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Southwestern Colorado Research Center

Research Report 2004

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Mark Stack, Manager
Colorado State University
Southwestern Colorado Research Center
Yellow Jacket, Colorado

Abdel Berrada, Research Scientist
Colorado State University
Arkansas Valley Research Center
Rocky Ford, Colorado

Robert Hammon, Extension Agent
Colorado State University
Tri-River Area Cooperative Extension
Grand Junction, Colorado

Tom Hooten, Extension Agent
Colorado State University
Montezuma County Cooperative Extension
Cortez, Colorado

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Table of Contents

Introduction

This report summarizes recent research at the Southwestern Colorado Research Center. Variety testing included in this report covers the years 1998 thru 2004 and the 1997 feed and hulless barley trial. Other research included in this report was initiated as far back as 1994. If the research was published in a journal or technical bulletin/report, it is not included in this report. However, an abstract or summary of the research is included in this report for informational purposes. Journal articles, technical bulletins/reports, articles in books, *From the Ground Up agronomy news*, and other publications are available at the Research Center and through the Agricultural Experiment Station. The Colorado State University Cooperative Extension also posts variety trial results on the internet at www.csucrops.com. In the future, the plan is to publish a research report annually for the Southwestern Colorado Research Center.

Dr. Abdel Berrada was the Research Scientist at the Southwestern Colorado Research Center until 2004 when he transferred to the Arkansas Valley Research Center at Rocky Ford, CO. Tom Hooten was a Research Associate during this period until 2004 when he accepted a position with Montezuma County Cooperative Extension in Cortez. Bob Hammon was the entomologist and pest management specialist at the Western Colorado Research Center at Fruita. In 2003, Bob was named the Tri-River Area Extension Agent for entomology and agronomy located in Grand Junction.

In 1987, the Research Center received irrigation water for the first time from the U.S. Bureau of Reclamation Dolores Project. Irrigation water from the Dolores Project is delivered under pressure to the Research Center. The Research Center irrigates primarily with wheel-line sprinkler systems and a 32-acre center pivot. Prior to 1987, the Research Center had been farmed in a dryland winter wheat-pinto bean rotation except for research plots. The Research Center conducts both dryland and irrigated crop research.

In 1989, a long-term dryland cropping systems project was established on 30 leased acres one-half mile north of the Research Center. The project was originally funded by the Colorado Agricultural Experiment Station, Energy Conservation for Colorado Agriculture, the Soil Conservation Service, and the Dove Creek and Dolores Soil Conservation Districts. This project was designed to evaluate various crop rotations under no-till, minimum tillage, and conventional tillage (moldboard plow). In addition to the traditional winter wheat-pinto bean rotation, the project has tested alternative crops for the area in the rotation including alfalfa, chickpeas, corn, safflower, and oats. In 2000, the project was expanded with a grant from the USDA's Sustainable Agriculture Research and Education Program (SARE). The project included sites at Goodman Point and Eastland, Utah. The work is currently funded by the Colorado Agricultural Experiment Station with research conducted only at the Yellow Jacket site. Colorado Agricultural Experiment Station Technical Bulletins TB95-2, TB02-2, and TB04-02 summarize the dryland cropping systems research.

Colorado State University began a comprehensive project to combat the Russian wheat aphid (RWA) after it was first discovered in the United States in 1986. Bob Hammon, entomologist at the Fruita Research Center, began field work on the Russian wheat aphid in southwestern Colorado beginning in 1989. Bob's work included surveying fields in southwestern Colorado, operating a suction trap at the Research Center, studying RWA damage to dryland winter wheat and irrigated spring wheat, control strategies, alternative hosts, and collaborating with the USDA-ARS in developing a RWA resistant spring barley adapted to southwestern Colorado. Colorado Agricultural Experiment Station Technical Report TR99-2 summarizes the RWA dryland winter wheat research.

Dolores County and Montezuma County Cooperative Extension manage the fruit tree orchard at the Research Center. The orchard was started in 1991 by Brian Leib, Salinity Extension Specialist for the McElmo Creek Salinity Control Project, to demonstrate surface drip and micro-spray irrigation. Dan Fernandez and Jan Sennhenn took over operation of the orchard in 1993 and expanded the orchard to include additional apple varieties, peaches, pears, wine grapes, high-density apple plantings, and grass cover plantings. Their investigations have included frost protection, hail protection, and pest management strategies. They host an annual fruit tree pruning workshop and sponsor orchard management field days. The fruit is marketed thru U-Pick days with the proceeds helping fund the operation of the orchard.

The Research Center initiated a plant materials garden in 1994 with over 100 cool and warm season grasses, legumes, and flowering plants. The public was invited to visit the garden and observe the different plantings as an aid to selecting plants for their own place. Due to the age of the stand, this project was ended in 2004 but it is planned to begin a similar demonstration planting in the near future.

In 1994, the Research Center cooperated with the Natural Resources Conservation Service, the Dolores Soil Conservation District, and the Colorado State Forest Service to establish plantings of trees and shrubs for windbreaks and wildlife to demonstrate various establishment practices under both dryland and irrigated (drip) conditions. The practices included fabric weed barrier, absorbent polymers, corrugated tree protectors, mesh guards, and wood slabs (for shade). The coniferous trees include ponderosa pine, Scotch pine, Austrian pine, Rocky Mountain juniper, and Eastern redcedar. The shrubs include caragana, cotoneaster, sumac, native plum, lilac, and Woods rose. The trees and shrubs are available annually thru the Colorado State Forest Service and local Soil Conservation Districts. The plantings can be viewed at the Research Center.

In 1996, the Research Center initiated a study to evaluate irrigation water management in the Full Service Area of the Dolores Project. A questionnaire was mailed to landowners and farm operators to assess current irrigation practices. This was followed by calibration of the Watermark soil moisture sensor in the laboratory and evaluation of the ETgage atmometer. The ETgage data was compared with evapotranspiration (ET) obtained from data recorded by the automated weather station (CoAgMet site) at the Research Center computed using the Kimberly-Penman equation. In 1997 and 1998, the Watermark soil moisture sensors were used to monitor alfalfa fields in the Full Service Area. ETgage atmometers were used to estimate evapotranspiration and water balance tables were maintained. The water management research is summarized in Colorado Agricultural Experiment Technical Reports TR01-6, 7, and 8.

Beginning in 2000, the Southwestern Colorado Research Center and Colorado State University, New Mexico State University, University of Arizona, Utah State University, and the U.S. Bureau of Reclamation sponsored an annual Four Corners Irrigation Workshop. The Research Center hosted the workshop in 2000 and 2002. Proceedings of the workshops are available at the Research Center including Colorado Agricultural Experiment Station Technical Bulletin LTB03-1.

In 2000, a subsurface drip irrigation project was initiated at the Research Center and is located south of the orchard. This project was funded by the Bureau of Reclamation and the Colorado Agricultural Experiment Station. Drip tape (13-mil, 24 gal/hr/100 ft) was placed at an 18-inch depth on 60-inch centers. The system includes a screen filter, controllers, water meters, solenoid valves, and pressure regulators designed for conducting research with replicated plots. Research was conducted on alfalfa water management during 2001 thru 2003. Colorado Agricultural Experiment Station Technical Bulletin TB05-01 summarizes alfalfa water management research using subsurface drip irrigation.

History

Abdel Berrada and Mark Stack

Agricultural research in southwestern Colorado began at the San Juan Basin Research Center near Hesperus in 1921. The major emphasis was to identify crop species and varieties adapted to the high altitudes of southwestern Colorado. The crops grown included grasses, clovers, alfalfa, field peas, corn, potatoes, dry beans, sugar beets, small grains, and vegetables. Research was conducted on both irrigated and dryland sites.

By the mid-1940's, the drylands of southwestern Colorado had developed into a major pinto bean-producing area. A comprehensive edible dry bean research program was initiated during this period. The pinto bean variety 'San Juan Select' was developed and released in 1946. A Yellow Jacket unit of the San Juan Basin Research Center was opened in 1962 to study management of dryland soils and crops. Major emphasis was on the production of pinto beans, winter wheat, and soil and water conservation practices. Additional crops studied at Yellow Jacket under dryland conditions included grasses, alfalfa, sunflowers, oats, barley, safflower, and sorghum.

The soil and crop sciences section of the San Juan Basin Research Center separated from animal science in 1971 and leased a farm 10 miles northwest of Cortez in the Arriola area. The need for a research facility in the Cortez area was catalyzed by plans to construct the Dolores Project, a Bureau of Reclamation irrigation, municipal, industrial, and recreation project. The Colorado Legislature, the Bureau of Reclamation, the Four Corners Regional Commission, and the Soil Conservation Service provided the funding to lease and operate the 300-acre farm. Surface and sprinkler irrigation systems were studied utilizing furrow, flood, gated pipe, sideroll, center pivot, end-tow, and traveling gun. Analyzing the economic impact of converting from dryland farming to irrigated agriculture was a priority. An adjacent 20-acre dryland site was added in 1976 for research on plant-water relationships, erosion control, dryland cultural practices, fertilizer use, and bean root rot control. The lease on the Arriola farm expired and research at the San Juan Basin Research Center-Cortez Unit ceased in 1983.

The present 158-acre farm located 15 miles north of Cortez on County Road Z was purchased by the State Board of Agriculture (now Board of Governors of the Colorado State University System) in 1981. An office, shop, equipment shed, and later a hay storage facility were constructed. A 650 ft. length (32-acre) center pivot was donated by Valmont Industries with the help of Jarmon Irrigation and erected in 1986. Water from the Dolores Project was delivered to the research center for the first time in June 1987. The Dolores Water Conservancy District and the Southwestern Water Conservation District contributed funds for the development of the research center. **The name 'Southwestern Colorado Research Center' (SWCRC) was officially given to this research facility in 1984.** In 1988, 30 acres one-half mile north of the research center was leased to conduct research on dryland cropping systems.

Personnel

Southwestern Colorado Research Center	P.O. Box 233 16910 County Road Z Yellow Jacket, CO 81335	Phone 970-562-4255 Fax 970-562-4254
Mark Stack	Manager	mark.stack@colostate.edu
Dr. Abdel Berrada (Arkansas Valley Res. Ctr.)	Research Scientist/Scholar III	abdel.berrada@colostate.edu Phone 719-254-6312
Jerry Mahaffey	Technician III	Phone 970-562-4255
Cooperative Extension	109 W. Main Street, Room 102 Cortez, CO 81321 409 N. Main Street Dove Creek, CO 81324	Phone 970-565-3123 Fax 970-564-8615 Phone 970-677-2283 Fax 970-677-2860
Jan Sennhenn	Montezuma County Ext. Director	jsennhen@coop.ext.colostate.edu
Dan Fernandez	Dolores County Ext. Director	danfern@coop.ext.colostate.edu
Tom Hooten	Montezuma County Ext. Agent	thooten@coop.ext.colostate.edu
Robert Hammon	Tri-River Area Ext. Agent Entomology/Agronomy	bhammon@co.mesa.co.us
Faculty Cooperators **Colorado State University** **Fort Collins, CO 80523**	Dept. of Soil and Crop Sciences	Phone 970-491-6517 Fax 970-491-0564
Dr. Mark Brick Professor	Bean Breeding	mark.brick@colostate.edu
Dr. Joe Brummer Research Scientist	Western Colorado Res. Center Forage	joe.brummer@colostate.edu
Dr. Jessica Davis Professor	Extension Soils Specialist	jessica.davis@colostate.edu
Dr. Scott Haley Professor	Wheat Breeding	scott.haley@colostate.edu
Dr. Jerry Johnson Research Scientist	Extension Crop Production Specialist	jjj@lamar.colostate.edu
Dr. Gary Peterson Professor	Department Head	gary.peterson@colostate.edu
Dr. Dwayne Westfall Professor	Soil Fertility	dwayne.westfall@colostate.edu

Advisory Committee

The mission of the Southwestern Colorado Research Center is to conduct research and demonstration projects to meet the needs of agriculture in southwestern Colorado. The Advisory Committee of the Southwestern Colorado Research Center is made up of members of the local farming and agri-business community. Members meet annually to review the research at the Southwestern Colorado Research Center and to discuss future research priorities.

Advisory Committee Chairmen		
2005	Jack Knuckles	Dove Creek, CO
2004	Joe Mahaffey	Yellow Jacket, CO
2003	Gene Donovan	Pleasant View, CO
2002	Walter Henes	Pleasant View, CO
2001	Scott Mahaffey	Yellow Jacket, CO
2000	Brian Wilson	Pleasant View, CO
1999	Bruce Riddell	Dove Creek, CO
1998	Kalen Elliott	Durango, CO

Historically, the San Juan Basin Research Center, Hesperus (animal science and range management) and the Southwestern Colorado Research Center (soil and crop sciences) held a combined Advisory Committee meeting composed of members appointed by both Research Centers. Since 1999, both Research Centers have organized their own Advisory Committee to better focus the discussion and receive input from their clientele.

The Southwestern Colorado Research Center thanks the many members of the agricultural community who have served on our Advisory Committee.

Climate and Soils

Long-term weather records (1971-2000) for Yellow Jacket indicate the annual precipitation mean is 15.9 inches. Average total snowfall is 68.1 inches. June is the driest month. The mean temperature is 48.0°F (1971-2000). The frost-free period is 100 to 120 days. The Research Center lies at an elevation of 6900 ft., latitude 37°32' N and longitude 108°44' W. Tables 1 and 2 are summaries of the precipitation and temperature data for Yellow Jacket (www.wrcc.dri.edu).

The principal soil series at the Research Center is Wetherill loam (fine-silty, mixed, superactive, mesic Aridic Haplustalfs). Subsoils have high clay content. The Wetherill Series are very deep, well drained, and situated on mesas and hills. The parent material is eolian derived from sandstone. The color is yellowish red. The infiltration rate of Wetherill is approximately one-half inch per hour. Its water holding capacity averages from 1.8 to 2.0 inches per foot with low organic matter content (1%). The soil pH normally ranges from 7.2 to 7.8. Topography of the region is generally rolling. Slopes vary from 1 to 12% at an elevation of 6,200 to 7,400 ft. Wind and water erosion can both be problems if the soil is not protected (Price et al., 1988; Ramsey, 1997).

References

Price, A.B., W.D. Nettleton, G.A. Bowman, and V.L. Clay. 1988. Selected properties, distribution, source, and age of eolian deposits and soils of southwest Colorado. Soil Sci. Soc. Am. J. 52:450-455.

Ramsey, D.K. 1997. Soil survey of Cortez area, Colorado, parts of Dolores and Montezuma Counties. USDA, NRCS.

Table 1. Monthly Precipitation at Yellow Jacket, CO in 1994-2004.[1]

	inches											
	1971-2000	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
January	1.20	0.38	1.78	0.79	2.18	0.88	0.19	1.33	1.88	0.0	0.23	0.37
February	1.30	1.44	0.44	0.70	1.16	1.98	0.51	0.97	1.14	0.0	2.71	1.52
March	1.37	1.15	3.76	0.59	0.0	2.19	0.03	1.60	0.60	0.31	1.92	0.12
April	0.92	2.78	0.92	0.30	1.40	0.72	2.70	0.55	1.48	0.06	0.10	2.92
May	1.32	1.36	2.28	0.13	1.70	0.50	1.83	0.09	0.87	0.15	0.85	0.0
June	0.59	0.27	0.88	1.79	0.31	0.05	1.17	0.56	0.13	0.01	0.17	0.40
July	1.53	0.43	1.81	1.84	2.72	2.23	1.51	1.03	0.72	0.28	0.60	1.65
August	1.65	1.10	1.82	0.38	2.32	0.41	3.07	3.35	3.06	1.09	0.53	0.69
September	1.54	1.89	1.56	1.69	2.71	0.78	1.21	1.45	0.24	3.60	2.55	4.94
October	1.95	1.72	0.0	4.28	1.72	3.33	0.0	2.02	0.50	2.39	1.02	2.71
November	1.53	1.53	0.31	2.02	1.16	2.30	0.26	1.26	0.93	0.24	1.10	1.13
December	1.04	1.28	0.11	1.29	0.80	0.11	0.32	0.65	1.30	0.61	0.37	no data
Total	15.94	15.33	15.67	15.80	18.18	15.48	12.80	14.86	12.85	8.74	12.15	16.45

Table 2. Monthly Average Temperature at Yellow Jacket, CO in 1994 to 2004.[1]

	degrees Fahrenheit											
	1971-2000	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
January	26.8	29.6	28.1	30.1	27.4	30.6	34.1	32.3	27.0	27.5	33.8	24.6
February	31.2	28.7	39.5	36.3	30.0	29.3	36.8	37.1	32.7	27.8	31.4	25.5
March	37.7	42.6	40.8	40.6	40.8	37.2	45.2	39.4	40.3	36.0	35.7	43.9
April	45.3	46.8	44.2	47.8	43.6	43.4	42.4	51.0	47.8	53.0	44.9	46.3
May	54.4	56.0	50.1	60.5	56.9	55.1	53.0	60.5	59.3	58.7	58.0	58.3
June	64.8	69.2	60.7	68.4	64.5	63.4	63.8	68.2	68.5	71.0	67.3	65.2
July	70.5	72.4	69.4	73.0	70.2	72.6	71.6	72.9	72.6	75.5	75.7	70.3
August	68.7	72.3	71.8	71.6	68.0	72.0	68.0	72.3	68.9	71.3	70.3	67.1
September	61.2	63.1	62.8	59.8	63.7	66.4	61.1	64.0	65.2	62.1	61.7	59.2
October	50.0	49.0	50.8	48.5	49.6	50.9	55.0	50.5	53.4	48.3	55.1	47.9
November	36.7	33.4	42.7	38.3	37.1	39.3	46.0	31.5	40.8	38.0	36.3	37.1
December	28.8	34.0	34.0	29.9	28.5	32.1	30.9	29.8	no data	28.1	31.0	no data
Total	48.0	49.8	49.6	50.4	48.3	49.3	50.7	50.8	52.4	49.8	50.1	49.6

[1]The data are from the National Weather Service Cooperative Observer Program weather station located 1 mile west and 1.5 miles south of the Research Center. In 2003, their weather station was moved to a location 4 miles east and 1 mile north of the Research Center. Arthur Wilson, a Yellow Jacket farmer and volunteer observer, operated the station until 2003.

Forage Yields of 20 Alfalfa Varieties at the Southwestern Colorado Research Center at Yellow Jacket in 2000-2004

Mark Stack, Abdel Berrada, and Tom Hooten

Summary

An alfalfa variety trial was planted in 2000 and evaluated over a four-year period. In the establishment year, a planting date of June 2 was too late to allow for more than one cutting. In 2001, the first full year, the alfalfa trial averaged 8.25 tons/acre. This relatively high yield may be attributed to the new stand and harvesting only one cutting the previous year. In 2002, alfalfa was damaged by cold spring temperatures. The first cutting yield of 1.65 tons/acre was below average. As a result, the total yield for 2002 was only 5.85 tons/acre. In 2003, the alfalfa variety trial averaged 6.14 tons/acre for three cuttings notwithstanding an army cutworm infestation and a late summer hailstorm. The combined 4-year total yield (2001, 2002, 2003, and 2004) for each alfalfa variety shows that the 12 highest yielding varieties were not statistically different. There were significant yield differences for each cutting and for each year except for the second cutting in 2001. Ranger, the check variety, was the lowest yielding variety in each year.

Introduction and Objectives

Alfalfa variety performance tests conducted under local conditions provide growers with information to assist them in selecting varieties for their own farm. Variety tests also provide seed companies, seed dealers, and consultants with information to evaluate and recommend varieties.

In southwestern Colorado, alfalfa is the main crop in terms of acreage, production, and cash value. In 2001, 86,000 acres of alfalfa were harvested in the five counties of southwestern Colorado (Archuleta, Dolores, La Plata, Montezuma, and San Miguel). Approximately 85% of this acreage was irrigated (Colorado Agricultural Statistics Service, 2003). The majority of the irrigated areas are served by older water delivery systems. The Dolores Project, a pressurized irrigation system developed by the Bureau of Reclamation, supplies irrigation water to the Dove Creek/Yellow Jacket area and to the Ute Mountain Ute Indian Reservation. The average growing season is 120 days with annual precipitation of 15.9 inches. One-half of the precipitation is received as snow with June being the driest month. The major soil series is Wetherill clay loam with a water holding capacity of 1.8 to 2.0 inches per foot and soil organic matter content of 1%. The soils are generally low in phosphorus and high in potassium. The elevation where alfalfa is produced ranges from 5,500 ft. to 7,000 ft.

Average irrigated alfalfa yields in 2001 ranged from 2.60 tons/acre in Archuleta County to 4.35 tons/acre for Montezuma County (Colorado Agricultural Statistics Service, 2003). The Dolores Project lands in the Dove Creek/Yellow Jacket area averaged 4.20 tons/acre in 2001.

There are usually three cuttings per year. They are typically done in June, late July, and September. Alfalfa varieties recommended have dormancy ratings of 3 to 5. The primary insects and diseases in the area are pea aphids, thrips, crown and root rots, and alfalfa weevils in the lower elevation areas. The interaction between stem nematodes and root and crown rots is receiving increased attention in the area.

The winters of 2001-02 and 2002-03 were extremely dry with below average snowpack in the mountains. The record low stream runoffs resulted in limited irrigation water supplies in southwestern Colorado. The dry soil moisture conditions going into the growing season and a shortage of irrigation water made it difficult for area growers to meet the water requirements of the alfalfa crop. Most growers had enough irrigation water for only one or two cuttings each year. The Southwestern Colorado Research Center was able to reallocate water from other crops to provide adequate water for the alfalfa variety trial during this period.

Alfalfa hay quality in southwestern Colorado is good to excellent due to dry weather and relatively few disease and insect problems. The older irrigated areas of southwestern Colorado produce alfalfa targeted either for their own livestock operations or for livestock operations in the Four Corners area. A significant market for alfalfa hay has been developed with members of the nearby Indian tribes. A majority of the alfalfa produced under the Dolores Project is marketed to dairies in the southwestern United States.

Materials and Methods

The alfalfa variety trial was planted on June 2, 2000. A randomized complete block design with four replications was used for the trial. The trial was seeded with a Kincaid cone planter at 20 lbs/acre. A Carter Forage Plot Harvester (sickle-bar) was used to harvest the plots. Pursuit herbicide was used in the seeding year to achieve a weed-free stand. A good to excellent alfalfa stand was obtained. Phosphate fertilizer (200 lbs P_2O_5/acre) was broadcast in 2001. Mustang Max insecticide was applied on April 11, 2003 to control a severe army cutworm infestation. A wheel-line irrigation system and sprinklers with a single nozzle (40 ft. spacing) was used to irrigate the variety trial. Wheel-line moves were 60 ft. initially. This spacing was modified in 2002 and a spreader nozzle was added to improve irrigation efficiency. Irrigation water applied per acre in 2001, 2002, 2003, and 2004 was 19.5, 30.0, 34.5, and 27.0 inches, respectively. Precipitation for 2001, 2002, 2003, and 2004 was 10.0, 8.5, 9.3, and 15.4 inches, respectively.

Results and Discussion

Only one cutting was made in the seeding year due to the late planting date. The results for 2000 are not included in this report due to high variability in the data caused by hot and dry conditions during the summer. The average yield for the initial cutting in 2000 was 1.71 tons/acre.

In 2001, the average yield for all three cuttings was 8.25 tons/acre. This relative high yield for the area may be due to the new stand and harvesting only one cutting during the establishment year. The results are shown in Table 1.

In 2002, the variety trial averaged 5.85 tons/acre with a first cutting average of 1.65 tons/acre (Table 2). The alfalfa trial was damaged by cold weather in April and early May. On April 21, the temperature dropped to 21.9°F. The alfalfa never recovered from the freeze damage and the first cutting yields were well below average. The high variability (CV%) for the first and second cuttings may be primarily due to lack of winter moisture, freeze damage, and poor uniformity of irrigation water application. To improve the irrigation water uniformity, the wheel-line moves were shortened to 40 ft. after the first cutting and a spreader nozzle was added for the third cutting. This practice was continued in 2003 and 2004.

Table 3 shows the 2003 and the 3-year combined yield totals. The varieties are ranked in descending order by total yield. In 2003, the average yield was 6.14 tons/acre. The high variability in the third cutting was due to a severe hailstorm on September 9. It is estimated that the third cutting yield was

reduced by 50% due to leaf loss and broken stems. In 2004, the variety trial averaged 6.81 tons/acre (Table 4).

The combined 4-year total yield (2001, 2002, 2003, and 2004) for each alfalfa variety shows that the 12 highest yielding varieties were not statistically different at the 0.30 significance level. There were significant differences for each cutting and total yields for each year except for the second cutting in 2001. Ranger, the check variety, was the lowest yielding variety in each year.

Acknowledgments

We thank Jerry Mahaffey, Southwestern Colorado Research Center staff member, for his assistance in planting, irrigating, and harvesting the alfalfa variety trial.

References

Colorado Agricultural Statistics Service. 2003. Colorado agricultural statistics. Natl. Agric. Statistics Service and Colorado Dep. of Agric., Lakewood, CO.

Table 1. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2001.[1]

Variety	Brand/Source	1st Cut 6/6/01	2nd Cut 7/20/01	3rd Cut 9/5/01	2001 Total
		----------tons/acre[2]----------			
ZG 9650A*	ABI Alfalfa, Inc.	4.41	2.68	1.90	8.98
Focus HSN	Arkansas Valley Seeds	4.64	2.54	1.65	8.83
DK 134	DeKalb	4.11	3.00	1.69	8.79
WL 327	Germain's Seed	3.68	3.09	1.92	8.70
Award	Asgrow Seed Co.	4.24	2.74	1.70	8.67
Magnum V	Dairyland Seed Co.	3.93	2.85	1.79	8.58
DK 142	DeKalb	3.76	2.92	1.83	8.51
Pro Gro	MBS Genetics	3.76	2.70	1.97	8.42
Aspire	Asgrow Seed Co.	4.05	2.62	1.74	8.41
DK 143	DeKalb	3.89	2.67	1.83	8.39
Baralfa 54	Barenbrug USA	3.73	2.63	1.97	8.33
Millennia	IFA	3.75	2.58	1.94	8.26
Forecast 1001	Dairyland Seed Co.	3.59	2.63	1.92	8.14
Archer II	America's Alfalfa	3.78	2.38	1.93	8.09
AmeriGraze 401+Z	America's Alfalfa	3.48	2.60	1.78	7.85
WL 325HQ	Germain's Seed	3.63	2.57	1.55	7.75
Abound	Asgrow Seed Co.	3.59	2.30	1.86	7.74
Geneva	Novartis Seeds	3.27	2.55	1.87	7.69
ZX 9652*	ABI Alfalfa, Inc.	3.46	2.43	1.73	7.61
Ranger	Public	3.42	2.27	1.39	7.07
Average		**3.81**	**2.64**	**1.80**	**8.25**
CV%		12.98	16.31	14.52	9.52
$LSD_{(0.30)}$		0.37	NS	0.19	0.58

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/2/00.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
*Indicates experimental entry.

Table 2. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2002.[1]

Variety	Brand/Source	1st Cut 6/14/02	2nd Cut 7/24/02	3rd Cut 9/25/02	2002 Total	2-Year Total
		tons/acre[2]				
Magnum V	Dairyland Seed Co.	2.27	1.80	2.44	6.52	15.10
Baralfa 54	Barenbrug USA	1.59	2.22	2.47	6.29	14.62
WL 327	Germain's Seed	1.80	2.00	2.47	6.27	14.97
Millennia	IFA	1.80	1.93	2.50	6.23	14.49
Aspire	Asgrow Seed Co.	2.00	1.61	2.59	6.20	14.61
Geneva	Novartis Seeds	1.60	2.17	2.36	6.13	13.82
ZG 9650A*	ABI Alfalfa, Inc.	1.50	1.92	2.65	6.06	15.04
Pro Gro	MBS Genetics	1.46	2.15	2.38	5.99	14.41
DK 142	DeKalb	1.81	1.68	2.45	5.93	14.44
Forecast 1001	Dairyland Seed Co.	1.61	1.89	2.39	5.89	14.03
Focus HSN	Arkansas Valley Seeds	1.88	1.61	2.40	5.88	14.71
ZX 9652*	ABI Alfalfa, Inc.	1.63	1.91	2.33	5.87	13.48
Archer II	America's Alfalfa	1.47	1.84	2.54	5.85	13.94
DK 134	DeKalb	2.00	1.47	2.34	5.81	14.60
DK 143	DeKalb	1.27	2.12	2.41	5.80	14.19
WL 325HQ	Germain's Seed	1.74	1.79	2.14	5.66	13.41
AmeriGraze 401+Z	America's Alfalfa	1.45	1.89	2.29	5.63	13.48
Award	Asgrow Seed Co.	1.62	1.64	2.33	5.59	14.26
Abound	Asgrow Seed Co.	1.23	2.10	2.21	5.54	13.28
Ranger	Public	1.33	1.28	1.36	3.98	11.05
Average		**1.65**	**1.85**	**2.35**	**5.85**	**14.10**
CV%		30.57	24.83	7.96	10.27	7.81
$LSD_{(0.30)}$		0.37	0.34	0.14	0.44	0.81

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/2/00.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
*Indicates experimental entry.

Table 3. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2003.[1]

Variety	Brand/Source	1st Cut 6/9/03	2nd Cut 8/5/03	3rd Cut 9/24/03	2003 Total	3-Year Total
		tons/acre[2]				
ZG 9650A*	ABI Alfalfa, Inc.	2.99	2.56	0.77	6.32	21.36
Magnum V	Dairyland Seed Co.	3.05	2.28	0.83	6.16	21.26
Baralfa 54	Barenbrug USA	3.08	2.56	0.99	6.63	21.25
Millennia	IFA	3.11	2.71	0.88	6.70	21.19
WL 327	Germain's Seed	2.96	2.44	0.75	6.15	21.12
DK 134	DeKalb	2.93	2.51	0.87	6.31	20.91
Forecast 1001	Dairyland Seed Co.	3.32	2.54	0.98	6.84	20.87
Focus HSN	Arkansas Valley Seeds	2.75	2.60	0.74	6.09	20.80
Pro Gro	MBS Genetics	3.07	2.47	0.83	6.37	20.78
DK 142	DeKalb	2.84	2.62	0.76	6.22	20.66
DK 143	DeKalb	2.87	2.61	0.79	6.27	20.46
Award	Asgrow Seed Co.	2.77	2.49	0.77	6.03	20.29
Aspire	Asgrow Seed Co.	2.48	2.38	0.80	5.66	20.27
Geneva	Novartis Seeds	3.04	2.49	0.87	6.40	20.22
Archer II	America's Alfalfa	2.94	2.49	0.80	6.23	20.17
ZX 9652*	ABI Alfalfa, Inc.	2.85	2.34	0.82	6.01	19.49
AmeriGraze 401+Z	America's Alfalfa	2.79	2.40	0.72	5.91	19.39
WL 325HQ	Germain's Seed	2.89	2.35	0.67	5.91	19.32
Abound	Asgrow Seed Co.	2.81	2.33	0.68	5.82	19.10
Ranger	Public	2.45	1.90	0.42	4.77	15.82
Average		**2.90**	**2.45**	**0.79**	**6.14**	**20.24**
CV%		6.04	5.38	14.97	5.27	6.00
$LSD_{(0.30)}$		0.13	0.10	0.09	0.24	0.90

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/2/00.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
*Indicates experimental entry.

Table 4. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2004.[1]

Variety	Brand/Source	1st Cut 6/10/04	2nd Cut 8/4/04	3rd Cut 10/15/04	2004 Total	4-Yr Total
		tons/acre[2]				
ZG 9650A*	ABI Alfalfa	3.47	2.37	1.28	7.12	28.48
Millennia	IFA	3.37	2.37	1.36	7.12	28.31
Baralfa 54	Barenbrug USA	3.53	2.28	1.15	6.96	28.21
Forecast 1001	Dairyland Seed Co.	3.49	2.46	1.31	7.26	28.13
Magnum V	Dairyland Seed Co.	3.31	2.29	1.18	6.78	28.04
WL 327	Germain's Seed	3.20	2.36	1.35	6.91	28.03
Pro Gro	MBS Genetics	3.41	2.36	1.24	7.00	27.78
DK 134	DeKalb	3.26	2.30	1.28	6.84	27.75
Focus HSN	Arkansas Valley Seeds	3.31	2.27	1.24	6.83	27.63
Geneva	Novartis Seeds	3.52	2.42	1.40	7.33	27.55
DK 142	DeKalb	3.27	2.27	1.27	6.82	27.48
DK 143	DeKalb	3.49	2.28	1.25	7.01	27.47
Award	Asgrow Seed Co.	3.41	2.28	1.26	6.95	27.24
Archer II	America's Alfalfa	3.31	2.25	1.21	6.77	26.94
Aspire	Asgrow Seed Co.	3.12	2.19	1.31	6.63	26.90
AmeriGraze 401+Z	America's Alfalfa	3.21	2.31	1.31	6.83	26.22
ZX 9652*	ABI Alfalfa	3.07	2.24	1.19	6.50	25.99
Abound	Asgrow Seed Co.	3.28	2.24	1.20	6.73	25.83
WL 325HQ	Germain's Seed	3.18	2.11	1.08	6.37	25.69
Ranger	Public	2.88	1.89	0.68	5.45	21.27
Average		**3.30**	**2.28**	**1.23**	**6.81**	**27.05**
CV%		6.40	4.94	7.15	4.55	5.23
$LSD_{(0.30)}$		0.16	0.08	0.06	0.23	1.05

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/2/00.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
*Indicates experimental entry.

Forage Yields of 20 Alfalfa Varieties at the Southwestern Colorado Research Center at Yellow Jacket in 1996-1999[1]

Abdel Berrada

Variety	Brand/Source	1st Cut 25-Jun	2nd Cut 02-Aug	3rd Cut 04-Oct	1999 Total	1998 Total	1997 Total	1996[2] Total	4-YR Total
		tons/acre[3]							
Blazer XL	Sharp Bros. Seed Co.	2.35	1.87	1.08	5.31	7.15	7.95	3.68	24.09
5472	Pioneer Hi-Bred Int'l.	2.40	2.16	1.18	5.74	7.57	7.34	3.28	23.93
330	Union Seed Co.	2.22	1.85	1.12	5.19	7.54	7.78	3.33	23.85
Reward	Drussel Seed & supply	2.30	2.15	1.26	5.71	7.59	7.09	3.37	23.78
5454	Pioneer Hi-Bred Int'l.	2.22	2.07	1.07	5.36	7.49	7.26	3.24	23.35
Sterling	Cargill Hybrid Seeds	2.10	1.91	1.07	5.08	7.02	7.46	3.61	23.16
Rushmore	Novartis	2.14	1.86	0.98	4.98	7.44	7.48	3.17	23.08
ZX 9345	ABI Alfalfa	2.11	1.90	1.10	5.11	7.09	7.35	3.48	23.03
Innovator + Z	ABI Alfalfa	2.15	1.83	0.98	4.96	7.12	7.17	3.36	22.61
Archer	ABI Alfalfa	2.22	1.99	1.03	5.24	7.01	7.15	3.22	22.61
Evergreen	Arkansas Valley Seed	2.03	1.83	0.91	4.77	7.00	7.16	3.53	22.46
WL 323	W-L Research, Inc.	2.07	1.77	0.81	4.65	7.04	7.57	3.20	22.45
Affinity + Z	ABI Alfalfa	2.10	1.83	0.85	4.78	6.90	7.29	3.31	22.27
Vernema	Southwest Seed, Inc.	2.18	1.83	0.93	4.94	6.97	7.08	3.21	22.20
WL 325	W-L Research, Inc.	2.14	1.96	1.06	5.17	7.08	6.86	3.03	22.15
AlfaLeaf II	Cal/West Seeds	2.14	1.67	0.80	4.61	7.15	7.26	3.06	22.08
Depend + E	ABI Alfalfa	2.16	1.93	0.94	5.02	6.79	6.99	3.11	21.91
DK 127	DeKalb Genetics Corp.	1.91	1.87	0.97	4.76	7.05	6.89	2.95	21.64
WL 252HQ	W-L Research, Inc.	2.05	1.75	1.02	4.81	6.84	6.90	3.08	21.62
Ranger	Arkansas Valley Seed	1.78	1.80	0.77	4.34	6.77	6.71	2.93	20.75
Average		**2.14**	**1.87**	**1.00**	**5.03**	**7.13**	**7.24**	**3.26**	**22.65**
CV%					**12.22**	**5.56**	**6.20**	**7.00**	**6.51**
$LSD_{(.05)}$					**0.87**	**0.32**	**0.63**	**0.44**	**2.09**

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/15/96.
[2]There were only two cuttings in 1996.
[3]Yields were calculated on an oven-dry basis.

Comments: In 1999, frequent rains in late July and August delayed the second and third cuttings. This resulted in poor hay quality for the second cutting and low yields for the third cutting. Grass and dandelions gradually invaded the trial which may have contributed to the lower yield in 1999.

Irrigated Alfalfa Response To Water Deficit Using Subsurface Drip Irrigation[1]

Abdel Berrada

ABSTRACT

The recent drought and expanding alfalfa acreage in southwestern Colorado, under the Dolores Irrigation Project, led to high water usage in 2000 and 2001 and water shortages in 2002 and 2003. Consequently, there has been renewed interest in research and education to enhance water conservation and management in southwestern Colorado. In this context, a field experiment was conducted in 2002 and 2003 to investigate the effect of water stress on alfalfa dry matter (DM) yield and hay quality. Three water stress levels (low, moderate, and severe) were imposed on three alfalfa cultivars (AmeriGraze 401+Z, Archer II, and Innovator+Z) with contrasting dormancy ratings, in a split-block design. In the least stressed treatment, soil water content in the root zone (0 to 6 ft.) was maintained at approximately 50% of available water capacity (AWC) throughout each growth period. In the moderate and severe stress treatments, soil water content was maintained at 50% AWC during the first two weeks of each growth period and at either 25% AWC (moderate) or ≤10% AWC (severe) thereafter. The irrigation system used was subsurface drip irrigation (SDI) with 60-in. lateral spacing and 18-in. placement depth. Total alfalfa DM production (adjusted to 12% moisture) averaged 5.7 tons/ac in 2002 and 5.3 tons/ac in 2003, with no significant differences among cultivars. Alfalfa DM production increased significantly with increasing amounts of irrigation. A hailstorm on September 9, 2003 reduced alfalfa yield at the third cut, particularly in the least and moderately stressed water treatments. Alfalfa protein concentration averaged 21% in 2002 and 2003, with no significant differences among cultivars or irrigation treatments. Alfalfa relative feed value (RFV) was highest in the most stressed treatment and lowest in the least stressed treatment. Alfalfa water use efficiency averaged 395 to 467 lbs of DM per inch of water (precipitation + irrigation + change in soil water) in 2003. It took 4.5 inches of water to produce one ton of alfalfa hay in the least stressed treatment and 5.1 inches in the most stressed one. More water, 5.3 to 6.1 inches, would have been required to produce one ton of hay with the predominant irrigation system (sideroll) in the Full Service Area of the Dolores Project. Visual observations suggest that 40-in. lateral spacing would be suitable for alfalfa hay production with SDI. Research is needed to determine the optimum drip tape lateral spacing and placement depth for alfalfa and other crops grown in southwestern Colorado. Initial cost, maintenance, and gopher control are among the challenges that could hamper the use of SDI for field crop production in southwestern Colorado.

[1]Published March 2005 as Colorado Agricultural Experiment Station Technical Bulletin TB05-01.

Irrigated Alfalfa Response To Phosphorus And Potassium In A Calcareous Soil[1]

Abdel Berrada and Dwayne G. Westfall

ABSTRACT

The response of alfalfa (*Medicago sativa* L.) to P and K fertilizer often varies with soil type, the initial soil test P and K levels, irrigation and harvest management, and yield level. The objectives of this study were to determine the response of irrigated alfalfa to P and K fertilizer on a Wetherill loam soil in southwestern Colorado and to assess the impact on soil test P and K levels. Four P_2O_5 (0, 75, 150, and 300 lbs/ac) by three K_2O (0, 100, and 200 lbs/ac) rates were applied to newly seeded alfalfa in the fall of 1995. An additional 75 lbs P_2O_5/ac was applied annually to half of each plot in the spring of 1997, 1998, and 1999. Potassium fertilizer increased alfalfa dry matter (DM) yield significantly in 1996 only. Alfalfa K uptake averaged 278 lbs/ac/yr in 1997-1999. Soil test K level at the 0- to 12-in depth was not impacted by K fertilization and remained above the critical level throughout the duration of the study. Based on these and other research results, a response to K fertilization is unlikely on most alfalfa producing soils in Colorado, due to their high K buffering capacity.

The initial application of 75 to 300 lbs P_2O_5/ac did not affect alfalfa DM production significantly in 1996, 1997, 1998, and in total from 1996 through 1999. Alfalfa DM increased by a total of 1.4 tons/ac in 1997 through 1999, with 75 lbs P_2O_5/ac/yr when no P was applied initially. Both the initial and annual P fertilizer applications increased alfalfa P concentration significantly in 1997 through 1999. Alfalfa P uptake averaged 29 lbs/ac/yr. Similarly, the initial and/or annual P application increased soil ammonium bicarbonate-diethylenetriaminepentaacetic acid (AB-DTPA) extractable P significantly in 1998 through 2000. When no P was applied, soil test P level at the 0- to 6-in depth dropped from 8.3 ppm at the initiation of the study in Aug. 1995 to less than 1.0 ppm at study termination in Apr. 2000. It took a total of approximately 307 lbs P_2O_5/ac to raise soil test P to its initial level after four years of production. Over 532 lbs P_2O_5/ac would have been required to raise soil test P level to where a response to P fertilization would not be expected. Alfalfa yield response to P fertilizer was small even when soil test P level dropped to well below the critical level. No yield advantage was observed to maintaining soil test P above the critical level. Although not conclusive, our results indicate that annual P fertilizer applications are superior to one-time applications on our calcareous soils. More research is needed to refine P fertilizer recommendations and soil test correlation relationships for irrigated alfalfa hay production in southwestern Colorado.

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Does Colorado Alfalfa Need Boron?

Boron rate studies in Colorado show fertilization is beneficial only under certain conditions.

Jessica Davis, Abdel Berrada, and Ron Meyer[1]

Alfalfa is known to have a high boron (B) requirement and boron fertilization is commonly recommended back East. Boron fertilizer is sometimes recommended for alfalfa in Colorado although, in general, our soils have plenty of boron to supply the requirements of a vigorous alfalfa crop. Soils most likely to be low in boron are those with a pH near 8.5, low organic matter levels, and a sandy texture. Alfalfa rarely displays boron deficiency symptoms prior to the first cutting. Later in the season, one may observe bunchy, rosette growth due to shortened stems, yellowish red coloration of younger leaves, and eventually death of the terminal bud. These symptoms are signs of possible boron deficiency.

In 1997 and 1998, we studied alfalfa yield response to boron at two different test sites. In each test, soil samples were taken prior to test initiation to confirm that soil boron levels were low (<0.1 ppm). Alfalfa tests were located near Yellow Jacket in southwestern Colorado and in the sandhills near Wray in northeastern Colorado. We evaluated five boron application rates: 0, 0.5, 1.0, 2.0, and 4.0 lbs B/A. Solubor (from U.S. Borax) was used as the boron source and was applied prior to the first irrigation; the 4 lbs/A rate was split into two applications before and after the first irrigation in order to avoid burning.

There was no effect of B application rate on alfalfa yield at either location, either by individual cutting or total yield (Tables 1, 2, and 3). We intentionally placed each of these tests under conditions where we thought a B response was probable. Locations had low soil B and low soil organic matter levels. The Wray site was also sandy. However, we still did not get measurable yield responses.

These results could be due to high B levels in the irrigation water. Irrigation water samples (92) from the South Platte Basin had an average B concentration of 0.52 ppm with a range from 0.03 ppm up to 2.30 ppm. If a crop consumes 30-36 inches of water/year, it would take up 3.5-4.2 lbs B/year using “average” irrigation water. This is probably the main reason we have not measured yield responses to B in this area of the state. However the Wray site uses water from the Ogallalla Aquifer which we would expect to have a lower B concentration, and the Yellow Jacket irrigation water tested at 0.02 ppm B. A boron concentration of 0.3 ppm in irrigation water would supply 2 lbs B/A (based on 30 inches of consumptive water use). Therefore, yield increases in alfalfa are most likely when soil B is less than 0.1 ppm and water B is less than 0.3 ppm. When soil and water levels are above these critical levels, B fertilizer application will probably not increase alfalfa yields.

[1]Ron Meyer is Extension Agronomist, Kit Carson County.

Table 1. Impact of boron application rate on alfalfa yield results (tons/ac) in 1997 near Yellow Jacket, CO.

B rate (lbs/acre)	First Cutting	Second Cutting	Third Cutting	Total
0	3.00	2.31	1.44	6.75
0.5	2.73	2.37	1.44	6.54
1.0	2.85	2.33	1.40	6.58
2.0	2.74	2.37	1.44	6.55
4.0	2.92	2.32	1.49	6.73

Table 2. Impact of boron application rate on alfalfa yield results (tons/ac) in 1998 near Yellow Jacket, CO.

B rate (lbs/acre)	First Cutting	Second Cutting	Third Cutting	Total
0	2.50	1.95	1.28	5.73
0.5	2.58	1.94	1.31	5.83
1.0	2.54	1.94	1.25	5.73
2.0	2.53	1.94	1.30	5.77
4.0	2.55	1.93	1.34	5.82

Table 3. Impact of boron application rate on alfalfa yield results (tons/ac) in 1998 near Wray, CO.

B rate (lbs/acre)	First Cutting	Second Cutting	Third Cutting	Fourth Cutting
0	1.74	1.59	1.30	1.63
0.5	1.91	1.52	1.32	1.62
1.0	1.85	1.54	1.26	1.45
2.0	1.77	1.50	1.24	1.60
4.0	1.84	1.60	1.19	1.58

Dry Bean Research at the Southwestern Colorado Research Center
Yellow Jacket, CO

Mark Stack and Mark Brick

The Southwestern Colorado Research Center conducts a dryland pinto bean breeding program in collaboration with Dr. Mark Brick, the Colorado State University dry bean breeder. This nursery includes early and advanced generation lines and a dryland pinto bean variety trial. In addition, the Research Center cooperates with Dr. Jerry Johnson, CSU Crops Testing Program, to plant and harvest an irrigated pinto bean variety trial.

Southwestern Colorado is one of the few areas in Colorado that produces dry beans in a low rainfall area without the benefit of irrigation water. The long-term annual average precipitation in the San Juan Basin is 16 inches. Winter precipitation is critical to recharge the soil profile and provide moisture for seed germination and early plant growth. Beans are planted in late May to early June. Seed germination and plant development coincides with the driest weather of the year. The bean plant must survive until summer rains provide adequate moisture for growth and pod fill. Subsequently, the beans must mature and dry for harvest by mid-September to avoid the fall freeze. In 2004, 21,800 acres of dryland pinto beans were harvested with an average yield of 350 lbs/acre in Dolores and Montezuma Counties (Colorado Agricultural Statistics Service, 2005).

The variety 'San Juan Select' pinto bean was released in 1946. San Juan Select was the primary pinto variety grown in southwestern Colorado until 1981, when 'Cahone' was released by Colorado State University. Cahone is still the predominant pinto grown on dryland in southwestern Colorado. In 1994, 'Fisher' was released by Colorado State University for dryland pinto production. Fisher is more susceptible to environmental conditions and is not widely planted.

The goal of the breeding program at the Southwestern Colorado Research Center is to broaden the genetic base, improve disease resistance, and improve market quality. The release of Cahone was the result of a concentrated research effort to develop a pinto bean with resistance to Fusarium root rot. Root rot diseases are intensified by continuous bean rotations and soil compaction. Bacterial bean blights can also be a serious problem for dryland bean farmers if contaminated seed is planted or summer storms move bacteria in rain showers.

The dry bean breeding process begins in the greenhouse at Fort Collins. The initial cross between parents with desired traits is made by hand-pollination. The F_1 generation (seed from the initial cross) is also grown in the greenhouse. The succeeding F_2 generation is planted the next summer at Yellow Jacket. The F_3 and succeeding generations are planted at Yellow Jacket from selections made the previous year. Selections are made each year and advanced through the F_5 to F_7 generation. If an advanced generation is judged to have potential, the seed is increased and then planted in a dryland variety trial to compare its performance with Cahone, Fisher, and released varieties. If the selection is considered superior to Cahone (yield, market quality, and disease resistance) it may be considered for release.

The breeding program focuses primarily on pinto beans, but other market classes have been involved, including dryland and irrigated Anasazi beans, and tepary beans (P. coccineus) for improved Fusarium root rot resistance. The breeding nursery currently is evaluating drought and bacterial bean blight resistance lines crossed with Cahone and Fisher.

Irrigated pinto bean production is becoming more important under the Dolores Irrigation Project due to limited irrigation water. Growers are searching for an alternative crop to rotate with alfalfa. Irrigated pinto beans require less water than alfalfa and may be a fit for some growers. In 2004, 1,800 irrigated acres with an average yield of 1,780 lbs/acre were harvested in Dolores and Montezuma Counties (Colorado Agricultural Statistics Service, 2005).

The irrigated uniform pinto bean trial is coordinated by the CSU Crops Testing Program. The same entries are tested at multiple locations in Colorado to evaluate how the pinto entries perform when subjected to different environments. The year 2004 was the sixth consecutive year the uniform trial was planted at Yellow Jacket. Results from the last three years are reported in Johnson et al. (2002, 2003, and 2004).

Beginning in 1997, pinto lines from the CSU bean breeding program targeted for irrigated eastern Colorado were evaluated at Yellow Jacket for their adaptability to southwestern Colorado. These lines do not have rust resistance which is now critical for beans grown in eastern Colorado. Bean rust is not a problem for western Colorado growers. These lines were tested as 'Cortez Prelim.' and 'Experimental Lines' at Yellow Jacket. This screening program ended in 2003 without identifying a pinto bean line that was superior to currently grown irrigated cultivars in southwestern Colorado. However, several lines were identified with upright plant architecture and relative early maturity that may be useful for white mold avoidance.

Zinc deficiencies occur sporadically throughout bean fields in the area. In 1999, a foliar application of 5 and 10 lbs Zn/acre was applied to the variety 'Bill Z'. Bill Z had a significant response to the foliar application of Zn. In 2000, however, there were no statistical differences between varieties, application rates, or application method (preplant or foliar spray).

White mold disease is a major problem affecting irrigated bean production in southwestern Colorado. White mold can seriously impact yield and bean seed quality. Sprinkler irrigation creates an ideal environment for the white mold to sporulate and infect the plants at flowering time. To reduce the damage caused by white mold, growers can reduce plant populations, manage irrigation water, select upright growth habit varieties, and use fungicides that are effective in managing white mold. In 2001, a white mold demonstration study indicated that one or two fungicide applications could significantly increase yields and net returns.

An irrigated market class variety trial was planted in 2000. Blacks, small whites, light red kidneys, one pink, and one Great Northern were evaluated for adaptation to southwestern Colorado. The black bean 'Shiny Crow' appears to be suitable for dryland production in the area. The small white bean entries exhibited severe zinc chlorosis. Additional evaluation is needed to identify adapted alternative market class beans.

References

Colorado Agricultural Statistics Service. 2005. Colorado agricultural statistics. Natl. Agric. Statistics Service and Colorado Dep. of Agric., Lakewood, CO.

Johnson, J.J., H.F. Schwartz, M.A. Brick, F. C. Schweissing, C.H. Pearson, A. Berrada, M. Stack, J.P. Hain, C.L. Johnson, S.J. Nissen, J.B. Ogg, and K. Otto. 2002. Making Better Decisions, 2002 Dry Bean Variety Performance Trials. Colorado Agric. Exp. Stn. Tech. Rep. TR02-9. Fort Collins.

Johnson, J.J., H.F. Schwartz, M.A. Brick, F.C. Schweissing, C.H. Pearson, M. Stack, J.P. Hain, C.L. Johnson, M.M. McMillan, S.J. Nissen, J.B. Ogg, and K. Otto. 2003. Making Better Decisions, 2003 Dry Bean Variety Performance Trials. Colorado Agric. Exp. Stn. Tech. Rep. TR 03-09. Fort Collins.

Johnson, J.J., M.A. Brick, H. Schwartz, S. Nissen, J.P. Hain, C.L. Johnson, M.M. McMillan, J.B. Ogg, K. Otto, F. Peairs, C. Pearson, and M. Stack. 2004. Making Better Decisions, 2004 Dry Bean Variety Performance. Colorado Agric. Exp. Stn. Tech. Rep. TR 04-08. Fort Collins.

Summary of the 2004 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack

In 2004, Yellow Jacket received 15.4 inches of precipitation compared to the long-term average of 16.0 inches. Approximately 50% of the moisture was received during the last four months of the year. This was a big improvement in contrast to the dry years of 2000 thru 2003. There was adequate soil moisture for good germination at planting in the dryland fields. However, Dolores County (Dove Creek) still received below average precipitation for June, July, and August. Yellow Jacket, located just south of the Dolores County line, did receive 2 inches of rain in July which contributed to better bean growth in that area. Irrigated growers in the Yellow Jacket to Dove Creek area received a full supply of irrigation water from the Dolores Project for the first time since 2001. The area received 3 to 4 inches of moisture in September, 1.75 inches in October, and 1.5 inches in November. This extremely wet fall made it difficult for growers to get their beans harvested. Fields were continually rained on while the beans were still in the windrow waiting to be threshed, which resulted in discolored beans**.** It is estimated that 10% of the beans could not be harvested due to the wet weather in the area. Dryland pinto yields were in the range of 2.5 to 3.5 cwt/acre while well-managed irrigated pinto bean fields yielded 20 cwt/acre. The long-term average yield for dryland pintos in this area is 4 to 5 cwt/acre.

Bean yields were limited by cooler summer temperatures and dry conditions following planting. Isolated areas reported hail damage in late July and again in early September. Bacterial bean blights were not observed in irrigated or dryland bean fields. In 2004, white mold was present only at very low levels in irrigated fields. The first hard freeze did not occur until the end of October which helped late maturing bean fields.

The dryland acreage is planted primarily to Cahone pinto beans. Irrigated pinto bean acreage has shifted from Bill Z to Montrose, Poncho, and UI 196. UI 196 was not tested in the irrigated pinto bean trial but area growers reported that it performed very well in 2004. Anasazi beans continue to be grown in limited acreages on both dryland and irrigated fields. There were no reports of white mold being a problem in 2004. White mold still presents a serious threat to sprinkler irrigated fields in southwestern Colorado.

Irrigated Pinto Bean Uniform Variety Trial (Table 1)

The irrigated uniform pinto bean trial was planted for the sixth consecutive year at Yellow Jacket. The trial was planted on spring moldboard plowed alfalfa ground due to dry soil conditions that prevented fall plowing. The ground was pre-irrigated to minimize clods and provide moisture for germination. Slow growth characterized the trial in spite of the pre-irrigation and subsequent irrigations. The trial was damaged by hail on July 23 which resulted in leaf loss and a subsequent delay in the maturity of the beans. Row cultivation was delayed until August 1 to allow the beans to put on additional leaves. A cooler than normal summer may have also delayed the maturity of the beans.

A second hail storm on Sept. 4 bruised the pods but did not result in any shattering of the beans. The fall season was characterized by very wet weather which delayed harvest until Nov. 16. Bean quality was damaged by the hail and the wet weather. Yields were not adjusted for discolored beans since the ranking of the entries would not be significantly changed. For comparison, a commercial field of pinto beans surrounding the trial had 6 – 8% discolored beans when delivered to the warehouse. Outlook herbicide was applied preplant and incorporated. Good weed control was achieved. No bacterial bean blights were noted in the trial and only very low levels of white mold were observed in the trial.

Poncho, Buckskin, and Montrose appear to be well adapted for irrigated production in southwestern Colorado.

Dryland Bean Breeding Nursery and Variety Trial (Table 2)

The goal of the breeding program (Dr. Mark Brick and Barry Ogg) at Yellow Jacket continues to be to broaden the genetic base, improve drought tolerance, improve disease resistance, and improve market quality.

The F_3 nursery consisted of 88 entries planted in single rows and replicated twice. One to three pods were selected from each plant for each entry and bulked for planting in 2005.

The advanced breeding nursery had 7 pinto, 5 Anasazi, and 6 tepary lines. The plots consisted of two rows and were replicated twice. The plots were harvested by hand (20 row-ft. with the plants pulled and bulked). A hail storm on July 23 triggered bacterial bean blight and root rots in the nursery. The data are not presented in this report since it is of limited value. The tepary lines were not affected by bacterial bean blight. The advanced nursery will be repeated in 2005.

The dryland variety trial consisted of 3 advanced lines selected in 2003, 4 experimental lines selected from the advanced nursery prior to 2003, and 5 commercial lines. The data from the dryland pinto bean variety trial are of limited value. The variety trial's average yield (551 lbs/acre) is higher than comparable production fields. The higher yield is due to hand harvest and not discounting discolored or small beans. The trial had poor emergence due to dry weather immediately following planting and was defoliated by hail in a storm on July 23. The hail damage triggered bacterial bean blight and root rots for the experimental lines. The bacterial bean blight may be systemic in the experimental lines. The variety trial benefited from a long growing season. The first freeze did not occur until late October. Montrose performed well under dryland conditions in its second year of testing under dryland conditions.

Table 1. 2004 irrigated pinto bean uniform variety trial at Yellow Jacket.[1]

Variety	Yield	Seeds/lb	Maturity[2]
	lbs/ac	no	
Poncho	2040	1028	L
Buckskin	1960	1018	L
Montrose	1731	1219	L
Buster	1529	1070	L
Pro Vita 00191	1516	1337	L
CO12786	1463	1372	L+
CO96731	1426	1163	L+
Pro Vita 99230	1404	1144	L+
Pro Vita 02225	1331	1031	VL
CO96753	1303	1178	L+
CO83783	1301	1096	VL
Bill Z	1288	1132	M+
Rally	1250	1126	L+
Pro Vita 99232	1237	1044	L
Othello	1222	1109	M
Grand Mesa	1171	1271	L
CO12531	1052	1195	M+
CO12613	935	1122	L+
GTS-900	845	1113	VL
Average	**1368**	**1146**	
CV%	11.5		
$LSD_{(0.05)}$	260		

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/10 and harvested 11/16.
[2]M =medium; L = late; VL = very late.

Site Information:

Soil Type:	Wetherill silty clay loam
Previous crop:	Alfalfa
Tillage:	Spring moldboard plowed
Seeding rate:	Approx. 83,600 seeds/ac (2.5-inch spacing on 30-inch rows)
Fertilizer:	None
Herbicide:	Outlook 18 oz/ac preplant (June 6, 2004) (incorporated with field cultivator)
Insecticide/fungicide:	None
Irrigation:	12.9 inches (6 passes wheel-line sprinkler)
Precipitation:	January 1, 2004 thru August 31, 2004: 8.0 inches (long-term average 9.7 inches)

Table 2. 2004 dryland pinto bean variety trial at Yellow Jacket.[1]

Entry	Yield	Seeds/lb	Notes
	lbs/ac	no	
Montrose	828	1521	good color
Cahone	769	1567	
Bill Z	743	1444	
Fisher	732	1386	
San Juan Select	690	1530	splits
CO90436	525	1489	
CO432	514	1724	
CO438	511	1393	few splits
CO30051	455	1444	
CO90432	417	1494	good color
CO30068	303	1799	
CO30048	127	---	bean blight, root rot disease
Average	**551**		
CV%	18.5		
$LSD_{(0.05)}$	172		

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/14 and harvested 11/3.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow
Tillage:	Fall moldboard plowed
Seeding rate:	Approx. 23,000 seeds/ac (9-inch spacing on 30-inch rows)
Fertilizer:	None
Herbicide:	None
Bactericide:	Kocide DF 2.5 lbs/ac (Sept. 2, 2004)
Insecticide/fungicide:	None
Precipitation:	January 1, 2004 thru August 31, 2004: 8.0 inches (long-term average 9.7 inches)

Summary of the 2003 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack

Southwestern Colorado received below average precipitation for the fourth consecutive year. The total precipitation at Yellow Jacket for 2000, 2001, and 2002 was 11.3, 10.0, and 8.5 inches, respectively. By comparison, the long-term average precipitation for Yellow Jacket is 15.9 inches per year. The January thru August 2003 precipitation was just 6.5 inches (long-term average 9.7 inches).

In 2003, dryland pinto bean farmers in southwestern Colorado experienced a good year in spite of the continuing drought. There was sufficient soil moisture for planting and emergence of the pinto beans. Reported yields for 2003 are in the range of 300 to 550 lbs/acre. Many farmers had fallow ground on which to plant their beans due to insufficient soil moisture at planting time in 2002. In 2002, only 1200 acres of pinto beans were planted with 100 acres harvested due to the drought. In addition, some farmers planted dryland pinto beans in 2003 on land that is normally irrigated due to a shortage of irrigation water. Farmers continued to produce a small quantity of dryland organic pinto beans. Anasazi beans were also grown on limited dryland acreage.

Irrigated pinto bean acreage was up in 2003 due to farmers choosing to irrigate beans rather than alfalfa or small grains that require more irrigation water. In addition, some farmers planted irrigated Anasazi beans under contract to Adobe Milling in Dove Creek. Irrigated bean yields, however, were only in the range of 800 to 1,500 lbs/acre. The low irrigated yields were due to a combination of factors i.e. poor field preparation, poor weed control, and lack of proper bean equipment. Many of the farmers who planted irrigated beans had not farmed beans in a number of years and lacked the knowledge and proper equipment to achieve consistent yields under irrigation. The Dolores Project irrigated land from Yellow Jacket to Dove Creek received only 12.1 inches of irrigation water per acre. Their normal allocation is 22.4 inches. There were no reports of white mold being a serious problem in 2003.

Cahone is the most common dryland pinto bean planted in southwestern Colorado. Fisher pinto bean is preferred by some farmers, primarily on higher elevation ground where it may get more precipitation. Some farmers are also planting Bill Z if they are forced to replant their dryland fields. Bill Z is still the predominate pinto planted on irrigated ground.

Irrigated Pinto Bean Uniform Variety Trial (Table 1)

The irrigated uniform pinto bean trial was planted for the fifth consecutive year at Yellow Jacket. The trial was planted under a 1/8 mile center pivot on ground that slopes to the south. The center pivot is equipped with flexible drops and Nelson rotators. The field was not pre-irrigated. The dry weather resulted in the soil moisture drying out quickly after planting as evidenced by erratic emergence. Even though 0.6 inches/acre of irrigation water was applied immediately after planting, subsequent irrigations were needed to achieve full emergence. Very good weed control was obtained with Pursuit herbicide applied before the beans emerged. No bacterial bean blight or white mold disease was observed in the trial.

The entries preceded by ‘CO’ are experimental lines from the Colorado State University bean breeding program. The remaining entries in the trial are released varieties. The average yield for the trial was 1,709 lbs/acre. The hot and dry conditions and the location of the trial in the field (moderate slope) contributed to the lower than expected yields. The better yielding lines in the trial would not have matured in a normal year. All of the entries in the trial were mature by the September 19 harvest date. A severe storm on September 9 brought 2.15 inches of rain and was accompanied by 1-inch diameter hail. Since most of the pods were still somewhat green, damage from the hail was not significant. There was

only minor seed shattering on the earlier maturing entries. The most serious damage resulting from the storm was from erosion where water followed the tracks left by the cultivator. The resulting ruts between the rows made it difficult to cut the beans. The first freeze did not occur until October 14, 2003.

The recommended irrigated varieties to plant in southwestern Colorado remain Bill Z and Poncho. Montrose is not recommended for planting in southwestern Colorado due to its prostrate growth habit that makes it susceptible to white mold disease. However, Montrose may be suitable for planting in areas of a field that are not conducive to white mold growth. Grand Mesa may be an option for planting in fields with a high probability of white mold due to its semi-upright growth habit.

Dryland Bean Breeding Nursery and Variety Trial

The goal of the breeding program (Dr. Mark Brick and Barry Ogg) at Yellow Jacket continues to be to broaden the genetic base, improve drought tolerance, increase yield, and improve market quality.

The advanced breeding nursery had 63 advanced lines that included Anasazi, teparies, and pinto crosses for drought tolerance. Entire row selections (23 lines) were made where the plants were hand-pulled and bulked for planting in 2004. The F_2 nursery consisted of 262 entries. Seventy-four F_2 entries were selected where individual plants were harvested for planting as individual rows in 2004.

The dryland variety trial (Table 2) consisted of five experimental entries from Colorado State University's bean breeding program, four commercial varieties, and San Juan Select. San Juan Select is a southwestern Colorado cultivar that dates back to the 1930's. CO432, CO438, and CO441 are entries that merit further testing. UI 126, an irrigated bean from Idaho, performed poorly under the very dry growing conditions. UI 126 has been used for replanting dryland acres in southwestern Colorado. Cahone did not perform as well as expected.

Table 1. 2003 irrigated pinto bean uniform variety trial at Yellow Jacket.[1]

Variety	Yield	Seeds/lb	Growth Habit[2]	Maturity[3]	Desirability[4]
	lbs/ac	no			
Pro Vita 99236	2056	1117	IIb	L+	6
Pro Vita 99195	2018	1322	II	L+	9
Pro Vita 00167	2011	1350	II	L+	7
CO12650	1936	1284	II	L/L+	9
Pro Vita 99218	1883	1148	IIb	L+	8
Pro Vita 00195	1862	1318	IIb	L+	8
CO83778	1769	1226	IIb	L/L+	6
Montrose	1740	1140	II	ML	6
CO83783	1717	1107	II	L+	9
Poncho	1670	998	III	ML	7
CO96753	1613	1114	III	L	8
CO96731	1601	1159	II	L+	7
Pro Vita 99204	1594	1154	II	ML	7
CO96737	1515	1185	II	L+	8
Pro Vita 99211	1497	1101	II	L	7
Bill Z	1466	1104	III	ML	6
Grand Mesa	1436	1179	II	ML	6
Buckskin	1376	1112	II	ML	7
Average	**1709**	**1173**			
CV%	10.3				
$LSD_{(0.30)}$	131				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/6 and harvested 9/19. Notes on growth habit, maturity, and desirability were taken by Mark Brick on 9/16/03.
[2]I = determinate; II = indeterminate; IIb = indeterminate, terminal guide possesses some climbing ability; III = indeterminate, semi-prostrate or twining. (Singh, S.P. 1982. A key for identification of different growth habits of Phaseolus vulgaris L. Annu. Rep. Bean Improv. Coop. 25:92-95.
[3]ML = medium late; L = late; VL = very late.
[4]1 = least desirable; 10 = most desirable (rating for growers in choosing which varieties to plant).

Site information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow; two-years ago: small grains
Tillage:	Fall chisel plowed
Seeding rate:	Approx. 83,600 seeds/ac (2.5-inch spacing on 30-inch rows)
Fertilizer:	None
Herbicide:	Pursuit 1.08 oz/ac pre-emerge
Insecticide/fungicide:	None
Precipitation:	January 2003 thru August 2003: 6.5 inches (long-term average 9.7 inches)
Irrigation:	13.6 inches (center pivot)

Table 2. 2003 dryland pinto bean variety trial at Yellow Jacket.[1]

Entry	Yield	Seeds/lb	Maturity[2]	Desirability[3]
	lbs/ac	no		
CO441	640	1052	L+	6
Montrose	634	1158	ML/L	6-8
CO432	613	1252	L	7,8
Fisher	584	993	L/L+	6-8
CO90432	581	1191	L	6,7
CO90436	569	1196	L/L+	7
CO438	561	1184	L/L+	7
Cahone	523	1108	L	6
San Juan Select	497	1253	L	6
UI 126	333	1091	ML	5
Average	**554**			
CV%	13.1			
$LSD_{(0.05)}$	105			

[1]Trial conducted at the Southwestern Colorado Research Center;
seeded 6/12 and harvested 10/22.
[2]ML=medium late; L = late.
[3]1 = least desirable; 10 = most desirable (rating used to select an entry for further testing).

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow
Tillage:	Fall moldboard plowed
Seeding rate:	Approx. 23,000 seeds/ac (9-inch spacing on 30-inch rows)
Fertilizer:	None
Herbicide:	None
Insecticide/fungicide:	None
Precipitation:	January 2003 thru August 2003: 6.5 inches (long-term average 9.7 inches)

Summary of the 2002 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack

Southwestern Colorado received below average precipitation for the third consecutive year. The total precipitation for 2000 and 2001 was 11.3 inches and 10.0 inches, respectively. The January thru August 2002 precipitation was only 1.8 inches. By comparison, the long-term average annual precipitation for Yellow Jacket is 16.0 inches. Precipitation finally came in late summer (2.9 inches in late August and early September) but was too late for the bean crop.

In 2002, very few acres of dryland beans (1,200 acres) were planted in southwestern Colorado due to the lack of soil moisture at planting time. In recent years, 30,000 acres have been planted to dry beans in Dolores and Montezuma counties. Planting time is usually the first 10 days of June. The beans that did emerge did not develop due to the lack of precipitation during the summer. It was estimated that only 100 acres of dryland pinto beans were harvested. At the Southwestern Colorado Research Center, the dryland bean nursery and variety trial was planted on June 13 but emergence was very erratic. The beans finally emerged in September due to the late summer rains. As a precaution, the dryland bean nursery and variety trial was also planted (duplicated) on irrigated ground. The beans were irrigated to achieve emergence and again in August when it became apparent that rain would not come in time.

Irrigated pinto beans did not fare much better than the dryland beans. The Dolores Project irrigated land from Yellow Jacket to Dove Creek received only 6.2 inches of irrigation water per acre. The normal allocation is 22.4 inches. It was estimated that only 500 acres of irrigated pintos were planted in this area.

Irrigated Pinto Bean Uniform Variety Trial (Table 1)

The uniform pinto bean variety trial was planted for the fourth consecutive year at Yellow Jacket. Several fields at the Research Center were fallowed in 2002 to save irrigation water for 20 acres of pinto beans (including the uniform variety trial and experimental lines). Alfalfa was irrigated only for the first cutting. The bean variety trial site was pre-irrigated (2 inches) in early May and good emergence was achieved. However, due to the low rainfall during the growing season and high temperatures, the maturity of the beans was behind schedule throughout the summer. The pre-emergence application of Frontier resulted in poor control of redroot pigweed and Russian thistle. A post–emergence application of Raptor herbicide was applied on July 17. Raptor provided excellent weed control but may have delayed the development of the bean plants.

The weather pattern changed in late summer and Yellow Jacket received much needed moisture in late August and early September. This rain and three irrigations in August allowed the beans to continue to develop well past their normal maturity date. The beans were cut on September 25 when the majority of the entries were physiologically mature (stripped or tan pods). It should be noted that all entries had some pods that were still green when the trial was cut. Rally, GTS-900, and CO83777 were very late maturing entries and had a high percentage of pods that were not stripped when they were cut. The first freezes of the year occurred on October 3 and 4. The cold temperatures damaged some pods even though the beans had been cut and drying for a week. It also rained approximately 0.75 inches in October before the beans were threshed. This rain was responsible for some additional discolored beans.

The variety trial averaged 1,963 lbs/acre. The yield was less than expected but good given the difficult growing conditions in 2002. Montrose was the best yielding entry in the trial at 2,352 lbs/acre. The absence of white mold disease pressure in 2002 allowed Montrose to exhibit its yield potential. Poncho, Bill Z, and Grand Mesa performed as expected. No bacterial diseases were noted in the trial, although copper was applied as a preventive measure.

Irrigated Pinto Bean Experimental Lines (Table 2)

This was the final year for testing experimental lines from the Fort Collins program for adaptability in southwestern Colorado. These lines do not have rust resistance and thus are not suitable for eastern Colorado. Two lines (CO77380 and CO77364) were identified that have good adaptation to southwestern Colorado. These lines both have upright architecture and relative early maturity. These lines may have a niche in southwestern Colorado if a semi-upright growth habit is needed to avoid white mold. The lines CO77444, CO77443, and CO77442 have yielded very well over the years but have maturities too late to escape the early frosts that are common in southwestern Colorado. None of the experimental lines has consistently performed better than released varieties that are available to the public.

Dryland Bean Breeding Nursery and Variety Trial

The goal of the breeding program (Dr. Mark Brick and Barry Ogg) at Yellow Jacket continues to be to broaden the genetic base, improve drought tolerance, and increase yields and improve market quality.

The nursery and variety trial was duplicated at two sites: dryland and irrigated. The dryland site had erratic emergence due to the drought and was abandoned. The duplicate site was irrigated to achieve bean emergence and again in August when it became apparent that rain would come too late for bean growth. The development of the beans had been delayed due to the hot, dry summer and when irrigated entered their reproductive stage. The irrigation water plus the rain that started in late August delayed the maturity of the bean nursery and variety trial.

The breeding nursery included Anasazi lines, teparies, and pinto crosses for drought tolerance. Approximately 80 lines were included in the nursery. The dryland variety trial consisted of eight experimental lines. The nursery was evaluated by Mark Brick on Sept. 9, 2002. Seed from selected breeding lines were hand harvested (single-pod-descent) for advancement to the 2003 nursery.

The dryland variety trial was not harvested due to delayed maturity. The experimental lines were evaluated for adaptation to southwestern Colorado. Maturity is an important trait when evaluating dryland bean lines due to the limited growing season. The experimental lines will again be planted in the 2003 variety trial.

Table 1. 2002 irrigated pinto bean uniform variety trial at Yellow Jacket.[1]

Variety	Yield[2]	Seeds/lb	Growth Habit[3]	Maturity[4]
	lbs/ac	no		
Montrose	2352	1158	III	ML
CO75965	2291	1129	III	L
USPT-72	2266	1109	II, III	L
Poncho	2225	1071	III	ML
Bill Z	2125	1108	III	ML
USPT-73	2097	1032	III	ML
Grand Mesa	2073	1198	II	ML
Rally	2060	1185	IIb	VL
CO83778	2034	1098	IIb/III	ML/L
CO96753	2000	1024	IIb/III	L
CO83783	1972	1083	IIb/III	L
CO75495	1955	1028	II	ML
CO75619	1933	1104	II	ML
Buckskin	1917	1132	III	ML/L
CO96775	1884	1128	III	L
CO84975	1872	1232	II	ML
CO75563	1829	1030	II/III	ML
CO96737	1745	1135	IIb/III	L
CO96731	1711	1126	IIb/III	L
GTS-900	1702	1176	IIb/III	VL
USPT-74	1629	1144	II, III	L
CO83777	1511	1051	IIb/III	VL
Average	1963			
CV%	10.5			
$LSD_{(0.05)}$	291			

[1]Trial conducted at the Southwestern Colorado Research Center, seeded 6/11/02, cut 9/25/02, and threshed 10/16/02. Notes on growth habit and maturity were taken by Mark Brick on 9/9/02.
[2]The yields were not adjusted for frozen or discolored beans. The weight of frozen or discolored beans in each plot ranges from 3.5 to 8.5% and does not significantly affect the ranking of the entries.
[3]I = determinate; II = indeterminate; IIb = indeterminate, terminal guide possess some climbing ability; III = indeterminate, semi-prostrate or twining. (Singh, S. P. 1982. A key for identification of different growth habits of Phaseolus vulgaris L. Annu. Rep. Bean Improv. Coop. 25:92-95.
[4]ML = medium late; L = late; VL = very late.

Site information:

Soil type:	Silty clay loam
Previous crop:	Spring wheat; two-years ago: alfalfa
Tillage:	Fall moldboard plowed
Seeding rate:	Approx. 83,600 seeds/ac (2.5-in. spacing on 30-in. rows)
Fertilizer:	None
Herbicide:	Frontier 6.0 20 oz/ac pre-emerge
	Raptor 4 oz/ac applied on July 17, 2002
Bactericide:	Copper (Kocide DF 2 lbs/ac): 3 applications
Precipitation:	January 2002 thru August 2002: 1.8 inches (long-term average 9.7 inches)
Irrigation:	16 inches (6 sprinkler applications)

Table 2. 2002 irrigated pinto bean experimental lines at Yellow Jacket.[1]

Entry	Yield[2]	Seeds/lb	Growth Habit[3]	Maturity[4]	Desirability[5]	Notes
	lbs/ac	no				
Montrose	2707	1212	III	ML, L	9,10	
CO77444	2537	1146	III	L	8, 9	
CO77443	2467	1112	III	L	8, 9	
CO77442	2283	1135	III	L	8	Discard, too late
Grand Mesa	2041	1280	II, IIb, III	ML, L	9,10	
CO77380	1938	1235	II, IIb, III	M, ML	9, 10	Best early line
CO34359	1868	1076	III	ML	9	
CO77364	1867	1140	II, IIb, III	M, ML	9, 10	Best early line
Bill Z	1829	1271	III	ML, L	7, 8	
CO77375	1823	1208	II, III	L, L+	8, 9	
CO48846	1821	1308	IIb, III	ML, L	9, 10	
CO77381	1713	1258	III	M, ML	8, 9, 10	
CO48969	1640	1248	II, III	ML, L	7, 8, 9	Discard
CO77362	1519	1405	IIb, III	L	7, 8	Discard
CO77347	1388	1130	II, IIb, III	ML	7, 8	Heat damage
Average	1963					
CV%	15.7					
LSD(0.05)	514					

[1]Trial conducted at the southwestern Colorado Research Center, seeded 6/11/02, cut 9/25/02, and threshed 10/15/02. Notes including growth habit, maturity, and desirability were taken by Mark Brick on 9/9/02.
[2]The yields were not adjusted for frozen or discolored beans.
[3]I = determinate; II = indeterminate; IIb = indeterminate, terminal guide possess some climbing ability; III = indeterminate, semi-prostrate or twining. (Singh, S.P. 1982. A key for identification of different growth habits of Phaseolus vulgaris L. Annu. Rep. Bean Improv. Coop. 25:92-95.
[4]M = medium; ML = medium late; L = late.
[5]1 = least desirable; 10 = most desirable (rating to help growers in choosing which varieties to plant).

Site information:

Soil type:	Silty clay loam
Previous crop:	Spring wheat; two-years ago: alfalfa
Tillage:	Fall moldboard plowed
Seeding rate:	Approx. 83,600 seeds/ac (2.5-in. spacing on 30-in. rows)
Fertilizer:	None
Herbicide:	Frontier 6.0 20 oz/ac pre-emerge
	Raptor 4 oz/ac applied on July 17, 2002
Bactericide:	Copper (Kocide DF 2 lbs/ac): 3 applications
Precipitation:	January 2002 thru August 2002: 1.8 inches (long-term average 9.7 inches)
Irrigation:	16 inches (6 sprinkler applications

Summary of the 2001 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack

Southwestern Colorado received below normal precipitation for the second consecutive year. However, above average precipitation was received in August 2001 (2.75 inches vs. 1.72 inches long-term average). The rain coincided with bean flowering and pod fill and allowed dryland pinto farmers to harvest near normal yields. Dryland pinto bean yields in the Yellow Jacket to Dove Creek area ranged from 300 to 400 lbs/ac. Cahone is still the most common pinto planted in dryland fields in southwestern Colorado. Fisher pinto bean is planted only on limited acreages. Fisher's yield does not appear to be as stable as Cahone under adverse weather conditions.

Irrigated pinto bean acreage continues to decline. Farmers indicate that white mold disease is a major obstacle for them to continue to raise irrigated pinto beans. In addition, low bean prices, lack of irrigated bean equipment, and competition from irrigated alfalfa has led to a decline in irrigated bean production in southwestern Colorado. Three white mold demonstration trials were conducted at the Research Center in 2001. The first site was planted in a field that had a history of white mold disease. A second site was planted to beans for the second consecutive year but yields were low due to soil compaction. A third site was located in a field that had been rotated from alfalfa. White mold was observed at this third site but was not uniformly distributed in the field. The results from the second and third sites were inconclusive. Lower plant populations, upright plant architecture, irrigation water management, and fungicide treatments are strategies that need to be employed if irrigated pinto bean production is to be a viable enterprise in southwestern Colorado.

Irrigated Pinto Bean Uniform Variety Trial (Table 1)

The uniform pinto bean variety trial was planted for the third consecutive year at Yellow Jacket. The beans were just starting to emerge when the area was hit by a late spring freeze on June 14 but only minor freeze damage was noted. The trial was subjected to moderate halo blight pressure. White mold pressure was minimal. Based on the higher than expected seed count (data not presented), the yields were probably limited by not applying enough irrigation water. The late-maturing entries were the lowest yielding. Poncho again yielded very well but its semi-vine growth habit makes it susceptible to white mold. Grand Mesa (CO75511) looked very good. Its semi-upright growth habit makes it more tolerant to white mold than Bill Z or Montrose. USPT-73 is an early maturing pinto with upright architecture that is adapted to southwestern Colorado.

Irrigated Pinto Bean Experimental Lines (Table 2)

This was the sixth year for testing experimental lines from the Fort Collins program for adaptability in southwestern Colorado. These lines do not have rust resistance and thus are not suitable for eastern Colorado. In addition to the replicated trial, an additional 12 lines were evaluated in an adjacent single-row nursery. Seed from four entries was saved based on their upright architecture and one entry for its yield potential. Based on the results of the testing over the last six years, it does not appear that any of these experimental lines are superior to the rust resistant entries being tested in the uniform variety trial. The exception may be if a semi-upright growth habit is needed to mitigate white mold in southwestern Colorado.

Market Class Bean Performance at Yellow Jacket (Table 3)

This trial was planted adjacent to the uniform pinto bean variety trial. Shiny Crow appears to be adapted to southwestern Colorado but may be a bit late under irrigation in years with an early fall freeze. The light red kidneys show promise and need to be further evaluated for southwestern Colorado. The small white bean entries exhibited severe zinc chlorosis. This site has tested very low for zinc.

White Mold Demonstration at Yellow Jacket in 2001 (Table 4)

Commercial pinto beans (Bill Z, 30-in. rows, approx. 100,000 seeds/ac) were planted at the Research Center in a field with a history of white mold. The demonstration trial was marked-off in the field after the beans had been cultivated. The objectives were to demonstrate the effectiveness of the fungicide Topsin M WSB (water-soluble bags) applied at 100% bloom and to compare one application with a second treatment applied 10 days later. The first treatment was applied on August 2 and the second treatment on August 13.

The field had a moderate to severe outbreak of white mold disease. Topsin was very effective in reducing the incidence of white mold. A 48% (671 lbs/ac) and 67% (939 lbs/ac) increase in yield was obtained with one and two sprays, respectively. The estimated cost of a Topsin application is $25/acre. It would have been economical to treat this field with one or two applications of Topsin fungicide for white mold.

Dryland Breeding Nursery

The Dry Bean Breeding Project (Dr. Mark Brick, Barry Ogg) in their nursery at Yellow Jacket evaluated over 190 breeding lines and 12 advanced lines in replicated plots. The goal of the breeding effort at Yellow Jacket continues to be to broaden the genetic base, improve drought tolerance, and thus increase yields and improve market quality. The germplasm crosses are made at Fort Collins.

The dryland pinto bean variety trial (Table 5) was planted on fallow ground and received above average precipitation during flowering and pod fill. Fallow ground plus the rain in August may explain the relative high yields (average 866 lbs/ac). Research plots also tend to yield higher compared to entire fields. Cahone and Fisher were two of the top three entries in the trial. The commercial varieties UI 126 and UI 114 yielded at the bottom of the trial. San Juan Select, the variety that Cahone replaced, yielded 160 lbs/ac less than Cahone.

An additional 16 dryland experimental entries were planted in single rows. Three entries were selected for a plant-to-row nursery in 2002 to improve uniformity and two entries were bulked for variety testing.

Table 1. 2001 irrigated pinto bean uniform variety trial at Yellow Jacket.

Variety	Yield	Maturity	Halo blight
	lbs/ac		
Poncho	2459		
CO64342	2423		
Montrose	2328		Moderate
Grand Mesa	2235		
CO73740	2220		
Buster	2216		
Burke	2151		
USPT-73	2142	Early	Moderate
Bill Z	2125		
CO75619	2100		Moderate
CO73680	2084		
Vision	2055		
CO64155	1992		Moderate
CO74017	1973	Late	
Rally	1749	Late	Moderate
CO83778	1550		
CO83785	1510		
GTS-900	1466	Very late	
CO84086	1406	Very late	
CO75944	1092	Late	Moderate
Average	**1964**		
CV%	11.6		
$LSD_{(0.30)}$	195		

Table 2. 2001 irrigated pinto bean experimental lines at Yellow Jacket.

Variety	Yield	Notes
	lbs/ac	
CO77444	2170	
CO77442	2138	1 week later then Bill Z
Montrose	2109	
Bill Z	2071	
CO34359	1980	Severe halo blight
CO77364	1958	
CO77443	1951	1 week later then Bill Z
CO77381	1673	
CO77375	1523	Moderate halo blight
CO77368	1058	Very late
Average	**1863**	
CV%	9.7	
$LSD_{(0.05)}$	311	

Trials conducted on the Southwestern Colorado Research Center; seeded 6/7, cut 9/18,and harvested 9/26.

Cultural Practices: (Tables 1, 2, and 3)

Soil type:	Silty clay loam
Previous crop:	Barley; two-years ago: fallow; three-years ago: alfalfa
Tillage:	Fall moldboard plowed
Seeding rate:	Approx. 87,000 seeds/ac on 30-in. rows
Fertilizer:	250 lbs $P_2 0_5$/ac plowed down in 1999
Herbicide:	Frontier 6.0 24 oz/ac preplant incorporated
Bactericide, fungicide, and insecticide:	None
Precipitation:	4.0 inches (June 7 thru Sept. 18).
Irrigation:	8.9 inches (4 sprinkler applications)

Table 3. 2001 market class bean performance at Yellow Jacket.

Variety	Market Class	Yield	Seeds/lb	Notes
		lbs/ac	no.	
L94C356	Pink	2072	1523	Poor seed quality
90:469	Great Northern	2067	1486	Poor seed quality
Shiny Crow	Black	1746	2869	Moderately late
Sacramento	Light red kidney	1500	865	
Midnight	Black	1403	3071	
B340	Light red kidney	1060	890	Late, poor seed quality
I9606-6	Black	822	2685	Late
Vista	Small white	672	2635	Very late
ND91-117-0502	Small white	438	2607	Very late
Average		**1309**		
CV%		15.9		
$LSD_{(0.05)}$		359		

Trial conducted at the Southwestern Colorado Research Center;
seeded 6/12, cut 10/03, and threshed 10/06.

Table 4. 2001 white mold demonstration at Yellow Jacket.
Mark Stack, Tom Hooten, and Howard Schwartz
Statistical analysis by Mark Brick.

Southwest Corner Field – Bill Z Pinto, sprinkler irrigated
[1st spray at 100% bloom, 2nd spray 10 days later, 2 lbs/ac Topsin M WSB in 28 gal water]

	Yield (lbs/A)	% White Mold (Disease Intensity)
1. Untreated Control	1396.9 b	57.50 a
2. Topsin – 1 spray	2068.1 a	9.25 b
3. Topsin – 2 sprays	2335.9 a	8.75 b

$LSD_{.05,}$ means separated by different letter are significantly different; RCB, 4 reps

Trial conducted at the Southwestern Colorado Research Center.
Planted 6/12, cut 9/24, harvested 10/16.

Results: This field had a moderate to severe outbreak of white mold. A 48% and 67% increase in yield was obtained with 1 and 2 sprays. Estimated cost per fungicide spray + application = $25/acre. With $20/cwt pintos, the net return would have been $109 or $137/acre for 1 and 2 sprays, respectively.

Cultural Practices:

Soil type:	Silty clay loam
Previous crop:	Wheat; two-years ago: pinto beans
Tillage:	Spring moldboard plowed
Seeding rate:	Approx. 100,000 seeds/ac with 30-in. rows
Fertilizer:	130 lbs $P_2 0_5$/ac + 28 lbs N/ac plowed down
Herbicide:	Frontier 6.0 24 oz/ac preplant incorporated
Insecticide:	None
Precipitation:	4.0 inches (June 12 thru Sept. 24)
Irrigation:	9.8 inches (4 sprinkler applications)

Table 5. 2001 dryland pinto bean variety trial at Yellow Jacket.

Entry	Yield
	lbs/ac
CO438*	1128
Cahone	1018
Fisher	977
CO90432-2-10*	949
CO432*	925
CO90432-2-8*	866
CO410*	865
San Juan Select	858
CO89721*(late)	848
CO90436-2-3*	839
CO439*	789
CO90436-2-2*	787
UI 126	760
CO429*	714
UI 114	665
Average	**866**
CV%	12.3
$LSD_{(0.05)}$	153

Trial conducted on the Southwestern Colorado Research Center.
seeded 6/12, cut 9/11, threshed 9/24.
*Experimental line from Colorado State University.

Cultural practices:

Soil type:	Silty clay loam
Previous crop:	Fallow
Seeding rate:	Approx. 23,000 seeds/ac (9-in. spacing on 30-in. rows)
Fertilizer:	None
Herbicide:	None
Bactericide, fungicides, and insecticides:	None
Precipitation:	3.9 inches (June 12 thru Sept. 11)

Summary of the 2000 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack

The 2000 growing season was very dry. Precipitation during the summer months was well below the long-term average. The August rainfall was primarily from one storm that occurred on August 30. Temperatures were consistently above average during the summer.

Dryland pinto bean yields in the Dove Creek area averaged 150 to 250 lbs/acre. A number of fields were not harvested due to the drought. Irrigated pinto bean yields were in the range of 2,000 to 2,500 lbs/acre. Cahone and Bill Z for dryland and irrigated acreages, respectively, are the most common varieties planted in southwestern Colorado.

In irrigated dry bean fields, white mold disease continues to increase in severity each year. A field at the Research Center that had previously been in alfalfa for seven years was rotated to pinto beans in 2000. This field exhibited significant white mold infection. This occurred in spite of the low rainfall, careful irrigation water management, and 30-inch row spacing. Other growers in the area reported similar problems with white mold. White mold was rarely seen when the Dolores Project first began delivering irrigation water to the area in 1987, but has steadily increased in intensity during the last decade.

Dryland farmers are faced each year with the uncertainty of adequate moisture. Local warehouses continue to market only pinto beans. Other market classes are not handled primarily due to lack of proper equipment and adequate storage to prevent contamination of the market classes. However, Anasazi beans are grown under contract on limited dryland acreage. A few producers grow pinto beans for the organic market.

Irrigated Pinto Bean Uniform Variety Trial (Table 1)

The uniform pinto bean variety trial was planted for the second consecutive year at Yellow Jacket. The trial was located within a commercial dry bean field that had previously been planted to alfalfa. The varieties in the trial were subjected to significant white mold pressure. White mold symptoms were first expressed in mid-August. No other diseases were noted. The trial looked very good throughout the growing season in spite of the white mold and the results should give very useful information. The first freeze occurred on Sept. 24 and resulted in discolored beans for the late maturing varieties. The trial averaged 2,400 lbs/acre. The experimental line CO75511 looked particularly promising. Named varieties that have maturities too late for southwestern Colorado are Buster, Cisco, and Kodiak. Experimental lines with upright architecture are CO64589, CO75714, and CO83778. This upright architecture may be an important trait to minimize white mold intensity.

Irrigated Pinto Bean Experimental Lines (Table 2)

This was the fifth year for testing experimental lines from the Fort Collins program for adaptability in southwestern Colorado. These lines do not have rust resistance and thus are not suitable for eastern Colorado. Since rust disease is not a problem in southwestern Colorado, it was hoped that several of these lines would prove superior to Bill Z. Testing of a small number of these lines will continue in 2001.

Dryland Variety Trial

The dryland variety trial was planted in a field that had previously been in wheat. An erratic stand was achieved in 2000 due to the dry soil conditions. The below average rainfall received during the summer coupled with the poor stand resulted in an average yield of 177 lbs/acre with a high coefficient of variation for the trial. The results are not summarized in this report since it is difficult to draw any conclusions. Cahone yielded 231 lbs/acre and was the second best yielding entry in the trial. On the other hand, Fisher yielded just 125 lbs/acre. Advanced lines from the breeding program that looked promising in prior years failed to perform better than Cahone. This trial will be repeated in 2001.

Dryland Breeding Nursery

The goal of the breeding effort at Yellow Jacket continues to be to broaden the genetic base and improve drought tolerance of the varieties adapted to the region. The germplasm crosses are made at Fort Collins. The breeding nursery was planted on fallow ground and a good stand was achieved. Selections were made for advancement to the 2001 nursery at Yellow Jacket.

The advanced line nursery at Yellow Jacket was not planted in 2000 since all entries had reached the advanced generation stage and transferred to the variety trial for yield testing. Advanced generation selections from the current breeding nursery will eventually be tested in the variety trial.

Irrigated Pinto Bean Zinc Fertility Trial (Table 3)

This experiment consisted of two varieties, Bill Z and Poncho, and three treatment rates (0, 5, and 10 lbs Zn/ac). Zinc was applied preplant incorporated and as a foliar application. Mackinac, a small white bean, and very sensitive to zinc was planted as a visual indicator for zinc deficiency. No visual signs of zinc deficiency were apparent in Mackinac, Bill Z, or Poncho. There were no statistical differences between the different varieties, application rates, or application method.

Table 1. 2000 irrigated pinto bean uniform variety trial at Yellow Jacket.

Variety	Yield lbs/ac	Seeds/lb no.
CO64342	2887	1164
CO75511	2819	1272
CO64589	2772	1198
CO64599	2732	1138
Poncho	2730	1254
CO74905	2721	1152
Buster	2721	1204
Montrose	2649	1161
CO74630	2644	1071
CO75714	2638	1146
CO83778	2561	1164
Chase	2506	1290
USPT-73	2451	1018
Cisco	2435	1141
CO64155	2432	1094
GTSCob502-94	2391	1201
Buckskin	2334	1204
Elizabeth	2286	1188
93:219P	2252	998
CO74518	2250	1297
97:395P	2174	1135
Othello	2173	1107
Bill Z	2173	1164
Kodiak	2120	1086
CO75944	1998	1158
Burke	1986	968
97:197P	1780	1224
94:1023P	1580	1217
Average	**2400**	
CV%	9.8	
LSD (0.05)	386	

Table 2. 2000 irrigated pinto bean expermental lines at Yellow Jacket.

Variety	Yield lbs/ac
CO77444	2457
CO77442	2444
Poncho	2391
CO77443	2315
Bill Z	2284
CO77364	2184
CO34359	2170
CO48846	2158
CO48972	2112
CO49031	2051
CO48954	2029
CO49077	2028
CO77368	2010
CO77375	2006
CO34387	2005
UI 126	1997
CO48969	1994
CO77380	1883
CO77362	1881
CO77341	1762
CO77381	1741
CO77384	1736
CO77347	1581
Average	**2053**
CV%	9.6
LSD (0.05)	325

Trials conducted at the Southwestern Colorado Research Center; seeded 6/13/00; cut 9/21/00; threshed 10/18/00.

Site information:

Soil type:	Silty clay loam
Previous crop:	Wheat; two-years ago: alfalfa
Tillage:	Fall moldboard plowed
Seeding rate:	Approx. 87,120 seeds/ac (2.4-in. spacing on 30-in. rows)
Fertilizer:	None
Herbicide:	Frontier 6.0 24 oz/ac preplant incorporated
Insecticides and fungicides:	None
Precipitation:	3.5 inches: June 14 thru Sept. 21
Irrigation:	12.2 inches (6 sprinkler applications)

Comments:

The growing season was characterized by above average temperatures and below average rainfall. The trial was subjected to significant white mold pressure. The first freeze on Sept. 24 (28°F) resulted in some frozen beans in the later maturing varieties. However, the beans were still marketable after discounting the frozen beans. The Experimental Lines trial was planted in a different field but with similar cultural practices.

Table 3. 2000 irrigated pinto bean zinc trial at Yellow Jacket.

Variety	Application method	Zinc rate (lbs/ac) 0	5	10	
		Seed yield in lbs/ac			Mean
Bill Z	PPI	2801.8	2842.4	2797.8	2814.0
	Foliar	2865.0	2775.4	2658.4	2766.3
	Mean	2833.4	2808.9	2728.1	2790.1
Poncho	PPI	2851.3	2936.0	2902.5	2896.6
	Foliar	2856.8	2917.9	2798.6	2857.8
	Mean	2854.1	2927.0	2850.6	2877.2

Statistical analysis: CV = 7.7%; No significant main or two-way interaction effects at alpha = 0.10 (90% probability)

Soil test results (May 2000) 0 – 12 inches:
pH: 7.5
Organic matter (%): 1.1
Nitrate-N (ppm): 20
Mehlich-3 P (ppm): 20. Corresponds to 3.4 ppm with the AB-DTPA method
K (ppm): 180
Zinc (ppm): 0.6
Laboratory recommendations: 30 lbs P_2O_5/ac and 4 lbs Zn/ac for a yield goal of 30 cwt/ac.

Experimental design: Split-split plot design with four replications.
Plot size:
Variety: 30’ x 40’
Method: 30’ x 20’
Rate: 10’ x 20’

Planting date: 6/9/00
Cut: 9/18/00
Threshed: 10/3/00

Forty pounds per acre of P_2O_5 as 0-45-0 was broadcast and incorporated in the soil with a field cultivator on 6/7/00. Zinc as zinc sulfate was applied on 6/7/00 (preplant treatment, 36% Zn) and on 7/18/00 (foliar application, 7% zinc sulfate solution).

Summary: Seed yield of Bill Z and Poncho pinto beans did not respond significantly to preplant or foliar application of zinc at 5 or 10 lbs/ac. Bill Z (Poncho was not included in the 1999 experiment) did respond to the foliar application of zinc at 5 and 10 lbs/ac in 1999. Zinc level in the soil was lower in 1999 than in 2000 (0.3 ppm vs. 0.6 ppm).

Summary of the 1999 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack and Abdel Berrada

Precipitation was well below normal in early 1999 (January to March) and substantially above normal in April through August. The 30-year average for April through August at Yellow Jacket is 5.8 inches. Precipitation during the same period in 1999 was 9.1 inches. September precipitation was below average in 1999 (0.9 inches versus 1.7 inches). The 1999 growing season also had cooler temperatures than normal and with the favorable moisture conditions resulted in record non-irrigated dry bean yields.

Dryland pinto bean yields ranged from 916 to 1454 lbs/ac, well above the long-term average for Dolores and Montezuma counties (300 to 500 lbs/acre). The most widely grown pinto bean variety in southwestern Colorado, Cahone, yielded equal or better than any of the entries in two variety trials (Tables 1 and 2) at Yellow Jacket. The variety Fisher averaged 1,198 lbs/ac in trial no. 1, which was not statistically different than the 1,347 lbs/ac produced by Cahone. The difference in yield between the two varieties was significant in trial no. 2, with Cahone yielding better than Fisher (1,454 versus 1,300 lbs/ac). The two trials were located next to each other and treated similarly. Fisher matured 3 to 5 days later than Cahone, which has been a common feature of Fisher in years with above normal summer precipitation.

Supplemental irrigation did not boost pinto bean yield compared to previous years. The irrigated dry bean trials were located in a low-area of a west-sloping field in 1999. Although only a total of 7.4 inches of irrigation water was applied throughout the growing season, above normal rainfall and probably runoff contributed to a high level of white mold infestation. Irrigated pinto bean yields ranged from 1,442 to 2,784 lbs/ac (Tables 3 to 5).

The results of the uniform pinto bean trial at seven locations showed that among the top entries only one, CO45188, performed well at Yellow Jacket. The newly released variety Montrose did poorly at Yellow Jacket, 1,953 lbs/ac compared to an average of 2,122 lbs/ac overall. In contrast, USPT-73 did better at Yellow Jacket and Fruita than in eastern Colorado. It also had the least number of seeds per pound of all the entries at Yellow Jacket. Frontier was damaged by a hard frost on Sept. 28, resulting in only 1,442 lbs/ac. It matured about 10 days later than Bill Z. It is common in southwestern Colorado to have a killing frost by the second or third week of September.

The yields reported here were obtained in small plots, typically 10 ft. by 40 ft. However, each variety was planted in four separate plots within each trial to account for variability in soil properties. Pinto beans were cut with knives, lifted with a bean rod, and threshed with a Hege plot combine. They were then cleaned with air and weighed. Most splits, shriveled beans, and discolored beans were not removed before calculating the yield.

Table 1. 1999 dryland pinto variety trial no. 1 at Yellow Jacket.[1]

Entry	Yield	Maturity
	lbs/ac	
Adv. 98-00	1373	
Cahone	1347	13-Sep
Adv. 424	1345	
F_2 441	1339	10-Sep
F_2 434	1328	
F_2 438	1238	
F_2 404	1202	
Fisher	1198	
F_2 437	1172	
F_2 442	1063	10-Sep
F_2 444	1028	10-Sep
F_2 466	916	6-Sep
Average	**1212**	
CV%	12.0	
$LSD_{(0.05)}$	210	

Table 2. 1999 dryland pinto variety trial no. 2 at Yellow Jacket.[1]

Entry	Yield	Maturity[2]
	lbs/ac	
Cahone	1454	13-Sep
CO89721	1416	+3-5 days
CO78158	1377	+3-5 days
CO90432-2-10	1324	+5-7 days
Fisher	1300	+3-5 days
CO90436-2-2	1272	+3-5 days
CO90436-2-3	1251	+3-5 days
CO28141-33	1246	+3-5 days
CO8140-3	1237	+3-5 days
CO90432-2-8	1209	+3-5 days
CO28140-8	1171	+3-5 days
CO10152-2-2	1109	+3-5 days
Average	**1281**	
CV%	4.3	
$LSD_{(0.05)}$	79	

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/12 and harvested on 9/15.
[2]Maturity relative to Cahone (80% pod-striping).

Site information:

Soil type:	Silty clay loam
Previous crop:	Winter wheat
Fertilizer:	None
Pesticide:	None
Precipitation:	5.3 inches (June thru August)

Table 3. 1999 irrigated pinto bean uniform variety trial at Yellow Jacket.[1]

Entry	Yield	Seeds/lb	Maturity[2]
	lbs/ac	no	
USPT-73	2662	1273	
CO45188	2634	1585	
CO75511	2462	1470	
CO64000	2438	1353	
Chase	2412	1521	+3 days
Burke	2375	1332	
Othello	2354	1333	
Vision	2327	1359	+5 days
Buster	2307	1405	+5 days
Maverick	2220	1344	+5 days
Buckskin	2156	1468	
Bill Z	2084	1567	
CO64155	2070	1389	
CO75714	2058	1621	
Poncho	2031	1389	+3 days
CO74905	1982	1494	
Cisco	1978	1486	
Montrose	1953	1538	
CO74630	1908	1461	
CO46322	1899	1538	
CO63603	1876	1526	
CO66032	1873	1632	
Elizabeth	1852	1445	
Kodiak	1686	1365	+7 days
Frontier	1442	1327	+10 days
Average	**2122**	**1449**	
CV%	15.2	2.5	
$LSD_{(0.30)}$	276	31	

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 6/11 and harvested 9/30.
[2]Maturity relative to Bill Z.

Table 4. 1999 irrigated pinto bean Cortez prelim. at Yellow Jacket.[1]

Entry	Yield
	lbs/ac
CO16378	2166
CO48969	2081
CO49031	2054
CO48972	2022
CO48846	2013
CO48954	1988
CO34387	1955
ROG 179	1863
CO49077	1830
CO34359	1777
CO49060	1718
CO34843	1653
CO48950	1639
Bill Z	1581
CO48832	1552
CO51711	1527
CO48960	1496
Average	**1798**
CV%	15.1
$LSD_{(0.05)}$	450

Table 5. 1999 irrigated pinto bean experimental lines at Yellow Jacket.[1]

Entry	Yield
	lbs/ac
CO77381	2784
CO77444	2460
CO77364	2438
CO77380	2411
CO77375	2381
CO77368	2362
CO77392	2312
ROG 179	2281
CO77443	2222
CO77393	2121
CO77362	2111
CO77442	2103
Bill Z	2089
CO77347	2050
CO77391	2028
CO77384	1824
CO77341	1774
CO77360	1552
Average	**2179**
CV%	14.2
$LSD_{(0.05)}$	503.2

[1]Trial conducted at the Southwestern Colorado Research Center; seeded on 6/11 and harvested on 9/30.

Irrigated site information:

Soil Type:	Silty clay loam
Previous crop:	Oats
Fertilizer:	30 lbs N/ac + 30 lbs P_2O_5/ac + 4 lbs Zn/ac
Herbicide:	Frontier
Insecticide/bactericide	None
Irrigation:	7.4 inches (3 sprinkler applications)
Precipitation:	6.2 inches (June 1 thru Sept. 23)

Summary of the 1998 Dry Bean Research
Southwestern Colorado Research Center, Yellow Jacket, CO

Mark Stack and Abdel Berrada

Moisture received during the 1998 growing season was below average. Soil moisture at planting was very good but the precipitation received during the summer was only 2.6 inches. Our wet fall did not start until late September by which time most producers had finished harvesting their beans. Dryland pinto bean yields (300 to 400 lbs/ac) in Dolores and Montezuma counties were near normal for most producers. Evidently the soil moisture at planting and July precipitation (2 inches) was enough to achieve average yields.

Irrigated pinto bean yields in the area ranged from 2,000 to 2,500 lbs/ac. Producers did not experience any unusual problems. Continued emphasis needs to be placed on white mold prevention, crop rotations, and water management.

Dryland Pinto Bean Nursery Variety Trial

Advanced pinto lines from selections made in previous years were tested for yield, maturity, and quality (Dryland Variety Trials 1 and 2). The trials averaged 883 and 1,028 lbs/ac which are greater than what a producer would expect in a normal year. The above average variety trial yields are attributable to a good location (uniform soil type), harvesting the plots by hand, and cleaning the beans only with air (most splits, shriveled beans, and discolored beans were not removed before calculating yield). Cahone and Fisher both yielded near the top of the trials. The goal is to select a bean that is better yielding than released varieties, with a maturity no later than Cahone, with good disease resistance, and good seed size and color. Two lines that have showed promise in previous years (CO90432 and CO90436) did not outperform Cahone in 1998.

Breeding Nursery

Single-seed-descent selection was used to select 13 early generation lines that appear to be adapted to southwestern Colorado. Bulked selections of 10 lines were also made for future variety testing.

Irrigated Dry Bean Nursery

The irrigated variety trial averaged 2,442 lbs/ac. Bill Z and ROG 179 performed very well. Advanced lines from the Fort Collins program (Cortez Prelim. and Experimental Lines) were again tested with the goal of finding a superior irrigated pinto bean for southwestern Colorado.

Bacterial bean blight was inadvertently introduced into the irrigated trials from several lines that had been selected in previous years. Several of the entries were very susceptible to the bean blight while other lines exhibited tolerance. The bean blight gave good selection pressure for the nursery. White mold was not a factor in 1998 since the site had not been in dry beans for at least five years.

1998 dryland pinto bean variety trial no. 1 at Yellow Jacket.

Variety	Yield	Maturity[1]	Notes
	lbs/ac		
Fisher	1000	+3-5 days	
CO89721	929	+ 3-5 days	upright
CO90436-2-3	909	+ 3-5 days	
CO90432-2-10	904	+ 3-5 days	
CO78158	888	+ 3-5 days	upright
Cahone	880	Sept. 10	
CO89716	859	+ 7 days	upright
CO90436-2-2	853	+ 3-5 days	
CO90432-2-2	816	+ 3-5 days	
CO89699	796	Sept. 10	upright
Average	**883**		
CV %	13.1		
LSD $_{(0.05)}$	168		

[1]Maturity relative to Cahone.

1998 dryland pinto bean variety trial no. 2 at Yellow Jacket.

Variety	Yield	Maturity[1]	Notes
	lbs/ac		
Cahone	1314	Sept. 10	
CO90432-2-8	1186	+3-5 days	
Fisher	1039	+3-5 days	
CO28140-8	1025	+3-5 days	
CO28140-3	1013	+3-5 days	
CO28141-33	1004	Sept. 10	small plant
CO28130-7	980	+5-7 days	
CO10143-1-2	915	+5-7 days	
CO10152-2-2	908	+3-5 days	
CO78153	894	+5-7 days	upright
Average	**1028**		
CV %	15.6		
LSD $_{(0.05)}$	232		

[1]Maturity relative to Cahone.

Site information:

Planted:	June 12, 1998
Harvested:	September 21, 1998
Seeding rate:	23,232 seeds/ac (9-in. spacing on 30-in. rows)
Previous crop:	Winter wheat (fall moldboard plowed)
Soil type:	Wetherill (silty clay loam)
Fertilizer:	None
Herbicide:	Dual 2 pt/ac
Insecticide/fungicide:	None
Precipitation:	2.6 inches (June 12 thru August 31)

1998 irrigated pinto bean variety trial at Yellow Jacket.

Variety	Yield	Maturity[1]
	lbs/ac	
Bill Z	2856	
ROG 179	2840	
CO51711	2772	
CO34843	2698	
CO46120	2673	bean blight
CO45580	2658	small white
Apache	2566	
Winchester	2554	late
CO34387	2490	
CO46341	2489	
Arapaho	2437	
Othello	2274	early
Remington	2233	bean blight
CO45437	2217	bean blight
CO34596-1	2107	bean blight
CO16378	1905	very late
Maverick	1750	very late
Average	**2442**	
CV %	10.3	
$LSD_{(0.05)}$	348	

[1] Maturity similar to Bill Z except as noted.
Bean blight was introduced from several experimental lines selected in 1997.

Site information:

Planted: June 10, 1998
Harvested: September 24, 1998
Seeding rate: 72,099 seeds/ac (2.9-in. spacing on 30-in. rows)
Previous crop: Winter wheat (fall moldboard plowed)
Soil type: Wetherill (silty clay loam)
Fertilizer: 50 lbs N/ac + 40 lbs P_2O_5/ac broadcast May 29, 1998
Herbicide: Dual 2 pt/ac applied May 12, 1998
Insecticide: None
Fungicide: None
Bactericide: Copper 4 pt/ac applied August 10, 1998
Precipitation: 2.6 inches (June 10 thru August 31)
Irrigation: 15.5 inches (6 sprinkler applications)

1998 Cortez prelim. and experimental lines at Yellow Jacket.

Variety	Yield	Notes[1]	Variety	Yield	Notes[1]
	lbs/ac			lbs/ac	
ROG 179	2654		CO77444	2585	bean blight
Bill Z	2599		CO77442	2570	Type III
CO48960	2551		CO77360	2499	late, Type III
CO48832	2529		CO77350	2376	
CO49077	2401		CO77381	2267	
CO48950	2372		CO77375	2212	
CO48954	2333		CO77380	2151	
CO48969	2241		CO77391	2138	Anasazi
CO49031	2208		CO77384	2130	
CO49003	2198		CO77364	2067	
Othello	2194		CO77368	2010	
CO48857	2187	very late	CO77392	1881	Anasazi, small plant
CO49060	2157		CO77341	1809	
CO48972	2129		CO77362	1731	
CO49012	2117		CO77393	1730	Anasazi
CO48846	2051		CO77347	1580	
CO48961	2012		**Average**	**2109**	
CO48952	1992		CV%	14.9	
CO49069	1970		$LSD_{(0.05)}$	NS	
CO48965	1834				
CO49049	1823	bean blight			
CO48964	1685	bean blight			
CO48879	1605				
Average	**2167**				
CV %	6.8				
$LSD_{(0.05)}$	209				

[1]Maturity similar to Bill Z except as noted.
Bean blight was introduced from several experimental lines selected in 1997.

Dry Bean Response to Zinc

Foliar application on irrigated dry beans in southwestern Colorado increased yield in one out of two years.

Abdel Berrada and Jessica Davis

Dry bean is an important crop in Colorado. It ranks fifth in acreage and total value in Colorado and fourth in the U.S. production. In southwestern Colorado, dry bean is produced mostly under dryland conditions but much higher yields can be achieved with supplemental irrigation. Most agricultural soils in southwestern Colorado have relatively high pH (7.0 to 8.0) and are low in organic matter and available P. High pH and low organic matter are among the factors that favor the development of Zn deficiency. Zinc deficiency causes chlorosis in bean plants and can delay maturity and reduce seed yield.

Khan and Soltanpour (Khan, A., and P.N. Soltanpour. 1978. Factors associated with Zn chlorosis in dryland beans. Agron. J. 70:1022-1026) attributed chlorosis in dryland dry bean in southwestern Colorado to high soil P/Zn ratio and a high incidence of root rot disease. The chlorotic bean plants were situated lower on the slope than the healthy plants, which led the authors to speculate that the higher soil moisture in lower areas may have increased P availability. Soil Zn level was about the same, 0.5 ppm in the areas with healthy or chlorotic bean plants. Spraying the chlorotic plants with a 1% Zn solution removed chlorosis and increased bean yield by 18 to 92%, but not up to the yield level of the healthy plants. The difference in yield between the healthy plants and those sprayed with Zn was attributed to the higher incidence of root rot in the chlorotic plants. Root rot resistant pinto bean varieties have been released since 1981 and are now widely grown in southwestern Colorado.

A field experiment was initiated in 1999 to determine the effect of Zn application rate and method on irrigated pinto bean yield in southwestern Colorado. 'Bill Z' pinto bean was planted in early June at approximately 22 seeds m^{-2} in 1999 and 2000 at the Southwestern Colorado Research Center at Yellow Jacket, CO. A second variety, 'Poncho' was included in the 2000 experiment. The soil type was Wetherill silty clay loam. Zinc sulfate was broadcast shortly before planting beans in both years at 5 and 10 lbs Zn/acre and incorporated into the soil with a field cultivator. Foliar spray of a 7% zinc sulfate solution was made at the same rates with a 3-m boom sprayer four to five weeks after planting.

Bean seed yield was much higher in 2000 (2936 lbs/acre) than in 1999 (2120 lbs/acre), probably due to better irrigation water management in 2000. No symptoms of zinc deficiency were visible before or after the foliar spray in any of the treatments in 1999 or 2000. However, a foliar application of 5 lbs Zn/acre resulted in significantly higher Bill Z seed yield in 1999 compared to the control (over 500 lbs/acre more). The broadcast treatments had no yield effect in 1999. Zinc application rate or method did not affect Bill Z or Poncho seed yield in 2000. Future studies will include shallower soil sampling and a close look at soil spatial variability since chlorosis often occurs in patches in bean fields in southwestern Colorado.

Table 1. Soil test results

Year	pH	OM	Soil Zn (ppm)	
			AB-DTPA	Mehlich-3
1999	7.2	1.0%	0.3	31
2000	7.5	1.1%	0.6	20

Results of Chickpea Research in Southwestern Colorado from 1994 to 2003[1]

Abdel Berrada

Summary

Chickpea (*Cicer arietinum* L.) studies at the Southwestern Colorado Research Center included variety yield trials, planting date trials, the response to irrigation and N fertilization, and the evaluation of drought tolerance of a chickpea core collection. Some of the results of the studies conducted prior to 1999 were published in various publications (Brick et al., 1998; Berrada et al., 1999). This bulletin contains more complete results of past and recent studies. **Garbanzo Bean Production Trials in Colorado and Wyoming Technical Bulletin TB 98-2** (Brick et al., 1998) is a good introduction to growing chickpeas. This bulletin is available at the Research Center in Yellow Jacket.

Chickpea variety trials were conducted at the Southwestern Colorado Research Center in Yellow Jacket from 1999 through 2003 under dryland conditions. The objectives of these trials were to evaluate the yield potential of several chickpea varieties and experimental lines, and to assess their adaptability to the climatic conditions of southwestern Colorado. This was part of a larger effort to assess the agronomic feasibility of chickpeas as an alternative to dry bean (Berrada et al., 1999). Producing chickpea with acceptable seed quality could be a challenge in southwestern Colorado due to the short growing season and late summer rains, which tend to trigger new growth and delay seed maturity.

A chickpea planting date study was conducted in 1997 and 1998. Chickpeas are more frost tolerant than dry bean and can be planted prior to May 25 when the probability of a killing frost is over 50%. It is recommended that chickpea be planted when soil temperature is above 42°F. In Mediterranean type climates, chickpea is generally planted in November through February. The results of the study showed that chickpea seed yield generally increased as the planting date was delayed past early May. However, the percentage of stained or green seeds generally increased with a delay in planting except for the dry year 1998.

Chickpea response to N fertilization and irrigation was studied in 1994 through 1999. Chickpea produced the maximum seed yield (3,378 lbs/ac) in 1999 with 15.0 inches of water. The application of 50 to 70 lbs N/ac increased the seed yield every year except in 1995. Water use efficiencies were generally enhanced with N fertilization. The study indicates a high chickpea yield potential in southwestern Colorado with limited irrigation -- 15 to 16 inches would maximize seed production. Late irrigations are likely to prolong chickpea growth and increase the percentage of immature seeds.

In 2002 and 2003, the Research Center received a grant to evaluate the National Plant Germplasm System core chickpea collection for drought tolerance. Drought tolerance was assessed by comparing the same chickpea entry at physiological maturity in wet and dry treatments. Information from this evaluation can be used in breeding programs to develop chickpea varieties adapted to a particular environment.

[1]Published December 2004 as Colorado Agricultural Experiment Station Technical Bulletin TB04-03.

Evaluation of Kodiak® Biological Seed Treatment to Control Seedling Diseases of Chickpea

Robert Hammon and Abdel Berrada

Summary

Kodiak® biological fungicide (*Bacillus subtilis* GBO3) seed treatment was evaluated at the Southwest Colorado Research Center to control seedling diseases of chickpea. Stand was reduced by *Fusarium oxysporum* f. sp. *ciceris* in untreated plots by 82.3% and 76.6% in two varieties tested. Yield of Kodiak® treated 'Sanford' chickpea was 2.6 times greater than that of the untreated seed.

Introduction and Objectives

Organic chickpeas are a viable alternative crop for many dryland producers in southwestern Colorado, with 1000 acres planted in some years. One limitation of organic production has been the lack of an effective seed treatment to control seedling diseases, which can be a limiting factor in chickpea production.

Kodiak® biological fungicide (*Bacillus subtilis* GBO3) was identified as a possible seed treatment for use by organic growers, but little is known regarding the nature of seedling pathogens, or the performance of Kodiak® under southwest Colorado conditions. An experiment was conducted during the 2001 growing season at the Southwest Colorado Research Center with the objectives of: 1) identification of pathogens affecting chickpea seedlings in southwest Colorado, and 2) evaluation of Kodiak® seed treatment as an aid in stand establishment.

Materials and Methods

Two varieties of chickpeas, 'Sanford' and 'Dwelley', were planted in a randomized complete block, split plot, design experiment with 12 replications. Cultivar was arranged as main plot, and seed treatment as subplot. Seed was treated with Kodiak® Concentrate Biological Fungicide (Gustafson Inc., Plano, TX) at a rate of 0.125 oz/100 lbs. Plots were planted into crop year 2000 fallow ground on 11 May 2001 in 30-inch rows at a rate of 35,000 seeds per acre. Treflan herbicide was applied at a rate of 1.5 pt/A on 7 May. There was 5.43 inches of rain recorded between planting and harvest, but much of that fell after grain fill of Sanford was nearly complete.

Rotted seed was collected on 12 June for pathogen identification by the Jefferson County Plant Diagnostic Clinic. Stand counts were taken on 12 row-ft in all plots on 6 June. Sanford plots were hand-harvested (30 row-ft per plot) on 24 October. Dwelley plots were not harvested.

Results and Discussion

Variety	Plants/row-ft		Yield lb/A	
	Treated	Untreated	Treated	Untreated
Sanford	1.50 A	0.26 C	586.6 a	227.2 b
Dwelley	1.19 B	0.28 C		

Means followed by the same case letter are not significantly different (P=0.05)

The pathogen *Fusarium oxysporum* f. sp. *ciceris* was cultured from rotted seed. Differences in stand and yield ('Sanford') due to seed treatment were significant at the P=0.001 level. Kodiak® is highly effective in protecting seedlings from root disease caused by *Fusarium oxysporum*.

Irrigated Spring Grain Performance Trials at Yellow Jacket 1998-2004

Mark Stack

Introduction

Irrigated spring barley, spring wheat, and oat variety trials are planted at the Southwestern Colorado Research Center to identify varieties and experimental lines for their adaptation to southwestern Colorado. Several experimental lines that have been tested at the Research Center have been released as named varieties. 'Sylvan' (UT002464) hard red spring wheat was released in 1994, 'Monico' (AbSP9-2) and 'Maverick' (Ab1322) oats, and 'Burton' (98ID251), a Russian wheat aphid (RWA) resistant spring barley (Bregitzer et al., 2005), were released in 2004.

Bob Hammon, entomologist at the Western Colorado Research Center at Fruita, performed work evaluating the impact of Russian wheat aphid (RWA) and different planting dates on irrigated spring wheat. Starting in 1998, Bob was also instrumental in coordinating the testing of RWA resistant barley lines that were developed by Phil Bregitzer, USDA-ARS, Aberdeen, ID and Dolores Mornhinweg, USDA-ARS, Stillwater, OK.

In 1997 and 1998, four varieties of oat, three barleys, four (three) triticale, and one spring wheat variety were planted to evaluate their potential as a forage or grain crop (dual use) in southwestern Colorado (Berrada and Brummer, 2004).

In 2002, the spring wheat trial focused on testing Russian wheat aphid (RWA) resistant lines developed by the wheat breeding program at Colorado State University. After two years of testing, none of these lines had acceptable agronomic traits to warrant further testing.

Materials and Methods

The spring wheat trial is coordinated with Dr. Scott Haley, CSU wheat breeder. Dr. Haley obtains entries from his program and from spring wheat breeding programs in Idaho, Utah and other western states. The spring barley and oat entries have been obtained from the USDA-ARS breeding program at Aberdeen, ID and the Colorado State University Crops Testing program (entries submitted on a fee basis). The waxy and hulless barley entries were obtained from Washington State University and Western Plant Breeders, Inc.

The trials are grown under sprinkler irrigation with cultural practices common in southwestern Colorado. The goal is to obtain yields with moderate crop inputs that can be duplicated by the average grower. Cultural practices include crop rotation, adequate fertility, good weed control, and irrigation water to meet the requirements of the crop. An insecticide was applied to control RWA in spring wheat and barley (except when testing RWA resistant entries). Oats are not susceptible to RWA feeding pressure. The only disease noted was loose smut on some barley and oat entries. Loose smut can be controlled with seed treatment.

The trials were planted with a Kincaid spinner planter with double disks at 8-inch row spacing. The spring wheat seeding rate is 1,200,000 seeds/ac (approx. 100 lbs seed/ac) and the barley and oat trials are planted at 100 lbs seed/ac. The trials were harvested with a 'Hege' plot combine. The grain was cleaned with a 'Clipper M2BC' two-screen air cleaner. Grain moisture (not reported) and test weight

(lbs/bu) were determined using a 'Seedburo GMA-128' grain moisture analyzer. Spring wheat protein and hardness tests were performed by the CSU wheat breeding program.

The dual use irrigated spring cereal study (oat, barley, triticale, and wheat) was planted in 1997 and 1998 with a Kincaid spinner planter at 90 lbs/ac. The plots designated as forage were cut with a Carter forage harvester. The growth stage for harvesting the forage was soft dough in 1997 and watery ripe to soft dough in 1998. The grain plots were threshed with a Hege plot combine. A sample was taken from each plot and air-dried to determine moisture content at harvest. A subsample was sent to Mountain Meadows Research Center at Gunnison, Colorado for crude protein (CP) and in-vitro dry matter disappearance (IVDMD) analysis. IVDMD is a measure of how well the plant material would be digested by ruminants (Berrada and Brummer, 2004).

Results and Discussion

The spring wheat, barley, and oat trial results for the last seven years are presented on pages 51 thru 68. The 2004 oat trial was damaged by hail on July 23 and again on Sept. 4 and the results are not reported. The 2003 oat trial was damaged by hail on Sept. 9 and the results are presented for informational purposes only. In 1998, an oat trial was not planted. A barley trial was not planted in 2000 although 50 entries in the RWA barley resistant nursery were evaluated. Results from the 1998 and 1997 feed and waxy/hulless barley trials are presented. Sylvan is the recommended full-season hard red spring wheat for southwestern Colorado while 'Blanca' and 'Centennial' are good yielding soft white spring varieties. Durum wheat typically yields less than hard red or soft white varieties. Increased emphasis by breeding programs is being directed toward developing hard white and RWA resistant spring wheat varieties. The results of the spring grain trials are available on the internet (www.csucrops.com).

For the dual use cereal study, forage dry matter (DM) yield of all the entries was greater in 1997 than in 1998. IVDMD was also greater (except for 'Steptoe'), but CP was generally lower as was grain yield. The wetter and cooler conditions in 1997 favored DM production but contributed to lodging, which reduced grain yield and quality. Steptoe barley appears to be well-suited for forage or grain production in southwestern Colorado, while Sylvan wheat and Ajay oat might be better suited for grain production, given their short stature. Triticale had comparable DM yield to oat and wheat in 1997 and to oat and barley in 1998. Triticale seed yield was significantly greater than that of most oat and barley varieties in 1997 and similar to wheat, 'Monida' and 'Ajay' oat, and to Steptoe barley in 1998. Triticale CP was similar to that of wheat or oat and its IVDMD was comparable to that of wheat and barley. Oat digestibility at harvest was the lowest of the four cereals in 1998. The results appear to be variety-dependent (Berrada and Brummer, 2004).

References

Berrada, A. and J.E. Brummer. 2004. Evaluation of spring cereals for dual use. p. 101-106. *In* J.E. Brummer and C.H. Pearson (ed.) Colorado forage research 2003 alfalfa, irrigated pastures, and mountain meadows. Colorado Agric. Exp. Stn. Tech. Bull. TB04-01. Fort Collins.

Bregitzer, P., D.W. Mornhinweg, R. Hammon, M. Stack, D.D. Baltensperger, G.L. Hein, M.K. O'Neill, J.C. Whitmore, and D.J. Fielder. 2005. Registration of 'Burton' barley. Crop Sci. 45:1166-1167.

Acknowledgments

Dr. Jim Quick, former Soil and Crop Sciences department head and wheat breeder, and Dr. Scott Haley, present wheat breeder, for coordinating the spring wheat trials. Dr. Jerry Johnson and Cynthia Johnson, CSU Crops Testing Program, for soliciting entries for the barley and oat trials and publishing the results of the spring grain trials. Merlin Dillon, San Luis Valley Cooperative Extension, coordinated the entries in the spring barley and oat trials with USDA-ARS, Aberdeen, ID. Dr. Phil Bregitzer, USDA-ARS Aberdeen, ID and Bob Hammon, Western Colorado Research Center at Fruita, coordinated the RWA resistant barley nursery and trials.

2004 irrigated spring wheat performance trial at Yellow Jacket, CO.[1]

Entry	Market Class	Grain Yield[2]	Test Weight	Grain Protein[3]	Plant Height	Heading Date[4]
		bu/ac	lbs/bu	%	in	days
Alturas	Soft white	145.6	58.8	11.0	34	183
Sylvan	Hard red	142.1	60.4	13.4	37	187
Lolo	Hard white	139.4	59.5	12.2	34	180
IDO599	Soft white	139.4	59.1	11.3	32	175
IDO597	Hard white	132.7	57.8	13.5	33	177
Jerome	Hard red	127.8	59.2	14.4	32	175
IDO592	Hard red	121.5	59.1	12.8	32	175
Pristine	Hard white	119.2	60.5	13.7	32	173
Centennial	Soft white	116.7	59.8	11.7	31	180
IDO593	Hard red	109.6	58.6	11.8	30	175
ID377s	Hard white	108.0	59.0	13.4	32	178
Kronos	Durum	107.9	58.7	14.1	27	173
WB881	Durum	92.3	57.4	14.4	27	180
Average		**123.2**	**59.1**	**12.9**	**32**	
CV%		7.4				
$LSD_{(0.05)}$		13.0				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/27/04 and harvested 9/9/04.

[2]Yield based on 60 lbs/bu and 12% moisture.

[3]Protein based on 12% moisture.

[4]Number days after January 1.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow; two-years ago: winter wheat
Seeding rate:	1,200,000 seeds/ac (8-inch row spacing)
Fertilizer:	85 lbs N/ac broadcast preplant (April 21, 2004)
Herbicide:	Harmony Extra XP 0.4 oz/ac + 2,4-D Ester 5.3 oz/ac (June 5, 2004)
Insecticide:	Lorsban 1pt/ac (June 5, 2004)
Irrigation:	17.6 inches (5 sprinkler wheel-line passes)
Precipitation:	January 1, 2004 thru August 31, 2004: 8.0 inches (long-term average 9.7 inches)

Comments:

Most of the entries performed very well with very good yields and test weights. Sylvan was again the best yielding hard red spring wheat. Alturas, a soft white spring wheat, appears to be well adapted to southwestern Colorado. Two hard white spring wheats (Lolo and IDO597) performed very well in the trial.

The entries were treated with Lorsban to control Russian wheat aphids (RWA) on June 5. Two soft white spring wheat entries (Alturas and Centennial) had very visible RWA symptoms. ID377s had lodging that ranged from 80 to 100%. Lolo lodged 90% in one plot. None of the other entries lodged. The spring wheat trial received minor damage from hail storms on July 23 and September 4. The durum wheats were more susceptible to seed shattering than the other market classes.

2003 irrigated spring wheat performance trial at Yellow Jacket, CO.[1]

Entry	Market Class[4]	Grain Yield[2]	Test Weight	Grain Protein	Plant Height	Heading Date[3]
		bu/ac	lbs/bu	%	in	days
Sylvan	Hard red	76.6	59.3	16.3	30	188
Lolo	Hard white	75.2	60.3	15.7	29	178
Centennial	Soft white	73.2	59.0	14.2	26	176
ID377s	Hard white	72.4	58.9	14.6	28	178
CO98S01	Hard red	69.1	57.8	16.2	29	181
Hank	Hard red	63.3	58.0	16.4	25	174
Kronos	Durum	57.6	59.1	17.6	20	174
WB881	Durum	55.4	58.3	16.8	22	178
Plata	Hard white	50.0	58.4	15.4	24	178
CO98S17	Hard red	45.4	57.3	15.5	24	175
CO98S49	Hard red	40.4	56.8	15.9	23	174
Average		**61.7**	**58.5**	**15.9**		
CV%		9.5				
$LSD_{(0.05)}$		8.5				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/1/03 and harvested 9/22/03.
[2]Yields based on 60 lbs/bu and 12% moisture.
[3]Number of days after January 1.

Site Information:

Soil Type:	Wetherill silty clay loam
Previous crop:	Dry beans
Seeding rate:	1,200,000 seeds/acre (8-inch row spacing)
Fertilizer:	75 lbs N/ac broadcast preplant + 30 lbs N/ac top-dress
Herbicide:	Harmony Extra 0.4 oz/ac + 2,4-D Amine 8 oz/ac (June 10)
Insecticide:	Lorsban 1 pt/ac (June 10)
Precipitation:	January 1, 2003 thru August 31, 2003: 6.5 inches (long-term average 9.7 inches)
Irrigation:	15.5 inches (center pivot)

Comments:
The growing season was again very hot and dry. The spring wheat trial was damaged by a storm on Sept. 9 that brought 2.15 inches of rain and was accompanied by 1-inch diameter hail. Estimated grain yield losses are in the range of 20 to 30%. The trial was treated with Lorsban for control of Russian wheat aphids on June 10. None of the entries lodged.

Sylvan, Lolo, Centennial, and ID377s had acceptable yields and good test weights notwithstanding the hail damage. CO98S01, a Russian wheat aphid resistant line, yielded well but with a lower test weight. The two other Russian wheat aphid resistant lines, CO98S17 and CO98S49, had low yields and low test weights. The Russian wheat aphid resistant lines all exhibit undesirable agronomic characteristics i.e. poor straw strength or seed shattering. The durum wheat (Kronos and WB881), yielded less than the hard red, hard white, and soft white entries.

Sylvan was released in 1994 by Colorado State University and takes a full season to mature in southwestern Colorado.

2002 irrigated spring wheat performance trial at Yellow Jacket, CO.[1]

Entry	Market Class	Yield[2]	Test Weight	Grain Protein	Plant Height	Heading Date[3]
		bu/ac	lbs/bu	%	in	days
Centennial	Soft white	74.1	62.0	13.5	25	173
ID377s	Hard white	72.6	61.8	14.5	27	173
Sylvan	Hard red	69.9	60.2	15.1	31	179
CO98S17	Hard white	60.7	61.8	15.5	28	173
CO98S01	Hard red	60.4	60.4	15.6	26	175
CO98S12	Hard red	55.0	60.0	15.0	24	168
CO98S13	Hard white	54.8	60.0	15.4	24	166
CO98S49	Hard red	53.7	61.6	14.7	24	171
Kronos	Durum	52.5	59.4	15.9	23	168
CO98S68	Hard red	47.4	61.3	17.2	30	173
CO98S28	Hard red	45.0	61.5	17.0	25	169
CO98S21	Hard red	43.6	61.3	15.0	24	166
CO98S31	Hard red	43.3	61.0	16.3	28	170
CO98S24	Hard red	39.2	59.9	17.2	25	166
CO98S44	Hard red	35.8	59.9	16.6	26	168
Average		**53.9**	**60.8**			
CV%		11.0				
LSD ($_{0.05}$)		8.5				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/23/02, harvested 8/22/02.
[2]Bushel yield based on 60 lbs/bu and 12% moisture.
[3] Number of days after January 1.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry beans
Seeding rate:	90 lbs/acre; (8-inch row spacing)
Fertilizer:	75 lbs N/ac broadcast preplant + 30 lbs N/ac top-dress
Herbicide:	Harmony Extra 0.5 oz/ac + 2,4--D Ester 8 oz/ac
Insecticide:	None
Irrigation:	22.5 inches (sprinkler)
Precipitation:	January 1, 2002 thru August 22, 2002: 1.1 inches (long-term average 9.7 inches)

Comments:

The spring wheat variety trial yields were below average this year. The check varieties of Sylvan and ID377s yielded 69.9 bu/ac and 72.6 bu/ac compared to their five-year average of 98.3 bu/ac and 97.4 bu/ac, respectively. The low yields in 2002 may be due to the hot and dry conditions that persisted throughout the growing season. Sylvan and ID377s also headed earlier in 2002 compared to previous years. None of the entries lodged this year. Harvest was two weeks earlier than any spring wheat trial over the past five years at Yellow Jacket.

The CO98S entries are experimental lines from Colorado State University with Russian wheat aphid (RWA) resistance. Many of these lines had short tillers with small heads that were late in maturing. Stress to the wheat plant early in the year may have caused the plants to produce the short tillers. The RWA resistant lines also exhibited seed shattering. No insecticide to control RWA was applied in order to subject the experimental lines to RWA feeding pressure. There was moderate RWA activity present in the trial.

2001 irrigated spring wheat performance trial at Yellow Jacket, CO.[1]

Variety	Yield[2]	Test Wt	Plant Ht	Heading Date[3]	Grain Protein	Grain Hardness[4]
	bu/ac	lbs/bu	in		%	rating
Sylvan	109	59.8	35	7/5	15.9	50
GM400019	108	62.3	29	7/6	16.1	19
GM400016	100	62.0	29	6/23	13.6	63
GM40004	99	59.8	29	6/25	15.0	80
ID377s	97	58.7	30	6/25	15.6	60
Centennial	93	58.7	27	6/29	16.7	65
GM400020	92	62.0	25	6/25	15.3	69
GM40003	91	61.7	25	6/23	14.7	63
Spillman	90	55.8	32	7/5	18.2	53
GM90009	83	55.1	24	6/26	15.2	88
Utopia	80	55.1	25	6/23	14.3	63
GM90002	80	56.8	25	6/23	14.1	111
Kronos	75	57.0	25	6/27	13.8	109
GM40002	74	61.6	27	6/23	14.5	39
Average	**91**					
CV%	9.8					
$LSD_{(0.05)}$	13					

[1]Trial conducted at the Southwestern Colorado Research Center;
seeded 5/2, harvested 9/11.
[2]Bushel yield based on 60 lbs/bu and 12% moisture.
[3]Date 50% of the plants headed.
[4]Grain hardness: Hard wheats >35; Soft wheats <35.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Alfalfa (spring moldboard plowed)
Seeding rate:	90 lbs/acre (8-in. row spacing)
Fertilizer:	75 lbs N/ac broadcast preplant, + 40 lbs N/ac top-dress on June 15
Herbicide:	2,4-D Amine 1 pt/ac on June 15
Insecticide:	Lorsban SG 1pt/ac on June 15
Precipitation:	May thru August 4.4 inches
Irrigation:	14.5 inches (center pivot)

Comments:

Precipitation was below normal for May thru August (4.4 inches vs. 5.0 inches long-term average). The spring wheat benefited from following alfalfa in the rotation – less compaction and root diseases. The high grain protein indicates that nitrogen did not limit grain yields. The good test weights indicate that yields were not impacted by insufficient irrigation water. Lorsban was applied to control Russian wheat aphid.

The hard white entries (GM40002, GM40003, GM400016, GM400020) incurred some frost damage to their heads from a freeze on June 14 (31°F). GM 40004 and GM 400019 escaped damage from the freeze. None of the other entries exhibited any freeze damage to their heads.

Both Sylvan and Spillman had lodging that ranged from 10 to 50% in the four replications. ID377s lodged 20 to 90% while the durum entry GM 90009 had lodging that ranged from 10 to 50%. None of the other entries had significant lodging.

2000 irrigated spring wheat variety performance trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	lbs/bu	in		%	rating
GM 50002	Hard red	96.6	57.2	28	6/30	14.2	25
ID 377s	Hard white	95.2	58.4	29	6/21	15.1	36
GM 40001	Hard white	92.6	56.4	29	6/26	14.5	38
GM 90002	Durum	88.3	57.8	25	6/23	16.1	78
Blanca	Soft white	86.4	55.3	30	7/1	15.8	-
GM 90000	Durum	85.3	56.8	21	6/21	15.9	104
Sylvan	Hard red	84.9	57.0	33	7/1	14.4	51
WB 881	Durum	84.6	57.2	25	6/24	15.8	77
Spillman	Hard red	82.6	52.5	29	7/1	15.5	39
GM 90004	Durum	79.1	54.4	23	6/26	17.4	76
GM 40003	Hard white	75.8	59.9	28	6/19	15.3	16
GM 50018	Hard red	72.5	56.6	22	6/20	15.6	47
GM 40002	Hard white	67.2	57.8	24	6/16	15.5	41
Average		**83.9**					
CV(%)		7.6					
$LSD_{(0.05)}$		6.3					

[1] Trial conducted at the Southwestern Colorado Research Center;
Seeded 4/26/200, harvested 9/14/2000.
[2] Bushel yield based on 60 lbs/bu and 12% moisture.
[3] 50% of plants headed.
[4]Grain Hardness: Hard wheats>40; Soft wheats<40.

Site Information:

Soil type: Wetherill silty clay loam
Seeding rate: 90 lbs/acre
Fertilizer: 112 lbs N/ac broadcast on April 21, 2000
Herbicide: Buctril 1pt/ac on June 1, 2000
Insecticide: Lorsban 1pt/ac on June 1, 2000
Precipitation: 1.1 inches: April 26, 2000 thru August 15, 2000
Irrigation: 17 inches (7 sprinkler applications)

Comments:

The growing season was very dry and marked by above average temperatures. Lorsban was applied to control Russian wheat aphid. No lodging was observed. The low test weights and high protein percentages indicate that moisture was a limiting factor. General Mills varieties are designated by ' GM'. GM 50002 and GM 40003 are not as hard as accepted hard varieties. Sylvan was released in 1994 by Colorado State University and is the predominant spring wheat planted in the area.

1999 irrigated spring wheat variety performance trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Grain Moisture	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	%	lbs/bu	in		%	rating
Blanca	Soft white	100.5	10.9	54.8	36	7/02	9.3	19
Whitebird	Soft white	92.9	10.3	57.9	34	7/02	9.8	18
Sylvan	Hard red	92.1	10.2	56.8	38	7/04	10.2	66
BZ692-108	Soft white	90.7	10.0	55.4	32	6/30	9.7	8
Zeke	Hard red	87.5	10.2	54.3	32	6/28	11.1	43
ID377s	Hard white	86.2	10.2	57.7	34	6/28	10.5	80
ID506	Soft white	81.9	10.6	54.6	33	6/30	10.9	11
Spillman	Hard red	80.1	10.0	54.1	33	7/02	11.3	44
ID502	Hard red	79.1	10.1	56.5	32	6/30	10.8	80
MT RWA116	Hard red	69.2	10.1	55.4	34	6/30	12.1	76
Average		**86.0**						
CV%		8.5						
$LSD_{(0.05)}$		10.7						

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/19/99, harvested 9/07/99.
[2]Bushel yield based on 60 lbs/bu and 12% moisture.
[3]Date 50% of the plants headed.
[4]Grain hardness: Hard white >40; Soft white <40.

Site Information:

Soil type: Wetherill silty clay loam
Previous crop: Irrigated pinto bean
Fertilizer: 130 lbs N/ac + 75 lbs P_2O_5/ac
Herbicide: None
Insecticide: Lorsban 1pt/ac on June 30 (Russian wheat aphid)
Precipitation: 7.1 inches: April 20 thru August 15
Irrigation: 8.5 inches (4 sprinkler irrigations)

Comments:

Cooler temperatures and competition from volunteer pinto beans may have contributed to lower yields compared to previous years. Also, irrigation water applied was considerably less than prior years due to a wet July and August. No lodging was observed.

1998 irrigated spring wheat variety trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]
		bu/ac	lbs/bu	in	
Pomerelle	Soft white	104.5	59.5	29	6/29
Sylvan	Hard red	103.2	63.0	32	7/01
Blanca	Soft white	101.2	59.0	31	6/29
ID474	Soft white	98.0	63.0	30	7/01
ID377s	Hard white	97.6	63.0	31	6/29
ID506	Soft white	93.5	61.5	32	6/29
UT3172	Hard red	91.0	60.0	32	6/29
Spillman	Hard red	90.7	60.0	30	6/29
SDM50031	Hard red	88.2	64.0	31	6/29
CA876	Hard white	86.4	62.0	28	6/29
ID462	Hard red	86.1	63.0	28	6/29
SDM50032	Hard red	85.8	63.5	31	6/29
Oslo	Hard red	78.1	61.5	29	7/01
MT RWA116	Hard red	71.0	62.0	28	6/29
Average		**91.1**			
CV%		5.0			
LSD ($_{0.05}$)		6.5			

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/23/98, harvested 9/01/98.
[2]Bushel yield based on 60 lbs/bu and not adjusted for moisture.
[3]Date 50% of the plants headed.

Site Information:

Soil type:	Wetherill silty clay loam
Seeding rate:	90 lbs/ac
Previous crop:	Dry beans (fall chisel plowed)
Fertilizer:	120 lbs N/ac + 40 lbs P_2O_5/ac (urea and 11-52-0) was broadcast on April 21
Herbicide:	Harmony Extra 0.5 oz/ac + 2,4-D Amine 4 oz/ac on June 18
Insecticide:	Lorsban 1pt/ac on June 18
Precipitation:	3.5 inches: April 23 thru August 31
Irrigation:	20 inches (6 sprinkler irrigations)

Comments:

The 1998 growing season was drier than normal, however, temperatures were not unusually hot (highest recorded temperature was 95°F with only six days above 90°F). The trial was sprayed to control Russian Wheat Aphid on June 18. Spillman had 5% off-type plants while UT3172 had 1% red-chaffed heads. Pomerelle, SDM50031, and SDM50032 still had some green heads at harvest. Lodging was observed in Pomerelle (20% in one plot), MT RWA116 (10 to 50%), ID377s (50% in one plot), and ID474 (5% in one plot). The lodging was confined to areas in proximity to the sprinkler wheel line during the last irrigation set. At harvest, Pomerelle and Blanca were the only entries with grain moisture above 12% (15 and 14%, respectively) at harvest. Grain was air-dried to below 12% moisture prior to weighing and calculating yields.

2004 irrigated spring barley performance trial at Yellow Jacket, CO.[1]

Entry	Type	Grain Yield[2]	Test Weight[3]	Plant Height	Heading Date
		bu/ac	lbs/bu	in	days
01OST1587	2-row	108.2	50.5	28	173
01OST1514	2-row	98.5	50.4	28	177
01OST1677	2-row	94.5	49.9	28	177
01OST1758	2-row	91.8	50.5	27	176
Baronesse + Gaucho	2-row	90.6	50.2	29	179
01OST1750	2-row	88.7	49.6	27	177
01OST1615	2-row	88.2	50.5	27	177
98ID251 (Burton)	2-row	87.7	50.0	32	180
01OST1655	2-row	86.0	50.1	27	177
Baronesse	2-row	84.2	49.2	27	179
Creel	6-row	79.0	45.8	33	173
Colter	6-row	77.1	45.4	33	173
Camas	2-row	71.3	48.4	31	175
Garnet	2-row	61.7	48.3	34	180
Bowman	2-row	59.8	49.2	31	175
Criton	2-row	53.3	47.9	29	177
Average		**82.5**			
CV%		12.5			
LSD(0.05)		14.7			

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/27/04 and harvested 9/7/04.
[2]Bushel yield based on 48 lbs/bu and 12% moisture.
[3]Number of days after January 1.

Site Information:

Soil Type:	Wetherill silty clay loam
Previous crop:	Fallow; two-years ago: winter wheat
Seeding rate:	100 lbs/ac (8-inch row spacing)
Fertilizer:	85 lbs N/ac broadcast preplant (April 21, 2004)
Herbicide:	Harmony Extra XP 0.4 oz/ac +2,4-D Ester 5.3 oz/ac (June 5, 2004)
Insecticide:	None
Irrigation:	17.6 inches (5 sprinkler passes)
Precipitation:	January 1, 2004 thru August 31, 2004: 8.0 inches (long-term average 9.7 inches)

Comments:

The trial was designed to test Russian wheat aphid resistant entries. The numbered entries are Russian wheat aphid resistant experimental lines from USDA-ARS at Aberdeen, ID. Baronesse was treated with Gaucho seed insecticide to measure the effect of Russian wheat aphid damage on Baronesse. Baronesse, a Western Plant Breeders variety, is not resistant to Russian wheat aphid. The Russian wheat aphid resistant entries were higher yielding and had better test weights than the released varieties that were not resistant to the Russian wheat aphid. 98ID251 has been released as the variety 'Burton.'

The barley trial was damaged by hail on July 23 and again on September 4. The September hailstorm caused more seed to shatter since the grain was ready to harvest. Several entries lodged in plots that were directly under the sprinkler wheel-line. Careful management of irrigation with wheel-lines is required to prevent serious lodging.

2003 irrigated spring barley performance trial at Yellow Jacket, CO.[1]

Entry	Type	Grain Yield[2]	Test Weight	Plant Height	Heading Date[3]
		bu/ac	lbs/bu	in	days
Baronesse	2-row	104.6	50.8	24	179
Ab11993	2-row	100.6	50.3	23	184
Creel	6-row	100.4	48.5	27	178
Ab8333	6-row	96.4	48.4	24	172
Ab13449	6-row	96.2	49.2	26	178
98ID242	2-row	93.3	50.6	27	183
Garnet	2-row	91.5	50.5	28	184
Ab12362	6-row	90.5	49.3	27	179
MT960228	Unknown	89.6	50.5	26	184
MT970116	2-row	86.3	51.4	30	184
98ID251	2-row	86.1	50.3	28	186
Ab2323	2-row	85.6	51.1	29	186
Average		**93.4**	**50.1**		
CV%		5.4			
$LSD_{(0.05)}$		8.6			

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/1/03 and harvested 9/22/03
[2]Bushel yield based on 48 lbs/bu and 12% moisture.
[3]Number of days after January 1.

Site Information:

Soil Type:	Wetherill silty clay loam
Previous crop:	Dry beans
Seeding rate:	100 lbs/ac (8-inch row spacing)
Fertilizer:	75 lbs N/ac broadcast preplant (April 18, 2003)
Herbicide:	Harmony Extra 0.4 oz/ac + 2,4-D Amine 8 oz/ac (June 10, 2003)
Insecticide:	Lorsban 1 pt/ac (June 10, 2003)
Irrigation:	15.5 inches (center pivot)
Precipitation:	January 1, 2003 thru August 31, 2003: 6.5 inches (long-term average 9.7 inches)

Comments:
The growing season was again hot and dry. The barley trial was damaged by a severe storm with 1-inch diameter hail on September 9 before it could be harvested. Estimated yield losses are in the range of 20 – 30% range. The trial was treated with Lorsban for Russian wheat aphid on June 10. None of the entries lodged except MT960228 where one plot lodged 100%.

Baronesse and Ab11993 yielded very well with good test weight notwithstanding the hailstorm. Two Russian wheat aphid resistant entries (98ID242 and 98ID251) were also tested in the trial. None of the entries in the trial developed the late tillers that resulted in green heads at harvest in 2002.

2002 irrigated spring barley performance trial at Yellow Jacket, CO.[1]

Entry	Type	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Lodging[4]	Grain Moisture
		bu/ac	lbs/bu	in	days	1-9	%
MT970116	2-row	141.8	53.7	29	177	1	9.6
Criton	2-row	138.0	52.2	26	179	2	9.4
98ID242	2-row	135.0	52.9	27	179	1	9.4
Farmington	2-row	132.3	51.7	23	184	3	9.8
Baronesse	2-row	132.2	51.7	24	178	2	8.9
98Ab12364	6-row	131.9	48.8	29	177	1	9.1
Creel (93Ab688)	6-row	131.6	48.2	29	173	1	9.5
Colter	6-row	129.1	46.3	29	173	1	9.2
97ID1269B	6-row	127.7	49.1	33	178	1	9.3
98Ab11993	2-row	127.4	50.7	25	177	4	9.3
85Ab2323	2-row	125.2	51.8	28	179	3	10.7
WA8682-96	2-row	124.8	52.2	25	178	2	9.6
Garnet	2-row	124.4	52.5	29	179	3	8.9
98Ab12362	6-row	124.1	48.9	32	177	1	8.2
98Ab11865	2-row	123.5	51.8	23	184	6	11.2
97Ab8333	6-row	120.3	47.6	28	168	1	10.1
98ID196	2-row	118.1	51.4	29	184	1	10.2
98Ab12905	6-row	113.2	47.3	28	173	1	10.0
94Ab13449	6-row	110.5	47.7	29	173	1	10.4
Average		**126.9**	**50.4**				
CV%		8.0					
$LSD_{(0.05)}$		14.4					

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/23/02, harvested 8/26/02.
[2]Bushel yield based on 48 lbs/bu and 12% moisture.
[3]Number of days after January 1.
[4]Rating scale 1-9, with 1 = no lodging and 9 = completely lodged.

Site Information:

Soil type: Wetherill silty clay loam
Previous crop: Dry bean
Seeding rate: 100 lbs/acre (8-inch row spacing)
Fertilizer: 75 lbs N/ac broadcast preplant + 20 lbs N/ac top-dress
Herbicide: Harmony Extra 0.5 oz/ac + 2,4-D Ester 8 oz/ac
Insecticide: Lorsban SG 1 pt/ac (seed treated with Vitavax for loose smut)
Irrigation: 22.5 inches (sprinkler)
Precipitation: January 1, 2002 thru August 26, 2002: 1.1 inches (long-term average 9.7 inches)

Comments:

The spring barley variety trial yielded remarkably well notwithstanding the hot and dry conditions that persisted throughout the growing season. Lorsban SG was applied on June 18 to control Russian wheat aphids. The lines 98ID242, 97ID1269B, and 98ID196 were developed with resistance to the Russian wheat aphid. The 2-row barleys all had greater test weights (50.7 lbs/bu or better) than the 6-row barley types. Colter had the lowest test weight (46.3 lbs/bu). The 6-row barley types also were prone to developing late tillers. These tillers had small heads that were still green at harvest. Stress to the barley plant early in the growing season may have caused the plants to produce the late tillers.

2001 irrigated spring barley performance trial at Yellow Jacket, CO.[1]

Variety	Yield[2]	Test Wt	Plant Ht	Heading Date[3]
	bu/ac	lbs/bu	in	
93Ab688	151	47.5	26	6/27
98Ab12905	145	47.4	26	6/29
98Ab11865	144	51.7	22	7/3
96RWA1192	141	48.2	25	6/27
Baronesse	137	50.1	21	6/27
Garnet	135	50.4	25	7/2
93Ab859	131	51.5	26	7/2
97Ab8333	130	45.6	26	6/27
94Ab13449	128	47.9	28	6/29
Colter	127	44.8	27	6/26
98Ab12210	127	49.4	19	7/2
Alexis	126	50.2	21	7/5
92Ab5180	125	43.9	27	6/29
Comarque	112	48.6	21	7/3
Moravian 14	99	50.1	17	6/24
Average	**131**			
CV%	5.7			
$LSD_{(0.05)}$	11			

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/1, harvested 9/6.
[2]Bushel yield based on 48 lbs/bu and 12% moisture.
[3]Date 50% of the plants headed.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Alfalfa
Seeding rate:	100 lbs/acre (8-in. row spacing)
Fertilizer:	75 lbs N/ac broadcast preplant
Herbicide:	2,4-D Amine 1 pt/ac
Insecticide:	Lorsban SG 1pt/ac on June 15
Precipitation:	May thru August 4.4 inches
Irrigation:	14.5 inches (center pivot)

Comments:

Precipitation was below normal for May thru August (4.4 inches vs. 5.0 inches long-term average). The excellent barley yields for southwestern Colorado may be attributed to alfalfa in the crop rotation. Lorsban was applied to control Russian wheat aphid. The best yielding entry 93Ab688 averaged 25% lodging in the four replications. Baronesse's lodging ranged from 10 to 50% while Comarque's lodging ranged from 50 to 75%. Alexis, Garnet, 93Ab859, and 98Ab12210 also lodged to a lesser extent. The entry 98Ab12905 may mature too late for southwestern Colorado.

1999 irrigated spring barley variety performance trial at Yellow Jacket, CO.[1]

Variety	Source	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Moisture
		bu/ac	lbs/bu	in		%
93Ab688	USDA-ID	123.0	46.9	36	6/24	12.2
Xena	Westbred	121.5	48.7	33	6/26	12.5
Baronesse	Westbred	117.4	48.4	31	6/24	12.1
Nebula	Westbred	116.7	43.2	25	6/28	11.9
Steptoe	CSU	113.5	44.0	37	6/24	11.7
91Ab3148	USDA-ID	110.5	46.1	33	6/26	12.3
Colter	USDA-ID	110.5	45.0	33	6/24	12.2
Jersey	Westbred	107.1	48.3	30	6/28	12.1
92Ab5189	USDA-ID	106.8	42.6	32	6/24	12.6
93Ab859	USDA-ID	104.0	47.7	31	6/28	12.2
92Ab1368	USDA-ID	102.7	45.5	41	6/22	11.8
Average		**112.2**	**46.0**			
CV%		6.5				
LSD ($_{0.05}$)		11				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/19/99, harvested 8/25/99.
[2]Bushel yield based on 48 lbs/bu and 12% moisture.
[3]Date 50% of the plants headed.

Site Information:

Soil type: Wetherill silty clay loam
Previous crop: Irrigated pinto bean
Fertilizer: 130 lbs N/ac + 75 lbs P_2O_5/ac
Herbicide: None
Insecticide: Lorsban 1 pt/ac on June 30 (Russian wheat aphid)
Irrigation: 8.5 inches (4 sprinkler irrigations)
Precipitation: April 20, 1999 thru August 15, 1999: 7.1 inches

Comments:

Cooler temperatures and competition from volunteer pinto beans may have contributed to lower yields compared to previous years. Also, irrigation water applied was considerably less than prior years due to a wet July and August. No lodging was observed.

1998 feed and waxy/hulless barley trial at Yellow Jacket, CO.[1]

Variety	Type	Source	Grain Yield[2]	Test Weight	Plant Height	Heading Date[3]
			lbs/ac	lbs/bu	in	
Baronesse	Feed	Western Plant Breeders	5059	53.5	22	7/03
Steptoe	Feed	Colorado State Univ.	4728	48.0	25	6/29
Nebula	Feed	Western Plant Breeders	4517	47.0	19	7/06
Westford	Forage	Western Plant Breeders	4281	43.0	35	7/19
Stanwax	Hulless	Western Plant Breeders	3854	58.5	28	6/29
Washford	Forage	Washington State Univ.	3821	40.0	33	7/09
Bear	Hulless	Washington State Univ.	3812	61.0	29	7/06
Merlin	Hulless	Western Plant Breeders	3664	59.0	18	7/05
Average			**4217**			
CV%			4.7			
LSD ($_{0.05}$)			293			

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/04/98, harvested 8/31/98.
[2]Grain yield was not adjusted for moisture (all varieties <10% moisture at harvest).
[3]Date that 50% of the plants headed.

Site Information:

Soil type: Wetherill silty clay loam
Previous crop: Dry beans (fall chisel plowed)
Seeding rate: 90 lbs/acre
Fertilizer: 120 lbs N/ac + 40 lbs P_2O_5/ac broadcast on 4/21/98
Herbicide: Harmony Extra 0.5 oz/ac + 2,4-D Amine 4 oz/ac on 6/18/98
Insecticide: Lorsban 1 pt/ac on 6/18/98
Irrigation: 21 inches (7 sprinkler applications)
Precipitation: May 4, 1998 thru August 25, 1998: 3.0 inches

Comments:

The 1998 growing season was drier than normal, however, temperatures were not unusually hot (highest recorded temperature was 95°F with only six days above 90°F). The trial was sprayed for Russian wheat aphid on June 18. None of the entries lodged. Nebula's seed is yellow colored with awns that are difficult to remove with our plot combine. Washford and Westford are hooded barleys grown for forage. Westford threshed easier than Washford, although Westford had some green sucker heads at harvest. Loose smut was noted in Washford. The waxy and hulless barleys are grown for niche markets.

1997 feed and waxy/hulless barley trial at Yellow Jacket, CO.[1]

Variety	Type	Source	Grain Yield as is	Test Weight	Plant Height	Heading Date[2]	Lodging
			lbs/ac	lbs/bu	in		%
Baronesse	Feed	Western Plant Breeders	5881	50	29	6/30	20
Nebula	Feed	Western Plant Breeders	5429	42	18	7/04	None
Steptoe	Feed	Colorado State Univ.	4967	44	31	6/25	80
Merlin	Hulless	Western Plant Breeders	4754	56	22	7/04	None
Bear	Hulless	Washington State Univ.	3685	52	30	7/03	20
Stanwax	Hulless	Western Plant Breeders	3503	52	30	6/25	50
Shonkin	Hulless		2680	52	29	7/03	100
Average			**4414**				
CV%			10				
LSD ($_{0.05}$)			641				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/03/97, harvested 9/25/97.
[2]Date that 50% of the plants headed.

Site Information:

Soil type: Wittco silty clay loam
Previous crop: Dry beans (fall chisel plowed)
Seeding rate: 90 lbs/acre
Fertilizer: 140 lbs N/ac + 40 lbs P_2O_5/ac
Herbicide: Harmony Extra 0.5 oz/ac + 2,4-D Amine 8 oz/ac on 5/29/97
Insecticide: None
Irrigation: 13.5 inches (5 sprinkler applications)
Precipitation: May 1, 1997 thru August 31, 1997: 6.2 inches

Comments:

Harvest was delayed due to late summer precipitation which increased lodging in several of the varieties. Baronesse is a popular variety in Washington and Idaho. Nebula is a new release adapted to a large area in Arizona to Montana. Nebula was difficult to thresh with our plot combine which resulted in its low test weight. The waxy and hulless specialty barleys are for niche markets. Merlin is used as a pearl-rice additive in Japan.

2003 irrigated oat performance trial at Yellow Jacket, CO.[1]

Entry	Grain Yield[2]	Grain Yield[3]	Test Weight	Plant Height	Heading Date[4]
	bu/ac	bu/ac	lbs/bu	in	days
Ab10854	165.8	106.8	37.8	35	190
Ab8597	-----	114.7	37.2	35	187
AbSP19-9	174.0	125.0	37.0	33	188
Ajay	151.7	114.2	36.4	28	188
Lamont	126.8	102.1	41.9	36	190
Maverick	-----	109.7	36.4	31	186
Monico	171.0	126.3	38.4	35	181
Monida	157.3	123.1	35.4	36	188
Powell	156.0	109.5	36.2	31	188
Provena	-----	82.9	47.2	34	188
Russell	157.1	115.5	36.0	36	181
Average	**157.5**	**111.8**	**38.2**		

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/1/03. Hailstorm occurred on 9/9/03. Yields based on 38 lbs/bu and 12% moisture.
[2]Yield based on plots harvested on 9/5/03 before the hailstorm.
[3]Yield based on plots harvested on 9/19/03 after the hail damage.
[4]Number of days after January 1.

Site Information:

Soil Type:	Wetherill silty clay loam
Previous crop:	Dry beans
Seeding rate:	100 lbs/acre (8-inch row spacing)
Fertilizer:	75 lbs N/ac broadcast pre-plant
Herbicide:	Harmony Extra 0.4 oz/ac + 2,4-D Amine 8 oz/ac (June 10, 2003)
Insecticide:	None (seed treated with Vitavax for loose smut)
Precipitation:	January 1, 2003 thru August 31, 2003: 6.5 inches (long-term average 9.7 inches)
Irrigation:	15.5 inches (center pivot)

Comments:

The results are presented for informational purposes only. The 2003 irrigated oat performance trial was damaged by a storm on Sept. 9 that brought 2.15 inches of rain and was accompanied by 1-inch diameter hail. Approximately 25% of the trial was harvested prior to the storm when mechanical problems with the plot combine forced a delay. The combine was not repaired until after the storm. It is estimated that the yield loss from the hail ranged from 20 to 35% depending on the entry. Ab8597, Maverick, and Provena did not have any plots harvested before the hailstorm. Russell had lodging that ranged from 50 to 80% while Monida lodged 50% in one plot and Powell lodged 25% in one plot. None of the other entries lodged. Lamont and Provena are hulless oats which are lower yielding but have higher test weights. Monico and Maverick were released in 2003.

2002 irrigated spring oat performance trial at Yellow Jacket, CO.[1]

Entry	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Lodging[4]	Grain Moisture
	bu/ac	lbs/bu	in	days	1-9	%
AbSP19-9	165.9	38.5	36	180	1	7.5
Maverick (90Ab1322)	161.5	37.4	32	181	2	7.9
Monico (AbSP9-2)	160.7	40.5	35	179	1	7.9
Ajay	157.3	38.0	31	180	1	7.6
Powell	155.9	38.1	32	179	2	7.8
91Ab406	154.9	37.8	31	178	3	7.7
96Ab8597	152.3	38.1	37	180	2	8.1
95Ab10854	143.1	39.8	37	184	3	7.6
Rio Grande	140.1	37.9	33	175	2	7.6
Monida	140.0	37.2	38	181	3	7.5
Otana	128.6	38.7	38	180	2	8.0
Lamont	124.2	45.1	37	185	1	9.5
Russell	119.8	38.3	38	179	3	7.6
Provena	114.2	49.4	35	186	1	9.7
Average	**144.2**	**39.7**				
CV%	6.9					
LSD $_{(0.05)}$	14.3					

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/23/02, harvested 8/26/02.
[2]Bushel yield based on 38 lbs/bu and 12% moisture.
[3]Number of days after January 1.
[4]Rating scale 1-9, with 1 = no lodging and 9 = completely lodged.

Site Information:

Soil type: Wetherill silty clay loam
Previous crop: Dry bean
Seeding rate: 100 lbs/acre (8-inch row spacing)
Fertilizer: 75 lbs N/ac broadcast preplant
Herbicide: Harmony Extra 0.5 oz/ac + 2,4-D Ester 8 oz/ac
Insecticide: None (seed treated with Vitavax for loose smut)
Irrigation: 22.5 inches (sprinkler)
Precipitation: January 1, 2002 thru August 26, 2002: 1.1 inches (long-term average 9.7 inches)

Comments:

The oat variety trial yielded remarkably well notwithstanding the hot and dry conditions that persisted throughout the growing season. AbSP9-2 is being released as the variety 'Monico' and performed very well with a yield of 160.7 bu/ac and 40.5 lbs/bu test weight with no lodging. 90Ab1322 is proposed to be released as the variety 'Maverick'. It also yielded very good (161.5 bu/ac) and its' relatively short plant height provides superior lodging resistance. 'Ajay' (157.3 bu/ac) continues to perform very well in southwestern Colorado. 'Lamont' and 'Provena' are hulless spring oats and consequently had the best test weights. Hulless oats are used as a high-quality feed for horses and dairy cows.

2001 irrigated spring oat variety performance trial at Yellow Jacket, CO.[1]

Variety	Yield[2]	Test Wt	Heading Date[3]
	bu/ac	lbs/bu	
AbSP9-2	154	36.7	7/2
95Ab10854	152	39.8	7/10
90Ab1322	151	36.2	7/5
Powell	151	36.4	7/6
91Ab406	148	33.6	7/5
94Ab5546	146	37.6	7/5
AbSP19-9	146	35.4	7/5
94Ab5818	143	36.3	6/27
91Ab502	140	33.9	6/25
Ajay	138	36.7	7/6
Monida	137	35.1	7/6
Rio Grande	135	34.9	7/2
Lamont	133	44.0	7/12
Otana	132	37.8	7/12
Russell	124	35.7	7/4
95Ab12970	118	40.0	7/2
Average	**141**		
CV%	7.8		
$LSD_{(0.05)}$	16		

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 5/7, harvested 9/14.
[2]Bushel yield based on 38 lbs/bu and 12% moisture.
[3]Date 50% of the plants headed.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Alfalfa
Seeding rate:	100 lbs/acre (8-in. row spacing)
Fertilizer:	75 lbs N/ac broadcast preplant
Herbicide:	2,4-D Amine 1 pt/ac on June 15
Insecticide:	None
Precipitation:	May thru August 4.4 inches
Irrigation:	14.5 inches (center pivot)

Comments:

Precipitation was below normal for May thru August (4.4 inches vs. 5.0 inches long-term average). The excellent oat yields may be attributed to alfalfa in the crop rotation. The USDA-ARS may release AbSP9-2 as a named variety this year. All of the entries had significant lodging at harvest. Plant height was not measured due to the lodging. The lodging was due to the good soil fertility conditions. The relatively low test weights may be attributable to the extensive lodging in the trial. Lamont and 95Ab12970 are hulless spring oats.

1999 irrigated oat variety performance trial at Yellow Jacket, CO.[1]

Variety	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Lodging	Grain Moisture
	bu/ac	lbs/bu	in		%	%
91Ab406	152.8	36.8	34	7/2	0	8.8
Powell	147.2	36.9	33	7/4	0	8.9
AbSP19-9	144.7	39.4	35	7/6	25	9.1
Monida	140.3	37.2	38	7/8	20	9.0
AbSP9-2	135.0	39.3	34	6/30	10	9.2
Rio Grande	133.2	37.5	31	6/30	5	8.8
90Ab1322	131.0	38.2	33	7/2	0	9.2
Otana	130.8	38.8	45	7/2	0	9.3
Ajay	121.3	36.2	33	7/6	5	8.9
Russell	114.2	38.3	38	7/2	40	9.1
Average	**135.1**	**37.8**				
CV%	14.1					
LSD ($_{0.05}$)	27.6					

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 4/19/99, harvested 9/7/99.
[2]Bushel yield based on 38 lbs/bu and 12% moisture.
[3]Date 50% of plants headed.

Site Information:
Soil type: Wetherill silty clay loam
Previous crop: Irrigated dry beans
Fertilizer: 130 lbs N/ac + 75 lbs P_2O_5/ac
Herbicide: None
Insecticide: None
Irrigation: 8.5 inches (4 sprinkler irrigations)
Precipitation: April 20, 1999 thru August 15, 1999: 7.1 inches

Comments:
Cooler temperatures and competition from volunteer pinto beans may have contributed to lower yields compared to previous years. Also, irrigation water applied was considerably less than prior years due to a wet July and August.

Evaluation of Russian Wheat Aphid Resistant Spring Barley

Robert Hammon[1], Mark Stack[2], Tom Hooten[2], Phillip Bregitzer[3], and Dolores Mornhinweg[4]

[1] Western Colorado Research Center, 1910 L Road, Fruita, CO
[2] Southwestern Colorado Research Center, 16910 Road Z, Yellow Jacket, CO
[3] USDA-ARS, National Small Grains Germplasm Research Facility, Aberdeen, ID
[4] USDA-ARS , Plant Science and Water Conservation Research Laboratory, Stillwater, OK

Background

Barley is occasionally grown as a feed crop under irrigated conditions in southwestern Colorado. The appearance of Russian wheat aphid in 1986 impacted barley production by increasing production costs and lowering the quality of grain. USDA-ARS researchers at Aberdeen, ID and Stillwater, OK have been breeding barley cultivars that are resistant to Russian wheat aphid feeding damage. These barley lines have been tested at Yellow Jacket, CO, Aberdeen, ID, Tetonia, ID, Sidney, NE, Soda Springs, ID, and Genesee, ID in an effort to develop varieties that are adapted to a range of growing conditions, with excellent yield potential, test weight, and straw strength, as well as Russian wheat aphid resistance.

Evaluation of Russian wheat aphid resistant spring barley at Yellow Jacket began in 1998, with a total of 90 lines (including susceptible controls) tested in replicated and non-replicated trials. Thirty-five lines were tested in replicated trials in 1999, and 50 in 2000. Ten Russian wheat aphid resistant lines and two susceptible controls were tested in 2001. From these ten lines, six have been chosen for seed increase and future testing at Yellow Jacket and other locations in 2002.

Methods

The 2001 trials were planted under the center pivot irrigation system at the Southwest Colorado Research Center. The 5 ft x 15 ft plots were planted on May 1, 2001. Plots were arranged in a randomized complete block design with four replications. Analysis of variance was conducted on data for yield, test weight, and grain moisture. Plant height and heading date data were collected on two replications only. Harvest was on September 7, 2001 using a Hege plot combine. The center ten feet of each plot were harvested after five foot wide lanes were cut between plots. Other agronomic information for the site is:

Soil type:	Wetherill silty clay loam
Previous crop:	Alfalfa; spring moldboard plowed
Seeding rate:	80 lb/A; 8 in. row spacing
Fertilizer:	75 lb N/A broadcast preplant
Herbicide:	2,4-D Amine 1 pt/A June 15
Precipitation:	4.4 inches May thru August
Irrigation:	14.5 inches (center pivot)

Results

Description of barley lines are in Table 1. Results from the 2001 trial at Yellow Jacket are in Table 2. Results from trials conducted at other locations and years are not shown, but are similar. Six lines have been selected for seed increase and further testing. These varieties are printed in boldface in Tables 1 and 2. The selections were made using data generated at Yellow Jacket and other sites. There are three basic groups of genetic material based on pedigree. Resistance to Russian wheat aphid is acquired from PI366450 in all cases. In the first group of three lines with the malting parents Stander and Excel in their pedigree, 96RWA1194 was chosen based on greater straw strength than 96RWA1192 or 96RWA1218. 96RWA1194 has good yield potential but test weights have been low at Yellow Jacket, however acceptable test weights were seen at the Idaho test locations. Two other lines, 97ID1269B and 97ID1270, are derived from Stander backcrosses. Both appear superior to 96RWA1194 in yield potential

and test weight, and straw strength appears to be similar. Four two-row barley lines (98ID242, 98ID251, 98ID243, and 98ID240) are derived from Baronesse, Crystal, and Klages. One additional two-row line (98ID196) is derived from Bancroft, Hector, Crystal, and Klages. They have markedly higher test weight than the six-row lines, and good yield potential. Straw strength appears to be as good as Baronesse, but 98ID243 and 98ID240 were dropped from further testing because of lodging at the Aberdeen, ID test site.

The selected lines were tested in replicated trials and test strips at Aberdeen, ID, Yellow Jacket, CO and Farmington, NM in 2002. Further selection was made from the six lines after the 2002 growing season. Burton (98ID251) was released in 2004.

Table 1. Pedigree and characteristics of barley varieties.

Line	Pedigree	Type	RWA Resistance ?
98ID242	**Baronesse/3/Crystal//Klages*3/PI366450**	**feed, 2 row**	**Yes**
97ID1269B	**Stander*4/PI366450**	**malt, 6 row**	**Yes**
98ID251	**Baronesse/3/Crystal//Klages*3/PI366450**	**feed, 2 row**	**Yes**
97ID1270	**Stander*4/PI366450**	**malt, 6 row**	**Yes**
96RWA1192	PI366450/Stander*2//Excel	malt, 6 row	Yes
96RWA1218	PI366450/Stander*2//Excel	malt, 6 row	Yes
98ID196	**Bancroft/Hector/3/Crystal//Klages*3/PI366450**	**feed, 2 row**	**Yes**
98ID240	Baronesse/3/Crystal//Klages*3/PI366450	feed, 2 row	Yes
98ID243	Baronesse/3/Crystal//Klages*3/PI366450	feed, 2 row	Yes
Baronesse	Baronesse	feed, 2 row	No
96RWA1194	**PI366450/Stander*2//Excel**	**malt, 6 row**	**Yes**
Steptoe	WA3564/Unitan	feed, 6 row	No

Table 2. Performance data from 2001 trial at Yellow Jacket. Means within a column followed by the same letter are not significantly different (LSD, α=0.05).

Line	Heading Date	Height (inches)	Yield Bu/A@12%	Test Weight Lb/bu	% Moisture	% Plumps
98ID242	**02-Jul**	**23.5**	**124.6 a**	**51.3 a**	**10.1 de**	**92.9**
97ID1269B	**30-Jun**	**26.5**	**122.6 a**	**48.4 b**	**10.6 ab**	**79.2**
98ID251	**03-Jul**	**25.5**	**122.3 a**	**50.9 a**	**10.2 cde**	**89.9**
97ID1270	**05-Jul**	**22.5**	**122.0 a**	**48.0 b**	**10.9 ab**	**87.0**
96RWA1192	27-Jun	25.0	119.5 a	47.2 b	10.1 de	82.3
96RWA1218	02-Jul	22.0	113.2 ab	47.4 b	10.0 e	76.9
98ID196	**05-Jul**	**25.0**	**113.1 ab**	**50.9 a**	**10.6 abc**	**94.5**
98ID240	02-Jul	25.0	113.1 ab	51.2 a	10.3 bcde	94.3
98ID243	02-Jul	22.0	111.2 abc	50.6 a	10.1 de	88.9
Baronesse	27-Jun	18.5	103.6 bc	48.4 b	10.2 de	76.4
96RWA1194	**28-Jun**	**24.5**	**103.6 bc**	**47.6 b**	**10.1 de**	**83.1**
Steptoe	29-Jun	25.0	97.5 c	41.7 c	10.4 bcde	78.9
Average		24.0	113.9	48.6	10.3	85.4
CV %			8.43	1.74	2.59	
LSD (α=0.05)			13.73	1.22	0.38	

Spring Wheat Planting Date Effect On Russian Wheat Aphid And Grain Yield In Differing Environments[1]

Robert Hammon

Summary

Spring wheat planting date effects followed the same pattern observed in 1997 and 1998. Earlier planted spring wheat delivered better yields than later planted spring wheat in the Grand Valley, following a near linear trend. Spring wheat planting date effects on yield were insignificant in plots at Yellow Jacket. The difference in planting date effects on yield between the two environments is probably related to summer temperatures. In 1999, there tended to be more Russian wheat aphid foliar symptoms in the later planting dates at Fruita, but not at Yellow Jacket. During the late season sampling, more Russian wheat aphids were found feeding on wheat heads than on leaves or stems. Head feeding was responsible for some yield loss, but control efforts aimed at Russian wheat aphid earlier in the season tended to reduce the number of aphids found on heads during grain fill.

[1] Published June 2000 in Colorado Agricultural Experiment Station Technical Report TR00-4.

Results Of The Irrigated Winter Triticale Yield Trials at Yellow Jacket 1996 - 1999[1]

Abdel Berrada

Summary

Irrigated winter triticale (x *Triticosecale* Wittmack) trials were conducted at the Southwestern Colorado Research Center in Yellow Jacket from 1996 to 1999 to evaluate the yield potential of several varieties and experimental lines. This research was part of a program to evaluate alternative crops in southwestern Colorado. Triticale is a cross between wheat and rye. It combines the grain quality, yield, and disease resistance of wheat with the vigor and hardiness of rye (Wichman et al., 1995). Triticale seed yield and other agronomic traits have improved greatly since the initiation of the triticale breeding program at the International Maize and Wheat Improvement Center (CYMMYT) in 1968. Spring, facultative and winter triticales are increasingly used for grazing, forage, forage/grain dual purpose, and silage. They are also an acceptable partial to complete replacement for corn and other grains and as an energy source in some poultry and swine rations (Varughese et al., 1996).

Winter triticale produced as much as 157 bu/acre in 1998 and as little as 58 bu/acre in 1999. Yields averaged (including the checks) 99, 100, 137, and 79 bu/acre in 1996, 1997, 1998, and 1999, respectively. It is not possible to compare entries over the 4-year period since different entries were tested each year, with few exceptions. Differences in seed yield from year to year are likely due to variations in genetic material, climatic conditions, and management (planting and harvest dates, irrigation scheduling, fertilizer amounts, pest control, etc.). It is likely that the higher seeding and fertilizer rates in 1998 and adequate precipitation (rain and irrigation) led to the higher seed yield compared to the other years. In addition, there were fewer entries in 1998 and possibly only the best selections were entered that year. Poor weed control, low irrigation amount, and harvest conditions (10 to 20% shattering) may have contributed to the relatively low yields in 1999. Russian wheat aphids (RWA) were observed on Fairview and TAM107 in 1996. None of the triticale entries showed susceptibility to RWA in any of the 4 years of testing. Most of the winter and spring wheat varieties currently grown in southwestern Colorado and southeastern Utah are susceptible to RWA. No other disease or insect problems were noted. In general, wheat yield was substantially lower than that of most of the triticale entries. In contrast, wheat test weight was higher than that of triticale. The test weight of triticale was generally in the low to mid 50 lbs/bu while that of wheat consistently measured around 60 lbs/bu.

References

Varughese, G., W.H. Pfeiffer, and R.J. Pena. 1996. Triticale: A successful alternative crop (Part 2). Cereal Foods World: 635-645. Am. Assoc. of Cereal Chemists, Inc.

Wichman. D., L. Talbert, S. Lanning, G. Kushnak, G. Stallknecht, G. Carlson, and T. Keener. 1995. Triticale grain production and quality performance in Montana. Montana AgResearch: 23-26. Spring 1995.

[1]Published January 2004 in Colorado Agricultural Experiment Station Technical Bulletin TB04-01.

Dryland Winter Wheat Performance Trials at Yellow Jacket 1998-2004

Mark Stack, Abdel Berrada, Tom Hooten

Summary

Winter wheat variety trials are planted each year at the Southwestern Colorado Research Center to identify varieties and experimental lines adapted to southwestern Colorado. The data for the 2004 trial are not presented since the plots were severely damaged by a hailstorm on July 23. The yields were very low in the drought years 2000, 2001, and 2002. The emphasis has been on testing hard red and hard white market class wheat in recent years. The wheat breeding and genetics program to develop a dwarf bunt and Russian wheat aphid (RWA) resistant winter wheat for southwestern Colorado was not successful using selections from a single three-way cross.

Introduction and Objectives

Dryland winter wheat variety trials are planted at the Southwestern Colorado Research Center to identify varieties and experimental lines that are adapted to southwestern Colorado. 'Fairview' (ID338) was released in 1991 from this testing program. Fairview was a joint release of the USDA-ARS and the Colorado and Idaho Agricultural Experiment Stations.

Emphasis has been on identifying superior varieties with dwarf bunt (*Tilletia controversa* Kuhn) resistance. Dwarf bunt is a seed head fungal disease endemic to winter wheat in the northwestern United States. The disease is soil borne and the intensity of the disease is related to the duration of snow cover. In the late 1980's, Russian wheat aphid (RWA) *Diuraphis noxia* (Mordvilko) became established in southwestern Colorado. The Russian wheat aphid affect on dryland winter wheat was studied at the Research Center from 1990-1998 (Hammon et al., 1999).

In recent years, emphasis has been on developing a winter wheat adapted to southwestern Colorado with both dwarf bunt and RWA resistance. The breeding program to develop a hard red winter wheat with dwarf bunt resistance combined with RWA resistance is summarized in the next section.

Materials and Methods

The dryland winter wheat trial is coordinated with Dr. Scott Haley, CSU wheat breeder. Dr. Haley obtains entries for the trial from his own program and from wheat breeders in Idaho, Utah, and other western states. The winter wheat entries from the CSU breeding program are primarily developed for eastern Colorado. Wheat varieties developed for eastern Colorado do not have dwarf bunt resistance but many do have resistance to the original RWA biotype.

The trials are planted on fallow ground or in a rotation following pinto beans. Good agronomic practices are employed to obtain achievable yields. Usually 50 lbs N/ac is applied in the fall before planting. An insecticide (Lorsban 1 pt/ac) is applied to control RWA in the spring when necessary. A pyrethroid insecticide was applied in March 2003 to control a severe infestation of army cutworms following a mild winter. The goal is to obtain reasonable yields that can be duplicated by the grower.

The trials are planted with a 'Kincaid' spinner planter (600,000 seeds/ac or approx. 50 lbs seed/ac) with double disks at 12-inch row spacing and harvested with a 'Hege' plot combine. The grain

was cleaned with a 'Clipper M2BC' two-screen air cleaner or by hand using a fanning mill. Grain moisture (not reported) and test weights (lbs/bu) are determined by using a 'Seedburo GMA-128' grain moisture analyzer. Grain protein and hardness tests are determined on campus by the wheat breeding program.

Results and Discussion

The results for the last six years starting with 2003 are presented on pages 77 thru 83. The results for 2004 are not presented since the trial received severe damage from a July 23 hailstorm while the trial was being harvested. Fairview is the predominant hard red winter wheat grown in southwestern Colorado. 'Manning' and 'Jeff' are older varieties used as check varieties. 'Presto', a winter triticale, has been included in the trial and performs very well in southwestern Colorado. In recent years, the CSU wheat breeding program has focused on developing hard white winter wheat varieties. 'Golden Spike', a hard white wheat with dwarf bunt resistance, was released by Utah and is licensed to General Mills. 'Above' is a hard red wheat developed by CSU that yielded well in 2002 but does not have dwarf bunt resistance. Above has tolerance to Beyond™ herbicide for control of downy brome, jointed goat grass, and feral rye. UT203032 has been released by Utah as the variety 'Deloris' and has dwarf bunt resistance. 'Hayden' is a dwarf bunt resistant variety that is adapted to northwestern Colorado.

The results of the winter wheat trials are published annually by the CSU Crops Testing Program (*Making Better Decisions*) and are available on the internet (**www.csucrops.com).**

Reference

Hammon, R.W., D.V. Sanford, M.W. Stack, and A. Berrada. 1999. Dryland winter wheat planting date and Russian wheat aphid studies in southwestern Colorado, 1990-1998. Colorado Agric. Exp. Stn. Tech. Rep. TR99-2. Fort Collins.

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Winter Wheat Breeding and Genetics Program
Scott Haley, Wheat Breeder
Colorado State University

The program was initiated by Jim Quick, former CSU wheat breeder. The objective was to develop a winter wheat cultivar adapted to southwestern Colorado by combining resistance to dwarf bunt (a head smut disease) and Russian wheat aphid (RWA) in a single cultivar with stress tolerance for dryland production. Resources were provided by the CSU wheat breeding program and collaboration with Dr. Blair Goates (USDA-ARS plant pathologist, Aberdeen, ID) and the Southwestern Colorado Research Center. In late 2003, the decision was made to terminate the original breeding strategy and initiate a program based on backcrossing RWA resistance into lines with good dwarf bunt resistance. Dr. Ed Souza, Plant Breeding and Genetics, Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID will supply dwarf bunt resistant winter wheat germplasm for the crossing program.

1993 – Three-way cross 'Fairview/Lamar///Halt'. Fairview was the donor of dwarf bunt resistance, Halt the donor of RWA resistance, and Lamar is an eastern Colorado wheat with stable performance under drought stress conditions. Bulk populations were advanced without selection to provide lines for field evaluation beginning in the fall of 1998.

1999 – 204 experimental lines tested at Yellow Jacket. Grain yield, test weight, heading date, plant height, and visual observations were used to select 40 lines for advancement.

2000 – 40 lines tested in replicated field trials at Yellow Jacket. Remnant samples from 1999 were evaluated for predictive milling and baking quality tests. Because of low (9-16 bu/ac) and erratic yields, no selection was made and the entire set was retained for further testing.

2001 – 40 lines tested again in replicated field trials at Yellow Jacket. RWA screening was done in the greenhouse at Fort Collins and dwarf bunt screening was done at Aberdeen on two replications in the field. Remnant samples were evaluated for predictive milling and baking tests. Although yields were again low and erratic (range 5-16 bu/ac), selection of a subset of 12 lines was made based on combined resistance to dwarf bunt and RWA, milling and baking quality test data, and apparent adaptability in field trials.

2002 – 12 lines tested in replicated field trials at Yellow Jacket. RWA and dwarf bunt screening was repeated to confirm resistance although some discrepancy was noted between 2001 and 2002 dwarf bunt resistance data. Yields were again low with very few differences noted.

2003 – Additional field testing of the 12 lines in replicated field trials at Yellow Jacket. The lines were again screened for dwarf bunt resistance at Aberdeen. Based on yield data and dwarf bunt resistance screening, the decision was made to discontinue further testing of the 12 lines. Most of the lines did not yield competitively with Fairview and exhibited poor agronomic characteristics (e.g. straw strength). Only two of the lines had good dwarf bunt resistance but these two lines do not have yields comparable to Fairview. Lastly, a new RWA biotype discovered in eastern Colorado in 2003 compromised the RWA resistance in the lines. The decision was made to adopt a new strategy to develop an adapted dryland winter wheat for southwestern Colorado with both RWA and dwarf bunt resistance. The new program starts with adapted lines from Idaho that have good dwarf bunt resistance and RWA resistant germplasm.

2004 – In spring 2004, crosses were made between four winter wheat lines from the University of Idaho wheat breeding program and wheat germplasm lines carrying RWA resistance. The Idaho experimental lines were all dwarf bunt resistant lines. They included three hard red winter lines (IDO616, IDO617, and IDO618) and one hard white winter wheat line (IDO619). Two different sources of RWA resistance were chosen, both showing excellent resistance to the new biotype of RWA identified in southeast Colorado in 2003. These lines are CI2401, a landrace wheat germplasm accession from Tajikistan, and 2414-11, a germplasm accession from Stillwater, OK. In fall 2005, we will screen the F1 seed from each of these crosses and backcross resistant plants to the IDO recurrent parent. This process will be repeated in spring and fall 2006 and then lines will be extracted from the final backcross for field testing. In addition to these crosses, we will obtain several new experimental lines from the Idaho breeding program and begin crossing in fall 2005. Based on current information, we are uncertain whether CI2401 and 2414-11 confer resistance to additional, virulent biotypes identified in Colorado and other states in 2004 and 2005. We may need to choose other resistant parents for future backcrossing efforts.

2003 dryland winter wheat performance trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein
		bu/ac	lbs/bu	in		%
CO970547	Hard red	33.4	52.7	27	5/29	16.7
CO99177	Hard red	32.7	52.5	25	5/29	15.3
Lakin	Hard white	32.5	53.5	25	6/1	17.4
Avalanche	Hard white	32.2	54.7	26	6/1	15.9
CO99W183	Hard white	31.9	52.4	25	5/29	16.6
CO99W188	Hard white	31.9	53.1	24	6/2	16.7
Fairview	Hard red	31.2	52.3	26	6/4	16.6
CO99314	Hard red	31.1	53.1	24	5/29	17.9
Above	Hard red	30.8	51.6	24	5/29	18.7
CO99W277	Hard white	29.9	53.5	25	6/2	16.6
CO970547-7	Hard red	29.8	51.8	26	6/1	15.5
CO980607	Hard red	29.7	52.8	22	6/2	15.8
CO980630	Hard red	29.6	53.7	24	6/3	17.7
CO99141	Hard red	29.2	54.9	25	5/29	16.0
CO99W192	Hard white	29.2	53.5	24	6/2	16.4
Ankor	Hard red	28.9	51.7	23	6/2	17.2
Deloris	Hard red	28.6	53.9	28	6/6	15.8
CO970547-2	Hard red	28.5	52.8	25	6/2	16.4
CO99W254	Hard white	28.4	54.9	23	5/29	17.1
Golden Spike	Hard white	28.3	52.3	26	6/6	16.5
Manning	Hard red	28.2	53.1	25	6/4	16.4
Gary	Hard white	28.0	53.5	26	6/7	17.3
CO99W329	Hard white	27.7	52.5	25	5/29	17.6
ID0571	Hard red	27.6	55.4	26	6/4	16.5
CO980376	Hard red	26.2	52.6	26	6/2	18.1
Moreland	Hard red	24.5	50.1	22	6/4	17.0
Jeff	Hard red	24.5	55.5	29	6/6	17.5
Hayden	Hard red	23.7	55.2	29	6/7	16.8
Average		**29.2**	**53.2**	25	6/1	**16.8**
CV%		8.6				
$LSD_{(0.05)}$		3.5				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 9/27/02 and harvested 8/4/03.
[2]Bushel yield based on 60 lbs/bu. Yields were not adjusted for moisture.
[3]Date 50% of plants headed.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow
Seeding rate:	50 lbs/ac (12-in. row spacing)
Fertilizer:	50 lbs N/ac broadcast preplant
Herbicide:	None
Insecticide:	Mustang 1.5 EC 3.5 oz/ac aerial applied 3/23/03
Precipitation:	October 2002 thru June 2003: 8.8 inches (11.1 inches long-term average)

Comments:

The dryland winter wheat variety trial yielded above average in spite of the continuing drought in southwestern Colorado. The 29.2 bu/ac average grain yield is attributable to planting on fallow ground, good fertility, above

average fall precipitation, and emergence in early October. The below average test weights (average 53.2 lbs/bu) and the very high grain protein (average 16.8%) indicates that moisture was the limiting factor for grain yield.

There was a severe army cutworm infestation in southwestern Colorado during the winter and spring of 2003. The plots were treated in March with a pyrethroid insecticide. The wheat variety trial escaped serious damage from cutworm feeding due to the insecticide application. Area wheat fields that were not treated either incurred serious damage or suffered a complete loss due to army cutworm feeding. Russian wheat aphid damage was not observed in any of the entries nor was dwarf bunt noted at harvest.

2002 dryland winter wheat variety trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	lbs/bu	in		%	rating
CO970547	Hard red	24.2	59.6	22	5/24	16.8	33
Above	Hard red	22.1	59.5	22	5/24	16.2	59
Lakin	Hard white	21.8	59.9	21	5/24	15.6	48
Presto	Triticale	21.5	54.6	31	5/22	15.3	11
CO99534	Hard red	21.3	59.2	21	5/24	16.5	52
ID0575	Hard red	20.7	58.0	24	5/28	17.6	54
Avalanche	Hard white	19.5	60.8	21	5/24	16.5	50
ID0574	Hard red	19.5	59.8	26	5/31	17.6	50
Ankor(CO99508)	Hard red	18.8	58.9	21	5/28	16.3	40
Fairview	Hard red	18.7	58.3	23	5/31	18.6	51
Golden Spike	Hard white	18.6	58.9	23	5/31	17.2	63
ID0571	Hard red	18.4	60.9	22	5/31	16.6	58
UT910422	Hard red	18.4	59.5	23	5/31	17.0	43
Deloris(UT203032)	Hard red	18.0	57.4	23	5/28	17.6	38
Manning	Hard red	17.6	60.2	23	5/31	16.6	56
Jeff	Hard red	17.6	60.4	24	5/31	17.4	61
ID0517	Hard red	17.6	55.4	19	5/28	17.7	34
Hayden	Hard red	17.0	59.7	25	5/31	18.1	65
Gary(ID0550)	Hard white	16.4	59.5	23	5/31	15.8	59
UT910320	Hard white	16.2	55.1	19	6/5	19.4	69
Trego	Hard white	15.5	61.9	19	5/28	17.1	57
ID0573	Hard red	15.5	58.6	23	6/3	17.4	59
Average		**18.9**					
CV%		6.9					
LSD $_{(0.05)}$		1.8					

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 10/11/01 and harvested 7/17/02.
[2] Bushel yield based on 60 lbs/bu and 12% moisture.
[3]Date 50% of plants headed.
[4]Grain hardness: hard wheats >35; soft wheats <35.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow
Seeding rate:	50 lbs/ac (12-in. row spacing)
Fertilizer:	50 lbs N/ac broadcast preplant
Herbicide:	None
Insecticide:	None
Precipitation:	October 2001 thru June 2002: 2.6 inches (11.1 inches long-term average)

Comments:

The dryland winter wheat variety trial yielded better than expected in spite of the drought conditions. Deloris is a recent hard red release from Utah and Gary is a new hard white wheat from Idaho. For comparison, the average yields (1996-2000) for Dolores and Montezuma counties are 16.6 and 23.7 bu/ac, respectively. In the fall of 2001, there was sufficient moisture at planting to germinate the seed and to allow some growth before winter. Evidently, the fallow period (12 months) allowed the soil moisture to be recharged enough to achieve average yield potential. In 2002, Russian wheat aphid damage was not observed in any of the entries nor was dwarf bunt noted at harvest.

2001 dryland winter wheat variety trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	lbs/bu	in		%	rating
Presto	Triticale	8.8	51.0	25	5/29	15.9	-6
ID0548	Hard red	7.7	55.9	21	6/2	17.9	73
Promontory	Hard red	7.4	55.5	20	6/2	17.4	75
Jeff	Hard red	7.3	57.5	24	6/8	17.5	79
ID0550	Hard white	7.1	56.0	20	6/8	17.4	59
Manning	Hard red	7.0	56.0	22	6/2	17.7	87
Trego	Hard white	6.5	56.3	17	6/2	18.8	62
Golden Spike	Hard white	5.7	55.7	20	6/8	17.6	78
OR941044	Hard white	5.5	53.7	17	6/8	17.8	55
Avalanche (CO940611)	Hard white	5.3	52.8	17	5/3	18.3	70
UT203032	Hard red	5.2	55.4	21	6/5	17.9	68
Fairview	Hard red	5.0	55.6	23	6/5	18.2	76
NuFrontier (GM10001)	Hard white	4.7	53.8	18	6/2	17.7	62
Hayden	Hard red	3.9	55.1	20	6/8	19.0	68
Boundary	Soft white	3.6	48.9	14	6/11	18.7	54
Blizzard	Hard red	3.5	55.1	17	6/11	18.5	90
Lakin	Hard white	3.2	48.9	18	6/2	17.6	72
Nuplains	Hard white	3.2	54.8	14	6/8	14.1	62
MTW9432	Hard white	3.1	55.8	21	6/8	18.7	44
NuHorizons (GM10002)	Hard white	3.1	55.6	15	6/2	17.3	34
OR942496	Hard white	2.9	54.2	18	6/5	18.0	33
ID0517	Hard red	2.4	50.5	15	6/2	18.3	50
MTW9441	Hard white	2.0	-	16	6/8	19.2	79
Average		**5.0**					
CV%		27.8					
$LSD_{(0.05)}$		1.9					

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 10/16/00 and harvested 8/8/01.
[2]Bushel yield based on 60 lbs/bu and 12% moisture.
[3]Date 50% of plants headed.
[4]Grain hardness: Hard wheats >35; Soft wheats <35.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow
Seeding rate:	50 lbs/ac (12-in. row spacing)
Fertilizer:	50 lbs N/ac broadcast preplant
Herbicide:	Harmony Extra 0.5 oz/ac + 2,4-D Ester 4 oz/ac on May 17, 2001
Insecticide:	None
Precipitation:	October 2000 thru June 2001: 7.6 inches (11.1 inches long-term average)

Comments:

The yields were very low due to two years of below normal winter and spring precipitation. There was no noticeable damage to the heads from a freeze that occurred on June 14 (31°F). However, some area farmers attributed their low winter wheat yields in part to the freeze. Dwarf bunt was observed in CO940611, Nuplains, MTW9432, MTW9441, and OR942496. No significant Russian wheat aphid damage was observed. Avalanche is a new hard white release from the CSU breeding program.

2000 dryland winter wheat variety trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	lbs/bu	in		%	rating
Jeff	Hard red	19.1	61.5	22	6/7	13.5	58
Presto	Triticale	17.6	57.2	26	5/31	13.2	3
Manning	Hard red	17.6	58.3	16	6/5	14.2	56
Fairview	Hard red	16.4	58.1	18	6/7	15.2	50
ID0551	Hard white	14.9	58.6	18	6/12	14.6	39
Prowers 99	Hard red	14.6	59.8	18	6/7	15.3	44
ID0550	Hard white	14.3	58.4	17	6/7	14.5	41
ID0513	Hard red	14.3	58.2	15	6/7	15.4	46
Promontory	Hard red	14.2	60.4	15	6/5	14.8	50
ID0548	Hard red	14.1	58.0	18	6/7	15.0	36
OR942946	Hard white	14.0	57.7	16	6/5	14.8	37
UT100	Hard red	13.9	57.3	16	6/9	15.6	56
ID0535	Hard red	13.7	58.3	17	6/12	15.3	47
Golden Spike	Hard white	13.6	58.0	18	6/12	14.3	43
208032	Hard red	13.5	57.8	17	6/5	14.6	48
Blizzard	Hard red	13.5	58.4	18	6/12	15.6	55
ID0549	Hard red	13.3	59.6	18	6/12	15.4	48
Hayden	Hard red	13.3	58.3	18	6/9	15.8	56
Boundary	Hard red	10.9	55.5	14	6/9	15.5	26
OR948575	Hard white	10.0	52.5	14	6/14	16.1	30
Average		**14.3**					

All replications of each variety were inadvertently planted in the same range.
Thus, there is only one replication, albeit longer, for each variety.
[1]Trial conducted at the Southwestern Colorado Research Center;
seeded 10/19/99 and harvested 8/1/00.
[2]Bushel yield adjusted to 60 lbs/bu and 12% moisture.
[3]Date 50% of the plants headed.
[4]Grain hardness: hard wheats > 35; soft wheats < 35.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry Bean
Seeding rate:	50 lbs/ac (12-in. row spacing)
Fertilizer:	50 lbs N/ac broadcast in fall 1999
Herbicide:	Harmony Extra 0.5 oz/ac on 4/26/00
Insecticide:	Lorsban 1 pt/ac
Precipitation:	October 1999 thru July 2000: 4.9 inches (30 year average 12.5 inches)

Comments:
The 1999-2000 growing season can be characterized as very dry. The wheat did not emerge until spring. Consequently, yields were much below average. There was barely any snow cover, no dwarf bunt was observed, but there was moderate Russian wheat aphid pressure.

1999 dryland winter wheat variety trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	lbs/bu	in	date	%	rating
Presto	Triticale	51.4	52.9	33	6/02	11.2	33
UT201971	Hard red	44.1	58.1	30	6/14	12.3	90
Manning	Hard red	43.1	55.4	27	6/11	12.8	62
Lambert	Soft white	42.8	53.4	28	6/11	12.9	20
Jeff	Hard red	42.7	57.7	29	6/14	13.6	88
Fairview	Hard red	42.7	57.4	30	6/11	12.7	90
ID498	Hard red	42.2	55.1	28	6/14	12.7	66
ID539	Hard white	41.6	54.9	26	6/11	11.9	69
UT199847	Hard red	41.5	57.8	31	6/16	12.7	74
ID479	Hard red	41.3	56.3	26	6/11	12.7	54
Prowers	Hard red	40.5	57.7	29	6/11	14.2	62
ID537	Hard red	39.9	51.8	31	6/11	13.8	56
ID513	Hard red	39.9	54.9	25	6/16	13.7	63
UT944151	Hard red	39.9	53.6	29	6/14	14.0	60
ID535	Hard red	39.8	54.2	27	6/16	15.4	57
UT203032	Hard red	39.8	54.5	29	6/11	14.0	58
ID944158	Hard white	39.7	53.2	25	6/16	12.8	52
Brundage	Soft white	39.5	54.2	24	6/11	12.6	9
Hayden(ID465)	Hard red	37.8	52.2	31	6/14	14.4	78
Promontory	Hard red	37.1	57.0	25	6/11	12.9	74
UT100	Hard red	36.7	53.1	30	6/14	13.4	79
Blizzard	Hard red	34.3	54.2	29	6/16	13.3	66
ID511	Hard red	33.5	54.4	27	6/14	14.9	65
Boundary	Soft white	31.8	53.0	24	6/16	13.1	66
Average		**40.1**	**54.9**				
CV%		7.5	2.1				
LSD $_{(0.05)}$		4.3	1.6				

[1]Trial conducted at the Southwestern Colorado Research Center; seeded 10/14/98 and harvested 8/31/99.
[2]Bushel yield based on 60 lbs/bu and adjusted to 12% moisture.
[3]Date 50% of the plants headed.
[4]Grain hardness: >40=hard white, <40=soft white.

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow
Seeding Rate:	40 lbs/ac (12-in. row spacing)
Fertilizer:	50 lbs N/ac broadcast on April 22, 1999
Herbicide:	None
Insecticide:	None
Precipitation:	October 14, 1998 thru July 15, 1999: 11.8 inches

Comments:

The 1998-99 growing season can be characterized as a wet fall, dry winter, and above average precipitation in April, May, and June. Consequently, yields were well above average. Russian wheat aphid damage was not evaluated in the trial but there was good RWA pressure during the spring on winter wheat in southwestern Colorado. Dwarf bunt was not observed in any of the entries. None of the entries lodged.

1998 dryland winter wheat variety trial at Yellow Jacket, CO.[1]

Variety	Market Class	Yield[2]	Test Weight	Plant Height	Heading Date[3]	Grain Protein	Grain Hardness[4]
		bu/ac	lbs/bu	in	date	%	rating
Presto	Triticale	33.2	54.0	31	6/5	13.1	25
ID479	Hard red	32.2	56.0	25	6/12	14.4	54
UT201971	Hard red	31.4	58.0	28	6/16	15.4	65
UT203032	Hard red	31.1	55.0	27	6/12	14.9	50
TAM107	Hard red	31.1	56.5	24	6/5	13.8	71
UT944151	Hard red	30.9	54.0	27	6/17	15.4	58
ID511	Hard red	30.5	56.0	24	6/16	14.0	55
Fairview	Hard red	30.0	57.0	27	6/12	13.4	75
UT944157	Hard white	29.9	60.0	28	6/12	13.0	58
UT199847	Hard red	28.9	58.5	27	6/16	15.4	64
ID498	Hard red	28.4	55.0	26	6/10	13.9	79
ID512	Hard red	28.3	58.5	25	6/17	14.1	65
Prowers	Hard red	28.1	56.5	26	6/12	15.1	58
OR889128	Hard white	27.9	58.0	27	6/16	12.9	53
Manning	Hard red	27.6	58.5	25	6/12	13.6	78
ID514	Hard white	27.4	59.0	26	6/17	13.0	70
Jeff	Hard red	27.4	59.0	28	6/12	13.5	76
ID355	Hard white	26.6	58.0	24	6/17	15.8	70
82CAM097	Hard white	26.4	52.5	25	6/17	14.4	9
95CAM012	Hard red	25.8	60.0	24	6/17	13.8	68
UT182064	Hard red	25.4	54.0	25	6/17	15.7	40
Average		**29.0**					
CV (%)		11.1					
$LSD_{.05}$		4.8					

[1] Trial conducted at the Southwestern Colorado Research Center; seeded 10/14/97 and harvested 8/5/98.
[2]Bushel yield based on 60 lbs/bu and was not adjusted for moisture.
[3]Date: 50% of the plants headed.
[4]Grain hardness: >40 = hard wheat; < 40 = soft wheat.

Site Information:

Soil type:	Wetherill silty clay loam
Previous Crop:	Fallow
Seeding rate:	48 lbs/ac (12-in. row spacing)
Fertilizer:	50 lbs N/ac broadcast on August 26, 1997
Herbicide:	Harmony Extra 0.5 oz/ac + 2,4-D Amine 6 oz/ac on May 18, 1998
Insecticide:	None
Precipitation:	October 14, 1997 thru July 31, 1998: 8.7 inches

Comments:

Grain yields (29.0 bu/ac average) were higher than expected. Precipitation in 1998 was below normal but planting on fallow ground probably played a significant role in the 29.0 bu/acre average yields. Russian wheat aphid (RWA) was not a problem for winter wheat in 1997-98. Prowers, a RWA resistant variety, did not show any yield advantage. Dwarf bunt was not observed to any extent in the varieties. No other disease or insect problems were noted.

Yellow Jacket Fruit Tree and Vineyard Research and Demonstration Project

Dan Fernandez - Colorado State University Cooperative Extension, Dolores County Director
Jan Sennhenn - Colorado State University Cooperative Extension, Montezuma County Director
Kenny Smith - Colorado State University Cooperative Extension, former Montezuma County Extension Agent
Tom Hooten - Colorado State University Cooperative Extension, Montezuma County Extension Agent
John Lestina - Natural Resources Conservation Service, Dove Creek

Project Background:

The Fruit Tree and Vineyard Research and Demonstration Project was implemented in April 1991, and is a cooperative effort among Montezuma County Cooperative Extension, Dolores County Cooperative Extension, Natural Resources and Conservation Service in Dolores County and the Colorado State University Southwest Colorado Research Center at Yellow Jacket, Colorado. The completion of the Dolores Irrigation Project has resulted in a substantial number of new client requests for local research based information/data on fruit tree and vineyard varieties, equipment usage and cultural practices. Prior to this project, all fruit tree information originated from the Grand Junction area Experiment Stations which have a considerably different growing environment. Presently, the Team is evaluating 40 different fruit tree varieties including 21 field apples and 9 trellised apple varieties, 6 peach and 4 pear. We are also studying 6 trellised grape varieties, 1 raspberry variety and 14 grass varieties.

Variety Testing Results

Apples - The apples have performed exceptionally well the last 12 seasons. With the exception of four seasons (a freeze in 2001 and hail in 1995, 2003, and 2004), we have experienced consistent production. Even with the hail damage in 2004, we sold over 7,000 pounds of fruit. Tree losses have been limited to a total of 4 trees out of 226 planted, with 3 of those lost as the result of severe trunk damage due to excessive crop overload. With the exception of varieties on the wrong rootstock for field or trellis applications, additional varieties that are questionable for our area include Honey Crisp, Improved Red Delicious, and possibly Idared.

Peaches - A much different situation exists here when compared with the apples. Virtually all of our plantings (old and new) have suffered 50% tree losses within the first year. We attribute this in part to our late planting date for peaches and the possibility that we have planted trees that were of too large a diameter and limited root system. The peach trees have arrived partially leafed out, and when you add this to tree transplant shock, early tree death is inevitable. The first 2 varieties planted in 1991, Redskin and J.H. Hale, have been eliminated with one crop in seven years and significant yearly die-back. We have added 4 new varieties: Flamin'Fury PF#15A, Starfire FA11, Suncrest, and Red Globe which seem to have more promise.

Pears - The four varieties planted; Max Red Bartlet, Du Comice, D'Anjou, and Bronze Beauty have all developed well with minor problems. They do require considerable limb training and are highly susceptible to the pear slug. Pears take time to produce with the Max Red and Du Comice (planted in 1996) producing their first crop in 2001. All trees are now in production.

Grapes - Of the original 8 varieties planted in 1994, Seyval Blanc, Pinot Noir, and White Riesling were removed in 1998. These varieties require a longer growing season than what is "normal" for the location of the vineyard. In their place, Cayuga White, DeChaunac, Edelweiss and Chardonel were planted in 1999. The performance of these four varieties has been extremely disappointing. The year 2001 was the third growing season and the vines have not performed any better than the newly planted vines. The reason for this poor performance is baffling as these vines received the same treatment as the more mature plantings. In 2000, there was a 100% infestation of crown gall in the Foch, Gewurztraminer, Merlot, and Chardonnay vines. When the infestation of 2000 occurred in all of the 4 above named varieties, they were removed.

The only remaining original planting is Lemberger. This red variety has produced crops from the third season until present. Shoot thinning and cluster removal prior to veraison are methods used to promote fruit development and maturation.

Grasses - Thirteen different grasses along with one legume were planted between the fruit tree rows in the demonstration orchard between April 1993 and November 1995 to evaluate their erosion control potential. These were dryland plantings with no supplemental water given. Lovington blue grama, Canbar canby bluegrass, birdsfoot trefoil/Ephraim crested wheatgrass mix, and Topgun buffalograss have been judged unsuitable for erosion control.

Irrigation

We are currently evaluating a variety of irrigation systems including various types of drip emitters, several types of maxi and mini sprinklers, pulsators, and surface drip tubing. We currently use a 50-mesh filtration system due to very good irrigation water quality. Plugging of the filter screens has not been a problem. Our only significant problem has been with the maxi and mini sprinklers that have moving parts. A slight buildup of calcium causes the spinners to jam and spray only in one direction. These were removed and replaced with static sprinkler heads with a 360-degree spray pattern.

Additional Investigations

Work continues on frost protection systems for the fruit trees and grapes, hail netting applications, bird control, and integrated pest management. Workshops on pruning and fruit production and management are conducted every year with a significant growth in the number of participants each year.

Strong emphasis continues to be placed on demonstrating, evaluating and testing varieties, irrigation equipment, orchard equipment and cultural practices that are cost effective, user friendly and available through local suppliers.

We continue to investigate marketing opportunities as well as 'Home-Based Business' opportunities as they relate to fruit and vineyard product utilization, i.e. fruit by-products.

Fruit Tree and Vineyard Project
2004 Season Apple Variety Descriptions, Evaluations, and Ratings

Dan Fernandez, Dolores County Director
Colorado State University Cooperative Extension

Scarlet Gala – Emla 7: Beautiful color with bright red striping over an orange background. Mid-bloom, with moderate to large fruit size and moderate to heavy yields in SW Colorado. Recommend using central leader training to allow good light penetration. Moderate tree development but in the 8th and 9th seasons several trees have begun leaning, requiring support. Root sprouts have become a real issue requiring two prunings a season. Matures early to mid September. 5 out of 6 seasons of fairly consistent fruiting with a huge 5.6bu/tree crop in 2001. 2000 Powdery mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Rating dropped ½ point due to leaning and sprout problems. Planted 1992. ******1/2 RATING.**

Nured Jonathan - Mark: This variety has been replaced with an improved version of this variety in 2000.

Swiss Gourmet – Emla 7: Beautiful color with a bright red over a rich yellow background. Mid-bloom, medium sized fruit that even with light crop loads does not size-up -matures early to mid September. Excellent tree development on trellis system but fruit set & crop did not fare well through the Spring, 1999 cold snaps and the freezes of Spring 2000 completely ruined the crop. 2000 Powdery Mildew outbreak heavily affected this variety. Thin fruit skin makes this variety susceptible to light hail. Crop in 2001 was light to moderate and combined with other problems leads to a half point drop from a 3.5 to a 3 in the overall rating. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. For the first time crop was heavy and of excellent size. Rating will stay the same awaiting another year of analysis. Planted 1995. ****½ RATING**

Royal Empire – Emla 7: Excellent dark red fruit that colors early. Mid-bloom, medium to large fruit that is fairly resistant to light hail. Matures mid September. Long shelf life. Excellent tree development on trellis system. The fruit set & crop did not fare well through the Spring 1999 cold snaps and the freezes of Spring 2000 completely ruined the crop. 2000 Powdery Mildew outbreak moderately affected this variety. Excellent yield in 2001 of 3.9bu./tree on a high density spacing. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Planted 1995. ****** RATING**

Liberty – Emla 7: Good fruit color with deep red over a slight yellow background, but the fruit has a tendency to be slightly irregular in shape. Mid-bloom, highly resistant to major apple diseases. Excellent tree development on trellis system but vigorous growth on EMLA 7 indicates that a more dwarfing rootstock is required on a trellis system - use EMLA 26. Large fruit size with consistent heavy production with excellent 2001 crop of 4.2bu./tree on a high density planting. 2000 Powdery Mildew outbreak moderately affected this variety. Proper pruning is essential to accommodate heavy fruit load. Thin fruit skin makes this variety highly susceptible to light hail. Matures a week to 10 days later than Scarlet Gala with late September to early October harvest. 3 freezes in early 2002 eliminated the crop. Planted 1995. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. ***** RATING**

Golden Delicious - Emla 26: Golden apple with an excellent light red blush that develops on sun exposed side. Mid-bloom, early heavy bearer with small to medium fruit, needs early thinning. Alternate bearing a possibility but an excellent crop with good size even through the adverse weather conditions of Spring, 1999. The freezes of Spring 2000 completely ruined the crop but the 2001 crop was excellent at

4.2 bu./tree. 2000 Powdery Mildew outbreak moderately affected this variety. Mid to late September harvest. Moderate tree development in the 6th season. 3 freezes in early 2002 eliminated the crop. Planted 1994. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. ****** RATING**

Honey Crisp - Emla 7: Excellent color with a scarlet red over a yellow background. Mid-bloom, large fruit, keeps well in storage-high quality. Good tree development but poor, low yields seem to be a chronic problem with this variety. 2000 Powdery Mildew outbreak did not affect this variety. Tree also tends to grow upright and requires substantial limb training. Mid September harvest. This was the only variety to have a significant crop in 2002. Planted 1995. Hail in 2003 eliminated the crop. **** RATING**

Red Fuji - Emla 9: Good color development with red stripe over a yellow-green background - better color than expected for Fuji's grown in Colorado. Mid to late-bloom, late harvest mid October, very firm apple with excellent storage qualities that is very resistant to light hail. Excellent tree development on trellis system with medium to large fruit. Several seasons of consistent fruiting even through the adverse weather conditions of Spring, 1999. But the freezes of Spring 2000 completely ruined the crop. 2000. 2001 crop was excellent at 3.9bu./tree. Powdery Mildew outbreak heavily affected this variety. Heavy crop requires proper pruning to avoid limb breakage. Big market potential. 3 freezes in early 2002 eliminated the crop. Planted 1995. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Fruit has tended to the small to mid size range. Lowering rating ½ point to ****** RATING**

Red JonaGold - Emla 7: Excellent red blush over a slight yellow background that makes a nice pie apple. Mid-bloom with late color development, small to medium fruit, susceptible to mildew but resistant to light hail. Very good tree development several seasons of fairly consistent, but light, fruiting even through the adverse weather conditions of Spring, 1999. The freezes of Spring 2000 completely ruined the crop. 2001 crop was excellent at 3.8bu./tree. 2000 Powdery Mildew outbreak did not affect this variety. Mid to late September harvest. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Planted 1994. ***** RATING**

Lustre Elstar - Emla 26: Beautiful scarlet red blush over a yellow background, mid-bloom, medium fruit size. Good tree development but this variety has been susceptible to limb breakage, especially during the winter. Several seasons of fairly consistent fruiting even through the adverse weather conditions of Spring, 1999. The freezes of Spring 2000 completely ruined the crop. 2001 crop was excellent at 3.4bu./tree. 2000 Powdery Mildew outbreak heavily affected this variety. Mid to late September harvest. Resistant to light hail. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop and hail in July 2004 damaged the crop. Planted 1994.*****½ RATING**

Super Jon – Emla 7: Mid-bloom, dark red small to medium fruit good for pies and resistant to light hail. Very good tree development with several seasons of fairly consistent, but light, fruiting even through the adverse weather conditions of Spring, 1999. The freezes of Spring 2000 completely ruined the crop. 2001 crop was again light to moderate at 2.7bu./tree. 2000 Powdery Mildew outbreak did not affect this variety. Mid to late September harvest. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Planted 1994. ***** RATING**

Mor-Spur McIntosh - Emla 7: Bright cherry red blush. Early, reported to be a heavy producer BUT NOT HERE SO FAR. Smaller tree size is good for high density plantings. Tree has a very good natural spread to limb development that requires little limb training. The freezes of Spring 2000 completely ruined the crop. 2001 crop was excellent at 3.0bu./tree. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Planted 1996. ***** RATING**

Improved Red Delicious - Emla 7: Campbell strain that is highly striped with strong red color. Consistent medium to very large fruit that is mid-bloom. Upright tree growth requires substantial limb training. Poor tree development with fruit set & crop very light due to the Spring freezes of 1999. The freezes of Spring 2000 completely ruined the crop. 2001 crop was very light at 1.7bu./tree. This tree, on this rootstock, may be more suited for a high density planting on a trellis system than a field planting. I am also starting to wonder if the stated rootstock from the nursery may have been an error. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Rating increased another ½ point because of consistent, exceptional large fruit. Planted 1996. ***** RATING**

Royal Gala - Emla 26: Produces a beautiful fruit with red stripes over an orange-red undercolor. Medium sized fruit which may exhibit a wide variation of fruit coloration. Very good tree development so far with a moderate crop in the fourth season with excellent color. Powdery Mildew outbreak heavily affected this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. 97 planting. *****½ RATING**

Myra Red Fuji - Emla 26: Medium to large apple which colors up substantially. The finish color is a pinkish red. Matures 10 days earlier than Red Fuji. Very good tree development so far with a good crop in fourth season with excellent color. A 1bu./tree crop in 2001 is an excellent crop for a young, high density tree. 2000 Powdery Mildew outbreak moderately affected this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. 97 planting. *****½ RATING**

Gravenstein - Emla 26: Large, red-striped, crisp and juicy. Excellent for cooking and pies. Hardy tree with very good tree development but this variety does mature up to 3 weeks earlier - last part of August to 1st week in September. There was a heavy crop in the fourth season but this variety is one of the earlier maturing varieties - mid to late August. 2001 crop was on the ground before data could be collected. 2000 Powdery Mildew outbreak heavily affected this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. 97 planting. ***** RATING**

Idared - Emla 26: A solid, beautiful bright red apple. Tree development is slowing rapidly as the bud union is starting to swell considerably. This tree on EMLA 26 is better suited to a trellis system. 2001 crop was moderate for the amount of tree development. 2000 Powdery Mildew outbreak heavily affected this variety. Rating is lowered from a 3 to 2.5 because of the poor tree development. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the very large crop. 97 planting. ****½ RATING**

Lodi - Emla 111: Yellow fruit large in size with very early maturity - mid to late August. On EMLA 111 excessive growth on trellis that is very hard to handle. This variety should be on a more dwarfing rootstock like EMLA 26. Powdery Mildew outbreak moderately affected this variety. **THESE TREES HAVE BEEN REMOVED FROM THE PROJECT.**

Rubinstar JonaGold - Emla 26: Intense red coloration that is uniform throughout the tree. Tree development has been moderate and needs to watched for future progress. Matures one week ahead of Jonagold and is less susceptible to sunburn. A limited crop in fourth season and there were signs of Bitter Pit susceptibility. 2000 Powdery Mildew outbreak heavily affected this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. 97 planting. ***** RATING**

Sun Fuji - Emla 7: Extremely firm apple with a pinkish/red stripe over yellow-green ground color. The flesh is yellowish-greenish, dense and crisp. Flavor is sweet, fruity, slightly aromatic, sub-acid and very

pleasant. High soluble solids. Outstanding keeper. Initial tree development is excellent and in 2001 had an excellent crop for the third season. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the excellent crop. 99 planting. ****** RATING**

Galaxy Gala - Emla 7: This Gala's big difference to Royal is that it develops an almost complete, bright, cherry red layer under more intense red stripes. The degree of striping is similar to Royal Gala, but the color is more complete. Initial tree development is excellent and in 2001 had an excellent crop for the third season.. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the excellent crop. 99 planting. ****** RATING**

Improved Gala (Mitchell Cultivar) - Emla 7: Bright red stripes over yellowish undercolor. Multiple pick apple. Noted for its increased color stability. Medium sized fruit. Outstanding flavor. Initial tree development is excellent and in 2001 had a good crop for the third season. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the excellent crop. 99 planting. *****½ RATING**

Pacific Gala - Emla 7: Ripens 5-7 days ahead of Royal Gala. The coloration of the fruit was observed to be distinctly different than the Tenroy cultivar and the Galaxy Gala, showing much higher color on 90 to 100% of fruit. Initial tree development is excellent and in 2001 had an excellent crop for the third season. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the excellent crop. 99 planting. ****** RATING**

Pinova - Emla 7: A medium sized apple with outstanding flavor, similar to Golden. Skin is a bright, florescent pinkish/red; 50 to 80% blush over yellow background. Flesh is firm, fine grained and cream color. Matures with Golden Delicious. Tree has a low to medium vigor. Pinova is cold hardy and very productive and in 2001 had a good crop for the third season.. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the excellent crop. 99 planting. ***** RATING**

Cameo - Emla 7: Cameo is a pleasing bright red stripe over a golden blend with a sweet tart flavor. Prone to excessive suckering. The creamy white flesh shows virtually no browning when cut. Cameo stores and handles well retaining its firmness and dessert qualities for 5 months in regular storage. The tree has growing characteristics similar to a golden delicious. This variety is harvested in mid to late September and in 2001 had a small crop for the third season. Initial tree development is excellent but upright growth and significant suckering continues to require significant limb training and pruning. If this continues to be a problem, I will have to lower the rating by ½ point next season. 2000 Powdery Mildew outbreak did not affect this variety. 3 freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the excellent crop. 99 planting. ***** RATING**

Improved Golden - Emla 7: The finish is smoother to the touch in comparison to a regular Golden. Medium to large fruit that is Russet resistant. Initial tree development and fruiting are excellent. Still evaluating for a rating in SW Colorado. 2000 PLANTING.

Golden Supreme - Emla 7: Sweet flavor with smooth texture. Preferred as the cooking and eating golden delicious. Soft yellow finish may be touched with a red blush. Superior storage capabilities. Large fruit that is very smooth ready to harvest with the Galas. Russet resistant. Initial tree development and fruiting are excellent. Still evaluating for a rating in SW Colorado. 2000 PLANTING.

Nured Jonathan Sport - Emla 7: Dark red small fruit that is excellent for cooking. Excellent storage capabilities. Requires heavy thinning and is very cold hardy. Initial tree development and fruiting are excellent. Still evaluating for a rating in SW Colorado. 2000 PLANTING.

Improved McIntosh - Emla 26: Early maturing, mid September with very deep red color. A trellis planting. Tree growth and shape have been excellent. Still evaluating for a rating in SW Colorado. 2002 PLANTING.

Buckeye Gala – Emla 7: The fruit is full size with food flavor and quality. Colors is a deep red with s light yellow stripe. Tree growth and shape have been excellent. Still evaluating for a rating in SW Colorado. 2002 PLANTING.

Refer to the enclosed production records for specific yield information.

APPLE ROOTSTOCKS

EMLA 9: Produces a tree that is 35-40% of a standard tree or semi dwarf, does well in heavy soil and wet conditions, needs mechanical support throughout the life of the tree, large fruit.

EMLA 26: Produces a tree that is 40-50% of a standard tree, may need mechanical support as the tree develops and begins cropping, though it roots well and is better anchored.

EMLA 7: Produces a tree that is 50-60% of a standard tree. Winter hardy, disease resistant, needs well drained soil. Develops an extensive root system and does not need mechanical support in our soils but we have several cases of 9 year old Scarlet Galas on EMLA 7 that have started to lean and requiring support.

EMLA 111: Produces a tree that is 70-75% of a standard tree. Winter hardy, adaptable to a wide range of soils, tolerant of drought, excellent for spur type cultivars. Because of the limiting dwarfing, this may not be suited for use on a trellis system. Does not need mechanical support.

Rating Scale:

5 Stars	*****	Excellent potential
4 Stars	****	Very good potential
3 Stars	***	Good potential
2 Stars	**	Poor potential
1 Star	*	Forget about it

Fruit Tree and Vineyard Project
2004 Season Peach Variety Descriptions, Evaluations, and Ratings

Dan Fernandez, Dolores County Director
Colorado State University Cooperative Extension

J.H. Hale: This variety has been eliminated from the variety trial. Fruit matures too late for SW Colorado and the trees continually suffered from winter injury. *** RATING**

Redskin: This variety has been eliminated from the variety trial. Fruit matures too late for SW Colorado and the trees continually suffered from winter injury. *** RATING**

Red Globe: Firm yellow flesh with good flavor. Has a bright skin color and is excellent for canning and freezing. Fruit appears to mature in late August. Good initial growth but Spring, 1999 & 2000 freezes eliminated the crop. Good crop in 2001, 2002 and 2003 with excellent size. Most fruit was harvested before the 2003 hail. Hail in July 2004 damaged the excellent crop. 1996 Planting. ***** RATING**

Flamin' Fury series PF#15A: Large red fruit that has good flavor and shipping qualities. The trees are very winter hardy and fruit appears to mature in late August. Good initial growth, but Spring, 1999 & 2000 freezes eliminated the crop. Good crop in 2001,2002 and 2003 with excellent size. Most fruit was harvested before the 2003 hail. Hail in July 2004 damaged the excellent crop. 1996 Planting. ***** RATING**

Starfire, (FA 11): Very large, solid red peach with clear yellow flesh. Fruit shape is round with a slight tendency for a high shoulder. Shipping and eating quality is reported to be outstanding. Planted in spring 1999, these trees did not fare well with the Spring 1999 cold snaps with several trees dying. In 2001, 2002 and 2003 there was a limited crop with good tree development. Most fruit was harvested before the 2003 hail. Hail in July 2004 damaged the excellent crop. 1999 Planting. ****½ RATING**

Suncrest: Fruit is large, round and has a light pubescence. About two thirds of the surface is covered with a bright, red blush over a yellow background color. Yellow flesh, firm but melting, and of good texture and color. All the trees survived the Spring 1999 freezes and developed normally for newly planted trees. In 2001, 2002 and 2003 there was a limited crop with good tree development. Most fruit was harvested before the 2003 hail. Hail in July 2004 damaged the excellent crop. 1999 planting ***** RATING.**

Notes:

- Only use ½ inch caliper or less nursery stock for new plantings.
- The only rootstock currently being evaluated on all varieties is Certified Peach.
- Refer to the enclosed production records for specific yield information.

Rating Scale:

5 Stars	*****	Excellent potential
4 Stars	****	Very good potential
3 Stars	***	Good potential
2 Stars	**	Poor potential
1 Star	*	Forget about it

Fruit Tree and Vineyard Project
2004 Season Pear Variety Descriptions, Evaluations, and Ratings

Dan Fernandez, Dolores County Director
Colorado State University Cooperative Extension

Max Red Bartlett: Tree growth is satisfactory with a very limited crop in 1999, no fruit in 2000 but a nice crop in 2001 with moderate fruit sizes. 3 freezes in early 2002 did NOT affect this variety. Excellent crop with most fruit harvested before the 2003 hail. Hail in July 2004 damaged the excellent crop. Planted 1996. ***** RATING**

Du Comice: Excellent dessert pear with a rich, juicy flavor. Its flesh is tender, smooth and the fruit is large, color clear yellow. Tree growth is satisfactory and we finally had our first moderate crop in 2001, with medium sizes, but crop was off the tree before data could be collected. 3 freezes in early 2002 eliminated the crop. Excellent crop with most fruit harvested before the 2003 hail. Hail in July 2004 damaged the excellent crop. Planted 1996. ****½ RATING**

D'Anjou: Firm, juicy with excellent flavor. Excellent storage capabilities. Tree growth is satisfactory with limited production through the 2004 season. Most fruit was harvested before the 2003 hail. Hail in July 2004 damaged the crop. Planted 1997. **** RATING**

Bronze Beauty: Fruit is medium to large with a russet that takes on a bronze color when ripe. Tree is vigorous and large, exhibiting a spreading habit. Tree growth is satisfactory. Limited crop in 2001, none in 2002 and small crop in 2003 and 2004. Most fruit was harvested before the 2003 hail. Hail in July 2004 damaged the crop. Planted 1997. ****½ RATING**

Rootstocks

Old Home x Farmingdale rootstock (O.H. x F.): is hardy well-anchored and productive. Produces a semi-dwarf tree.

Old Home x Farmingdale #97 rootstock (O.H. x F.#97):

Notes:

- All pear varieties are subject to severe attacks from the Pear Slug. Timely sprays must be applied to avoid defoliation.
- As pears take several years to come into production, good yield data may still be a few years away on the later planted varieties.
- Refer to the enclosed production records for specific yield information.

Rating Scale:

5 Stars	*****	Excellent potential
4 Stars	****	Very good potential
3 Stars	***	Good potential
2 Stars	**	Poor potential
1 Star	*	Forget about it

Research Publications at the
Southwestern Colorado Research Center

Al-Kaisi, M.M., A.F. Berrada, and M.W. Stack. 1997. Evaluation of irrigation scheduling program and spring wheat yield response in southwestern Colorado. Agric. Water Management 34:137-148. Elsevier Science B.V.

Al-Kaisi, M.M., A.F. Berrada, and M.W. Stack. 1999. Dry bean yield response to different irrigation rates in southwestern Colorado. J. Prod. Agric. 12:422-427.

Berrada, A. 2000. Forage yields of 20 alfalfa varieties at the Southwestern Colorado Research Center at Yellow Jacket, Colorado in 1996-1999. p.15. *In* J.E. Brummer, C.H. Pearson, and J.J. Johnson (ed.) Colorado forage research 1999 alfalfa, irrigated pastures, and mountain meadows. Colorado Agric. Exp. Stn. Tech. Rep. TR00-6. Fort Collins.

Berrada, A. 2001. Irrigated dry bean response to zinc application rate and method. Annu. Rep. Bean Improv. Coop. 44: 43-44.

Berrada, A. 2004. Results of the winter triticale yield trials at Yellow Jacket 1996-1999. p. 95-100. *In* J.E. Brummer and C.H. Pearson (ed.) Colorado forage research 2003 alfalfa, irrigated pastures, and mountain meadows. Colorado Agric. Exp. Stn. Tech. Bull. TB04-01. Fort Collins.

Berrada, A. 2004. Developing sustainable dryland cropping systems in SW Colorado and SE Utah using conservation tillage and crop diversification. 2002 and 2003 results. Colorado Agric. Exp. Stn. Tech. Bull. TB04-02. Fort Collins.

Berrada, A. 2004. Results of chickpea research in southwestern Colorado from 1994 to 2003. Colorado Agric. Exp. Stn. Tech. Bull. TB04-03. Fort Collins.

Berrada, A. 2005.Alfalfa response to water deficit using subsurface drip irrigation. Colorado Agric. Exp. Stn. Tech. Bull. TB05-01. Fort Collins.

Berrada, A., M.W. Stack, D.V. Sanford, and A.G. Fisher. 1995. Management systems for dryland wheat and bean production in southwestern Colorado conservation tillage project, 1989-93. Colorado Agric. Exp. Sta. Tech. Bull. TB95-2. Fort Collins.

Berrada, A., M.W. Stack, B. Riddell, M.A. Brick, and D.L. Johnson. 1999. Chickpea: a potential crop for southwestern Colorado. p. 206-213. *In* Jules Janick (ed.) Perspectives on new crops and new uses. Proc. Fourth National Symposium New Crops and New Uses Biodiversity and Agricultural Sustainability, Phoenix, AZ. November 8-11, 1998. ASHS Press, Alexandria, VA.

Berrada, A. and J. Davis. 2001. Dry bean response to zinc. From the ground up agronomy news. Colorado State Univ. Coop. Ext. 21(6):14. Fort Collins.

Berrada, A., M.W. Stack, and G. E. Cardon. 2001. Assessment of irrigation water management and demonstration of irrigation scheduling tools in the full service area of the Dolores Project: 1996-2000. Part I: Survey results. Colorado Agric. Exp. Stn. Tech. Rep. TR01-6. Fort Collins.

Berrada, A., T.M. Hooten, and I. Broner. 2001. Assessment of irrigation water management and demonstration of irrigation scheduling tools in the full service area of the Dolores Project: 1996-2000. Part II: Calibration of the Watermark soil moisture sensor and ETgage atmometer. Colorado Agric. Exp. Stn. Tech. Rep. TR01-7. Fort Collins.

Berrada, A., T.M. Hooten, I. Broner, and G.E. Cardon. 2001. Assessment of irrigation water management and demonstration of irrigation scheduling tools in the full service area of the Dolores Project: 1996-2000. Part III: Monitoring of irrigated alfalfa fields using the Watermark moisture sensor and ETgage atmometer. Colorado Agric. Exp. Stn. Tech. Rep. TR01-8. Fort Collins.

Berrada, A., and G.A. Peterson. 2002. Developing sustainable dryland cropping systems in SW Colorado and SE Utah using conservation tillage and crop diversification. Colorado Agric. Exp. Stn. Tech. Bull. TB02-2. Fort Collins.

Berrada, A., T. Hooten. 2003. Proceedings of the third annual four corners irrigation workshop. Colorado Agric. Exp. Stn. Tech. Bull. LTB03-1. Fort Collins.

Berrada, A. and J.E. Brummer. 2004. Evaluation of spring cereals for dual use. p. 101-106. *In* J.E. Brummer and C.H. Pearson (ed.) Colorado forage research 2003 alfalfa, irrigated pastures, and mountain meadows. Colorado Agric. Exp. Stn. Tech. Bull. TB04-01. Fort Collins.

Brick, M.A., A. Berrada, H.F. Schwartz, and J. Krall. 1998. Garbanzo bean production trials in Colorado and Wyoming. Colorado Agric. Exp. Stn. Tech. Bull. TB98-2. Fort Collins.

Davis, J., A. Berrada, and R. Meyer. 1999. Does alfalfa need boron? From the ground up agronomy news. Colorado State Univ. Coop. Ext. 19(4):6-7. Fort Collins.

Davis, J.G., A. Berrada, and R.F. Meyer. 2000. Alfalfa response to boron fertilization. p. 41-45. *In* J.E. Brummer et al. (ed.) Colorado forage research 1999 alfalfa, irrigated pastures, and mountain meadows. Colorado Agric. Exp. Stn. Tech. Rep. TR00-6. Fort Collins.

Fernandez, D., J. Sennhenn, K. Smith and J. Lestina. 1998. Southwest Colorado fruit tree and vineyard research and demonstration project fruit crop management guide. Colorado State Univ. Coop. Ext.

Fisher, A.G., M.A. Brick, R.H. Riley, and D.K. Christensen. 1987. Dryland stand establishment and seed production of revegetation species. Crop Sci. 27:1303-1305.

Fisher, A.G. and M.W. Stack. 1987. Alfalfa variety performance tests for southwestern Colorado: 1985 and 1986 results. Colorado Agric. Exp. Sta. Tech. Rep. TR87-12. Fort Collins.

Fisher, A.G., M.A. Brick, D.R. Wood, M. Stack, H.F. Schwartz, J.B. Ogg, C.H. Pearson, J.F. Shanahan, and M. Ballarin. 1995. Registration of 'Fisher' pinto bean. Crop Sci. 35:1511.

Hammon, R.W. 1999. Spring wheat planting date studies in western Colorado. p. 27-31. *In* R.W. Hammon and S.M. Max (ed.) Western Colorado Research Center 1998 research report. Colorado Agric. Exp. Stn. Tech. Rep. TR99-12. Fort Collins.

Hammon, R. 2000. Spring wheat planting date effect on Russian wheat aphid and grain yield in differing environments. p. 75-78. *In* A. Gaus et al. Western Colorado Research Center 1999 research report. Colorado Agric. Exp. Stn. Tech. Rep. TR00-04. Fort Collins.

Hammon, R.W., D.V. Sanford, M.W. Stack, and A. Berrada. 1999. Dryland winter wheat planting date and Russian wheat aphid studies in southwestern Colorado, 1990-1998. Colorado Agric. Exp. Stn. Tech. Rep. TR99-2. Fort Collins.

Leib, B.G., D. Fernandez, and A.G. Fisher. 1993. Frost protection design for fruit trees in southwest Colorado. p. 48-55. *In* R.G. Allen (ed.) Management of irrigation and drainage Systems. Proc. Int. Conf. on Water Resources Planning and Management. ASCE Irrigation and Drainage Div., July 21-23, 1993. Park City, UT.

Mann, R., A.G. Fisher, and R.A. Young. 1986. Economic aspects of utilizing Dolores Project irrigation water in southwest Colorado. Colorado State Univ., Ft. Collins.

Quick, J.S., E. Souza, and D.W. Sunderman. 1993. Registration of 'Fairview' wheat. Crop Sci. 33:878.

Quick, J.S., R.S. Albrechtsen, and M. Stack. 1996. Registration of 'Sylvan' wheat. Crop Sci. 36:802.

Stack, M.W., and A. G. Fisher. 1992. Winter wheat fertilization for southwestern Colorado: 1986-1989. Colorado Agric. Exp. Stn. Tech. Rep. TR92-2. Fort Collins.

Stack, M.W., D.V. Sanford, A. Berrada, and J.S. Quick. 1995. Irrigated spring wheat variety performance test, 1989-94, Southwestern Colorado Research Center, Yellow Jacket, CO. Colorado Agric. Exp. Stn. Tech. Rep. TR95-5. Fort Collins.

Wood, D.R., A.G. Fisher, and M. Ballarin. 1983. Registration of Cahone bean. Crop Sci. 23:399.

Zacharisen, M.H. 1990. Water-use efficiency and carbon isotope discrimination in dry beans. M.S. thesis. Colorado State Univ., Ft. Collins.