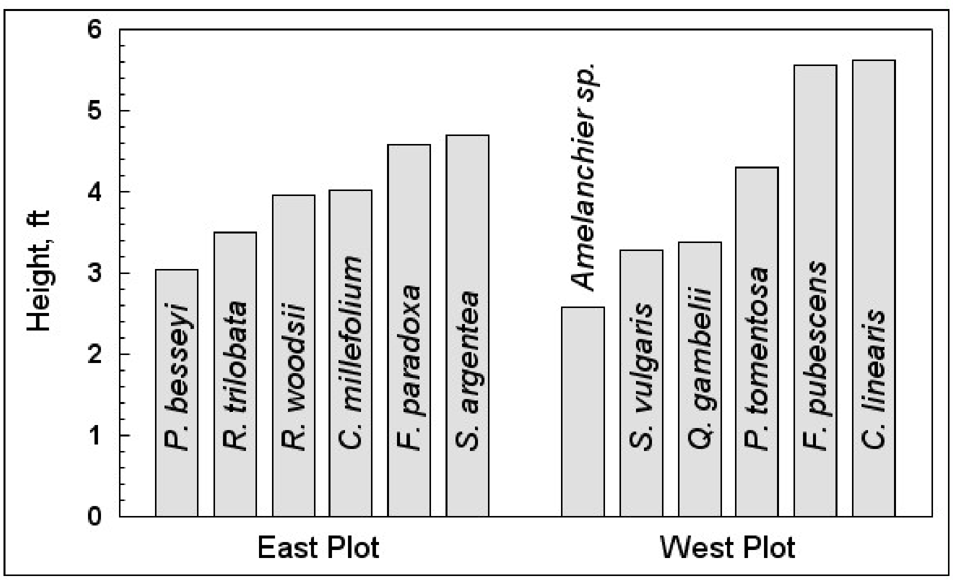

Figure 9. **Average height of twelve xeric-adapted plant species included in the study to evaluate establishment and growth at various drip irrigation levels. Unless otherwise indicated in the plant survival discussion, each average represents the mean measurements from 40 plants among all irrigation levels. NMSU Agricultural Science Center at Farmington, NM. 2012.**

Conclusions

The results of this research study to date indicate that several (mostly native) plant species can be established in disturbed, wind-blown soils after one season of weekly irrigations using a drip irrigation system. Additional drip irrigations in subsequent years of the study had limited effect on plant survival or growth in most of the species. These results, coupled with the results from the previous section of this report on performance of drip emitters at low pressure, could be married in designing tank irrigation systems for establishing plantings for soil stabilization at remote sites.

New Mexico Plants for Pollinators Project

Tessa Grasswitz, Dan Smeal, Dave Dreesen, Keith White, Alex Taylor, Margaret West, and 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.

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. A list of the species planted in 2011 can be found in Table 69 of the 2011 Annual Progress Report. http://aces.nmsu.edu/aes/farm/documents/NMSU%20AnnRpt%202011.pdf

In 2012, the plants were irrigated for 3 hours, twice weekly from mid-April through mid-October. About six individuals of 24 new species (Table 75) were planted on June 26, 2012 in spots left vacant by annuals planted in 2011. Insect collections were made Dr. Grasswitz monthly during the growing season.

Table 75. New species planted in the pollinator study plot on June 26, 2012. NMSU Agricultural Science Center at Farmington, NM. 2012.

Species Name	Common Name	Perennial (P), Biennial (B) or Annual (A)
Carum carvi	caraway	B
Malva moschata	musk mallow	P
Coreopsis gigantea	giant coreopsis	P
Hyssopus officinalis	hyssop	P
Agastache breviflora	Trans-Pecos giant hyssop	P
Tagetes lemmonii	Lemmon's marigold	P
Nepeta racemosa	raceme catnip	P
Echinops ritro ssp. ruthenicus	southern globethistle	P
Levisticum officinale	garden lovage	P
Chamaemelum nobile	Roman chamomile	P
Prunella vulgaris	common selfheal	P
Enceliopsis covillei	Panamint daisy	P
Rumex scutatus	French sorrel	P
Petroselinum crispum var. *tuberosum*	Hamburg turnip-rooted parsley	B
Calamintha nepeta	lesser calamint	P
Achillea millefolium var. *occidentalis*	western yarrow	P
Perovskia atriplicifolia	Russian sage	P
Tecoma stans	yellow trumpetbush	P
Penstemon strictus	Rocky Mountain penstemon	P
Penstemon palmeri	Palmer's penstemon	P
Xylorhiza venusta	charming woodyaster	P
Dalea ornata (Majestic)	Blue Mountain prairie clover	P
Lathyrus eucosmus	bush vetchling	P
Cuminum cyminum	cumin	A
Dalea ornata (Spectrum)	Blue Mountain prairie clover	P

Results and discussion

An impressive diversity of native bees, predatory wasps and other beneficial insects were noted and collected during 2012. The collections, which include specimens of taxa that have not been found at the other research sites, have not been fully processed. A list, once compiled, will be available in a future annual progress report.

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

Intermountain High Elevation Wine Grape Variety Trial: Lessons from Northwest New Mexico

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

Kevin A. Lombard[1], Bernd Maier[2], Jason Franklin Thomas[1], Aiessa Wages[1], Mick O'Neill[1], Sam Allen[1], and Rob Heyduck[3]

[1]Kevin Lombard (PI), Assistant Professor, New Mexico State University, Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499, 505-960-7757, klombard@nmsu.edu

Corresponding author

[2]Bernd Maier (Co-I), Extension Viticulture Specialist, New Mexico State University Cooperative Extension Service Viticulture Specialist, P.O. Box 30003 MSC 3AE, Las Cruces, NM 88003, 575-646-5943, bemaier@nmsu.edu

[1]Jason Franklin Thomas (Co-I), Research Assistant, New Mexico State University, Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499, 505-960-7757, fjt@nmsu.edu

[1]Aiessa Wages, Research Assistant (Co-I), New Mexico State University, Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499, 505-960-7757, horsecrazy021707@yahoo.com

[1]Mick O'Neill (Co-I), Professor, New Mexico State University, Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499, 505-960-7757, moneill@nmsu.edu

[1]Samuel Allen (Co-I), Senior Research Specialist, New Mexico State University, Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499, 505-960-7757, samallen@nmsu.edu

[3]Rob Heyduck (Co-I), Senior Research Specialist, John T. Harrington Forestry Research Center, New Mexico State University, PO Box 359 Mora, N.M. 87732, Phone: 575-387-2319, Fax: 575-387-9012 rheyduck@nmsu.edu

Submitted to HortTechnology

Abstract

Commercial grape production in Northwest New Mexico is now supported by two wineries. The challenges of growing grapes in the San Juan Basin are cold winter temperatures, killing spring frosts due primarily to an elevation >1,700 m, and elevated pH soils which induce micronutrient deficiencies. Nineteen wine grape cultivars were planted in 2007 on their own roots and evaluated for 5 years. Among red wine grape cultivars, Baco Noir, Kozma and Leon Millot yielded in all years of evaluations. Malbec and Sangiovese failed in all years and were removed from the trial along with Agria. Among the white wine varietals, Chardonel, Seyval Blanc, Siegfried, Traminette, Valvin Muscat, and Vidal Blanc had greater than 71% of their vines yield grapes in 2011. Viognier, Muller-Thurgau, and Sauvignon Blanc did not perform in all years of the trial. This trial was replicated in part from other statewide trials located at lower elevations. Many *Vits vinifera* entries yielding in those locations did not do well in Farmington mainly because of winter kill and spring frosts. French-American and North American hybrid grapevines and *V. vinifera* cultivars from Northern Europe appear to have greater adaptability to high elevation intermountain sites. Once established, sugar to acid appears well balanced and shows the region has potential to produce favorable wines. Wise cultivar selection combined with sites avoiding frost pockets cannot be over emphasized and growers should be aware that each high elevation microclimate presents unique challenges which should be researched prior to the establishment of new vineyards.

Keywords: grapevine, hybrid, *Vitis vinifera*, freeze damage

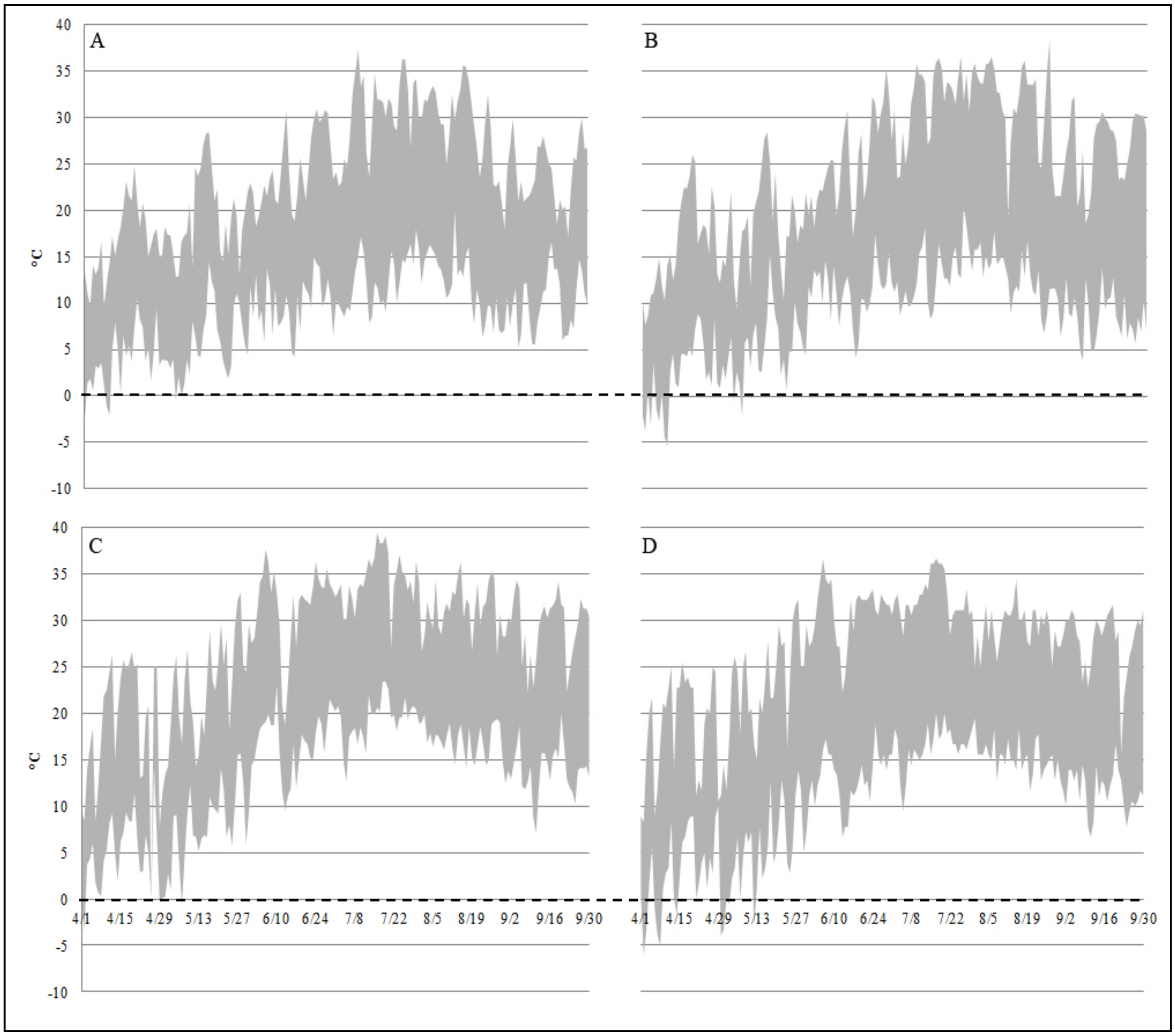

Figure 10. 2010 minimum and maximum temperatures at four Intermountain locations: Prosser Washington Irrigated Agricultural Experiment Station WSU HQ weather station Lat: 46.3 Lng: 119.7 Elevation: 265 m (A), University of Idaho AgriMet Parma, Idaho AgriMet Weather Station (PMAI) Lat: 43.8 N Lng: 116.93333 W Elevation: 703m (B), Colorado State University Orchard Mesa Experiment Station CoAgMet Weather station ORM01 Lat: 39.042 Lng: 108.46 Elev 1,402 m (C), NMSU-ASC Farmington National Weather Service weather station Lat: 36°41'20.95"N Lng: 108°18'45.56" W, Elev 1,720 m (D). NMSU Agricultural Science Center at Farmington, NM. 2012.

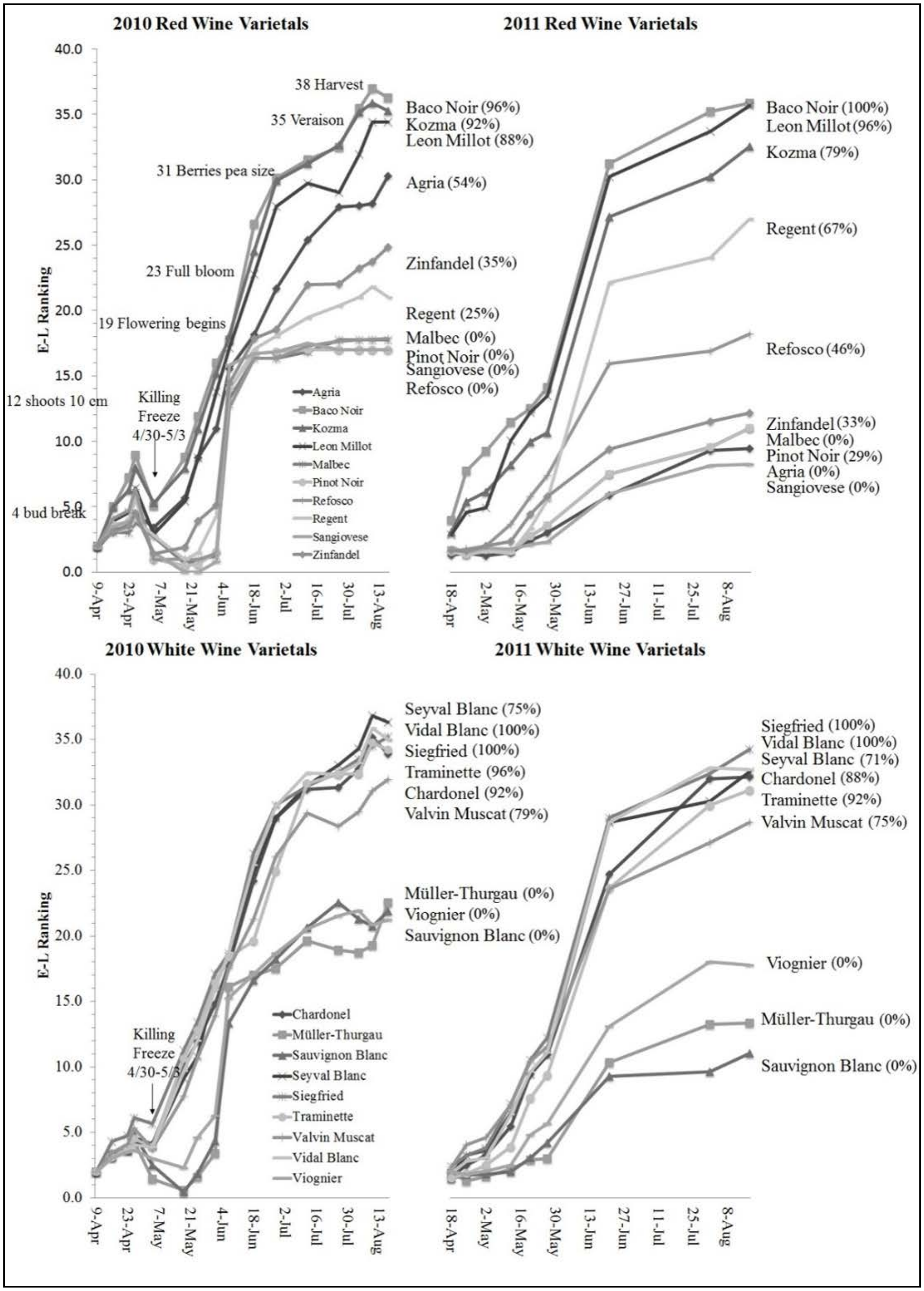

Figure 11. Modified Eichorn and Lorenz (E-L) (Coombe, 1995) evaluations and vines harvested (%) for 19 red and wine grapes grown at the NMSU-ASC Farmington. Years 2010 and 2011 illustrated. Reference: Coombe, B.G., 1995. Adoption of a system for identifying grapevine growth stages. Australian Journal of Grape and Wine 1:104-110. NMSU Agricultural Science Center at Farmington, NM. 2012.

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.

Results and discussion

Hops data collection and analyses are ongoing at the time of publication for this 2012 Annual Progress Report.

Healthy Gardens/Healthy Lives: Navajo Perceptions of Growing Food Locally to Prevent Diabetes and Cancer

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 A. Lombard[1], Shirley A.A. Beresford[2], India Ornelas[3], Carmelita Topaha[4], Tonia Becenti[4], Dustin Thomas[4], and Jaime G. Vela[5]

[1]Assistant Professor of Horticulture, New Mexico State University Agricultural Science Center at Farmington, Department of Plant and Environmental Sciences, P.O. Box 1018, Farmington, NM 87499-1018; Tel: 505-960-7757; Fax: 505-960-5246; Email: klombard@nmsu.edu. Corresponding author.

[2] Professor of Epidemiology, Department of Epidemiology, University of Washington School of Public Health, Box 357236, University of Washington, Seattle, WA 98195-7236; Tel: 206-667-4793 / 206-543-9512; Email: beresfrd@u.washington.edu

[3]Assistant Professor of Health Services, University of Washington School of Public Health, Box 359455, University of Washington, Seattle, WA 98195; Tel: 206-685-8887; Email: iornelas@u.washington.edu

[4]Student, San Juan College/New Mexico State University Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499-1018, Tel: 505-960-7757

[5]PhD candidate, Doctor of Economic Development, New Mexico State University, Las Cruces, NM.

Submitted to Health Promotion Practice

Abstract

Poor access to nutritious foods, departure from traditional diets, and reduced physical activity are associated with a rise in type-2 diabetes and certain types of cancers among the Navajo. Diabetes, in particular, is of concern because of its increased prevalence among Navajo youth. Gardening can successfully address issues of poor availability of fruits and vegetables and offer many other social and health benefits. Our assessment aimed to determine Navajo attitudes about gardening and health in San Juan County, New Mexico. We conducted seven focus groups (including 31 people) to assess knowledge and attitudes related to gardening, and uncover barriers and facilitators to participation in a garden project. Each group session was moderated by two Navajo students. Transcripts revealed that many Navajo are aware of adverse health issues, predominantly obesity and diabetes, which occur on the reservation. Participants expressed a preference for educational approaches that incorporated cultural traditions, respect for elders, use of visual aids and experiential learning. Several social and agronomic barriers to gardening were

also mentioned. Results suggested a broad interest in promoting gardening especially to reduce the risk of diabetes with the added value of enhancing social capital in Navajo communities.

Keywords: Gardening, Native American health perceptions, community needs assessment, fruit and vegetable consumption, traditional learning styles

Table 76. Gardening and Health Themed Focus Group Questions. NMSU Agricultural Science Center at Farmington, NM. 2012.

Questions 1-6	Questions 7-13
1. Is gardening important to you?	7. *What kind of gardens might work? School gardens? Senior Citizen Center gardens? Other ideas?*
2. How do you think that your health could be improved by tending a garden?	8. *Would you participate in a gardening class, canning class, or gardening 101? How might this help? In your home community, what are your major health concerns?*
3. How do you think that your economic and food security could be improved by tending a garden?	9. *What do you know about diabetes?*
4. What kinds of information have you received about gardening?	10. *Is cancer a health concern?*
5. What problems or barriers do you encounter for farming/gardening in your community?	11. *Does your chapter talk about diabetes at their meetings?*
6. *Where might a garden be placed in your community; are community or individual gardens preferred?*	12. *Does your chapter talk about cancer at their meetings?*
	13. *Can you think of ways we can reduce diabetes among the Navajo people?*

Table 77. Barriers and strategies to gardening and food preservation on the Navajo Nation as perceived by focus group participants. NMSU Agricultural Science Center at Farmington, NM. 2012.

Issues	Barriers	Strategies
Diabetes is high – in adults and now in children.	▪ Lack of education.	▪ Educate children and adults. ▪ Emphasize health benefits of gardening recognized as increased physical activity.
Foods are unhealthy.	▪ Cheaper to buy unhealthy junk foods.	▪ Growing your own fruits and vegetables is cheaper than purchasing.
Unfamiliar fruits and vegetables viewed as “white man’s food”.	▪ Lack of education.	▪ Emphasize traditional culinary herbs, fruits and vegetables and familiar foods that are healthy.
Loss of traditional knowledge.	▪ I never learned from my grandparents. ▪ Drifting away from traditional practices.	▪ Emphasize elders as a source of information and knowledge transfer. ▪ Emphasize Navajo tradition-based learning. ▪ Record/document elders and their stories.
Sedentary lifestyle.	▪ Kids watching too much TV and staying inactive.	▪ Emphasize parents as role models. ▪ Utilize multimedia in a positive way.
How do I go about gardening?	▪ Lack of information. ▪ Lack of tools.	▪ Emphasize hands-on, visually based demonstration plots and workshops – the starting point to gardening practices. ▪ Emphasize gardening/canning classes for kids. ▪ Use multimedia. “Navajo Martha Stewart”; magazines and printed media. ▪ Expand technical assistance to rural and underserved areas.
Where can I find space to garden?	▪ Lack of access to land. ▪ Live in an apartment complex in the city. ▪ Land lease agreements.	▪ Promote small patio gardens around house. ▪ Promote community gardens. ▪ Educate manager or owner of housing units to allow gardens on leased property.
Where can I find time to garden?	▪ Busy schedules prevent time to spend out of doors.	▪ Encourage family time on out of door activities instead of indoor activities.
Water.	▪ Lack of access to affordable and high quality water. ▪ Lack of water rights.	▪ Increase universal access to water. ▪ Promote water conservation. ▪ Promote rain catchment.
Soil quality is poor.	▪ Wind, sandy soil.	▪ Emphasize technical assistance.
Desire to avoid disputes.	▪ Disputes over water (e.g., access to irrigation canals). ▪ Theft of garden produce in communal spaces.	▪ Individual gardens around one’s home viewed as convenient and a way to avoid disputes. ▪ Communicate with one another. Community garden viewed as a way to foster greater communication, have other people around to assist when things got “busy”.

Southwest Plant Selector: A Mobile Application for iPhone and iPad

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

Submitted to HortTechnology

Abstract

To augment existing outreach resources and fill a critical need for information on desert-adapted landscape plants, we used the New Mexico State Engineer's Office (NMOSE) online database of New Mexico landscape plants to create a mobile plant selector application (app) for Apple iPhone™ and iPad™. The NMOSE database was reformatted to suit Apple's app format. User tests results and analysis of the use of the app suggest that the app is useful to New Mexico residents. Southwest Plant Selector was released on iTunes™ on 29 June 2012. Even with the specific user base of New Mexico residents who own Apple mobile devices and a focus on low-water landscape options, the app was downloaded 1145 times in the first two months after release. Furthermore, the app received 4- and 5-star ratings and positive reviews during that period. Southwest Plant Selector leverages mobile application technologies for education and outreach to provide New Mexicans with a much needed resource.

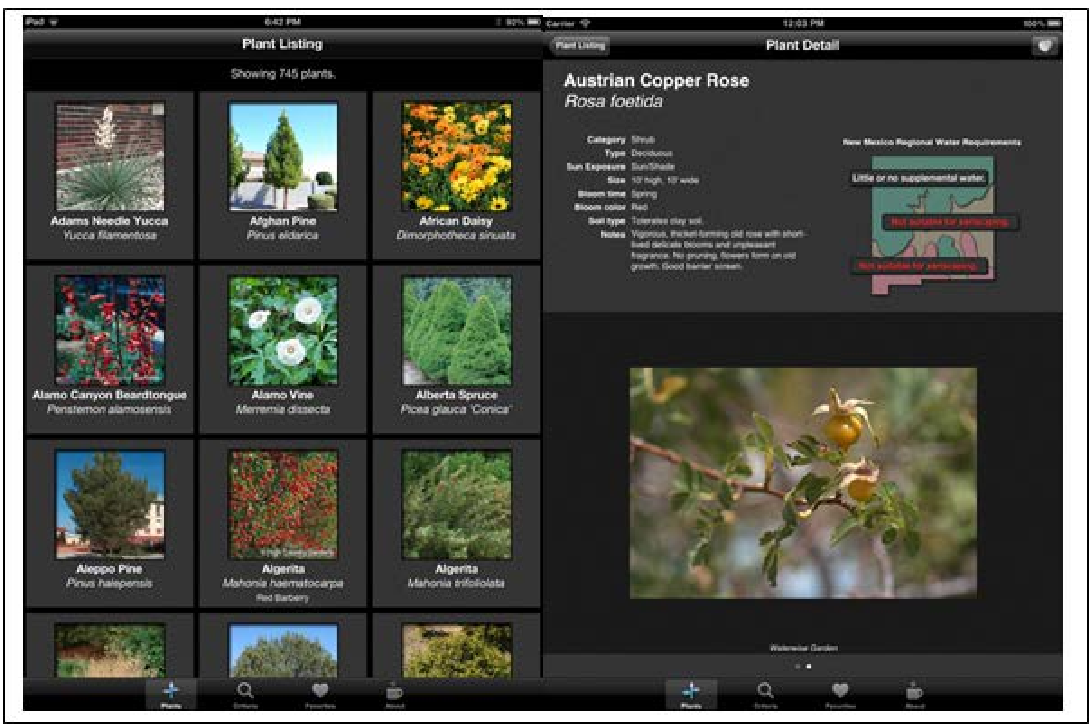

Figure 12. Screen capture all plants (left panel), and plant detail (right panel) displayed on the iPad. NMSU Agricultural Science Center at Farmington, NM. 2012.

Figure 13. Screen capture all plants (left panel), and plant detail (right panel) displayed on the iPhone. NMSU Agricultural Science Center at Farmington, NM. 2012.

Risk Management Education in Southwest Medicinal Herb Production and Marketing in New Mexico: Assessing Grower and Potential Grower Outcomes After a Two-day Workshop

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

Kevin Lombard[1], Charles Martin[2] and Jackie Greenfield[3]

[1]Assistant Professor of Horticulture, New Mexico State University Agricultural Science Center at Farmington, P.O. Box 1018, Farmington, NM 87499. Phone: 505-960-7757, E-mail: klombard@nmsu.edu

Corresponding author

[2]College Professor, New Mexico State University Sustainable Agriculture Science Center at Alcalde, PO Box 159 Alcalde, NM 87511, Phone: 505-852-4241, E-mail: cmartin@nmsu.edu

[3]VP Global Sourcing and Sustainability, Gaia Herbs, Inc, 101 Gaia Herbs Drive, Brevard, NC 28712, Phone: 828-883-5902, Email: jtg@gaiaherbs.com

Submitted to Journal of Herbs, Spices and Medicinal Plants

Abstract

We conducted a risk management educational program with the aim of helping small-scale, limited-resource, and socially-disadvantaged farmers manage risks associated with collecting, producing, and marketing native medicinal herbs of the US Southwest (SWH). Topics included 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; understanding unique risks associated with quality control and marketing SWH; and financial planning. Participants were re-contacted six months later to assess follow-through. Only five participants began the process of applying risk management principles to their growing operation. Respondents still indicated that the workshop series improved their interest and understanding of managing risks associated with growing SWH, but the study highlights the differences between 1) existing specialty crop growers who are able to transition to producing SWH and 2) individuals or groups only curious about SWH but not likely to grow these crops on any commercial scale. These results have implications for technical assistance delivery and how best to utilize resources to meet the needs of both these groups.

KEYWORDS: Medicinal herbs, business planning, small-scale herb producers, educational programming

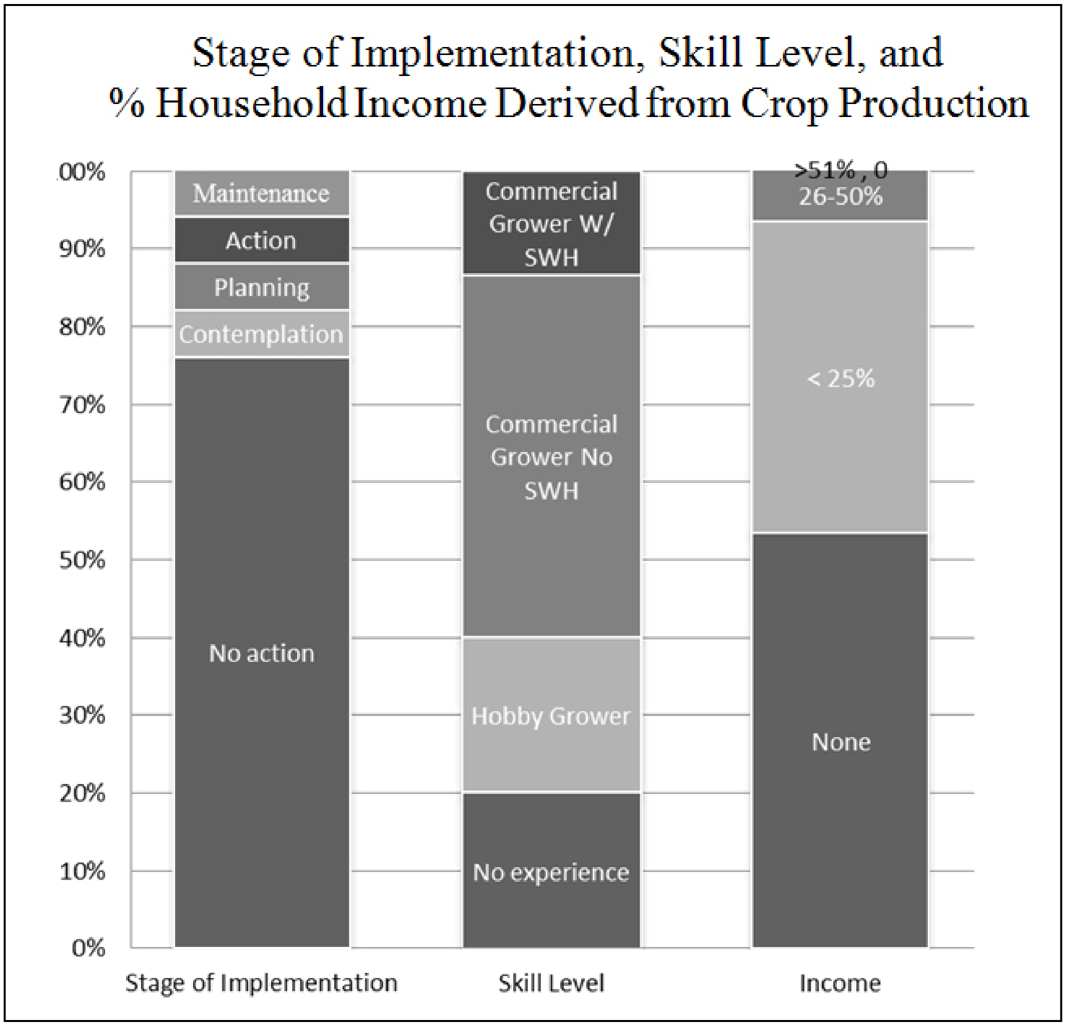

Figure 14. 1) Stages of implementation of developing a risk management plan, 2) skill level, and 3) percent of household income derived from growing any specialty crop, including SWH, for all respondents participating in a 6 month post-workshop follow-up survey. Note for stages of implementation: contemplation=thinking of implementing a risk management plan; planning=conducting marketing and production research; action=implementing the risk management plan; Maintenance=already engaged in business operation and maintaining the business using risk management principles. NMSU Agricultural Science Center at Farmington, NM. 2012.

Table 78. Qualitative themes of barriers and strategies to marketing, producing or wildcrafting southwestern medicinal herbs as perceived by all Risk Management attendees who participated in a six month post-workshop follow-up survey on SWH. NMSU Agricultural Science Center at Farmington, NM. 2012.

Issues	Perceived Barriers	Strategies
Marketing	▪ Lack of information.	▪ Increase access to market risk information. ▪ Encourage careful market analysis. ▪ Fact sheets on species helped participants to decide on which species to plant. ▪ Have other growers discuss their own personal experiences.
	▪ Lack of contracts.	▪ Encourage cooperatives. ▪ Provide detailed information about formation of cooperatives/grower networks.
	▪ Lack of support for local/regional markets.	▪ Conduct Risk Management Plan. ▪ Work with like-minded individuals.
	▪ What do I grow?	▪ Evaluate market, evaluate soil and climate, conduct risk management plan. Encourage use of online tutorial.
	▪ Not able to attend entire formal workshop because of time constraints.	▪ Encourage use of on-line tutorial http://aces.nmsu.edu/southwestherbs/ ▪ Make information on DVD's more widely accessible.
Production	▪ Business plan information in a hard to understand form.	▪ Simplify delivery. ▪ More basic business planning information. ▪ Workshop delivery to non-hobby growers.
	▪ Lack of information	▪ Have other growers discuss their own personal experiences.
	▪ Scaling an operation (e.g. too small).	▪ Encourage cooperatives between peer growers. ▪ Grow for local markets to meet small-scale demand and appropriate scale. ▪ Encourage the development of a business plan before investing in capital improvements and scaling up operations like irrigation improvement.
	▪ Lack of capital.	▪ Share equipment. ▪ Encourage serious growers to pursue producer support grants (e.g. through Western Center for Risk Management or Western Sustainable Agriculture Research Program, NRCS Environmental Quality Incentives Program (EQIP) and partner with Land-grant Cooperative extension and Research in grant writing.
	▪ Lack of time.	▪ Pursue other non-SWH herb crops that require less time commitment.
	▪ 3-5 years before return on investment for perennial herbs.	▪ Encourage crop diversity on the farm landscape to include annuals and perennials.
	▪ Lack of labor.	▪ Encourage small-scale mechanization (e.g. use of automatic hedge trimmers to harvest).

Issues	Perceived Barriers	Strategies
	▪ Lack of land.	▪ Link retiring growers with young growers. ▪ Encourage cooperatives.
	▪ Wholesale prices low and the standards/criteria high for marketing to larger herb companies.	▪ Adopt universal quality control standards for all scales of operation.
Wildcrafting	▪ Lack of information.	▪ Have other growers discuss their own personal experiences. ▪ Workshop topic sufficient to reinforce responsibility in collecting wildcrafted herbs. ▪ Encourage cultural sensitivity. ▪ Discourage wildcrafting of threatened species. ▪ Encourage growing species traditionally wildcrafted.

Other Horticultural Activities 2012:

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 the 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. 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: 1) Determine potential for weedy invasiveness of exotic *Lycium* entries. 2) Determine which cultivars/selections are best adapted to high pH soil (above 8). 3) Determine over winter potential of *Lycium* selections. 4) Determine yields (kg/ha) expressed on a fresh weight and dry weight basis. 5) Determine *Lycium* chemistry of major bioactive compounds under Four Corners environmental conditions. Compare chemical characteristics of fruit/leaves to other U.S. growing locations. 6) 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.

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.

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

- 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.

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 2009. 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 - 2012

- The "Wedge Landscape" broke ground August 2012.
- 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, US Bureau of Indian Affairs, and the José Fernández Memorial Chair in Crop Production.

Michael O'Neill, Kevin Lombard, and Samuel Allen

Abstract

Hybrid poplar (*Populus* spp.) is one of the fastest growing temperate trees, capable of producing merchantable products in rotations of 3-15 years. Hybrid poplar grown in the Four Corners region could supplement aspen supplies for wood products and provide environmental benefits, such as wildlife habitat and windbreaks. To evaluate hybrid poplar for 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 clonal entries were replicated in three blocks for a total of 480 trees.

Irrigation commenced on April 25 and concluded on September 29, 2012, and was based on meeting 100% of the trees' evapotranspirative (ET) demand. Total crop ET was estimated to be 49.5 inches (125.7 cm) while total irrigation during the season amounted to 53.0 inches (134.6 cm), plus an additional 2.3 inches (5.8 cm) was received in rainfall. Eleventh year survival and diameter at breast height (DBH) were determined for all study trees on December 5-6, 2012, with tree height determined on January 23-25, 2013. Clone OP-367 remained the tallest clone after 11 seasons, reaching a mean height of 69.0 feet (21.0 m). Significantly shorter than OP-367 were the clones 311-93, 58-280 and 49-177 (all ~58-60 ft in mean height; ~18 m), but these were significantly taller than the remaining 4 clones. OP-367 had the largest mean DBH at 11.5 inches (29.2 cm). This was followed by clones 311-93 and 58-280, both with DBH ~9.5 inches (~24 cm), with the remaining 5 clones of significantly smaller diameter. Maximum wood volume was obtained by OP-367 at 7,861 ft^3/acre (550 m^3/ha) and total biomass for OP-367 was 171 tons/acre (383 Mg/ha).

Introduction

Hybrid poplar (*Populus spp.*) is 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 79). 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 80. 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 79. Parental background of hybrid poplar clones grown under drip irrigation. NMSU Agricultural Science Center at Farmington, NM. 2002-2012.

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.

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

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

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

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

Where…

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

GDD = Growing degree days; and

ET = Evapotranspiration replacement rate (inches).

Irrigation was started on April 25, 2012 and programmed as prescribed by calculated ET demand. Irrigation was concluded on September 29, 2012. Total crop ET was estimated to be 49.5 inches while total irrigation during the season amounted to 53.0 inches, plus an additional 2.3 inches was received in rainfall (2012 was a very dry growing season).

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 encourage green growth, nitrogen fertilizer (U-32) was applied May 8, July 2 and August 14, 2012 through the irrigation system.

Diameter at breast height (DBH) was determined on December 5-6, 2012, with tree height (Ht) determined on January 23-25, 2013. Wood volume per tree was calculated after Browne (1962) using Equation 3 and scaled to ft^3/acre.

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

Where…

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

DBH = Diameter at breast height (inches); 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 80. Operations and procedures for the 2002-planted hybrid poplar production in the drip irrigation trial. NMSU Agricultural Science Center at Farmington, NM. 2012.

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/plot
Fertilization:	U-32 (32-0-0) fertilizer injected at 25, 12.5 and 12.5 lbs N per acre on May 8, July 2, and August 14, 2012
Fungicide:	None
Herbicide:	None
Insecticide:	None
Rodenticide:	None
Chlorine:	Injected September 7, 2012
Soil Type:	Doak sandy loam
Irrigation:	Surface drip irrigation managed via programmable solenoids
Irrigation Commenced:	April 25, 2012
Irrigation Concluded:	September 29, 2012

Results and discussion

Of the 10 *Populus sp*. evaluated (Table 79) 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 (ET_C) and water application plus rainfall for eleventh year hybrid poplar are presented in Figure 15. 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 2012 season, total crop ET amounted to 49.5 inches (125.7 cm) while total application plus rainfall was 55.3 inches (140.5 cm) for the poplar trees, of which 2.3 inches (5.9 cm) was received as precipitation.

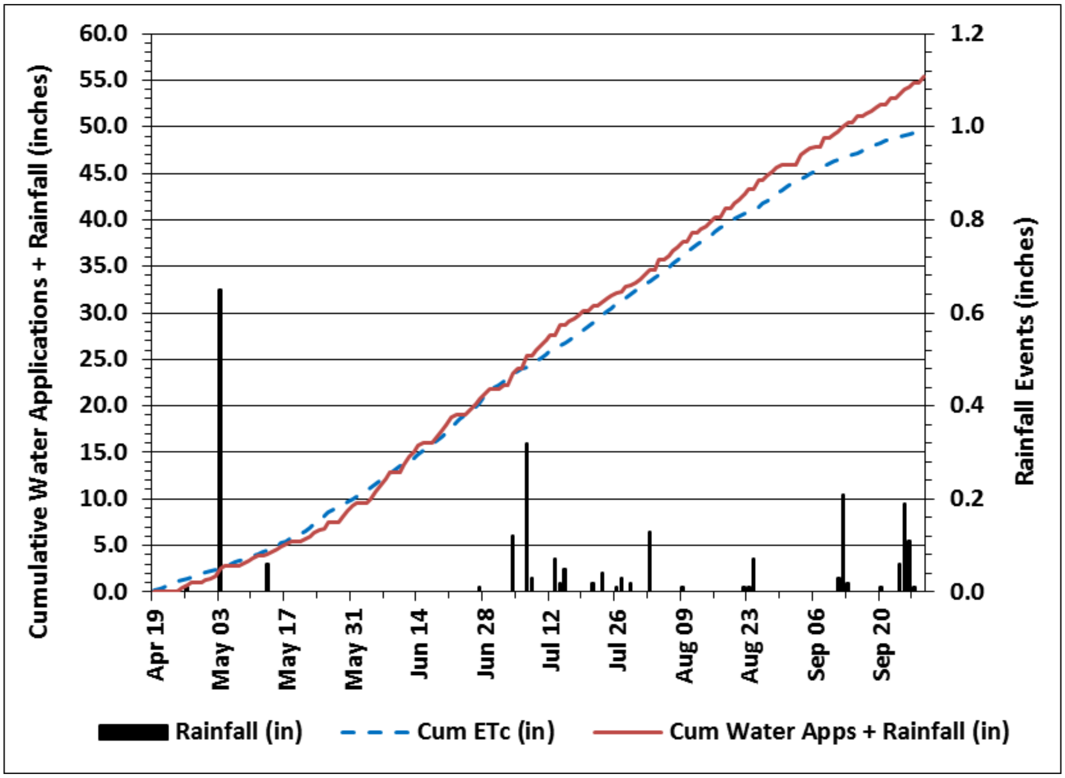

Figure 15. Cumulative evapotranspiration and water applications plus rainfall for hybrid poplar production under drip irrigation. NMSU Agricultural Science Center at Farmington, NM, 2012.

Growth

Clone OP-367 remains the tallest clone, reaching a mean height of 69.0 feet after 11 seasons. Significantly shorter than OP-367 were the clones 311-93, 58-280 and 49-177, with mean heights of 60.0, 58.4 and 57.8 feet, respectively. These were significantly taller than the remaining four clones. The shortest clone was Eridano at 42.9 feet. OP-367 had the largest mean DBH at 11.5 inches. This was followed by clones 311-93 and 58-280 with mean DBH of 9.5 and 9.4 inches, respectively. The Eridano clone had the smallest mean DBH of 6.4 inches. Maximum wood volume was obtained by OP-367 at 7,861 ft^3/acre, followed by clones 311-93 and 58-280. Wood volume for the lowest ranked clone (Eridano) was 1,668 ft^3/acre. OP-367 and 311-93 were the only clones maintaining 100% survival, and mean survival for the trial was just under 88% (Table 81). Total biomass production to date for OP-367 was 171 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 CaCO3 concentrations (4,200 ppm).

Table 81. Growth and survival of 8 hybrid poplar clones grown under drip irrigation. NMSU Agricultural Science Center at Farmington, NM. 2012.

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	11.5	29.3	69.0	21.0	7,861	550	171	383
311-93	100	9.5	24.1	60.0	18.3	4,689	328	108	242
58-280	98	9.4	23.9	58.4	17.8	4,441	311	105	234
49-177	88	8.8	22.3	57.8	17.6	3,951	276	91	204
195-529	58	7.8	19.7	53.7	16.4	3,097	217	73	164
52-225	69	7.6	19.2	47.2	14.4	2,441	171	66	149
NM-6	98	7.4	18.9	51.9	15.8	2,614	183	62	140
Eridano	90	6.4	16.1	42.9	13.1	1,668	117	44	100
Mean‡	**88**	**8.7**	**22.0**	**55.7**	**17.0**	**3,985**	**279**	**93**	**208**
p>F	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CV%	27.5	16.5	16.5	12.0	12.0	33.8	33.8	35.6	35.6
LSD (0.05)	0.1	0.8	2.0	3.3	1.0	787.6	55.1	19.0	42.6

† DBH = Diameter at breast height (~ 4.5 ft or 1.37 m).
‡ Mean is calculated from 8 clonal entries, each consisting of 3 replications of 16 study 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 eleven-year growth period, with 311-93 and 58-280 ranking second, 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, Michael O'Neill, and Samuel Allen

Abstract

A 1.2-acre (0.5-ha) trial was initiated in Spring 2005 at ASC Farmington to test whether composted biosolids (a municipal waste) can serve as a suitable fertilizer for hybrid poplars growing on a chlorosis-prone, high pH soil. Prior to planting, plots received a one-time application of biosolids at 10 and 20 tons/acre (22.8 and 45.5 metric tons/hectare [Mg/ha]); 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 subsequently planted in a 12 x 12 foot (3.6 x 3.6 m) grid spacing. For 2012, effects of 2005-applied biosolids on tree growth were not evident, though annual growth was good for all treatments. Average diameter at breast height (DBH) and tree height for the trial was 9.2 inches (23.3 cm) and 66.4 feet (20.2 m) respectively, representing a 7.0% overall increase in DBH and 2.8% overall increase in height since 2011. Average wood volume and biomass was 3,500 ft^3/acre (245 m^3/ha) and 69 tons/acre (155 Mg/ha) respectively. A lack of treatment differences is explainable given natural soil turnover combined with vigorous growth of clone OP-367; in addition, electronic difficulties resulted in under-recording of water applications. Of note, border trees on the south side of the trial exhibited noticeable yellowing and stunting of leaves, with some limb die-back. This is believed to have been caused by an irrigation pipe rupture upstream that led to scouring of roots and exposure to herbicide (likely dicamba) leached from an adjacent field; long-term prognosis of the affected trees is good. Overall, the use of biosolids-amended soil appears to have been useful in addressing initial chlorosis issues, and resulted in adequate growth in subsequent years. In line with USEPA recommendations, the use of biosolids could be considered for similar land applications and by municipalities seeking alternative waste disposal options, but more study is needed.

Introduction

Hybrid poplars grown on high pH, calcareous soils typical of the Four Corners region may exhibit iron chlorosis to varying 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). Agricultural land application of biosolids has been encouraged by the USEPA as an alternative to land filling.

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 82.

Biosolids originating from the City of Albuquerque Pilot Composting Facility (Waste Water Utilities Division) 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 82. Selected chemical traits of soil and biosolids samples collected in 2005. NMSU Agricultural Science Center at Farmington, NM, 2012.

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	3,740.0

* 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 (22.8 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 83 along with current cultural practices.

Table 83. Operations and procedures for 2005-planted poplars in Biosolids Trial. NMSU Agricultural Science Center at Farmington, NM, 2012.

Operations	Procedures
Variety:	OP-367
Biosolids Application:	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 12 study 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*:	U-32 (32-0-0) fertilizer injected at 25, 12.5 and 12.5 lbs N per acre on May 8, July 2, and August 14, 2012
Fungicide:	None
Herbicide:	None
Insecticide:	None
Rodenticide:	None
Chlorine:	Injected September 10-11, 2012
Soil Type:	Doak sandy loam
Pruning:	Pruned to a single leader
Irrigation:	Surface drip irrigation managed via programmable solenoids
Irrigation Commenced:	April 25, 2012
Irrigation Concluded:	September 28, 2012

*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 December 4, 2012. 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). Trees received water several times weekly during the growing season, although electronic and water pressure difficulties resulted in under-recording of irrigation numbers. Total calculated ET amounted to 49.5 inches (125.7 cm) while total application plus rainfall was 15.4 inches (39.1 cm). Despite this problem, trees did not appear to be water stressed. However, border trees located nearest the dirt road that forms the southern border of the stand (i.e., trees 50 feet and closer) exhibited noticeable yellowing and stunting of leaves, with some limb die-back. This is believed to have been caused by an irrigation pipe rupture upstream that led to scouring of tree roots and exposure of the roots to herbicide leached from an adjacent agricultural field, likely dicamba (3,6-dichloro-2-methoxybenzoic acid) (Arnold, Personal Communication, 2013). Dicamba is persistent in soil and also prone to leaching, and has a half-life of 1 to 6 weeks. Long-term prognosis of the affected trees is good.

There was no significant difference in tree diameter or height among treatments for the 2012 growing season (Table 84). Average DBH was 9.2 inches and average height was 66.4 feet, compared to 8.6 inches and 64.6 ft for 2011, representing a 7.0% overall increase in DBH and 2.8% overall increase in height, respectively. Average wood volume was 3,500 ft^3/acre, and average biomass was 69 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 biosolids-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 2012.

Table 84. Selected growth parameters for hybrid poplar amended with composted biosolids. NMSU Agricultural Science Center at Farmington, NM, 2012.

Treatment*	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	9.3	23.7	65.5	20.0	3,492	244	71	159
Bio-20	9.1	23.1	67.8	20.7	3,525	247	67	151
Fe	9.3	23.6	66.4	20.2	3,531	247	70	158
Control	9.0	22.9	66.1	20.0	3,454	242	67	151
Mean‡	**9.2**	**23.3**	**66.4**	**20.2**	**3,500**	**245**	**69**	**155**
P	0.0819	0.0815	0.8163	0.8163	0.4496	0.4496	0.1145	0.1169
CV%	12.4	12.4	8.6	8.6	21.6	21.6	23.1	23.1
LSD (0.05)	0.6	1.4	10.7	3.3	759.1	53.1	7.7	17.5

* Treatments = Biosolids @ 10 & 20 tons/acre, Fe (Sprint 138), and Control.
† DBH = Diameter at breast height (~ 4.5 ft or 1.37 m).
‡ Mean is calculated from 4 replications with 12 study trees for each plot.

Conclusions

First-season results indicated that biosolids-amended soil had positive effects on chlorosis alleviation and biomass production for the clone OP-367, but statistically significant differences in measured parameters are lacking in the second through eighth year of this study. A possible reason for the lack of differences may be attributed to depletion of amended-soil constituents or possibly underwatering. 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. Use of herbicides in adjacent fields must also be considered in terms of their potential impacts on nearby trees. In line with USEPA recommendations, the use of biosolids could be considered for similar land applications and by municipalities seeking alternative waste disposal options, but more study is needed.

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. Thanks also to those who participated in the unloading.

Evaluation of Hybrid Poplar Grown Under Four Irrigation Treatments

Michael O'Neill and Samuel 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 target levels: 70, 80, 120, and 130% of reference poplar evapotranspiration (ET). Total ET (at 100% replacement) for the 2012 growing season was calculated at 49.5 inches (125.7 cm) for the sixth-year hybrid poplar. Actual applications (plus rainfall) for the respective treatments were 45.4, 46.6, 47.6, and 47.5 inches (i.e., 115.3, 118.3, 120.9, and 120.7 cm) or 92, 94, 96, and 96 percent of reference ET, respectively. Sudden drops in mainline water pressure during peak hours of on-station irrigation may have contributed to these low percentages. Looking at sixth year growth results from the 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, which were not significantly different. Average wood volume for these two treatments was 2,076 ft^3/acre (145 m^3/ha) and average biomass was 52 tons/acre (115 Mg/ha). Across clones, entry 433 (clone OP-367) led for height (50.8 ft; 15.5 m) and wood volume (1,881 ft^3/acre; 132 m^3/ha), followed by clone 544. Both clones had similar high DBH (7.7 and 7.6 inches, or 19.5 and 19.4 cm, respectively) and biomass (47 and 45 tons/acre, or 105 and 100 Mg/ha, respectively). It is expected that these clones will continue to show good performance 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 targets of 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 offer only limited insight into the realities being investigated. In fact, first year trends have been somewhat reversed in the second and third years. This trial will allow us to determine the relative merits 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 among the leading producers in the 2005 biomass study. Operations and procedures for the hybrid poplar trial are presented in Table 85. 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 foot (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 shown in Figure 16.

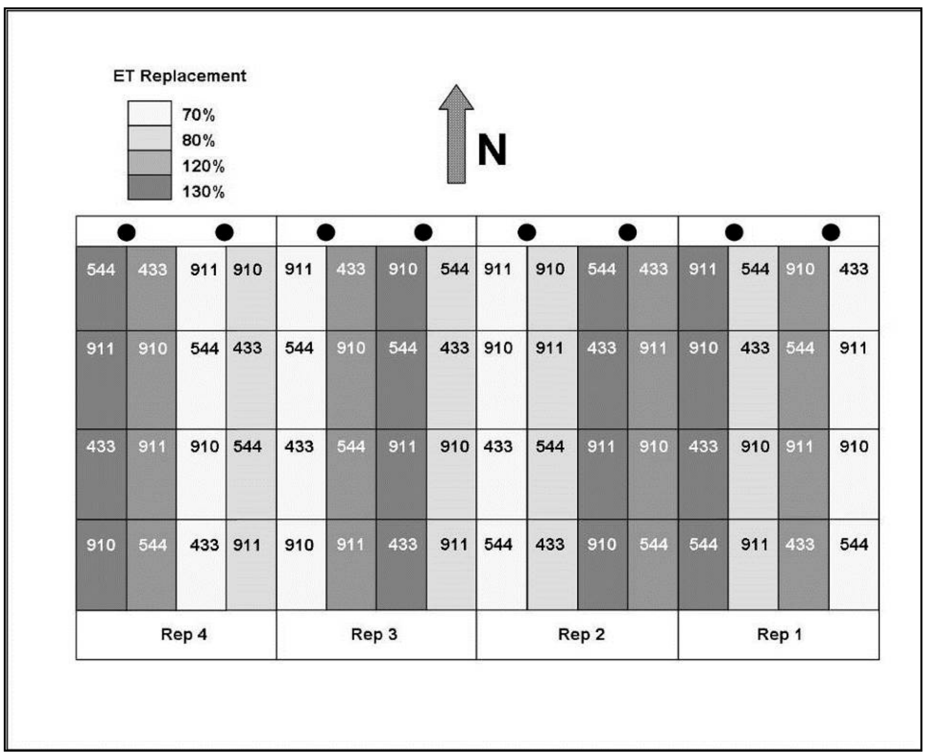

Figure 16. Detailed plot plan of four hybrid poplar clones grown under four irrigation levels. Clones are designated by 3-digit code in each subplot, shaded tones designate whole plot irrigation levels. NMSU Agricultural Science Center at Farmington, NM. 2012.

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

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

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

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

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

Where…

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

GDD = Growing degree days; 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 25, 2012 and programmed as prescribed by calculated ET demand. Irrigation was terminated September 29, 2012.

Tree growth data was collected December 10-12, 2012, 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 85. Operations and procedures for 2007-planted poplars. NMSU Agricultural Science Center at Farmington, NM. 2012.

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 12 study trees/plot
Fertilization:	U-32 (32-0-0) fertilizer injected at 25, 12.5 and 12.5 lbs N per acre on May 7, July 2, and August 14, 2012
Fungicide:	None
Herbicide:	Touchdown (glyphosate at 2 qt/ac) spot-sprayed on July 10, 2012
Insecticide:	None
Rodenticide:	None
Chlorine:	Injected September 5-8, 2012
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); managed via programmable solenoids
Irrigation Commenced:	April 25, 2012
Irrigation Concluded:	September 29, 2012

Results and discussion

Total ET (at 100% replacement) for the 2012 growing season was calculated at 49.5 inches (125.7 cm) for the sixth-year hybrid poplar (Figure 17). Actual applications (plus rainfall) for the respective treatments were 45.4, 46.6, 47.6, and 47.5 inches (i.e., 115.3, 118.3, 120.9, and 120.7 cm) or 92, 94, 96, and 96 percent of reference ET, respectively. Sudden drops in mainline water pressure during peak hours may have contributed to these low percentages. In spite of this, overall growth was satisfactory, with differences among clones largely consistent with previous results.

Across water treatments, the 120% and 130% irrigation levels produced the highest diameter at breast height (DBH) (8.2 and 8.0 inches, respectively) and tree height (51.3 and 53.4 feet, respectively) (Table 86). Mean wood volume for the irrigation treatments ranged from 1,115 ft^3/acre for the 70% irrigation level to 2,121 ft^3/acre for the 130% irrigation level, which was not significantly different from the 120% irrigation treatment (2,031 ft^3/acre). The two higher irrigation treatments also yielded the most biomass (52 and 51 tons/acre for 120% and 130% levels, respectively).

Across clones, DBH was greatest for clones 433 and 544 (at 7.7 and 7.6 inches, respectively), followed by clones 910 and 911 (at 7.3 and 7.2 inches, respectively) (Table 86). Clone 433 had the greatest mean height, 50.8 feet, significantly taller than all the other entries. Wood volume was also greatest for clone 433, which reached 1,881 ft^3/acre in 2012, significantly greater than other clones. Biomass was highest for clones 433 and 544, with 47 and 45 tons/acre, respectively. Thus, clone 433 led for height and wood volume and co-led with clone 544 for DBH and biomass. Also, while there was significant interaction between clones and irrigation treatments, and under watering may have impacted growth, the 120-130% ET irrigation treatments produced the most growth (Figure 18).

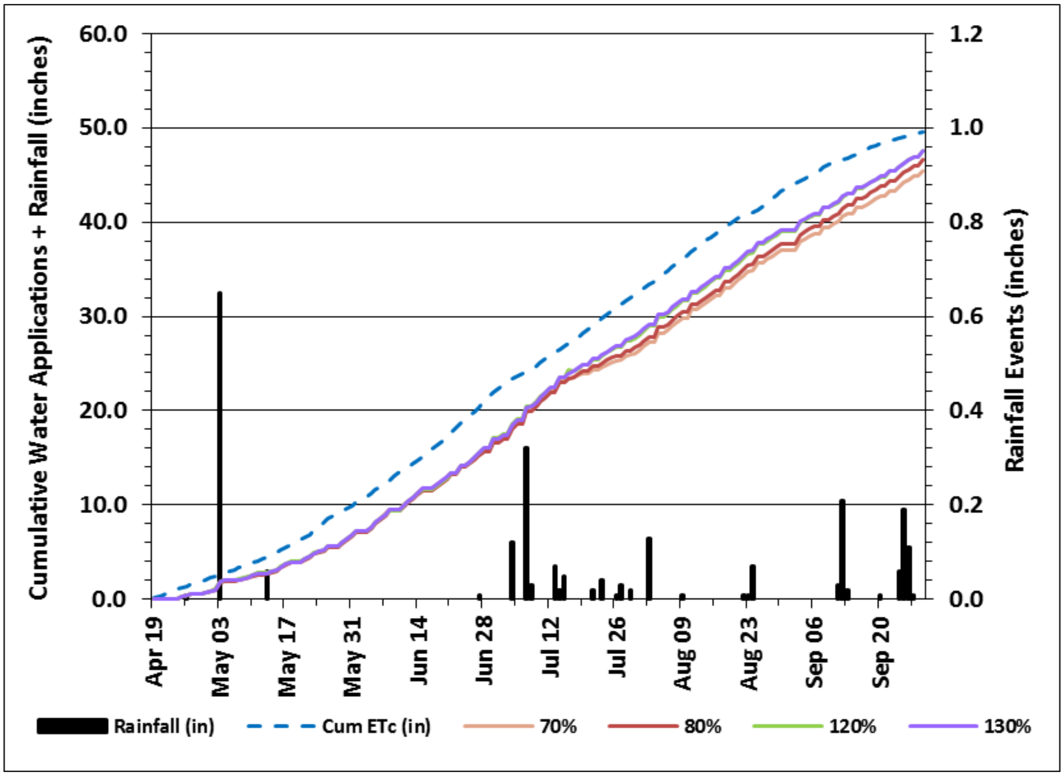

Figure 17. Cumulative evapotranspiration and water applications plus rainfall for hybrid poplar water-use trial (2007-planted) grown under drip irrigation trial. NMSU Agricultural Science Center at Farmington, NM. 2012.

Table 86. Mean DBH, height, wood volume, and biomass for four clones grown under four irrigation regimes. NMSU Agricultural Science Center at Farmington, NM. 2012.

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	6.6	16.8	41.7	12.7	1,115	78	32	72
2	7.0	17.7	44.6	13.6	1,305	91	36	81
3	8.2	20.7	51.3	15.6	2,031	142	52	116
4	8.0	20.4	53.4	16.3	2,121	148	51	115
433	7.7	19.5	50.8	15.5	1,881	132	47	105
544	7.6	19.4	48.5	14.8	1,710	120	45	100
910	7.3	18.4	45.6	13.9	1,497	105	40	91
911	7.2	18.4	46.2	14.1	1,509	106	40	89
Mean[‡]	**7.5**	**19.0**	**47.9**	**14.6**	**1,655**	**116**	**43**	**96**
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)	0.1156	0.1158	0.0001	0.0001	0.5425	0.5424	0.0655	0.0616
CV%	14.6	14.6	9.7	9.7	28.4	28.4	27.7	27.7
LSD (0.05) irr	0.3	0.8	2.8	0.8	182.6	12.8	4.1	9.1
LSD (0.05) clone	0.2	0.6	1.0	0.3	98.0	6.9	2.5	5.6

* Water applied equivalent to 1=70%, 2=80%, 3=120%, or 4=130% of reference Evapotranspiration (ET) rate.
† DBH = Diameter at breast height (~4.5 ft or 1.37 m).
‡ Mean is calculated from 4 replications with 12 study trees for each plot.

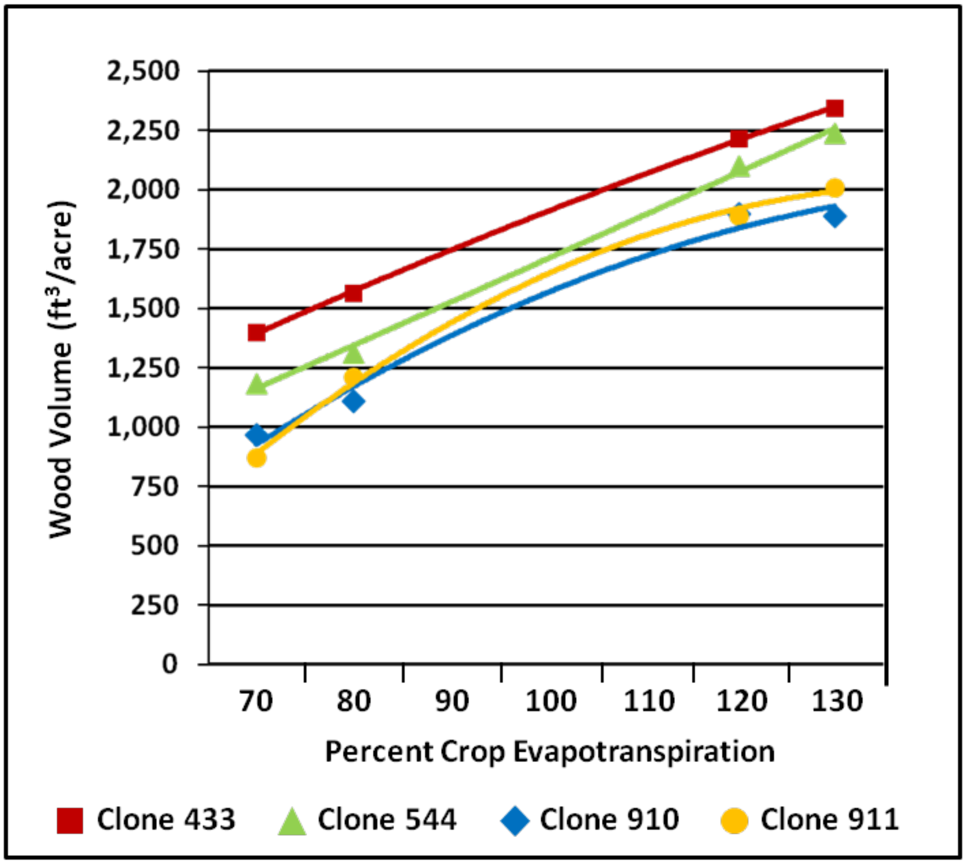

Figure 18. Wood volume for four hybrid poplar clones grown across four target irrigation regimes (70, 80, 120, and 130% of reference ET). NMSU Agricultural Science Center at Farmington, NM. 2012.

Conclusions

Similar to the previous year, the 120-130% water application levels emerged as statistically similar for 2012, resulting in the most productivity in this trial. Water pressure issues resulting in underwatering were a problem but overall tree growth proceeded normally, resulting in less pronounced but observable treatment effects. The clones OP-367 and 544 had highest DBH and biomass, and OP-367 continued to outperform the other clones with respect to height and wood volume. 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.

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

Michael O'Neill, Samuel Allen, and Robert Heyduck

Abstract

An abandoned oil refinery in Bloomfield, NM was targeted for a multi-phase phytoremediation project starting in spring 2010. Phase 1 involved the planting of 233 bareroot seedlings of local and hybrid poplars (*Populus spp.*), plus the xeric woody perennial, four-wing saltbush (*Atriplex canescens*), in four rows along the northern perimeter of the site. Phase 2, which began in March 2011 and is situated just west of Phase 1, involved the planting of 239 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). Poles were inserted into groundwater 5 feet (1.5 m) apart with 10 feet (3 m) alleys between rows. Phase 3, which began in April 2012, involved the planting of an additional 224 hybrid poplar poles with similar size and layout dimensions in the northwest corner of the site. Drip irrigation was supplied to all trees from an on-site well. As of late 2012, results were mixed for survival, height, DBH and leaf vigor, particularly across the three phases. Phase 1 plantings demonstrated adequate survival and growth after three growing seasons. Survival for hybrid poplar clones PC-6, DN-34, and OP-367 was 86.0%, 85.0%, and 82.9%, respectively, with native cottonwood at 82.9%, reflecting reasonable survival for these entries. Four-wing saltbush had 50.8% survival. Height and DBH were satisfactory for the three top poplar clones and the cottonwood, with height ranging from 5.9 to 8.8 feet (1.8 to 2.7 m), and DBH ranging from 0.6 to 0.9 inches (1.0 to 1.6 cm). Phase 2 poplars (OP-367) had near 100% survival and an average new stem growth of 8 inches after the first growing season; however, general health of these trees decreased somewhat during the second growing season. Average height in 2012 was 14.8 feet (4.5 m), a seasonal increase of 1 feet (0.3 m). Average DBH was 1.5 inches (3.8 cm), and average leaf vigor was 3.4. Phase 3 poplars (OP-367) failed to demonstrate acceptable survival or growth. Only 27% of trees were deemed to be 'healthy' (i.e., with a healthy/intact mainstem and a leaf vigor rating of 3 or higher). Many of the trees exhibited severe leaf yellowing and mainstem die-back at 3-7 feet (0.9-2.1 m) above tree base. Given the poor performance and high level of contamination in Phase 3, it is recommended that the western half of this area be replanted with a shallow-rooted xeric species, such as four-wing saltbush. Factors that may have inhibited tree growth include higher bark density at planting, late planting and its impact on bud break, and dry conditions resulting from lack of summer rains, salt and iron buildup in downstream driplines, and time needed for new irrigation installation in Phase 3. Initial observations suggest hybrid poplar, native cottonwood, and four-wing saltbush are capable of adequate initial growth on a petroleum-contaminated site. However, adequate and timely irrigation is a key factor in survival of transplanted material. In addition, disparities in tree health need to be examined, and long-term monitoring of plants, soil and groundwater is needed to determine if poplars are impacting the site.

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. A phytoremediation project was initiated in 2010 at the abandoned Thriftway Oil Refinery on CR5500 in Bloomfield, NM, to examine the ability of hybrid poplars (*Populus spp*.) to serve as phytoremediation agents for oil-contaminated soil and groundwater, in effect, serving as sponges for pollutants (El Gendy et al., 2009; Gordon et al., 1998). The project is an innovative collaboration between Animas Environmental Services, BioTech Remediation, and the New Mexico State University Agricultural Science Center (ASC) at Farmington. The refinery site, which had been in operation from 1973 to 1991, 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 site is situated along the Kutx Wash north of Bloomfield, and has been managed for several years by Animas Environmental Services and BioTech for mitigation of petrochemical contaminants in the soil and groundwater. The water table at the site is 5-6 feet below the soil surface. Analysis of groundwater at the planting site shows levels of total dissolved solids (TDS) exceeding 4,500 mg/L and concentrations of methyl tertiary butyl ether (MTBE) near 55 µg/L. Levels of Gasoline Range Organics (GRO C6-C10) are ~0.11 mg/L.

Materials and methods

The site has undergone three phases of tree plantings, starting in early 2010. In that first year, whips of local and hybrid poplar (*Populus spp*.) as well as bareroots of the xeric woody species, four-wing saltbush (*Atriplex canescens*), were planted in rows bordering the northern fenceline of the site. A drip irrigation system was then installed that supplies moderately to severely saline water (TDS 1,000 to 2,700 mg/L) from a 1,500-feet well approximately 200 feet from the irrigated area. For the second phase of tree planting (March 2011), 239 dormant poplar poles, 15-20 feet in length with a 1 to 2-inch aboveground diameter at breast height (DBH), were planted in four rows just west of the 2010 plantings. Poles were inserted into groundwater 5 feet apart with 10 foot alleys between rows. In April 2012, a third grouping of approximately 224 hybrid poplar poles with similar size and layout dimensions was planted towards the northwest corner of the site, and was also supplied with drip irrigation. NMSU's ASC-Farmington provided the poplar planting material, largely OP-367, a hybrid of *Populus deltoides* and *P. nigra* which has shown strong survival and growth characteristics in this region. Plantings were observed seasonally for general survival and health, and were evaluated at the end of each season for survival, height, DBH, and leaf vigor (for late 2012). Soil samples were also taken in increments down to water table depth at two sites in each of the planting sites in October 2012 using a heavy-duty sand auger paired with a split-core sampler, to aid in understanding physiochemical dynamics at the tree root zone as well as underlying factors impacting tree health.

Results and discussion

As of late 2012, results were mixed for survival, height, DBH and leaf vigor, particularly across the three phases (Table 87).

Table 87. Survival, height, DBH, and leaf vigor of local and hybrid poplars (*Populus* spp.) and four-wing saltbush (*Atriplex canescens*) planted in a multi-phase phytoremediation project at an abandoned oil refinery site in Bloomfield, NM; Study conducted by NMSU Agricultural Science Center at Farmington, NM. 2012.

			2010*		2011*			2012*			
Phase	**Species**	**Total Studied**	**Survival (%)**	**Height (ft)**	**Survival (%)**	**Height (ft)**	**DBH (in)**	**Survival (%)**	**Height (ft)**	**DBH (in)**	**Leaf Vigor (5-0)****
Phase 1 (Planted Spring 2010)											
	OP-367	111	91.0	4.5	84.7	6.9	0.6	82.9	8.8	0.9	2.9
	PC-6	50	86.0	4.2	86.0	6.4	0.6	86.0	8.6	0.8	3.1
	DN-34	20	85.0	3.5	85.0	4.9	0.4	85.0	5.9	0.6	2.2
	58-280	11	10.0	5.0	10.0	6.9	0.7	10.0	8.7	0.9	0.4
	Native	41	85.0	3.3	82.9	6.1	0.4	82.9	7.8	0.6	3.5
	Saltbush	61	80.3	0.8	50.8	2.0	-	50.8	2.5	-	1.2
Phase 2 (Planted Spring 2011)											
	OP-367	220	-	-	100.0†	13.8†	1.3†	97.3	14.8‡	1.5‡	3.4
Phase 3 (Planted Spring 2012)											
	OP-367	197	-	-	-	-	-	73.1	14.7‡	1.3‡	1.9

* End-of-season data collected October 2010, January 2012, and October/November 2012.
** Leaf vigor is a visual measure of leaf color/health/abundance, where 5=excellent, 4=good, 3=fair, 2=poor, 1=general absence of leaves, and 0=dead tree.
† Data based on a representative subsample (N=40).
‡ Data based on measurements from healthy trees, i.e., trees with a healthy/intact mainstem and a leaf vigor rating of 3 or higher (Phase 2 N=162; Phase 3 N=54).

Phase 1 plantings demonstrated adequate survival and growth after three growing seasons (Figure 19). Survival for hybrid poplar clones PC-6, DN-34, and OP-367 was 86.0%, 85.0%, and 82.9%, respectively, with native cottonwood at 82.9%, reflecting reasonable survival for these entries. Fourwing saltbush had 50.8% survival. Height and DBH were satisfactory for the three top poplar clones and the cottonwood, with height ranging from 5.9 to 8.8 feet, and DBH ranging from 0.6 to 0.9 inches.

Figure 19. Phase 1 plots (planted in 2010) with local cottonwood and hybrid poplar demonstrating exceptional growth and leafiness. Open area in center has been naturally revegetated with native grasses and forbs.

Phase 2 poplars (OP-367), planted in Spring 2011 as mature poles, demonstrated near 100% survival and an average new stem growth of 8 inches after the first growing season; however, general health and survival of these trees decreased somewhat during the second growing season (Figure 20). Average height in 2012 was 14.8 feet, representing approximately one foot of new growth since the previous year. Average DBH was 1.5 inches, and average leaf vigor was 3.4.

Figure 20. Phase 2 hybrid poplars (planted in 2011) demonstrating good growth and leafiness. Naturally revegetated native grass and herbaceous forb species are established along the drip irrigation line.

Phase 3 poplars (OP-367), planted in Spring 2012 as mature poles, failed to demonstrate acceptable survival or growth (Figure 21). Only 27% of trees were deemed to be 'healthy' (i.e., with a healthy/intact mainstem and a leaf vigor rating of 3 or higher). Many of the trees exhibited severe leaf yellowing and mainstem die-back at 3-7 feet above tree base.

A September 2012 evaluation showed variable leaf vigor and overall tree health, with most favorable health for 2010 plantings, mediocre health for 2011 plantings, and poor health for 2012 plantings.

A definite leafing gradient from healthy to poor was noted among the different plantings. Phase 3 trees exhibited poor leaf-out, discolored leaves, and an overall lack of vigor. Inhibiting factors may have included higher bark density at planting, late planting and its impact on bud break, and dry conditions resulting from lack of summer rains, salt and iron buildup in downstream drip lines, and time needed for new irrigation installation. Given the poor performance and high level of contamination in Phase 3, it is recommended that the western half of this area be replanted with a shallow-rooted xeric species, such as four-wing saltbush.

Figure 21. Phase 3 hybrid poplars (planted in 2012) showing poor growth and leafiness. Naturally revegetated native grass and herbaceous forb species are evident.

Soil and water samples from the site are still being analyzed, but they show some unique challenges faced by the introduced trees. Figure 22 shows the location of Phase 1 plantings at the refinery. Note the salt and iron deposits clearly visible in the downstream areas of the dripline. Analysis of groundwater at the planting sites indicated high levels of total dissolved solids (TDS) greater than 4,500 mg/L and concentrations of methyl tertiary butyl ether (MTBE), a pervasive residual contaminant, at nearly 55 µg/L. Levels of Gasoline Range Organics (GRO C6-C10) were ~0.11 mg/L. Soil samples taken in increments to water table depth (up to 5 ft) revealed a layer of dark, petroleum-laden sludge in the moisture zone, overlying a dense clay layer. This clay layer likely impairs root growth both physically and chemically, and restricts downward movement of water and petroleum. High levels of irrigation may be needed to promote healthy root development in this environment. Detailed soil and water analyses will be reported later.

Figure 22. Satellite image of phytoremediation site in Bloomfield, NM showing Phase 1 plantings in four long rows along the north perimeter of the refinery. Note the salt and iron deposits clearly visible in the downstream areas of the dripline on the west side of the site (Google, 2013). Despite the difficult growing environment, poplars have shown adequate growth and health.

Conclusions

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 significant foliage produced to date. Initial observations suggest hybrid poplar, native cottonwood, and four-wing saltbush are capable of adequate initial growth on a petroleum-contaminated site. However, adequate and timely irrigation is a key factor in early survival of transplanted poplars. In addition, disparities in tree health need to be examined, and long-term monitoring of plant tissue, soil and groundwater is needed to determine if poplars are impacting the site. It will be interesting to observe the degree of survival and growth of these poplars in future years, and to determine if they are able to exert a phytoremediatory effect on adjacent soil and groundwater.

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 Perspectives 106(4):1001-1004.

O'Neill, M., S. Allen, and R. Heyduck. 2012. Preliminary update: Poplar phytoremediation project on an abandoned oil refinery site in Northwestern New Mexico. 2011 Annual Progress Report. Agricultural Science Center at Farmington, New Mexico State University. p. 204-207. http://farmingtonsc.nmsu.edu/documents/NMSU%20AnnRpt%202011.pdf

Acknowledgments

We would like to thank BioTech Remediation and Animas Environmental Services for their collaboration on this project. Special thanks to the BioTech team of Mike Beauparlant and John Sandoval for on-going site management and for help with tree cutting and planting. Thanks also to Joe Ward and Chad Dawson for their technical assistance.

Non-cropland Conservation with Trees, Shrubs and Grasses

Samuel Allen and Robert Heyduck

Summary

A conservation area was established at ASC-Farmington in Spring 2009 to revegetate an unused portion of the station with xeric-adapted trees, shrubs and grasses of largely native origin. This was done to reduce wind erosion, increase aesthetics, and observe how well these plants would grow with minimal start-up costs and maintenance. (The full scope and description of the project is presented in the 2009 ASC Progress Report.) Additional plants were established in Summer 2011 (largely via volunteer plants) and Fall 2011. This brief follow-up report is to highlight those species that have fared the best after four growing seasons under minimal drip irrigation (Table 88). As of late 2012, the species exhibiting the best survival (original N>10) were New Mexican olive (*Forestieria neomexicana*) at 46.2%, four-wing saltbush (*Atriplex canescens*) at 45.5%, golden currant (*Ribes aureum*) at 38.5%, and Rocky Mountain juniper (*Juniperus scopulorum*) at 23.8%. Another species of note was giant sacaton grass (*Sporabalus wrightii*), which had a survival rate of 10.9% but which showed moderate volunteer activity around emitter sites. While having a small original N (<10), a few other species had standing plants after four years, including chokecherry (*Prunus virginiana*), mountain mahogany (*Cercocarpus montanus*), pinon (*Pinus edulis*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and three-leaf sumac (*Rhus trilobata*), showing survival potential. Of special mention is American plum (*Prunus americana*), which continues to survive in a large, healthy clump of several 5-foot (1.5-m) shrubs mixed with sacaton, and which also exhibits volunteer activity. Factors impacting plant survival include dry conditions, strong winds, predation from herbivores (elk or deer), prairie dogs, gophers, and other animals in the vicinity, and damage from farm equipment. Plantings will continue to undergo weekly watering and management in 2013, with the hopes that some of these species will thrive in these marginal areas once fully established.

Table 88. Survival of various trees, shrubs and grasses planted in a conservation area. NMSU Agricultural Science Center at Farmington, NM. 2009-2012.

	Establishment			Survival					
Common name/ Species	**Spring 2009/2010**	**Summer 2011***	**Fall 2011**	**4 yr**	**3 yr**	**2 yr**	**≤ 1 yr**	**% 4 yr survival**	**> 1 yr****
American plum (*Prunus americana*)	10	3	0	0	0	4	6	0.0	3
Black pine (*Pinus nigra*)	5	0	3	0	0	0	7	0.0	1
Buffaloberry (*Shephardia argenta*)	2	0	0	0	0	0	2	0.0	0
Chokecherry (*Prunus virginiana*)	7	0	0	1	0	5	1	14.3	0

Common name/ Species	----- Establishment ----- Spring 2009/2010	Summer 2011*	Fall 2011	--------------- Survival --------------- 4 yr	3 yr	2 yr	≤ 1 yr	% 4 yr survival	> 1 yr**
Fernbush (*Chamaebatiaria millefolium*)	0	0	4	0	0	0	3	0.0	1
Four-wing saltbush (*Atriplex canescens*)	52	3	0	25	3	11	13	45.5	3
Giant sacaton (*Sporabalus wrightii*)	45	19	0	7	9	13	16	10.9	19
Golden currant (*Ribes aureum*)	13	0	0	5	1	1	6	38.5	0
Mountain mahogany (*Cercocarpus montanus*)	24	0	4	2	1	6	19	7.1	0
New Mexican olive (*Forestieria neomexicana*)	13	0	0	6	0	1	6	46.2	0
Pinon pine (*Pinus edulis*)	17	0	0	1	3	2	11	5.9	0
Rocky Mountain juniper (*Juniperus scopulorum*)	21	0	0	5	0	4	12	23.8	0
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	11	0	0	1	0	2	8	9.1	0
Three-leaf sumac (*Rhus trilobata*)	6	0	3	2	0	3	4	22.2	0
Wax currant (*Ribes cereum*)	0	0	5	0	0	0	2	0.0	3

* Summer 2011 plants are largely volunteer plants (American plum, four-wing saltbush, and giant sacaton).
** > 1 yr survival applies to those plants established in 2011 but which are still alive (as of late 2012).

Literature Cited

Heyduck, R. 2010. Non-cropland conservation with grasses, shrubs, and trees. 2009 Annual Progress Report. Agricultural Science Center at Farmington, New Mexico State University. p. 215-223. http://farmingtonsc.nmsu.edu/documents/2009nmsu-annrptfinapdfall-screen.pdf

Acknowledgments

Thanks to Robert Heyduck for his vision and hard work in establishing the conservation site.

Dissemination and Staff Development

Publications and Reports

Arnold, Richard N., Daniel Smeal, Kevin Lombard, Michael K. O'Neill, Samuel Allen, Margret West, and Roselyn Yazzie. 2012. Broadleaf weed control in dry beans (Phaseolus vulgaris) with preemergence applications of Valor alone or in combination from 2004-2008. NMSU Bulletin 804. http://aces.nmsu.edu/pubs/research/agronomy/BL804.pdf

Arnold, Richard N., Michael K. O'Neill and Daniel Smeal and Kevin Lombard. 2012. Pest control in crops grown in northwestern New Mexico, 2010. NMSU Annual Data Report 100-2010. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_100-2010.pdf

Arnold, Richard N., Michael K. O'Neill and Daniel Smeal. 2012. Pest control in crops grown in northwestern New Mexico, 2009. NMSU Annual Data Report 100-2009. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_2009.pdf

Arnold, R. N., O'Neill, M. K., Smeal, D., Lombard, K. A. (2012). Pest control in crops grown in northwestern New Mexico, 2008. NMSU Annual Data Report 100-2008. http://aces.nmsu.edu/pubs/annualdatareports/docs/ADR_2008.pdf

Arnold, Richard N. Michael K. O'Neill and Kevin Lombard. 2012. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Western society of Weed Science. Abstract. No. 120.

Arnold, Richard N. Michael K. O'Neill and Kevin Lombard. 2012. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Proceedings of the Western society of Weed Science. No. 120. ISSN:0091-4487.

Arnold, Richard N., Michael K. O'Neill, and Samuel Allen. 2012. Broadleaf weed control in grain sorghum. Western Society of Weed Science Research Report. p.57. ISSN:0090-8142.

Arnold, Richard N., Kevin Lombard, and Samuel Allen. 2012. Broadleaf weed control in field corn with preemergence herbicides. Western Society of Weed Science Research Report. p.58. ISSN:0090-8142.

Arnold, Richard N., Kevin Lombard, and Samuel Allen. 2012. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Western Society of Weed Science Research Report. p.59. ISSN:0090-8142.

Lauriault, L.M., Ray, I., Pierce, C., Flynn, R.P., O'Neill, M.K., Owen, C., Place, T., Idowu, O.J. 2012. The 2012 New Mexico Alfalfa Variety Test Report. Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/variety_trials/AlfalfaVar2012.pdf

Leinauer, B., Smeal, D. 2012. Turfgrass Irrigation. NMSU Circular 660. Cooperative Extension Service, College of Agricultural, Consumer and Environmental Sciences. New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/_circulars/cr660/welcome.html

Leinauer, B., Smeal, D. 2012. How to water your lawn. NMSU Guide H-504. Cooperative Extension Service, College of Agricultural, Consumer and Environmental Sciences. New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/_h/H504.pdf

Lombard, K. A., Beresford, S. A.A., Topaha, C., Becenti, T., Thomas, D., Vela, J. G. Healthy Gardens/Healthy Lives: Navajo perceptions of growing food locally to prevent diabetes and cancer. Health Promotion Practice., Date Submitted: December 7, 2012, Item applies to Promotion and Tenure criteria: Scholarship and Creative Activity.

Lombard, K.A., Maier, B., O'Neill, M.K. 2012. Where's the Grape? High Elevation Wine Grape Trials in Northwest New Mexico). HortScience. pp. S277-278.

Lombard, K. A., Martin, C. A. Risk Management Education in Southwest Medicinal Herb Production and Marketing. Spokane Valley, WA: Western Center for Risk Management Education. Date Submitted: January 5, 2012, Date Accepted: January 2012.

Maier, B., Lombard, K. A. In Ana Henke, Frank Sholedice (Ed.), Wine Grape Varieties for Central and Northern New Mexico (pp. 6). Las Cruces, NM: NMSU Cooperative Extension Service., Abstract/Synopsis: Description of Grape Varieties suitable for Central and Northern New Mexico, Date Submitted: November 2, 2012.

Marsalis, M.A., Kirksey, R.E., Contreras-Govea, F., Flynn, R.P., O'Neill, M.K., Lauriault, L. M., Place, T. 2012. New Mexico 2011 Corn and Sorghum Performance Tests. Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/variety_trials/11CornSorghumRpt.pdf

Marsalis, M.A., Kirksey, R.E., Flynn, R.P., O'Neill, M.K., Lauriault, L.M., Place, M. 2012. New Mexico 2012 Corn and Sorghum Performance Tests. Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. Las Cruces, NM. http://aces.nmsu.edu/pubs/variety_trials/12CornSorghum.pdf

O'Neill, M. K., Arnold, R. N., Smeal, D., Lombard, K. A., Owen, C. K.., West, M.M. Field crop variety, fertilizer, and herbicide recommendations for 2010., Date Submitted: August 2012.

O'Neill, M.K., Robert, H.F., Allen, S.C., Lombard, K.A., Smeal, D., Arnold, R.N. Hybrid Poplar for Northwestern New Mexico: Ten Years of Poplar Research at NMSU's Agricultural Science Center in Farmington. Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. Las Cruces, NM. (In press).

O'Neill, M.K. and M.M. West (Ed). 2012. Forty-fifth Annual Progress Report: 2011 Cropping Season. With contributions from Arnold, R.N., Smeal, D., Lombard, K.A., Allen, S., Owen, C. NMSU Agricultural Science Center. Farmington, NM. http://farmingtonsc.nmsu.edu/documents/NMSU%20AnnRpt%202011.pdf

Painter, C.S., O'Neill, M.K., Arnold, R.N., Smeal, D., Lombard, K.A., Owen, C., West, M.M. Field crop variety, fertilizer, and herbicide recommendations for 2010. Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. Las Cruces, NM. (In press).

Sammis, T.W., O'Neill, M.K., Wang, J. Estimating Economic Value of Research Projects. Agricultural Experiment Station and Cooperative Extension Service, New Mexico State University. Las Cruces, NM. (In press).

Stamm, M., Berrada, A., Buck, J., Cabot, p., Classen, M., O'Neill, M. K., et al. 2012. Registration of 'Riley' Winter Canola. Journal of Plant Registrations. Journal of Plant Registrations, 6(3), 243-245. https://www.crops.org/publications/jpr/articles/6/3/243?highlight

Sutherin, S., Lombard, K. A., St Hilaire, R. Southwest Plant Selector: A mobile application for iPhone and iPad. HortTechnology. Date Submitted: November 29, 2012.

Proceedings

O'Neill, M. K., Heyduck, R. F., Allen, S. C., Lombard, K. A., Smeal, D., Arnold, R. N. Hybrid poplar for the Colorado Plateau: NMSU poplar research at Farmington, New Mexico. Tucson, AZ: University of Arizona Press., Date Submitted: February 2012.

Abstract, Posters and/or Oral Presentations

Arnold, R. N. (Presenter & Author), O'Neill, M. K., Lombard, K. A. 2012. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. March 13, 2012. 65th Western Society of Weed Science,Western Society of Weed Science. Reno, Nevada.

Arnold, R.N. 2012. Weed control in corn, alfalfa, dry beans, and small grains. University of Wyoming, Colorado State University and University of Nebraska Scottsbluff, Annual Weed Tour. June 19-22. Lingle, Wyoming, Fort Collins, Colorado, and Scottsbluff, Nebraska. No CEU or CCA offered.

Arnold, R.N. 2012. NMSU ASC Centennial Field Day. Weed control in crops grown in northwest NM. July 20. No CEU or CCA offered.

Arnold, R.N. 2012, Navajo Agricultural Products Industry, Basic Agronomy, Insects, and Weeds and Alfalfa Production, Farmington, NM. December 11, 2012. No CEU or CCA offered.

Arnold, R.N. 2012, Navajo Agricultural Products Industry, Corn Production, Farmington, NM. December 13, 2012. No CEU or CCA offered.

Arnold, R.N. 2012, Navajo Agricultural Products Industry, Dry Bean and Small Grain Production, Farmington, NM. December 18, 2012. No CEU or CCA offered.

Arnold, R.N. 2012, Navajo Agricultural Products Industry, Potato and forage Crop Production, Farmington, NM. December 20, 2012. No CEU or CCA offered.

Bauer, M., Lombard, K. A., Nez, F., and Bighorse, W. 2012. Navajo gardening, nutrition and community wellness. October 28, 2012. 8th Annual First Americans Land-grant Consortium (FALCON) National Conference, USDA/NIFA, Albuquerque, NM.

*Leuppe, D., Lombard, K. A., Hyder, D., and Idowu, O. J. 2012. Reverse osmosis waste water applied to agricultural land: Soil implications in the semi-arid southwestern United States Society for Advancement of Chicanos and Native Americans in Science (SACNAS). October 11, 2012. Annual Meeting, Society for Advancement of Chicanos and Native Americans in Science (SACNAS), Seattle, WA.

Lombard, K.A., Maier, B., and O'Neill, M.K. 2012. Where's the grape? High Elevation Wine Grape Trials in Northwest New Mexico. American Society for Horticultural Sciences Annual Meeting. July 31, 2012. Miami, FL. HortScience 9(47):S277-278).

*Moone, T., Bauer, M., Lombard, K. A. 2012. Assessment of interests, resources, barriers and attitudes towards gardening as a tool for improving nutrition and physical activity in four Navajo Nation communities. October 27, 2012.American Public Health Association (APHA) Annual Meeting, American Public Health Association (APHA), San Francisco, CA.

O'Neill, M.K., Allen, S., Heyduck, R., Lombard, K.A., Smeal, D., Arnold, R.N. 2012. NMSU hybrid poplar research at Farmington, New Mexico. November 3, 2012. W-2128 Annual Meeting. USDA Western Regional Collaborative Project for Microirrigation Research: Microirrigation for Sustainable Water Use, U.S. Department of Agriculture, Lake Buena Vista, FL.

Smeal, D. and S. Guldan. 2012. Evaluating irrigation efficiency. Feb. 17, 2012. New Mexico Organic Farming Conference. Albuquerque, NM.

Smeal, D. 2012. San Juan County water issues. March 16, 2012. Presentation to NMSU students. Farmington, NM.

Smeal, D. 2012. An introduction to irrigation systems. April 13, 2012. Navajo Farm Board meeting. Fort Defiance, AZ.

Smeal, D. 2012. Soil Sampling for Chemical Analyses. April 16, 2012.Students at Aztec Museum. Aztec, NM.

Smeal, D. 2012. Tour and presentation. May 4, 2012.Bureau of Land Management representatives from Colorado and New Mexico. NMSU Agricultural Science Center. Farmington, NM.

Smeal, D. 2012. NMSU ASC – Farmington Field Day and Open House. Tour and presentation. July 20, 2012. Farmington, NM.

Smeal, D. 2012. Performance of drip irrigation emitters at sub-standard pressure. Western SARE Conference. Water: The Foundation of Agricultural Sustainability. Santa Fe, NM. August 7, 2012. http://aces.nmsu.edu/programs/sare/documents/smeal-part-1.pdf

Smeal, D. 2012. Drip irrigation for gardens, small farms and landscapes. August 23, 2012.Navajo Dept. Ag. Agricultural Conference – Conservation. Window Rock, AZ.

Smeal, D. 2012. Sprinkler irrigation. August 23, 2012. Navajo Dept. Ag. Agricultural Conference – Conservation. Window Rock, AZ.

Smeal, D. 2012. Improving irrigation efficiency. October 16, 2012. Four Corners River Health Workshop. Farmington, NM.

Smeal, D., M.K. O'Neill, M. K. 2012. Performance of point source emitters at substandard pressure. Nov. 3, 2012. W-2128 Annual Meeting. USDA Western Regional Collaborative Project for Microirrigation Research: Microirrigation for sustainable water use. Lake Buena Vista, FL.

*Sutherin, S., Lombard, K.A., St Hilaire, R. 2012. Center for Landscape Water Conservation: An integrated approach to internet-based outreach. July 31, 2012. American Society for Horticultural Sciences Annual Meeting, Miami, FL, HortScience 9(47): S250.

**Indicates student from Diné College, New Mexico State University, or San Juan College working with Dr. K.A. Lombard.*

Media Contributions and Non-academic Paper or Reports

Lombard, K.A. 2012. Bridging disciplines: horticulture and health (with hops and gardens. March 6, 2012. Integrated Land Management Workshop, Colorado State University, Durango, CO.

Lombard, K.A. 2012. Audio/Video Production, Southwest Plant Selector App for iphone and ipad. Southwest Plant Selector is the only app of expert-recommended xeric landscape plants specifically for New Mexico and surrounding areas. All plants in this app thrive on little or no supplemental water and are typically both available and used in regional xeriscapes.

Lombard, K. A. 2012. Opportunities and challenges for viticulture in the Four Corners Region: A panel discussion. March 2, 2012. The 22nd Southwest Wine and Vine Annual Meetings, Southwest Wine and Vine Society, Albuquerque, NM.

O'Neill, M.K. 2012. Audio/Video Production, KENN Radio. March 20, 2012. Radio interview with Donnell Key to highlight research at ASC-Farmington and outline the Peace Corps Fellows and Master's International programs in ACES.

Meetings

Arnold, R.N. 2012. 60th Rocky Mountain Agric. Business Conference, Denver, Colorado, January 9-11, presenter and participant, CEU 15 and 9 CCA offered.

Arnold, R.N. 2012. New Mexico Crop Production Association Conference, Ruidoso, New Mexico, January 23-24, participant, CEU 6 and 6 CCA offered.

Arnold, R.N. 2012. 2012 Southern rocky Mountain Agricultural Conference and Trade Fair, Monte Vista, Colorado, February 7-9, participant, 6 CCA offered.

Arnold, R.N. 2012. 65th Western Society of Weed Science, Reno, Nevada, March 12-15, presenter and participant, NM CEU and CCA offered.

Arnold, R.N. 2012. Four Corners Master Gardeners, Aztec, New Mexico, February 2, presenter and participant.

Arnold, R.N. 2012. Four Corners Weed Symposium, Aztec, New Mexico February 28, participant, 5 CEU offered.

Arnold, R.N. 2012. Colorado State University Spring Training School, Fort Collins, Colorado, participant, 10 CEU offered.

Arnold, R.N. 2012. New Mexico State University ASC Advisory Board Conference, Farmington, New Mexico, April 10, presenter and participant.

Arnold, R.N. 2012. Colorado State University, University of Wyoming, and University of Nebraska Scottsbluff, Fort Collins, Colorado, Lingle, Wyoming, Scottsbluff, Nebraska, June 18-21, presenter and participant.

Arnold, R.N. 2012. Dupont Crop Protection and BASF Mountain States Weed Scientists Review of 2012 and 2013 Weed Protocols, Fort Collins, Colorado, September 25-27, presenter and participant.

Arnold, R.N. 2012. Navajo Agricultural Products Industry, Farmington, New Mexico, December 11, presenter.

Arnold, R.N. 2012. Navajo Agricultural Products Industry, Farmington, New Mexico, December 13, presenter.

Arnold, R.N. 2012. Navajo Agricultural Products Industry, Farmington, New Mexico, December 18, presenter.

Arnold, R.N. 2012. Navajo Agricultural Products Industry, Farmington, New Mexico, December 20, presenter.

Arnold, R.N. 2012. Navajo Agricultural Products Industry, Twice per month from March to November, presenter and participant.

Arnold, R.N. 2012. Bureau of Land Management Farmington Field Office, Once per month for weed committee, presenter and participant.

Arnold, R.N. 2012. BASF, DuPont Crop Protection, Bayer CropSciences, and Monsanto, Conference calls or throughout year concerning weed protocols, presenter and participant.

Arnold, R.N., O'Neill, M.K., Lombard, K.A. 2012. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Western Society of Weed Science. Moscow, ID. (pp. 1).

O’Neill, M.K. University engagement and discussion of RFA for Higher Education Solutions Network. January 24, 2012. Webinar to explain the proposal development process for the USAID-University Engagement Request for Applications (RFA). How was this activity applied in a meaningful way? Developed Concept Paper with International Arid Lands Consortium (IALC), University of Arizona, Texas A&M University - Kingsville, and University of Illinois.

O'Neill, M.K. 2012. RFA for Rwanda: Women's Leadership Program in Education. April 17, 2012. Higher Education for Development (HED) Webinar to explain the proposal development process for the Rwanda Request for Applications (RFA). How was this activity applied in a meaningful way? Developed proposal with Purdue University and Global Knowledge Initiative (GKI).

O'Neill, M.K. 2012. Conference Call. May 23, 2012, Conference call with Ryan Vroegindewey and Michelle Corzine, USAID/Mali and Connie Bacon USDA/Senegal. Discussed development of the shrub/tree fodder project for Mali.

O'Neill, M.K. 2012. Site Visit. July 17, 2012. Met with Jay Angerer, PI for the Mali Livestock and Pastoralist Initiative II. Discussed structure of project and how it fits into the Climate Change - Livestock CRSP. TAMU Blacklands Research and Extension Center. Temple, TX.

Smeal, D. 2012. Four Corners Educational Gardens, Inc. Board of Directors Meeting. Farmington, NM. February 13, 2012. Elected to Vice President.

Smeal, D. 2012. Western SARE Conference. Water: The Foundation of Agricultural Sustainability. Santa Fe, NM. August 7, 2012.

Smeal, D. 2012. W-2128 Annual Meeting. USDA Western Regional Collaborative Project for Microirrigation Research: Microirrigation for sustainable water use Lake Buena Vista, FL. Las Cruces, NM. Nov. 1-3.

Smeal, D. 2012. Irrigation Association Annual Conference Technical Sessions. Orlando, FL. November 4-5, 2012.

Awards

Arnold, R.N. 2012. Rocky Mountain Agric. Business Association, Distinguished Educator of the Year, Denver, Colorado, January 10.

Proposals and Grants

Grants Received

Arnold, R.N. (PI)
Chemical Weed Control Hatch Project, State of New Mexico Allocation 2012 ... $5,000
Extension Plant Science Allocation $2,500

Arnold, R.N. (PI) – Corporation Support
BASF $4,500
Bayer Crop Sciences $4,000
Dupont Crop Protection $1,500
Monsanto $6,500

Smeal, D. (PI)
Appropriate Water Conservation Technologies for Small Farms and Urban Landscapes
Hatch Project, State of New Mexico Allocation 2012........ $5,000

Lombard, K.A. (PI)
Improved Viticulture and Specialty Horticultural Crop Systems for the San Juan River Valley of Northwest New Mexico.
Hatch Project, State of New Mexico Allocation 2012........ $5,000

LaShell (PI), **Lombard, K.A. (Co-PI)**, Godin (Co-PI), Beye (Co-I). 2012. Analyzing hops varieties for high altitude production and alternative marketing schemes.
Colorado Specialty Crop Block Grant through USDA........ $60,118

Lombard, K.A. (PI). 2011. Internal Award - 2011-30 - Bridges/Mentor.
Sponsoring Organization. NIH Funded. (May 1, 2012 - December 31, 2012)..... $2,000

Lombard, K.A. (PI). Acharya (Co-PI), Henning (Co-PI). 2012
Enhancing Hops (*Humulus lupulus* L.) Production in New Mexico. New Mexico Department of Agriculture, Description: Continue to evaluate the agronomic, and market potential of hops production in New Mexico. Educate growers on opportunities and challenges to hops production $41,471

O'Neill, M.K. (PI)
Drip Irrigation in the Four Corners
Hatch Project, State of New Mexico Allocation 2012... $5,000
Extension Plant Science Allocation 2012 .... $2,500

O'Neill, M.K. (PI)
José Fernández Memorial Chair in Crop Production....................................... $20,000

Proposal Submitted in 2012 and Pending Review

Lombard, K.A. (PI), M.K. O'Neill, (Co-PI), and D. Smeal (Co-PI).
Landscape and garden enhancement with Navajo Nation Chapter Houses in northwest New Mexico. A New Mexico Legislative request from Rep. Ray Begaye. Submitted to NMSU Office of Governmental Affairs September 14, 2012.
Total funding request
Year 1 (capital and recurrent) $110,000
Year 2 and subsequent years (recurrent).. $70,000

O'Neill, M.K. (PI), M. Chaiken (Co-PI), R. Skaggs (Co-PI), R. Acharya (Co-PI), S. Archambault (Co-PI), A. Fernald (Co-PI), J.P. King (Co-PI), K.L. Lombard (Co-PI), M. Uchanski (Co-PI).
Improving food security and nutrition in East Africa: agricultural solutions for small-scale irrigation using science and technology (ASSIST). An international collaborative research project developed by NMSU, University of Arizona, Texas A&M University, aWhere Inc., World Agroforestry Centre (ICRAF), International Center for Agricultural Research in Dry Regions (ICARDA), Jomo Kenyatta University for Agriculture and Technology (JKUAT), and Addis Ababa University (AAU). Focus countries are Kenya and Ethiopia.
United States Agency for International Development (USAID)
Total request.. $15,204,461

Proposals Submitted but not Accepted

Bauer, M. (PI), B. Begay (Co-PI), **Lombard, K.A. (Co-PI)** (2012).
Promoting Wellness through Gardening, Nutrition, and Community Intervention on the Navajo Nation, Sponsoring Organization: Diné College, Sponsoring Organization Is: USDA-NIFA.
Submitted Feb 2012 ....$76,670

Lombard, K.A. (Co-PI), S.A.A. Beresford (Co-PI), I. Ornelas (Co-PI), J. Jim, (Co-PI). M. Bauer (Co-PI), **D. Smeal (Co-PI)**. Where Health and Horticulture Intersect: A Navajo Wellness Collaboration, Sponsoring Organization: NMSU/FHCRC

U54. Description: Design a cancer/diabetes/livelihoods intervention on the Navajo Nation.
A resubmission from the full proposal submitted 01/15/2012 ....$359,839

Lombard, K.A. (PI), St Hilaire, R. (Co-PI), **Smeal, D. (Co-PI)**, Sutherin, S. (Co-PI). Enhancing the Center for Landscape Water Conservation, Sponsoring Organization: US Department of the Interior Bureau of Reclamation,
Submitted Feb 2012. ....$47,100

Lombard, K.A. (PI), Penn, G. (Co-PI), Heyduck, R. (Co-PI). 2012. Macro- and Micro-Scale Estimation of Wild Populations of Osha (*Ligusticum porteri*) in the Sangre De Cristo and San Juan Mountains: Moving Towards Sustainable Management of Cultivated Osha, Sponsoring Organization: American Herbal Products Association. Submitted June 2012. ....$8,655

Gutierrez, Paul, Michael Hensley, Michael Morgan, Rex E Kirksey, and **M.K. O'Neill**. Botswana Sustainable Agriculture Initiative. Sponsoring Organization: Siemens Corp and others.

O'Neill, M.K. (PI), Lombard, K.A. (Co-PI), 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.
Total request .... $100,000.

O'Neill, M.K. (PI), Lombard, K.A. (Co-PI), Bachman, K.A.
Infant nutrition enhancement through agroforestry in drought prone eastern Kenya. Bill and Melinda Gates Foundation, Grand Challenge in Global Health.
Total request..$100,000

O'Neill, M.K. (PI), Pratt, R.C. (Co-PI), Chaiken, M. (Co-PI), Sanogo, S. (Co-PI), Gutierrez, P. (Co-PI), Gray, T. (Co-PI), Seevers, B.S. (Co-PI)
Graduate curriculum development for the Natural University of Rwanda – spearheading agricultural innovation leadership (SAIL): propelling women into leadership roles. Higher Education for Development (HED). $230,000

Hutchinson, C.F. (PI, IALC/UA), **M.K. O’Neill (Co-PI, NMSU)**, G.A. Rasmussen (Co-PI, TAMU-K), S. Korban (Co-PI, UIUC)
USAID Center for Sustainable Use of Marginal Lands. A collaborative Concept Paper developed by the International Arid Lands Consortium with the University of Arizona, New Mexico State University, Texas A&M University-Kingsville, and the University of Illinois. United States Agency for International Development (USAID)
Total request...$24,818,375

O’Neill, M.K. (PI, NMSU), A. Kalinganire (Co-PI, ICRAF)
Intensifying fodder production systems for improved livelihoods of smallholder farmers in the Sahel. An Associate Award Concept Paper for a collaborative research program developed by NMSU, ICRAF, ILRI, and aWhere. Submitted through the Climate Change - Livestock CRSP. Received Airline Reservations for

Mali trip to meet with potential collaborators, March 16, 2012. A coup d'état in Mali, March 21, 2012.United States Agency for International Development (USAID/Mali).
Total request..$5,207,000

O'Neill, M.K. (PI, NMSU), A. Kalinganire (Co-PI, ICRAF)
Integrated shrub/tree fodder production systems for Mali. A Request for Applications to develop a collaborative research program with NMSU, ICRAF, ILRI, and aWhere. Submitted through the Climate Change - Livestock CRSP. Due to the coup d'état and continued instability in the country, USAID/Mali declined to fund the project at this time. United States Agency for International Development (USAID/Mali)
Total request..$5,000,000

O'Neill, M.K. (PI), B.H. Hurd (Co-PI), J. Mexal (Co-PI), and C.P. Brown (Co-PI)
An interdisciplinary assessment of New Mexico's water footprint and extending the model overseas through the Peace Corps Master's International Program. A project proposal developed for the interdisciplinary Masters of Water Science and Management program. Collaborating departments were Plant and Environment, Agricultural Economics and Agricultural Business, and Geography. NMSU Interdisciplinary Research Grant. Office of the Vice President for Research
Total request...$42,600

Stories from the Popular Press

The Benefits of Berries – SJC Students Take Part in Summer Research Project

By Margaret Cheasebro, San Juan College Communicator: 09-10/2012

http://www.sanjuancollege.edu/documents/PR/Communicator/2012/Communicator_Sept-Oct_2012.pdf

The Benefits of Berries - SJC Students Take Part in Summer Research Project

Students at San Juan College had a unique opportunity to participate in two summer research projects that involved learning more about the health benefits of goji berries, a species of plant in the genus Lycium.

One project searched for an enzyme that makes flavonoids in the plants. Flavonoids are antioxidants that have health benefits for humans.

That project is funded through New Mexico State University, which administers a National Institutes of Health Bridges to Baccalaureate grant. Its purpose is to encourage minority students to get their baccalaureate degree in science, particularly chemistry, biology and plant sciences. This year, San Juan College's portion of that grant was $15,860.

The second project determined how much rutin, a kind of flavonoid, is found in species of the goji berry. Though some species grow in Asia, three are native to New Mexico. One grows on the San Juan College campus.

The rutin project is funded with part of a five-year, $1.2 million grant from the National Science Foundation. The $445,000 that goes to San Juan College's School of Math, Science and Engineering was shared by a research project studying how vegetables reduce inflammation caused by cigarette smoke. Known as the Four Corners Stem Success (FOCUSS) Program, the grant encourages more students to transfer to four-year colleges and graduate with a bachelor's degree in the fields of science, technology, engineering or math.

Research student Patricia Charley helped with the enzyme project.

"I was looking for a certain enzyme in the Lycium that makes the flavonoid," Charley explained. "I was extracting DNA to isolate the gene(s) that produces the enzyme flavonol synthase. My goal was to figure out which genes are responsible for this enzyme, and determine which plant had the most medicinal value."

She compared Asian varieties of the Lycium to the native New Mexico species.

Overseeing that project were Dr. Don Hyder and Dr. Veronica Evans, both associate professors of biology at SJC, and Dr. Kevin Lombard, assistant professor of horticulture at SJC. Lombard also is a researcher and assistant professor of horticulture at the New Mexico State University Agriculture Science Center, which is located south of Farmington.

The results show that native New Mexico species could provide an important medicinal and food source.

In the rutin study, research students Tonia Becenti and Kalyn Boyer collected cuttings from native New Mexico goji berry species. The project was headed by Hyder and Lombard.

"We clipped little pieces of fruit, flowers, bark or leaves," said Becenti. "We brought them back, dried them, weighed them and did an extraction protocol, which we had learned from similar documented research projects."

Results of the protocol showed that rutin in one native species was higher than in Asian species. It could become a valuable food and medicinal source.

Boyer noted, "The project showed me that I like research, and could potentially see myself working in a lab."

By Margaret Cheasebro

Pictured: Research student Tonia Becenti.
Photo by Paula Miller

NMSU Agricultural Science Center at Farmington to Host Field Day

By Jane Moorman, NMSU Communications – 06/28/2012

FARMINGTON, N.M. – Which alfalfa hybrid will have the best yield in the Four Corners region? Which grape variety can survive the harsh winter temperatures? What ornamental plants will grow with little or no water?

Richard Arnold gives talk on herbicides at the corn research plot as ASC Farmington.

Faculty members from New Mexico State University's Agricultural Science Center at Farmington have the answers to these questions and many more. During a field day Friday, July 20, the public can gleam helpful information about the research being conducted at the facility. The New Mexico Centennial event is free and open to the general public. Registration begins at 8:30 a.m. with field tours beginning at 10 a.m. Guests will be treated to a barbeque lunch at noon.

"This is your NMSU Agricultural Science Center for the Four Corners Region and we hope you will attend the celebration of our state's 100 years of statehood," Rick Arnold, NMSU professor and superintendent of the facility. "Join us for a learning experience on agroforestry, weed control, field and forage crops, vegetables, grapes, biofuel crops, drought tolerant landscape plants while celebrating the state's Centennial."

The public also will have the opportunity to learn about the Navajo Nation Special Diabetes Project and other programs NMSU provides to the Four Corners region.

The science center is located seven miles south Farmington. Travel six-and-a-half miles south of the San Juan River bridge on NM 371 Bisti Highway to Navajo Road 3003; travel west four miles to Navajo Road 4063, then turn north when you see the NMSU sign. Visit http://farmingtonsc.nmsu.edu/ for a map and more information about research being conducted at the facility.

The event is sponsored by the Agricultural Science Center-Farmington advisory committee, NMSU Agricultural Experiment Station, NMSU Cooperative Extension Service and the Farmington Chamber of Commerce's agricultural committee.

San Juan College Students Project to Promote Undergraduate Research

By Greg Yee gyee@daily-times.com12/09/2012

http://www.daily-times.com/ci_22159724/san-juan-college-students-project-promote-undergraduate-research?IADID=Search

FARMINGTON — San Juan College's video production students capped off three summer research projects with an interdepartmental project aimed at promoting community college level research and engaging students with real world experience.

The video project showcases biology students' research on hantavirus, the goji berry and compounds found in broccoli.

"We're the story tellers," said Luke Renner, assistant professor of digital media, arts and design. His video production class spent fall semester producing video, animation and photo illustrations for the project. "For me, this is an eye-opener for what can be accomplished," Renner said. "It can lead to collaboration outside the classroom. I'm amazed at what they've put together. It's applicable to careers. We've made a marketable product."

Renner's students were assisted by students from a 3D design and animation class to create a 3D animation of a lung and students from the digital image editing class to create animated graphics. "It's been great for the students," Renner said. Biology department professors hope that the video project will spur more interest in undergraduate research at the college. "It is unique that we have so much research at a community college," said Veronica Evans, associate professor of biology at the college.

Evans' students performed research on the hantavirus, goji berry and the sulforaphane compound found in broccoli and other vegetables. Conducting research early in a college career can help students be more successful when they transfer to four year colleges and universities.

"We have a number of students in the biology program that are interested in transferring that want to get their feet wet in research," said Don Hyder, associate professor of biology. "I think one of the advantages is that students, by the time they get done with research, they have a much higher confidence level for a four year college or a masters program."

San Juan College's programs offer students in the Four Corners a unique opportunity to engage in academic research, Hyder said. "There's not a very large number of community colleges that engage in undergraduate research," he said. "We also have a number of very well qualified faculty." The three research projects were conducted through a partnership with Ft. Lewis College in Durango and New Mexico State University, Hyder said. "It allows me the opportunity to have a number of students involved," he said. "We're trying to involve students across departments. These projects lead to results outside the classroom."

Activities Hosted by 2012 José Fernández Chair

http://aces.nmsu.edu/aes/fernandezchair

Summer Internships

Figure 23. Co-advisors, Mick O'Neill and Kevin Lombard, congratulate JFC Intern Seth Fulfer upon the completion of his program.

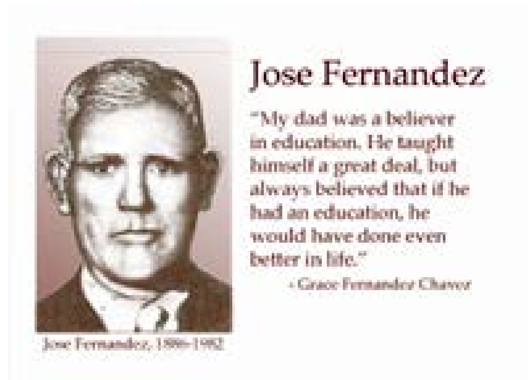

Figure 24. Seth Fulfer, 2012 JFC Intern, indicating apple graft.

- In 2012 the José Fernández Chair provided one summer internship conducted at NMSU's Agricultural Science Center at Farmington. The internship provides a student with the opportunity to assist faculty and staff on their specific research. The intern rotated the educational experience every two weeks between research projects.
- Coupled with the research assistant rotation, the intern was required to carry out a research project of his choice and present a report at the end of the summer internship period.
- The 2012 stipend-based internship was awarded to Seth Fulfer, Horticulture Student at San Juan College.
- Seth carried out an apple grafting field test with five varieties on a single rootstock variety. The title of his research project was High Production from of Small Scale Farmers: One Acre at a Time.

Continuing Internship

Figure 25. Co-advisor, April Ulery instructs JFC Intern, Zena Archie, in sampling procedures in Dr. Ulery's Las Cruces lab.

- In 2012 the José Fernández Chair provided support for Zena Archie while she continued her academic program in the NMSU Plant and Environmental Sciences (PES) Department under the directions of Drs. Bill Lindemann and April Ulery. Ms. Archie was a summer intern at the NMSU Agricultural Science Center-Farmington in 2011.
- Educational opportunities included working with PES faculty and graduate students in both laboratory and field settings.
- She has helped enter computer data, inventory of chemicals, update lab records, analyze soil and water samples, etc.
- The opportunity provided by the Jose Fernandez Chair through Dr. Michael O'Neill has allowed Zena to gain valuable experience and also to achieve one of her personal life goals of graduating with her Bachelor of Science degree.

Aggies Go Global
http://aces.nmsu.edu/sge/

Figure 26. Teri Schultz, NMSU Alumna.

The José Fernández Chair covered the cost for 2 tables at the NMSU Model UN Program annual banquet which included seating for 20 guests from the José Fernández Chair Internship program, the Aggies Go Global program, and the Peace Corps Paul D. Coverdell Fellows program.

- International feature reporter and NMSU alumna Teri Schultz (left) was the Distinguished Keynote Speaker.
- Contributed to general program support for Aggies Go Global.
- Aggies go Global has supported 110 Students between September 2011 thru August 2012.

Model United Nations (Platinum Supporter)
http://www.nmsu.edu/~govdept/modelun/

- The José Fernández Chair supported one table at the NMSU Model UN Program annual banquet which included seating for 10 guests from the José Fernández Chair Internship program, the Aggies Go Global program, and the Peace Corps Paul D. Coverdell Fellows program.

Figure 27. Members of the award-winning 2012 NMSU Model United Nations team.

- Contributions provided general program support for Model UN and the annual conference at the United Nations Headquarters in New York City. Awardees for the 2012 competition were:
  - Thomas Burnham and Haley Grant received an Outstanding Position Paper Award in the Organization of the Islamic Conference.
  - Zackary Quintero received an Outstanding Position Paper Award in the Economic and Social Commission of Western Asia.
  - Randy Taylor and Collin King received the Outstanding Delegates Award in the Security Council and Zackary Quintero received an Outstanding Delegate Award in the Economic and Social Commission of Western Asia.
  - Lydia Hammond was selected to serve as the Chair of the African Union and Derrick Vinson was selected to serve as the Rapporteur of the Peace Building Commission.

Audio-Visual and Computer Equipment

- The José Fernández Chair purchased AV equipment for the ASC-Farmington Conference room including 55-in LED TV, external speakers, and wall mount. Equipment to be used in lieu of the dated projector and screen previously used for presentations and internet webinars.
- Purchased computer for Research Specialist to be used for official duties including design and development of the center's web site.

Figure 28. LED TV for ASC library and communications capabilities.