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Southwestern Colorado Research Center

Research Report (2005 – 2009 Results)

Colorado State University

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Southwestern Colorado Research Center

2005-2009 Research Results

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[1] Abdel Berrada was reassigned to the Southwestern Colorado Research Center in July 2008 and became the manager after Mark Stack's retirement in August 2008.

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A brief history of the Southwestern Colorado Research Center

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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, southwestern Colorado had developed into a major dryland 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.

A fruit tree and wine grape demonstration project was started in 1991 to test the adaptation, production potential, and fruit quality of several varieties of apples, peaches, pears, and grapes. New and improved varieties of fruit trees and grapes have been introduced over the years. Several orchard management practices such as micro-irrigation, frost protection, high-density apple planting, bird control, trellis system, fruit thinning, tree prunning, and intergrated pest management have been tested and demonstrated. Thirteen grass species or varieties and one legume were planted between fruit tree and grape rows in 1993 and 1995 to control soil erosion and suppress weeds. A fruit tree pruning workshop is held every year. The proceeds from the sale of the fruits help fund the operation of the orchard. The fruit tree and grape demonstration project is managed by the Extension personnel of Dolores and Montezuma Counties. It has generated a lot of interest and attracted a large number of visitors.

In the last five years, agronomic research emphasis at the SWCRC has gradually shifted to the evaluation of oilseed crops, particularly sunflower, and the development of BMP's to enhance their oil production. Sunflower was reintroduced[1] in 2006 after the San Juan Bioenergy company was formed and made plans to build a processing facility in Dove Creek. The facility was inaugurated in December 2008. The company's initial goal was to produce biodiesel from sunflower, safflower, and canola oil[2]. However, the drop in fossil fuel prices and government subsidies forced it to sell all the oil produced at its Dove Creek plant in 2009 to refineries for processing as food-grade oil. The byproduct from the seed oil extrusion is marketed as feed meal (http://www.sanjuanbioenergy.com/). The sunflower seed hulls and the sunflower and safflower leaves and stems (dockage) are converted to syngas whose combustion is expected to provide up to 100% of the heat and 50% of the electricity needed to run the plant. Other oil crops tested at the SWCRC are safflower, canola, and camelina.

[1] Sunflower was grown in SW Colorado in the 1970s, but was abandoned due to low commodity prices and the long distance from processing plants or consumer markets.

[2] Currently, only sunflower and safflower are contracted by San Juan Bioenergy.

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 (Table 1). Members meet annually to review research at the Southwestern Colorado Research Center and to discuss future research priorities.

Table 1. Advisory Committee Chairmen

Year	Name	From This Area
2009	David McCart	Dove Creek, CO
2008	David McCart	Dove Creek, CO
2007	No meeting was held.	
2006	Trent Taylor	Hesperus, CO
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

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.

Soil and Climate at the Southwestern Colorado Research Center

Abdel Berrada and Mark Stack

Based on long-term weather records (1962-2002) for Yellow Jacket, the average annual precipitation is 15.6 inches (Table 2). The average annual snowfall is 68.1 inches. June is the driest month. The mean annual temperature is 48.0°F. The frost-free period is 100 to 120 days. The Research Center lies at an elevation of 6,900 ft., latitude 37°32' N and longitude 108°44' W.

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 deep, well drained soils situated on mesas and hills. The parent material is eolian derived from sandstone. The color is yellowish red. Soil infiltration rate is approximately one-half inch per hour. Its water holding capacity averages from 1.8 to 2.0 inches per foot. The soil pH ranges from 7.2 to 7.8 with low organic matter content (1%). Topography of the region is generally rolling with slopes of 1 to 12%. Wind and water erosion can both be significant if the soil is not protected (Price et al., 1988; Ramsey, 1997).

Table 2. Climate at Yellow Jacket, Colorado

Month	Average Precipitation and Temperature from 5/12/62 through 12/31/02[3]				Precipitation (in)[4]				
	Precipitation (in)	Snowfall (in)	Max. Temp. (F)	Min. Temp. (F)	2005	2006	2007	2008	2009
January	1.2	15.0	37.9	14.5	2.9	0.3	0.4	1.1	0.4
February	1.2	14.1	42.7	18.8	3.2	0.0	1.0	1.5	0.4
March	1.3	10.6	49.5	24.8	1.5	1.5	0.7	0.1	0.2
April	1.0	4.5	59.1	31.1	1.6	1.0	1.6	0.7	0.9
May	1.2	0.9	69.7	39.7	0.3	0.2	1.5	0.7	1.5
June	0.6	0.0	81.0	47.9	0.6	0.3	0.1	0.5	0.7
July	1.4	0.0	86.8	54.6	1.1	1.0	1.7	0.7	0.4
August	1.8	0.0	84.0	53.3	0.7	1.4	1.4	2.2	0.8
September	1.6	0.1	76.0	46.4	1.8	1.7	1.9	0.4	1.1
October	1.8	1.6	63.7	36.8	1.6	4.1	0.4	1.2	0.4

[3] Source: Western Regional Climate Center

[4] Data from the Coagmet station at Yellow Jacket (http://ccc.atmos.colostate.edu/~coagmet/). There is no direct measurement of snow moisture. Therefore, winter precipitation may not be accurate.

Month	Average Precipitation and Temperature from 5/12/62 through 12/31/02[3]				Precipitation (in)[4]				
November	1.4	7.2	48.9	25.5	0.3	0.3	1.1	1.1	0.5
December	1.2	14.1	39.5	17.0	0.1	0.4	2.7	1.2	0.6
Annual	**15.6**	**68.1**	**61.6**	**34.2**	**15.7**	**12.1**	**14.4**	**11.4**	**7.6**

During the period 2005 through 2009, only 2005 had average total precipitation (Table 2). January and February 2005 had above average precipitation while May, August, November, and December were below average. The year 2006 had a wet October in an otherwise dry year. Precipitation in 2007 was 76% of average. The year 2008 experienced a dry spring and summer. In 2009, every month except May had below normal precipitation.

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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.

Late-Season Alfalfa Harvest Schedule, Yield, and Stand Persistence

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[2]Southwestern Colorado Research Center, Yellow Jacket

Figure 1. Alfalfa harvest

Summary:

This research found that delaying the final alfalfa cutting until growth ceases increases subsequent first cutting yield in a four cutting, but not in a three cutting system. First cutting growth was impacted by cutting schedule and alfalfa varieties in the four cutting system. In the three cutting system, yield was influenced only by variety. In a four cutting system, alteration of the late-season cutting schedule will not be beneficial if the final cutting is not utilized. However, if a non-traditional use is developed, modification of the schedule could increase profits.

Introduction:

Alfalfa hay is the most important crop grown in the intermountain region of Colorado and Utah, both in acreage and gross financial return (http://www.nass.usda.gov). It is marketed locally, nationally, and internationally, and acreage has remained relatively constant for many years. The life span of alfalfa fields ranges from three to ten or more years depending on location and cultural practices. Some growers plant alfalfa with the intention of keeping it in production for three years and then rotating to other crops, while other growers plant with the intention of keeping it in as long as possible. For growers who wish to keep alfalfa stands productive as long as possible, profitability and sustainability are directly related to stand life. Many growers now are concerned that stands are tending to decline much quicker than they did in the past. The reasons for this are not completely clear, but changes in harvest practices and the presence of pests such as alfalfa stem nematode, *Ditylenchus dipsaci*, and diseases such as Verticillium wilt, Fusarium wilt, and crown and root rots play a role in stand decline. Changes in harvest practices have occurred over the past twenty or so years, and are in part the result of a shift to production of higher quality alfalfa, which necessitates more frequent harvesting.

Irrigated alfalfa is typically harvested four times a year in the lower irrigated valleys and two or three times in the higher elevations. The final harvest in each area is usually taken in late September or early October. Many stands decline after the third production year, much of which has been attributed to alfalfa stem nematode. Symptoms in spring growth include stunting, swollen nodes, shortened internodes, irregular growth and plant death. Fields with stem nematode damage in first cutting tend to recover and produce regrowth that is relatively free of symptoms in second, third, and fourth cuttings. Diseases such as Verticillium and Fusarium

wilts, and crown and root rots are present over much of the intermountain West, although their impact on yield and stand persistence has not been well quantified.

We hypothesize that much of the stand decline that is currently blamed on stem nematode and diseases are actually the result of multiple stresses on plants, exacerbated by lack of sufficient spring time carbohydrate reserves. This lack of carbohydrates allows stem nematodes and root diseases to damage the alfalfa plant to a greater degree that would have been possible if it had not been under nutrient stress. There is little doubt that stem nematode is responsible for much of the poor first cutting growth and plant death. Perhaps the solution to the stem nematode/stand decline problems may not lie with controlling the nematodes, but rather by managing the plant environment to minimize their damage. Investigation of the impact of an apparently simple change in harvest management practices is the aim of this project. An understanding of the interactions between harvest management, stored non-structural carbohydrates, alfalfa stem nematodes, and plant pathogenic fungi is necessary to fully implement any changes in the way alfalfa is managed.

Objectives:

1. Determine if modification of present late-season alfalfa harvest practices will affect stand persistence.
2. Determine relationships and interactions between late-season harvest management practices and alfalfa varieties on stored non-structural carbohydrates, alfalfa stem nematodes, and crown and root rot diseases of alfalfa.
3. Conduct an economic analysis of traditional and modified late-season harvest practices to determine how long-term profitability is affected by management changes.

Materials and Methods:

The effect of late-season harvest management on alfalfa stand persistence was studied with long-term experiments investigating the interactions between alfalfa varieties of different dormancy and pest resistance ratings and traditional and modified late-season harvest management regimes. These experiments were conducted at the Western Colorado Research Center at Fruita, CO and the Southwestern Colorado Research Center at Yellow Jacket, CO.

Experimental plots were planted at the Western Colorado Research Center (Fruita, Mesa County) in August 2002 and at the Southwestern Colorado Research Center (Yellow Jacket, Montezuma County) in May 2003. The Fruita site is located at an elevation of about 4,500 ft, furrow irrigated, and traditionally on a four cutting schedule. The Yellow Jacket site is approximately 7,000 ft in elevation, sprinkler-irrigated, and traditionally on a three cutting schedule. The experimental design was a split plot within a randomized complete block, with final harvest timing arranged as main plots and alfalfa varieties as sub plots. Two alfalfa varieties for each dormancy (ratings of 2, 4, and 6) were planted. Within each dormancy rating, one variety with a stem nematode rating of highly resistant, and one variety with stem nematode

resistance rating of less than highly resistant were used. The main plot (final harvest schedule) treatments consisted of the traditional harvest schedule with the final cutting taken in late September or early October, or a modified schedule which delayed the final harvest until after the first killing frost and cessation of alfalfa growth.

Plots at Fruita were harvested with a John Deere 2280 swather equipped with a scale system to record plot weight. Those at Yellow Jacket were harvested with a Carter forage plot harvester with electronic scales on board (Fig. 1). A moisture sample was taken from each plot, and weights were adjusted to an air-dry basis. All data was subjected to analysis of variance using MSTAT-C.

Each plot was sampled in late fall of 2003, early spring of 2004, and again in the fall of 2004 for non-structural carbohydrate concentration. Crowns and roots were randomly chosen from each plot for analysis using the methods described by Da Silveira et al. (1978). The carbohydrate analyses were done in the laboratory of Dr. R.D. Horrocks, Brigham Young University, Provo UT. Plant crown and root samples were cultured and fungal pathogens identified during the spring of 2005. The goal was to determine which pathogens were present. Plant pathology samples were collected, cultured, and pathogens identified by Dr. Curtis Swift (CSU Cooperative Extension, Grand Junction).

Fall cutting date studies, 2003-2005:

Experiments designed to determine the impact of different fall cutting dates on subsequent first cutting yield were conducted at the Western Colorado Research Center at Orchard Mesa during the 2003/04 and 2004/05 growing seasons. The final cutting was taken on five different cutting dates: September 29, October 6, 13, 20, & 27 in 2003 and October 1, 8, 15, 21, & 29 in 2004. There was an uncut control plot in each year. First cutting was taken on May 21, 2004 and May 19, 2005.

Plots were harvested using a self-propelled sickle bar mower. Plant material was transferred onto a tarp to be weighed using a hanging spring scale. Moisture samples were collected and yield adjusted to an air-dry basis. Non-structural carbohydrate samples were taken on November 13, 2003, and again on March 9, 2004. The 2004/05 experiment was sampled on November 18, 2004. Samples were collected and analyzed using the same methods outlined in the previous section.

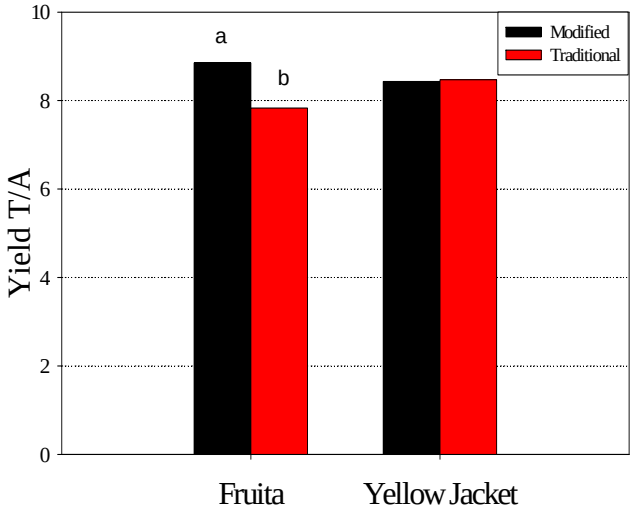

Figure 2. First cutting total yield in a modified vs. traditional cutting schedule. Fruita (P=0.0545), Yellow Jacket (NS)

Carbohydrate levels during regrowth:

A sampling scheme was designed to determine the pattern of carbohydrate use and production by the alfalfa plant during regrowth after a cutting. Two alfalfa fields at the Western Colorado Research Center at Fruita were sampled for non-structural carbohydrates nine times after the third-cutting in 2004. The samples were taken weekly from a newly planted and an established alfalfa field. The samples were analyzed using the methods described above.

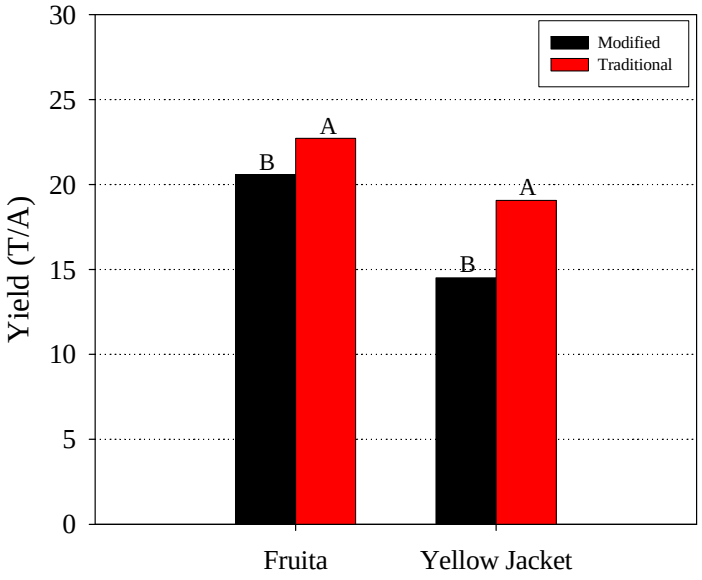

Figure 3. Total yield after three years of modified late-season cutting schedule treatments if the final cutting was not utilized. Fruita (P=0.0625) and Yellow Jacket (P=0.0034)

Results and Discussion

Long-term investigations at research centers: The data is presented in Tables 3 and 4. The economic analysis is presented in Tables 5 and 6.

Delaying the final harvest until growth had ceased significantly increased subsequent first-cutting yield in the four cutting system at Fruita (P=0.0545), but not in the three cutting system at Yellow Jacket (Fig. 2). There was an apparent increase in total yield of 1 ton per acre over the three years the treatments were applied at Fruita, although the difference was not statistically significant. If the final cutting was not utilized, total yield for the 3 years decreased by 4.6 tons per acre at Yellow Jacket (P=0.0034) and 2.1 tons per acre at Fruita (P=0.0625) (Fig. 3).

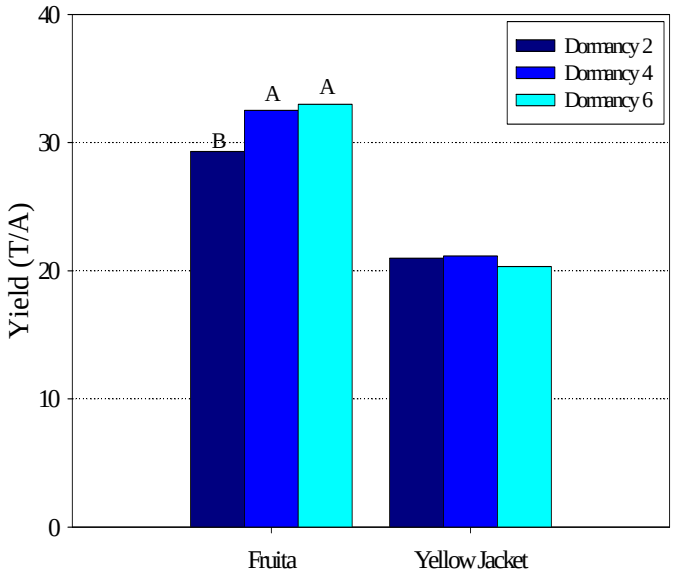

Figure **4**. Fall dormancy rating had a significant impact on yield at Fruita but not Yellow Jacket after four years. Fruita (P=0.0002) and Yellow Jacket (NS)

Dormancy 4 and 6 cultivars yielded more hay than dormancy 2 cultivars at Fruita (P=0.0002). Dormancy 2 and 4 cultivars had greater yield than dormancy 6 at Yellow Jacket NS (Figure 4). There was a yield benefit to stem nematode resistant varieties at both sites.

The resistant cultivars had a 1.13 ton/acre greater yield than susceptible varieties at Yellow Jacket (P=0.0059) and 3.6 ton per acre at Fruita (P=0.0001) over the four years that data was collected (Fig. 5).

Fall cutting date studies, 2003-2005:

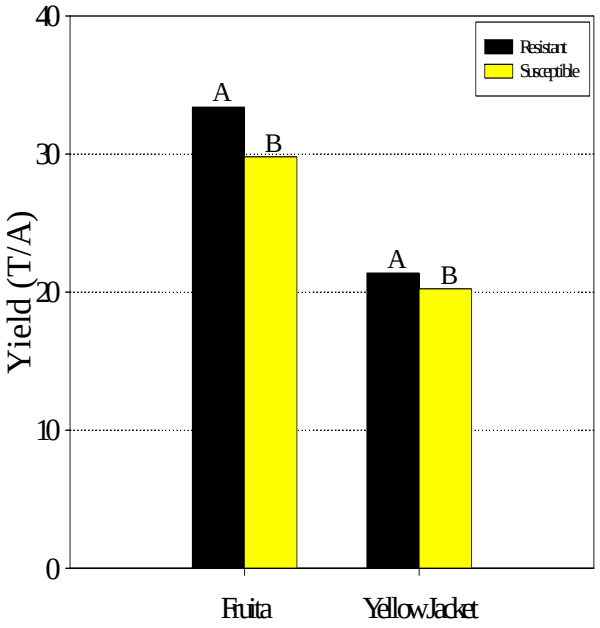

Figure 5. Stem nematode resistant varieties had greater total yield at both sites. Fruita (P=0.0001) and Yellow Jacket (P=0.0059)

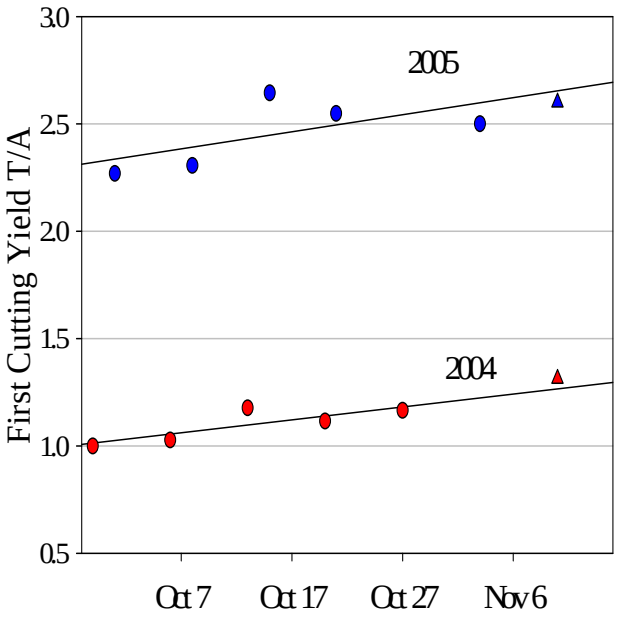

Figure 6. First cutting yield after final fall cutting dates at Fruita.
Note: Data represented by triangle is from plots that were not harvested in the fall.

The results of the harvest date studies in 2003 and 2004 confirm reports in the literature that harvest between two and six weeks before the time growth ceases are detrimental to subsequent first cutting growth (Scheaffer et al., 1988; Horrocks & Zaifnejad, 1997; Welty et al., 1988), at least in four cutting systems. There was strong correlation (r^2=0.97 in 2004 and r^2=0.87 in 2005) between final cutting date and subsequent first cutting yield, with later cutting dates resulting in greater first cutting hay yield than earlier cutting dates. In 2004, first-cutting plots that were cut after October 20 had 0.25 ton per acre greater yield than plots cut September 29. The first-cutting 2005 plots that were harvested after October 22 had 0.4 ton per acre greater yield than those cut October 1 (Fig. 6).

Literature cited:

Da Silveira, A.J., F.F. Feitosa Teles, and J.W. Stull. 1978. A rapid technique for total nonstructural carbohydrate determination of plant tissue. J. Agric. Food Chem. 26:770-772.

Horrocks, R.D., and M. Zaifnejad. 1997. Late-season management of alfalfa in irrigated valleys of the Intermountain West. J. Prod. Agric. 10:96-101.

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Welty, L.E., R.L. Ditterline, and L.S. Prestbye. 1988. Fall management of alfalfa. Montana Agric. Res. 5(2):16-19.

Table 3. Total yield over time as affected by fall harvest schedule (2004-2006) at Fruita. Means within a column grouping followed by the same letter are not significantly different.

Schedule	Dormancy	Resistance	Alfalfa air-dry yield by cutting (Tons/acre)				Total Yield	
							Modified	Traditional
			1st	2nd	3rd	4th	4/3	4/4
Modified			8.85 A	6.13	5.60	3.17	20.58 B	23.75
Traditional			7.83 B	5.86	5.86	3.17	22.72 A	22.72
P-value			0.0545	0.3716	0.3272	NS	0.0625	0.2615
	2		7.89	5.52 B	5.36 B	2.82 B	20.18 B	21.59 B
	4		8.49	5.95 B	5.87 A	3.30 A	21.95 A	23.60 A
	6		8.64	6.51 A	5.97 A	3.40 A	22.81 A	24.51 A
P-value			0.1438	0.0001	0.0002	0.0000	0.0011	0.0003
Modified	**2**		8.82	5.95 BC	5.31	2.82	20.08 B	22.89
Modified	**4**		8.78	5.89 C	5.68	3.30	20.35 B	23.65
Modified	**6**		8.95	6.55 A	5.82	3.40	21.33 B	24.73
Traditional	**2**		6.96	5.10 D	5.41	2.82	20.29 B	20.29
Traditional	**4**		8.20	6.01 ABC	6.05	3.30	23.56 A	23.56
Traditional	**6**		8.32	6.46 AB	6.11	3.40	24.30 A	24.30
P-value			0.1853	0.0456	NS	NS	0.0491	0.1216
		Resistant	8.72 A	6.30 A	5.94 A	3.36 A	22.63 A	24.31 A
		Susceptible	7.97 B	5.69 B	5.53 B	2.98 B	20.67 B	22.16 B
P-value			0.0239	0.0006	0.0008	0.0000	0.0008	0.0003
Modified		**Resistant**	9.49	6.49	5.85	3.36	21.83	25.19
Modified		**Susceptible**	8.21	5.77	5.36	2.98	19.34	22.32
Traditional		**Resistant**	7.94	6.10	6.02	3.36	23.43	23.43
Traditional		**Susceptible**	7.72	5.61	5.70	2.98	22.01	22.01
P-value			0.1070	NS	NS	NS	0.3182	0.1768
	2	**Resistant**	8.77 A	6.00	5.63	3.31 A	22.06 AB	23.71 AB

Schedule	Dormancy	Resistance	Alfalfa air-dry yield by cutting (Tons/acre)				Total Yield	
							Modified	Traditional
			1st	2nd	3rd	4th	4/3	4/4
	2	Susceptible	7.01 B	5.04	5.09	2.32 B	18.31 C	19.47 C
	4	Resistant	8.60 A	6.14	5.91	3.26 A	22.27 AB	23.90 AB
	4	Susceptible	8.38 A	5.76	5.82	3.34 A	21.64 B	23.31 B
	6	Resistant	8.77 A	6.75	6.27	3.52 A	23.55 A	25.31 A
	6	Susceptible	8.50 A	6.26	5.67	3.29 A	22.08 AB	23.72 AB
P-value			0.0935	0.2970	0.1386	0.0000	0.0583	0.0221
Modified	2	Resistant	10.25	6.42	5.60	3.31	1 22.3	5 25.66
Modified	2	Susceptible	7.40	5.47	4.93	2.32	17.81	20.13
Modified	4	Resistant	8.78	6.11	5.65	3.26	20.55	23.80
Modified	4	Susceptible	8.77	5.67	5.71	3.34	20.15	23.49
Modified	6	Resistant	9.43	6.93	6.22	3.52	22.59	26.10
Modified	6	Susceptible	8.47	6.17	5.43	3.29	20.07	23.35
Traditional	2	Resistant	7.30	5.57	5.58	3.31	21.77	21.77
Traditional	2	Susceptible	6.63	4.62	5.25	2.32	18.81	18.81
Traditional	4	Resistant	8.42	6.16	6.17	3.26	24.00	24.00
Traditional	4	Susceptible	7.99	5.86	5.93	3.34	23.12	23.12
Traditional	6	Resistant	8.11	6.57	6.32	3.52	24.51	24.51
Traditional	6	Susceptible	8.54	6.36	5.91	3.29	24.08	24.08
P-value			0.2450	NS	0.3546	NS	NS	NS

Table 4. Total yield over time as affected by fall harvest schedule (2004-2006) at Yellow Jacket. Means within a column grouping followed by the same letter are not significantly different.

			Alfalfa air-dry yield by cutting (Tons/acre)			Total Yield	
						Modified	Traditional
Schedule	Dormancy	Resistance	1st	2nd	3rd	3/2	3/3
Modified			8.43	6.07	4.38	14.50 B	18.88
Traditional			8.47	6.22	4.38	19.07 A	19.07
P-value			NS	NS	NS	0.0034	NS
	2		8.70 A	6.17	4.32 B	17.02 A	19.18 A
	4		8.62 A	6.23	4.50 A	17.10 A	19.35 A
	6		8.03 B	6.04	4.32 B	16.23 B	18.39 B
P-value			0.0042	NS	0.0035	0.0845	0.0548
Modified	**2**		8.65 AB	5.98 AB	4.32	14.63 C	18.94 ABC
Modified	**4**		8.34 AB	5.92 AB	4.50	14.26 C	18.76 BC
Modified	**6**		8.31 BC	6.30 AB	4.32	14.62 C	18.93 ABC
Traditional	**2**		8.75 AB	6.35 AB	4.32	19.42 A	19.42 AB
Traditional	**4**		8.91 A	6.54 A	4.50	19.95 A	19.95 A
Traditional	**6**		7.75 C	5.78 B	4.32	17.85 B	17.85 C
P-value			0.0298	0.0322	NS	0.0201	0.0261
		Resistant	8.65 A	6.24	4.55 A	17.17 A	19.44 A
		Susceptible	8.26 B	6.05	4.21 B	16.41 B	18.51 B
P-value			0.0235	0.2782	0.0000	0.0327	0.0087
Modified		**Resistant**	8.69	6.15	4.55	14.85	19.40
Modified		**Susceptible**	8.17	5.98	4.21	14.16	18.36
Traditional		**Resistant**	8.60	6.33	4.55	19.49	19.49
Traditional		**Susceptible**	8.34	6.11	4.21	18.66	18.66
P-value			NS	NS	NS	NS	NS
	2	**Resistant**	8.81	6.36	4.66 A	17.49	19.82

Schedule	Dormancy	Resistance	Alfalfa air-dry yield by cutting (Tons/acre)			Total Yield	
						Modified	Traditional
			1st	2nd	3rd	3/2	3/3
	2	Susceptible	8.59	5.97	3.97 D	16.55	18.54
	4	Resistant	8.91	6.33	4.58 AB	17.53	19.82
	4	Susceptible	8.34	6.13	4.42 BC	16.67	18.88
	6	Resistant	8.23	6.04	4.41 BC	16.47	18.67
	6	Susceptible	7.84	6.04	4.23 C	15.99	18.11
P-value			NS	NS	0.0001	NS	NS
Modified	2	Resistant	8.86	6.14	4.66	15.00	19.65
Modified	2	Susceptible	8.44	5.82	3.97	14.26	18.24
Modified	4	Resistant	8.63	5.92	4.58	14.55	19.13
Modified	4	Susceptible	8.05	5.92	4.42	13.97	18.39
Modified	6	Resistant	8.59	6.41	4.41	15.00	19.40
Modified	6	Susceptible	8.03	6.20	4.23	14.24	18.47
Traditional	2	Resistant	8.75	6.58	4.66	19.99	19.99
Traditional	2	Susceptible	8.75	6.13	3.97	18.85	18.85
Traditional	4	Resistant	9.19	6.74	4.58	20.52	20.52
Traditional	4	Susceptible	8.63	6.34	4.42	19.38	19.38
Traditional	6	Resistant	7.87	5.67	4.41	17.95	17.95
Traditional	6	Susceptible	7.64	5.88	4.23	17.75	17.75
P-value			NS	NS	NS	NS	NS

Table 5. Economic analysis of alfalfa production at Fruita under four scenarios

	S/unit	Traditional	Modified		
INCOME		4th-Cut	4th-Wasted	4th-Grazed	4th-Burn
Yield (T/A)		30.99	28.06	32.20	28.06
Hay $90/ton		$2,789.10	$2,525.40	$2,525.40	$2,525.40
Graze $71/ton		$0.00	$0.00	$293.94	$0.00
Total		$2,789.10	$2,525.40	$2,819.34	$2,525.40
EXPENSES					
Harvest					
Swath	$12/A	$192.00	$144.00	$144.00	$144.00
Rake	$6/A	$96.00	$72.00	$72.00	$72.00
Bale	$0.65/bale (70#)	$575.53	$521.11	$521.11	$521.11
Load/Stack	$0.40/bale	$354.17	$320.69	$320.69	$320.69
Haul	$12/ton	$371.88	$336.72	$336.72	$336.72
Total		$1,589.58	$1,394.52	$1,394.52	$1,394.52
Spray					
Insecticide	$10/A	$30.00	$30.00	$30.00	$0.00
Aerial app.	$8/A	$24.00	$24.00	$24.00	$0.00
Herbicide	$23/A	$92.00	$92.00	$92.00	$23.00
Ground app.	$7/A	$28.00	$28.00	$28.00	$7.00
Total		$174.00	$174.00	$174.00	$30.00
Total Income		$2,789.10	$2,525.40	$2,819.34	$2,525.40
Total Expense		$1,763.58	$1,568.52	$1,568.52	$1,424.52
NET		**$1,025.52**	**$956.88**	**$1,250.82**	**$1,100.88**

Table 6. Economic analysis of alfalfa production at Yellow Jacket under four scenarios

	$/unit	Traditional	Modified		
INCOME		3rd-Cut	3rd-Wasted	3rd-Grazed	3rd-Burn
Yield (T/A)		20.91	15.81	20.72	15.81
Hay $90/ton		$1,881.90	$1,422.90	$1,422.90	$1,422.90
Graze $71/ton		$0.00	$0.00	$348.61	$0.00
Total		$1,881.90	$1,422.90	$1,771.51	$1,422.90
EXPENSES					
Harvest					
Swath	$12/A	$132.00	$84.00	$84.00	$84.00
Rake	$6/A	$66.00	$42.00	$42.00	$42.00
Bale	$0.65/bale (70#)	$388.33	$293.61	$293.61	$293.61
Load/Stack	$0.40/bale	$238.97	$180.69	$180.69	$180.69
Haul	$12/ton	$250.92	$189.72	$189.72	$189.72
Total		$1,076.22	$790.02	$790.02	$790.02
Spray					
Herbicide	$23/A	$92.00	$92.00	$92.00	$23.00
Ground app.	$7/A	$28.00	$28.00	$28.00	$7.00
Total		$120.00	$120.00	$120.00	$0.00
Total Income		$1,881.90	$1,422.90	$1,771.51	$1,422.90
Total Expense		$1,196.22	$910.02	$910.02	$790.02
NET		**$685.68**	**$512.88**	**$861.49**	**$632.88**

Grain Cereals

Figure 7. Winter wheat harvest at Yellow Jacket in 2008

Introduction

Abdel Berrada

Thirty two thousand acres of land were planted to winter wheat in SW Colorado in 2008, of which 7000 acres were irrigated (http://www.nass.usda.gov/Statistics_by_State/Colorado). Grain yields averaged 33 bu/acre (18 bu/acre for non-irrigated). Winter wheat is the second largest field crop in acres after alfalfa. The hard red winter wheat variety 'Fairview' which was released in 1991 based on testing at the Southwestern Colorado Research Center (SWCRC) is the most widely grown variety in this area (Quick et al., 1993). It has good yield potential and excellent bread making quality. Certified seed of 'Fairview' has been in short supply in recent years. Another commonly grown winter wheat variety is 'Deloris', developed by the Utah Agricultural Experiment Station and released in 2002 (Hole et al., 2004). It has performed similarly to Fairview in the variety trials at Yellow Jacket. Both Deloris and Fairview possess resistance to dwarf bunt (*Tilletia controversa* Kuhn), which is a soil born, seed head fungal disease. Dwarf

bunt is “limited to areas with prolonged snow cover on unfrozen ground” (Cook and Veseth, 1991). It has not been observed in the variety trials to any significant extent for several years, except in 2007, which had very low yields due to water stress. Moreover, several of the top-performing varieties in 2008 and 2009, such as ‘Ripper’ and ‘Bill Brown’, do not have dwarf bunt resistance since they were developed for eastern Colorado.

Another pest of importance to wheat production in Colorado is Russian wheat aphid (RWA), *Diuraphis noxia* (Mordvilko). It became established in SW Colorado in the late 1980’s (Stack et al., 2006). RWA infestation appears to be greatest when winter wheat is planted early (Hammon et al., 1999). RWA has been more prevalent in spring wheat than in winter wheat at the SWCRC and usually requires an insecticide application. An attempt by Colorado State University’s (CSU’s) wheat breeding program to develop a winter wheat variety that has resistance to both dwarf bunt and RWA, using selections from a single three-way cross, was not successful (Stack et al., 2006 and Haley, 2006).

Spring wheat or oat is sometimes planted under rainfed conditions, for example when winter moisture is adequate, or when late bean harvest or other factors (time, weather, etc.) result in winter wheat not being planted. However, these two spring crops are more commonly grown under irrigation, especially after alfalfa, for example to take advantage of residual nitrogen or to control broadleaf weeds, including volunteer alfalfa. In 2008, a total of 5,100 acres of oat (only 1,600 acres were harvested) and 3,400 acres of spring wheat were planted in SW Colorado (http://www.nass.usda.gov/Statistics_by_State/Colorado). Most of the oat grown under irrigation is harvested for hay.

One of the best performing spring wheat varieties in SW Colorado is ‘Sylvan’, which was released in 1994 by the Utah and Colorado State Agricultural Experiment Stations (Quick et al., 1996). In 2009, 300 heads were hand-picked from a three-acre field at the SWCRC and sent to the wheat breeding program in Fort Collins. The seeds from each head will be planted in headrows in 2010. The most representative material will be planted at Yellow Jacket in 2011, rogued to remove off-types, harvested and used as the new breeder seed to produce Sylvan foundation seed in the future. Sylvan is a full-season variety and, due to its height, may lodge with excessive irrigation or wet, damp weather.

‘Monico’ oat had the highest grain yield (181 bu/acre) in 2005. Monico was released jointly by the USDA-ARS and the Idaho, Montana, and Colorado Agricultural Experiment Stations in 2007, partly based on its performance at Yellow Jacket. It is “an early to midseason, relatively tall spring oat with excellent yield potential under both irrigated and rainfed conditions” (Erickson et al., 2008). Other oat varieties grown in SW Colorado are ‘Russell’, ‘Monida’, and ‘Otana’.

Barley is occasionally grown as a feed crop in SW Colorado (Hammon et al., 2006). ‘Burton’ spring barley was released in 2004 by the USDA-ARS and the Idaho, Colorado, Nebraska, and New Mexico Agricultural Experiment Stations (Bregitzer et al., 2005) after extensive testing at Yellow Jacket and other locations. It was the first RWA-resistant barley

variety to be released. No barley or oat trials have been conducted at the SWCRC since 2006 and 2005, respectively, due to limited resources.

Materials and methods:

The wheat, oat, and barley variety trials were conducted in collaboration with CSU's wheat breeding and CSU's crop testing programs. They were arranged in randomized complete blocks with four replications. The seeds were planted with a Kincaid spinner planter with double disks. Plot size was 6 ft wide (6 rows at one-ft spacing) by 40 ft long for the winter wheat dryland trials and 4 ft (6 rows at 8-in spacing) by 30-40 ft for the irrigated spring grain trials. Spacing between plots in the irrigated trials was one ft. The middle four rows in the dryland trials and all six rows in the irrigated trials were harvested with a Hege plot combine for grain yield determination. Fertilizer rates were generally based on soil test results. Irrigation water in the irrigated trials was applied with a linear-move sprinkler system commonly referred to a wheel-line or 'sideroll'. Additional information is included below the tables of results.

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Dryland Winter Wheat Variety Performance Trials at Yellow Jacket, Colorado

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Table 7. Results of the 2009 Dryland Winter Wheat Variety Performance Trial

Entry	Market Class[1]	Source	Grain Yield[2] bu/ac	Grain Moisture (%)	Test Weight lb/bu	Grain Protein[3] %	Plant Height (in)	50% Heading Date[4]
Ripper	Hard red	CSU	70.9	7.1	55.7	14.1	27.4	27-May
Thunder CL	Hard white/CL	CSU	69.2	7.4	59.9	12.8	28.1	28-May
NuDakota	Hard white	Agripro	69.1	7.0	56.5	13.8	25.9	29-May
Winterhawk	Hard red	Westbred	66.2	7.5	59.5	13.7	27.5	29-May
Keota	Hard red	Westbred	65.8	7.7	59.9	13.5	30.4	30-May
Bill Brown	Hard red	CSU	64.3	7.5	57.4	13.9	27.8	30-May
Above	Hard red/CL	CSU	64.2	7.2	56.7	13.5	27.0	29-May
Fairview	Hard red	CSU/Idaho	63.9	7.0	56.3	14.4	30.1	4-Jun
Jagalene	Hard red	Agripro	63.7	7.6	61.2	14.7	28.6	1-Jun
TAM 112	Hard red	Watley Seed	62.9	6.9	56.9	14.5	27.6	29-May
UT9325-55	Hard red	Utah	62.5	7.1	58.3	14.6	31.6	2-Jun
Hawken	Hard red	Agripro	61.5	7.1	57.5	14.6	25.8	26-May
Avalanche	Hard white	CSU	60.7	7.5	59.3	13.6	28.9	30-May
Deloris	Hard red	Utah	60.7	7.4	57.2	14.9	31.5	4-Jun
IDO656	Hard red	Idaho	60.2	7.0	55.3	14.8	32.0	5-Jun
CO03W054-2	Hard white	CSU	60.2	7.4	56.7	13.9	30.5	30-May
IDO658	Hard white	Idaho	60.0	7.4	58.5	14.4	28.6	4-Jun
Hatcher	Hard red	CSU	59.9	7.5	57.4	13.5	25.3	29-May
Danby	Hard white	KSU	59.8	7.6	60.7	14.7	27.4	1-Jun
IDO660	Hard white	Idaho	57.9	6.8	57.5	15.4	24.9	2-Jun

Entry	Market Class[1]	Source	Grain Yield[2] bu/ac	Grain Moisture (%)	Test Weight lb/bu	Grain Protein[3] %	Plant Height (in)	50% Heading Date[4]
UI Darwin	Hard white	Idaho	57.0	7.6	59.2	15.3	33.5	4-Jun
Golden Spike	Hard white	Utah	56.3	7.0	56.7	15.1	28.4	6-Jun
CO03064-2	Hard red	CSU	56.1	6.9	53.8	14.6	29.0	2-Jun
IDO653	Hard red CL	Idaho	55.7	7.8	57.4	15.7	36.4	5-Jun
IDO651	Hard white CL	Idaho	55.3	7.3	55.1	14.9	37.5	4-Jun
Bond CL	Hard red/CL	CSU	54.6	7.3	57.0	13.6	27.9	27-May
Gary	Hard white	Idaho	51.5	7.5	56.9	15.6	28.6	6-Jun
Hayden	Hard red	CSU/Idaho	48.8	7.7	59.1	16.0	34.4	5-Jun
Average			**60.7**	**7.3**	**57.6**	**14.4**	**29.4**	-
CV (%)			**5.1**	**3.2**	**1.3**	**3.5**	**5.1**	-
$LSD_{.05}$			**4.3**	**0.3**	**1.1**	**1.1**	**2.1**	-

[1] CL = Clearfield wheat (resistant to 'Beyond' herbicide)

[2] Bushel yield based on 60 lb/bu and adjusted to 12% moisture

[3] Grain protein at 12% moisture. Data from replications 1 & 2 only

[4] Date 50% of plants headed

Trial information:

Soil type: Wetherill silty clay loam
Previous crop: 2008: Camelina (was disked due to residual Pursuit herbicide); alfalfa prior to that.
Seeded: September 22, 2008
Seeding rate: 600,000 seeds/ac (50 lb/ac on 12-in. row spacing)
Harvested: July 23, 2009
Fertilizer: 20 lb N/ac broadcast preplant
Pesticides: None
Precipitation: Planting to harvest: 7.6 in.

Comments:

The 2009 dryland winter wheat trial produced some of the highest dryland seed yields ever obtained at the Research Center. Ripper, Thunder CL, and NuDakota outperformed Fairview. Grain protein averaged 14.4% (12.8-16.0 %). There was good rainfall prior (i.e., 2.2 inches in August) to planting and in the spring of 2009. There were no noticeable RWA or dwarf bunt infestations in 2009. Grasshoppers were present in significant numbers late in the season, but did not seem to cause significant damage to the wheat. In addition to timely precipitation, the 2009 winter wheat may have benefited from residual nitrogen from the previous alfalfa crop.

Table 8. Results of the 2008 Dryland Winter Wheat Variety Performance Trial

Variety	Market Class[1]	Yield[2] (bu/ac)	Grain Moisture (%)	Test Weight (lb/bu)	Grain Protein[3] (%)	Plant Height (in)	Heading Date[4]
Ripper	Hard red	50.8	8.4	55.3	14.4	26	6/6
UT9325-55	Hard red	47.6	8.3	55.4	15.9	29	6/11
Bill Brown	Hard red	46.8	8.8	56.3	13.8	24	6/6
NuDakota	Hard white	46.6	8.6	53.9	14.7	24	6/6
Bond CL	Hard red/CL	46.3	8.8	54.1	14.7	27	6/6
TAM 112	Hard red	45.7	8.7	57.6	15.5	25	6/6
Keota	Hard red	45.6	8.9	58.1	15.2	28	6/9
Deloris	Hard red	43.2	8.5	55.6	16.3	29	6/13
Fairview	Hard red	42.9	8.6	54.9	15.2	28	6/13
UI Darwin	Hard white	42.8	9.2	59.3	15.9	28	6/13
Hawken	Hard red	42.5	8.5	55.3	14.7	24	6/6
IDO653	Hard red/CL	42.4	8.9	55.1	15.8	33	6/13
Danby	Hard white	41.8	8.9	58.8	15.6	24	6/9
Above	Hard red/CL	41.8	8.9	56.0	14.5	26	6/6
Hatcher	Hard red	41.7	8.5	55.9	14.1	24	6/6
Jagalene	Hard red	40.7	8.5	57.8	14.7	25	6/10
IDO651	Hard white/CL	40.4	8.6	52.1	16.5	33	6/11
IDO641	Hard white	39.9	8.6	57.6	14.8	25	6/9
Avalanche	Hard white	36.2	8.5	56.4	14.2	26	6/9
Gary	Hard white	34.7	9.0	57.4	15.2	27	6/16
Average		**43.0**	**8.7**	**56.1**	**15.1**	**27**	**6/9**
CV (%)		**10.6**					
$LSD_{0.05}$		**6.4**					

[1] CL = Clearfield wheat (resistant to 'Beyond' herbicide)

[2] Bushel yield based on 60 lb/bu and adjusted to 12% moisture

[3] Grain protein at 12% moisture

[4] Date 50% of plants headed

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Oct. 2006- Sept. 2007: Fallow; 2005: Dry beans
Seeded:	October 10, 2007
Seeding rate:	600,000 seeds/ac (50 lb/ac on 12-in. row spacing)
Harvested:	July 31 - Aug. 1, 2008
Soil test:	NO_3-N: 5 ppm; Mehlich-3 P: 7.1 ppm
Fertilizer:	35 lb N/ac broadcast preplant
Pesticides:	None

Precipitation: October 2007 thru June 2008: 8.8 in.
(11.1 inches long-term average)

Comments:

The trial benefited from excellent winter moisture. However, spring and summer precipitation was below average and resulted in low test weights for most varieties. UI Darwin had the highest test weight (59.3 lb/bu). The wheat varieties Ripper, Bill Brown, and Bond CL from the Colorado State University wheat breeding program yielded very well. These varieties were developed for eastern Colorado and do not have dwarf bunt resistance. Avalanche, a CSU hard white wheat, had poor emergence at planting. Russian wheat aphid damage was not observed in any of the entries nor was dwarf bunt observed in the trial.

Table 9. Results of the 2007 Dryland Winter Wheat Variety Performance Trial

Variety	Market Class[1]	Yield[2] (bu/ac)	Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	Heading Date[3]
Above	Hard red	12.3	10.0	50.0	22	6/6
NuDakota	Hard white	9.6	9.1	46.0	22	6/2
Avalanche	Hard white	9.6	9.6	51.5	22	6/2
Ripper	Hard red	8.1	9.3	48.5	21	6/2
Hatcher	Hard red	7.9	9.7	49.0	21	6/2
Ankor	Hard red	7.7	9.7	50.5	22	6/2
TAM 111	Hard red	6.9	9.7	54.0	22	6/2
Bond CL	Hard red	6.9	9.4	48.5	23	6/2
Fairview	Hard red	6.9	9.2	49.0	24	6/6
UT9325-55	Hard red	6.7	9.7	51.5	24	6/6
IDO641	Hard white	6.6	9.9	53.0	21	6/2
Juniper	Hard red	6.5	8.8	53.0	25	6/6
Golden Spike	Hard white	6.0	9.5	50.0	22	6/6
UI Darwin	Hard white	5.8	9.7	54.0	22	6/6
Hayden	Hard red	4.8	9.1	52.0	21	6/6
Deloris	Hard red	4.7	9.4	50.0	23	6/6
Jagalene	Hard red	4.4	9.9	54.5	21	6/2
Danby	Hard white	4.4	9.6	57.0	20	6/2
UT9508-88	Hard red	3.9	9.6	52.5	22	6/6
Gary	Hard white	3.1	9.1	51.0	20	6/6
Average		**6.6**	**9.5**	**51.0**	**22**	
CV (%)		**17.7**				
$LSD_{0.05}$		**NS**				

[1] CL = Clearfield wheat (resistant to 'Beyond' herbicide)

[2] Bushel yield based on 60 lb/bu and adjusted to 12% moisture
[3] Date 50% of plants headed

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow; two-years ago: safflower/sunflower
Seeded:	September 28, 2006
Seeding rate:	600,000 seeds/ac (50 lb/ac on 12-in. row spacing)
Harvested:	July 18, 2007
Fertilizer:	50 lb N/ac broadcast preplant
Herbicide:	None
Insecticide:	None
Precipitation:	October 2006 thru June 2007: 9.8 inches (4 .2 inches in October 2006) (11.1 inches long-term average)

Comments:

The dryland winter wheat yields were very low due to moisture stress and damage from a July 5 hailstorm. The yield results are statistically not significant (NS). Although the wheat survived the winter in excellent condition, below average precipitation during the winter and spring led to moisture stress. The deep soil moisture was also not recharged following the previous crop of safflower and sunflower. The wheat varieties from the CSU breeding program yielded at the top of the trial (Above, Avalanche, Ripper, Hatcher, and Ankor). NuDakota is an Agripro release noted for low test weights. The test weights were very low except for Danby. Russian wheat aphid damage was not observed in any of the varieties. Common bunt was observed in Jagalene, Avalanche, and Danby. Grain protein was not analyzed due to the very low yields.

Table 10. Results of the 2006 Dryland Winter Wheat Variety Performance Trial

Variety	Market Class	Yield[1] (bu/ac)	Grain Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	Heading Date[2]
NuFrontier	Hard white	26.1	12.0	55.4	22	5/31
AP03-20	Hard white	25.7	11.8	56.4	21	5/26
NuHills	Hard white	25.6	11.8	57.2	20	5/31
Lakin	Hard white	25.1	12.2	55.1	23	5/26
CO00016 (Ripper)	Hard red	24.8	12.2	53.3	22	5/24
Hatcher	Hard red	24.6	11.8	54.7	19	5/26
Jagalene	Hard red	23.9	11.8	56.4	21	5/31
Bond CL	Hard red	23.9	12.7	52.4	19	5/24
AP50W	Hard white	23.8	12.8	51.1	18	5/25
Avalanche	Hard white	23.0	12.2	55.1	21	5/26
AP530W	Hard white	22.9	11.9	55.6	19	5/31
TAM 111	Hard red	22.9	12.5	54.9	22	5/26
IDO573	Hard red	22.3	11.8	56.3	22	5/31
IDO575 (Juniper)	Hard red	22.0	11.6	55.3	24	5/31
Danby	Hard white	22.0	11.9	57.7	17	5/26
Ankor	Hard red	21.2	12.4	55.0	19	5/31
Golden Spike	Hard white	21.0	12.1	54.0	24	5/31
IDO616	Hard red	20.2	11.9	54.4	23	6/5
UT9508-88	Hard red	20.0	12.0	57.0	22	6/5
IDO604	Hard white	19.7	12.2	55.7	22	5/31
UT9508-157	Hard red	18.8	12.0	56.2	21	6/5
Above	Hard red	18.8	12.3	53.6	18	5/24
Deloris	Hard red	18.1	12.1	54.0	22	5/31
Fairview	Hard red	18.1	12.2	53.4	21	5/31
Gary	Hard white	17.3	12.3	54.4	19	5/31
Hayden	Hard red	16.4	12.3	55.2	25	6/5
Average		**21.9**	**12.1**	**55.0**	**21**	
CV (%)		**17.5**				
$LSD_{0.05}$		**5.4**				

[1] Bushel yield based on 60 lb/bu and adjusted to 12% moisture

[2] Date 50% of plants headed

Trial Information:

Soil type: Wetherill silty clay loam
Previous crop: Dry beans; two-years ago: winter wheat
Seeding rate: 50 lb/ac (600,000 seeds/ac) on 12-in. row spacing

Seeded:	October 15, 2005
Harvested:	August 3, 2006
Fertilizer:	40 lb N/ac broadcast on April 25, 2006
Pesticides:	None
Precipitation:	October 2005 thru June 2006: 5.1 inches (11.1 inches long-term average)

Comments:

The dryland winter wheat variety trial yielded 21.9 bu/ac with a test weight average of 55.0 lb/bu. The yields were better than expected since the trial received less than one-half the average winter and spring precipitation. Statistically, the high CV% (coefficient of variation) indicates that the results should be viewed with caution. The dry winter and spring resulted in the plots having erratic stands with limited vegetative growth during the spring. The predominant winter wheat varieties grown in the area (Fairview and Deloris) yielded near the bottom of the variety trial. The reason for their below average yields is unknown. Ankor had a poor stand in all replications. Significant damage from Russian wheat aphid feeding was not observed in any of the entries. Dwarf bunt was not found in the seed of any entry at harvest.

Table 11. Results of the 2005 Dryland Winter Wheat Variety Performance Trial

Variety	Market Class	Yield[1] (bu/ac)	Grain Moisture (%)	Test Weight (lb/bu)	Grain Protein (%)	Plant Height (in)	Heading Date[2]
CO00016 (Ripper)	Hard red	50.2	11.0	56.6	14.0	27	6/3
IDO573	Hard red	47.4	10.6	58.5	14.6	32	6/13
NuFrontier	Hard white	47.1	10.8	58.3	12.4	29	6/8
CO00796	Hard red	45.4	11.2	58.6	11.9	30	6/6
Fairview	Hard red	44.8	10.6	57.9	13.0	31	6/13
CO00554	Hard red	44.0	11.0	57.4	12.5	25	6/6
Lakin	Hard white	43.7	11.4	57.1	12.3	26	6/6
CO00739	Hard red	43.7	11.2	56.8	12.2	27	6/8
Hatcher	Hard red	43.5	10.6	56.0	12.3	24	6/6
Above	Hard red	43.2	10.9	56.6	12.3	25	6/3
IDO571	Hard red	42.4	10.9	57.8	13.9	27	6/13
Ankor	Hard red	42.2	11.6	56.0	13.7	26	6/6
Avalanche	Hard white	41.1	10.8	59.8	12.2	26	6/6
Deloris	Hard red	40.7	10.9	56.2	13.5	32	6/13
IDO575 (Juniper)	Hard red	40.5	10.5	58.2	14.2	35	6/13
IDO604	Hard white	40.0	11.1	59.0	14.6	29	6/13
Gary	Hard white	37.3	11.2	56.0	13.3	27	6/15
Golden Spike	Hard white	37.1	10.9	56.3	12.3	28	6/13
Hayden	Hard red	34.0	11.0	58.3	15.2	32	6/13
Average		**42.6**	**11.0**	**57.4**	**13.2**	**28**	
CV (%)		**7.4**					
$LSD_{0.05}$		**4.5**					

[1] Bushel yield based on 60 lb/bu and adjusted to 12% moisture

[2] Date 50% of plants headed

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow; two-years ago: dry beans
Seeded:	October 15, 2004
Seeding rate:	600,000 seeds/ac (50 lb/ac on 12-in. row spacing)
Harvested:	July 29, 2005
Fertilizer:	50 lb N/ac broadcast preplant
Pesticides:	None
Precipitation:	Oct. 2004 thru June 2005: 14.2 inches (11.1 inches long-term average)

Comments:

The 2004-2005 crop year had above average precipitation which resulted in good wheat yields. Nitrogen fertilizer helped achieve an average 13.2% grain protein. Russian wheat aphid (RWA) feeding pressure was low both in the fall and spring. None of the entries lodged. Dwarf bunt was not found in the seed of any variety at harvest.

Spring Grains

Irrigated Spring Wheat, Oat, and Barley Variety Performance Trials at Yellow Jacket, Colorado

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Table 12. Results of the 2006 Irrigated Spring Wheat Variety Performance Trial

Entry	Market Class	Grain Yield[1] (bu/ac)	Moisture (%)	Test Weight (lb/bu)	Grain Protein[2] (%)	Plant Height (in)	Heading Date[3] (days)
Lolo	Hard white	112.1	10.0	61.4	11.8	31	195
IDO645	Soft white	110.3	10.4	60.3	11.3	27	195
Alturas	Soft white	108.1	10.1	58.9	10.9	27	198
ID377s	Hard white	107.0	9.8	61.2	12.3	29	195
Sylvan	Hard red	104.3	10.3	61.3	10.9	35	202
IDO632	Soft white	102.7	10.5	57.5	11.1	26	186
IDO629 WXY	Waxy	99.3	9.4	59.2	10.8	34	202
IDO630 WXY	Waxy	99.2	9.3	57.5	11.4	30	202
Lochsa	Hard white	97.1	9.9	58.1	12.3	28	186
Blanca Grande	Hard white	87.1	9.7	59.9	12.6	22	186
Jerome	Hard red	87.1	9.9	58.8	13.3	26	186
Plata	Hard white	82.1	10.0	59.6	12.8	21	186
UI Winchester	Hard red	77.7	9.8	59.4	13.6	25	191
Average		**98.0**	**9.9**	**59.5**	**11.9**	**28**	
CV (%)		**7.6**					
$LSD_{0.05}$		**10.7**					

[1] Grain yield adjusted to 60 lb/bu and 12% moisture

[2] Protein based on 12 % moisture

[3] Number of days after January 1

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry beans; two-years ago: winter wheat
Seeding rate:	1,200,000 seeds/ac (8-inch row spacing)
Seeded:	May 12, 2006
Harvested:	October 2, 2006
Fertilizer:	50 lb N/ac broadcast preplant May 10, 2006
Herbicide:	Curtail M 2 pt/ac June 17, 2006

Insecticide: Lorsban 1 pt/ac June 19, 2006
Irrigation: 17.6 inches (7 sprinkler wheel-line passes)
Precipitation: January 1, 2006 thru August 31, 2006: 6.9 inches
(long-term average 9.7 inches)

Comments:

The trial averaged 98.0 bu/ac with a test weight average of 59.5 lb/bu. The hard white wheat Lolo performed very well (112.1 bu/ac seed yield with a 61.4 lb/bu test weight). Three soft white wheat entries (IDO645, Alturas, and IDO632) yielded above the trial average. Sylvan continues to be the best yielding hard red spring wheat for southwestern Colorado. IDO629 WXY with 20% lodging and ID377s with 15% lodging were the only entries with lodging above 10%. IDO645 and Lolo had lodging rated at 7.5%. None of the other entries lodged. UI Winchester exhibited poor straw strength but was not lodged. The variety trial was treated with Lorsban insecticide to control Russian wheat aphid (RWA).

Table 13. Results of the 2005 Irrigated Spring Wheat Variety Performance Trial

Entry	Market Class	Grain Yield[1] (bu/ac)	Moisture (%)	Test Weight (lb/bu)	Grain Protein[2] (%)	Plant Height (in)	Heading Date[3] (days)
Alturas	Soft white	102.7	15.4	54.3	12.5	24	199
Sylvan	Hard red	101.3	14.4	57.4	11.2	28	202
ID377s	Hard white	94.2	14.8	57.2	12.7	25	191
Lolo	Hard white	89.7	15.1	56.1	13.3	27	192
Lochsa	Hard white	86.4	14.8	55.6	15.2	26	191
Plata	Hard white	85.0	15.3	57.0	12.6	23	199
Centennial	Soft white	82.7	14.7	55.6	12.6	24	192
IDO630	Waxy	79.8	15.2	54.6	12.4	27	199
WB881	Durum	69.7	15.3	55.4	12.2	24	199
Jerome	Hard red	68.6	15.3	56.2	15.0	22	187
Pristine	Hard white	68.3	15.6	56.0	15.9	22	187
Oslo	Hard red	66.3	15.4	55.0	14.4	22	187
IDO593	Hard red	65.6	15.4	56.8	13.8	23	187
Yecora Rojo	Hard red	64.9	15.0	56.5	15.4	15	187
Snow Crest	Hard white	62.6	13.3	56.2	16.5	20	187
Blanca Grande	Hard white	55.4	15.3	54.7	15.1	18	187
Average		**77.7**	**15.0**	**55.9**	**13.8**	**23**	
CV (%)		**7.9**					
$LSD_{0.05}$		**8.8**					

[1] Yield based on 60 lb/bu and 12% moisture

[2] Protein based on 12 % moisture

[3] Number of days after January 1

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry beans; two-years ago: alfalfa
Seeding rate:	1,200,000 seeds/ac (8-inch row spacing)
Seeded:	May 18, 2005
Harvested:	November 3, 2005
Fertilizer:	100 lb N/ac broadcast preplant April 22, 2005
Herbicide:	None
Insecticide:	Lorsban 1 pt/ac July 5, 2005
Irrigation:	13.4 inches (5 sprinkler wheel-line passes)
Precipitation:	January 1, 2005 thru August 31, 2005: 11.8 inches (long-term average 9.7 inches)

Comments:

The trial averaged 77.7 bu/ac with a test weight of 55.9 lb/bu. Wet fall weather delayed harvest until early November. The soft white wheat entries Alturas and Centennial and the hard white wheat entries ID377s, Lolo, Lochsa, and Plata yielded above the trial average. Sylvan was the highest yielding hard red spring wheat. Test weights were low for all entries, which indicates that an additional irrigation should have been scheduled in mid-August. None of the entries lodged. The trial was treated with Lorsban to control Russian wheat aphid (RWA).

Table 14. Results of the 2005 Irrigated Oat Variety Performance Trial

Entry	Grain Yield[1] (bu/ac)	Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	Heading Date[2] (days)
Monico	181.5	10.3	33.0	34	191
Ajay	151.3	10.1	31.6	32	199
Russell	149.0	10.3	33.5	37	193
Maverick	146.6	10.3	33.7	33	199
Rio Grande	143.0	10.6	33.9	33	191
Monida	138.3	10.6	33.5	34	202
Lamont	131.4	11.3	40.0	39	202
Powell	123.9	10.4	30.6	31	199
Provena	116.3	11.4	43.9	33	193
Average	**142.4**	**10.6**	**34.8**	**34**	
CV (%)	**12.6**				
$LSD_{0.05}$	**26.3**				

[1] Yield based on 38 lb/bu and 12% moisture

[2] Number of days after January 1

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry beans; two-years ago: alfalfa
Seeding rate:	100 lb/ac (8-inch row spacing)
Seeded:	May 18, 2005
Harvested:	November 4, 2005
Fertilizer:	100 lb N/ac broadcast preplant April 22, 2005
Pesticides:	None
Irrigation:	13.4 inches (5 sprinkler wheel-line passes)
Precipitation:	January 1, 2005 thru August 31, 2005: 11.8 inches (long-term average 9.7 inches)

Comments:

The trial averaged 142.4 bu/ac with a test weight of 34.8 lb/bu. Wet fall weather delayed harvest until early November. Monico yielded 181.5 bu/ac but had a test weight of only 33.0 lb/bu. The low test weight average may indicate that an additional irrigation should have been scheduled. Lamont and Provena are hulless oats which are lower yielding but have higher test weights. Hulless oats are used as a high-quality feed for horses and dairy cows. Powell had lodging that ranged from 50% to 100%. Monida's lodging ranged from 25% to 50%. Monico lodged 25% in one replication. Monico is susceptible to lodging if irrigation water and nitrogen are not carefully managed.

Table 15. Results of the 2006 Irrigated Spring Barley Variety Performance Trial

Entry	Type	Grain Yield[1] (bu/ac)	Moisture (%)	Test Weight (lb/bu)	Lodging (%)	Plant Height (in)	Heading Date[2] (days)
Baronesse+Gaucho	feed, 2-row	123.8	9.5	50.2	30	28	195
00ID1550+Gaucho	feed, 6-row	123.7	9.8	45.6	0	33	191
Comarque+Gaucho	feed, 2-row	120.1	9.9	49.2	30	27	195
Nebula	feed, 6-row	119.9	9.5	47.6	0	25	202
Burton	feed, 2-row	119.9	9.6	51.6	5	33	195
01ST1758	feed, 2-row	116.7	9.5	50.2	10	27	191
01ST1587	feed, 2-row	116.2	9.7	50.2	25	28	191
Comarque	feed, 2-row	115.5	9.6	51.1	20	27	202
Eslick	feed, 2-row	112.3	9.6	51.1	35	30	198
Haxby	feed, 2-row	106.9	9.3	51.6	0	29	195
Baronesse	feed, 6-row	106.8	9.9	50.9	50	27	195
Alexis	malt, 2-row	106.5	9.6	50.9	20	27	202
00ID1550	feed, 6-row	105.0	10.0	44.9	0	31	191
Triumph	malt, 2-row	103.0	9.8	49.6	50	27	202
Average		**114.0**	**9.7**	**49.6**		**28**	
CV (%)		**8.6**					
$LSD_{0.05}$		**14.1**					

[1] Yield based on 48 lb/bu and 12% moisture

[2] Number of days after January 1

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry beans; two-years ago: winter wheat
Seeding rate:	100 lb/ac (8-inch row spacing)
Seeded:	May 12, 2006
Harvested:	October 2, 2006
Fertilizer:	50 lb N/ac broadcast preplant May 10, 2006
Herbicide:	Curtail M 2 pt/ac June 17, 2006
Insecticides:	None
Irrigation:	17.6 inches (7 sprinkler wheel-line passes)
Precipitation:	January 1, 2006 thru August 31, 2006: 6.9 inches (long-term average 9.7 inches)

Comments:

The trial averaged 114.0 bu/ac with a test weight of 49.6 lb/bu. The trial was designed to compare Russian wheat aphid (RWA) resistant entries with commercial varieties. The entries 01ST1587 and 01ST1758 are RWA resistant experimental lines from the USDA-ARS at

Aberdeen, ID. 00ID1550 is a hulled low-phytate barley with no RWA resistance. Burton is a RWA resistant variety that was released in 2004.

Baronesse, 00ID1550, and Comarque were treated with Gaucho seed insecticide. Gaucho is a systemic seed insecticide with good efficacy on aphids. There was high RWA feeding pressure in 2006 with symptoms readily observed in the non-RWA resistant entries. RWA symptoms were first observed in late June. The symptoms included twisted heads on 00ID1550, Alexis, and Triumph. The trial results illustrate the yield reduction caused by RWA feeding.

Table 16. Results of the 2005 Irrigated Spring Barley Variety Performance Trial

Entry	Type	Grain Yield[1] (bu/ac)	Moisture (%)	Test Weight (lb/bu)	Lodging (%)	Plant Height (in)	Heading Date[2] (days)
Nebula	feed, 6-row	106.3	10.7	46.6	0	21	203
Comarque+Gaucho	feed, 2-row	105.6	11.9	48.9	0	21	193
Nebula+Gaucho	feed, 6-row	97.5	10.8	46.4	0	21	203
01ST1615	feed, 2-row	97.4	12.0	49.5	0	21	188
Baronesse	feed, 2-row	97.4	11.9	49.1	0	20	188
Burton	feed, 2-row	94.8	11.8	50.0	0	24	195
C 69+Gaucho	malt, 2-row	87.6	11.6	48.3	0	19	193
01ST1514	feed, 2-row	83.1	11.8	49.8	0	21	191
01ST1750	feed, 2-row	83.0	11.9	49.1	60	21	188
01ST1587	feed, 2-row	81.6	11.5	49.1	0	21	191
01ST1677	feed, 2-row	81.1	12.0	49.5	50	18	191
Baronesse+Gaucho	feed, 2-row	77.5	11.9	50.2	0	21	188
01ST1655	feed, 2-row	75.5	11.9	49.1	70	18	188
01ST1758	feed, 2-row	74.4	11.8	49.7	60	19	188
Average		**88.8**	**11.7**	**48.9**		**20**	
CV (%)		**15.8**					
$LSD_{0.05}$		**20.1**					

[1] Yield based on 48 lb/bu and 12% moisture

[2] Number of days after January 1

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Dry beans; two-years ago: alfalfa
Seeding rate:	100 lb/ac (8-inch row spacing)
Seeded:	May 18, 2005
Harvested:	November 3, 2005
Fertilizer:	100 lb N/ac broadcast preplant April 22, 2005
Herbicide:	None
Insecticide:	None

Irrigation: 13.4 inches (5 sprinkler wheel-line passes)
Precipitation: January 1, 2005 thru August 31, 2005: 11.8 inches
(long-term average 9.7 inches)

Comments:

The trial averaged 88.8 bu/ac with a test weight of 48.9 lb/ac. Wet fall weather delayed harvest until early November. The relatively low yields and short plant height in 2005 indicate that an additional irrigation in mid-August should have been scheduled.

The trial was designed to test Russian wheat aphid (RWA) resistant entries. The numbered entries are RWA resistant experimental lines from the USDA-ARS at Aberdeen, ID. Burton, a RWA resistant variety, was released by the USDA-ARS in 2004. Baronesse, Comarque, and Nebula were treated with Gaucho seed insecticide for comparison with the RWA resistant experimental lines. RWA feeding pressure in 2005 was low which resulted in the untreated seed entries of Nebula and Baronesse yielding higher than their treated entries. It is unknown why Baronesse+Gaucho yielded significantly lower than Baronesse (untreated seed).

OILSEED CROPS

Introduction

Abdel Berrada

Oil crops gained interest in SW Colorado as part of the national drive to produce clean, renewable energy and to reduce our dependence on fossil fuels. Other incentives are diversification and the economic benefit derived from processing oil crops locally. Indeed, a plant to extract oil from sunflower (*Helianthus annuus* L.) and safflower (*Carthamus tinctorius* L.) was built recently[1] in Dove Creek in Dolores County, Colorado. Sunflower was reintroduced to the area in 2006 after San Juan Bioenergy was initially formed [2]. The company's main thrust was to produce biodiesel from sunflower, safflower, and canola oil[3]. However, a decrease in fossil fuel prices and government subsidies forced it to sell all the oil produced at its Dove Creek plant in 2009 to refineries for processing as food-grade oil. The byproduct from the seed oil extrusion is marketed as feed meal (www.sanjuanbioenergy.com). The sunflower seed hulls and the sunflower and safflower leaves and stems (dockage) are converted to syngas whose combustion is expected to provide up to 100% of the heat and 50% of the electricity needed to run the plant.

Figure 8. Sunflower plots with Sleeping Ute Mountain in the distance

The Dove Creek plant has the capacity to produce 2.5 million gallons of oil annually. This was based on an estimated 41,000 acres of harvested oil crops (mostly sunflower) in SW Colorado and San Juan County, UT (Jeff Berman, Personal Communication, January 2010).

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[1] The plant was inaugurated in December 2008. It is owned by San Juan Bioenergy.

[2] Sunflower was grown in SW Colorado in the 1970s but was abandoned due to low commodity prices and the long distance from processing plants.

[3] Currently only sunflower and safflower are contracted by San Juan Bioenergy.

Sunflower:

According to the National Agricultural Statistical Service (http://www.nass.usda.gov/Statistics_by_State/Colorado), 1700 acres of sunflower were harvested in 2006 in Dolores County and 7700 acres in 2007 in Dolores and Montezuma counties. Average seed yields ranged from 770 lb/acre in 2006 in Dolores County to 1135 lb/acre in 2007 in Montezuma County. The number of **planted** acres of sunflower in Dolores and Montezuma counties[4] is estimated at 11,500 acres for 2008 and 7,000 acres for 2009 (Dan Fernandez, Personal Communication, December 2009). There are no official estimates of the safflower acreage in SW Colorado or San Juan County, UT but it is believed to be 3,000 to 5,000 acres. Most of the sunflower and safflower acreage in SW Colorado and San Juan County, UT is non-irrigated. Acreage may fluctuate depending on commodity prices, oil prices, weather conditions, and other factors such as the acreage that will come out of the Conservation Reserve Program.

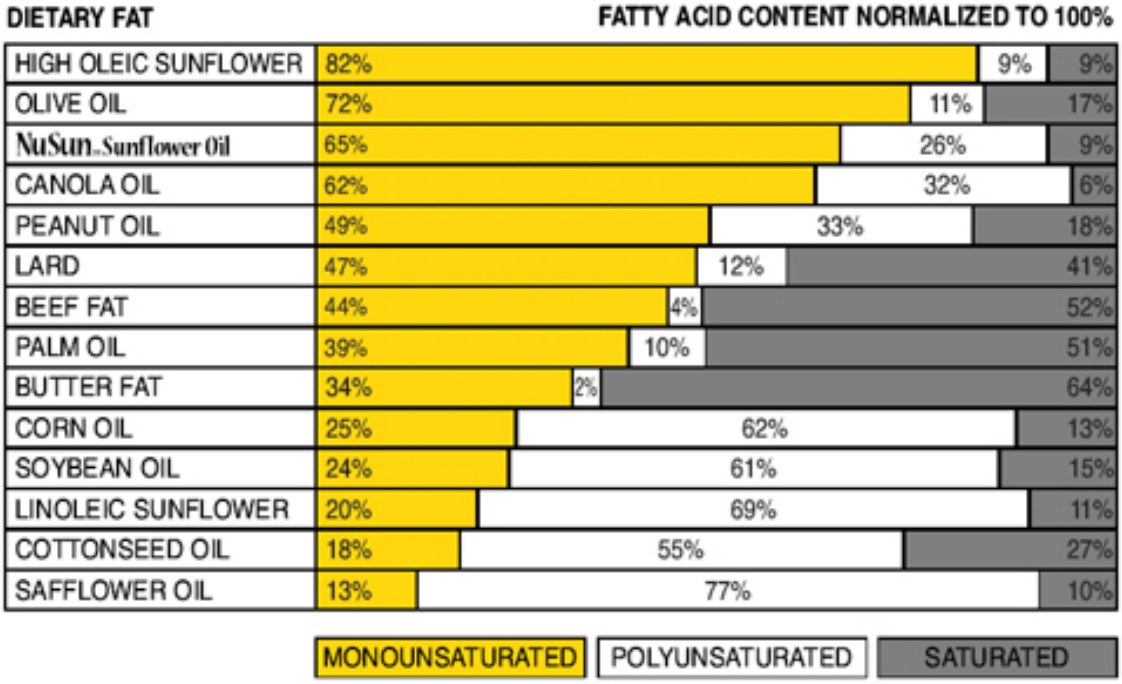

Figure 9. The fatty acid profiles of different fats and oils. http://www.sunflowernsa.com/

Comment: The safflower in this example is apparently of the linoleic oil type.

There are three types of sunflower oil: NuSun, linoleic, and high oleic. "NuSun® oil is the 'new' mid-oleic sunflower oil. It is lower in saturated fat (less than 10%) than linoleic sunflower oil and has higher oleic levels (55-75%) with the remainder being linoleic (15-35%) (Fig. 9).

[4] No official statistics were available as of this writing

Linoleic oil is the original sunflower oil and until recently has been the most common type of sunflower oil. This type of sunflower oil is predominantly (65%) polyunsaturated[5]. High oleic sunflower oil is usually defined as having a minimum 80 percent oleic acid." (http://www.sunflowernsa.com/)

Sunflower has been tested at the SWCRC since 2005. It consistently averaged over 1,000 lb of seeds/acre with no irrigation. In 2009, seed yield averaged 1,116 lb/acre and oil content averaged 44.6% with one hybrid topping 47% (Table 18). San Juan Bioenergy pays a premium for oil content over 40%, thus management practices that optimize oil concentration will increase revenue. Supplemental irrigation can boost sunflower seed yield drastically as was demonstrated in 2006 when seed yield averaged 2,210 lb/acre with 8.2 in. of gross irrigation water application (Table 23).

Safflower:

Figure 10. Dryland safflower plots in 2009

[5] "The type of polyunsaturated fat it contains is linoleic acid (an omega-6 acid) and is one of two essential fatty acids." http://www.sunflowernsa.com/

Other oilseed crops tested at the SWCRC are safflower (*Carthamus tinctorius* L.), canola (*Brassica napa* L.), brown mustard (*Brassica* juncea L.) and camelina (*Camelina sativa* (L.) Crantz). Safflower is one of the oldest cultivated crops. It has been used for coloring and flavoring foods, for making red (carthanin) and yellow dye, and as bird seed, among other things http://en.wikipedia.org/wiki/Safflower). In recent times, safflower has been grown mainly for edible oil production. Safflower oil is either 'oleic' or 'linoleic'. Oleic oils are high in monounsaturated fatty acids (C18:1) while linoleic oils are high in polyunsaturated fatty acids (C18:2). The predominant safflower edible oil market is for oleic oil.

Dryland safflower variety performance trials at the SWCRC in 2008 and 2009 averaged 1,020 lb of seeds/acre and 36% (2008) and 40% (2009) oil content (Tables 26 & 27). Both years had below the long-term average precipitation at Yellow Jacket of 15.6 inches. In 2005, which had 15.7 in. of precipitation and a longer than average growing season, seed yields ranged from 1337 to 1869 lb/acre and oil concentrations from 35.5% to 45.6% (Table 28). Safflower is a well established crop in SW Colorado and SE Utah and like sunflower, it has a deep root system which depletes soil moisture to a greater depth than wheat or dry bean. Thus, it may not be feasible to grow safflower or sunflower in the same field more than once every three or four years (Nielson et al., 1999).

Table 17. Oil production of several crops
Source: http://www.journeytoforever.org/biodiesel_yield.html

Crop	gal oil/acre
soybean	48
linseed (flax)	51
mustard seed	61
camelina	62
safflower	83
sunflower	102
peanut	113
rapeseed	127
olive	129
castor bean	151
jojoba	194
jatropha	202
coconut	287
oil palm	635

Canola:

Canola is a registered trademark of the Canadian Canola Association and refers to cultivars of rapeseed with low erucic acid content. The Northern Plains of North Dakota and Minnesota accounted for over 90% of the one million canola acres planted in the United States in 2009. Interest in canola is moving south and east as more improved canola varieties become available (http://www.uscanola.com/). Canola oil has 60 to 65% of monounsaturated fats (oleic), 30 to 35% of polyunsaturated fats (linoleic), and 5 to 8% of saturated fats (Raymer, 2002). Some canola hybrids contain over 70% of monounsaturaed fats.

Both winter and spring canolas have performed well at the SWCRC. However, winter canola is less subject to damage by hail, insects or birds since it matures earlier. It also requires less irrigation water to maximize production since it is grown during the cooler part of the year and benefits from fall and winter precipitation. Seed yields of over 4,000 lb/acre were achieved at the SWCRC with irrigation. Oil concentration averaged 40% and 41% in 2008 and 2009, respectively (Tables 29 & 30). Typical

oil production of several crops is shown in Table 17. To convert from pounds of oil to gallons of oil for crops like canola, safflower, or sunflower multiply by 7.6 lb/gal.

Camelina:

Camelina is native of Europe where it has been grown for a long time. It has been called 'gold-of-pleasure', false flax, wild flax, linseed dodder, etc. It is a member of the mustard family which includes rapeseed, cabbage, cauliflower, radish, and turnip. Camelina is heavily branched and produces "small, pale yellow and greenish-yellow flowers with four petals. Pods are about ¼ inch long and contain numerous seeds" (Putnam et al., 1993). The seeds are "pale yellow brown, oblong, rough, with a rigid surface." Camelina seeds contain 30 to 40% oil by weight (Pilgeram et al., 2007). The 2009 dryland camelina variety trial at Yellow Jacket averaged only 25% oil content (Table 35). McVay and Lamb (2008) reported an average composition of camelina oil of 64% polyunsaturated, 30% monounsaturated, and 6% saturated fatty acids. More importantly, camelina oil contains 35 to 39% of omega-3 fatty acid (C18:3) or Alpha-Linolenic-Acid (ALA) (Pilgeram et al., 2007). Omega-3 and omega-6 (Linoleic-Acid) are called 'essential fatty acids' because the human body cannot make them from other fatty acids (http://www.scientificpsychic.com/fitness/fattyacids1.html). Elevated amounts of omega-6 and very high omega-6 to omega-3 ratios have been linked to cancer, and to cardiovascular and inflammatory diseases. For example, omega-3 helps reduce inflammation while omega-6 tends to promote it.

Figure 11. Irrigated camelina in 2008. Spring canola in the distance

There are several potential markets/uses for camelina products (McVay and Lamb, 2008). Camelina oil (or seeds) can be used as an additive in a variety of food products (bread, baked foods, spreads, etc.) to enhance their nutritional value and health benefits. Tests have shown that biodiesel made from camelina oil performed similarly to biodiesel made from other oilseed crops such as soybean. Camelina oil can be converted to a wax ester and used in industrial and cosmetic products. The gum that coats the seed can be removed and utilized to coat the seeds of other crops to improve germination or as a soil

amendment to control erosion. Camelina seeds can also be used as bird feed or to supplement the rations of poultry, dairy goats, beef, fish, etc. The byproduct of oil extraction, camelina meal, contains 10 to 14% oil and 40% protein, which makes it competitive with soybean meal.

Camelina is a relatively new crop in the United States; hence there has not been a lot of research about its performance, adaptation, and best management practices. Montana State University has one of the few camelina breeding programs worldwide. Most of the camelina in the US is grown in Montana where the Great Plains Oil & Exploration company ('The Camelina Company') is located. Great Plains is "a renewable fuels energy company founded with the purpose of manufacturing and marketing biodiesel produced from camelina." (https://www.camelinacompany.com/Default.aspx)

Non-irrigated camelina averaged 332 to almost 1700 lb seed/acre at five locations in Montana in 2005 and 2006 (MacVay and Lamb, 2008). Seed oil content averaged 32%. Optimum seeding date at Cresson, Montana was mid-March. The 2009 dryland camelina variety trial at Yellow Jacket averaged 531 lb/acre and 25% oil content (Table 35). The irrigated trial in 2008 averaged 2002 lb/acre (Table 37). Seeding rate should be around 7 lb seed/acre to ensure a good stand, although one pound of camelina contains as many as 400,000 seeds. Because camelina seeds are very small, they should not be planted more than ¼ in. below the soil surface. The small size and light weight of camelina seeds increases the potential for harvest losses. The combine should be adjusted accordingly and holes in the combine and the shipping container should be plugged. There is the potential (varies with varieties) for pod shatter as was the case in 2009 at Yellow Jacket due to a hail storm and extensive bird feeding.

Camelina's short growing season (85-100 days) and relatively low water and nutrient requirements make it a good candidate as an alternative crop in dryland cropping systems. Currently there is no market for camelina and canola in SW Colorado.

Materials and methods:

All the field trials in this report were conducted at the Southwestern Colorado Research Center in Yellow Jacket, CO. The treatments were arranged in randomized complete blocks. The number of replications was four for the canola and safflower trials and three for the camelina and sunflower trials. The plot size of the irrigated canola trials was 5 ft. by 40 ft. That of the safflower trials was 6 ft. by 40 ft. Camelina plot size was 5 ft. by 30 ft. in 2008 and 5 ft. by 20 ft in 2009. Plot size of the sunflower trials varied from year to year. Plot length was at least 100 ft. (2006) and as much as 1300 ft (2007 and 2008). Plot width varied from two 30-in rows to eight 30-in rows, depending on the number of entries. In 2009, sunflower plot size was 10 ft. (4 rows) by 170 ft.

Camelina, canola, and safflower plots were planted with a Kincaid spinner planter with double disks and harvested with a Hege plot combine. The sunflower plots were planted with a Monosem pneumatic planter equipped with double disk openers and harvested with a JD 4420 combine equipped with "a wheat platform (reel removed) and attached sunflower pans (Fig. 12). The seeds from the irrigated or long plots were augured into a grain trailer and weighed on a truck scale at a local warehouse. In 2008, the seeds from each plot were augured into a weigh wagon and weighed. Plots from the dryland or shorter plots (e.g., in 2006 and 2009) were captured in a plastic container (Fig. 13) as the seed was augured into the grain bin and weighed on an electronic scale. Only the two middle rows were harvested and weighed in 2009. More information about each trial is posted under the table of results.

Figure 12. JD 4420 wheat head equipped with sunflower pans

Discussion:

Some of the challenges we had growing sunflowers included:

1. Achieving a uniform stand even when soil moisture at planting was adequate. Skips and doubles were not uncommon and may be related to seed size and shape, tractor or PTO speed, planting depth (skips), and soil condition. Some of the skips were due to seeds that did not germinate, seedlings that could not make it to the soil surface, or to damage by insects. The lack of germination was often due to the lack of good contact between the seed and the soil. In 2008 for example, we noticed that the 'walls' created by the disk openers (the seedbed was fairly moist) hardened after the soil dried out and left a void or trench, which inhibited seed germination (poor contact with the soil) or

Figure 13. Capturing sunflower seeds in a plastic container

emergence (compacted soil). In 2010, we purchased the so-called 'Posi Close Planter Wheels' (http://www.schlagel.net/Posi%20Close.htm) which we will attach to the Monosem Planter units to close the seeding trench created by the double disk openers and hopefully achieve better soil-seed contact than if we only rely on the rubber press wheel to firm up the soil behind the furrow opener.

2. A way to harvest the plots quickly and efficiently since we do not have a plot combine for row crops. Because of the size of our combine, JD 4420, we tried plots with various lengths (100 to 1300 ft.) and we either augured the seeds into a grain trailer (weigh wagon in 2008) or collected the seeds into a 'trash' can or bag and weighed them with an electronic scale. This takes up a lot of space, time, and effort, and limits how many sunflower plots/trials we can have each year. It also makes it difficult to have or to harvest border rows separately, which we did anyhow in 2009. Recently, we built a 20 in. by 24 in. by 14 in. deep box, which we will install in the grain bin of the JD 4420 combine to catch and weigh sunflower seeds from future research plots.

Figure 14. Deer damage to the sunflower heads in 2009. The edges of the field were sprayed with PlantSkydd (dried blood) earlier.

3. Damage from birds, and particularly deer or elk (Fig. 14) can be substantial in some years, especially if the sunflower plots are isolated, i.e., there are no other sunflower fields close by. We have tried several tools to scare off (propane canon) or keep the elk and deer away (sprays such as LiquidFence or

Figure 15. Sideroll stuck in spring canola in 2008

PlantSkydd), with mixed results. Allowing hunters access to the sunflower fields, in coordination with the Colorado Division of Wildlife, helps reduce damage from large game.

4. Irrigating sunflowers and also canola (tall crops) with siderolls. Siderolls are the main irrigation water delivery tool at the research center. When the crop gets taller than where the water pipe sits on the sideroll wheel (approximately 38" above the ground), we cannot move the sideroll through it without causing extensive damage to the sideroll or the crop (Fig. 15). The early termination of irrigation can severally impact crop yield, especially since it usually occurs prior to flowering. The 'limited-irrigation' label in this report refers to oilseed crops that were irrigated with siderolls and not to any targeted or deficit irrigation strategy.

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Sunflower Variety Performance Trials at Yellow Jacket, Colorado

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Table 18. Results of the 2009 Dryland Sunflower Variety Performance Trial

Company	Hybrid[1]	Oil Type[2]	Seed Yield[3]	Oil Content[3]	Seed Moisture	Test Weight	Plant Height	Stand	50% Flowering	Lodging	Deer & Elk Damage	Bird Damage
			lb/ac	%	%	lb/bu	in	plants/ac	date	%	%	%
Pioneer	**63M91**	NuSun	1387	46.0	5.4	31.1	50.7	13184	9-Aug	0.0	1.7	2.3
Mycogen	**8N453DM**	NuSun	1348	46.6	5.7	33.4	41.0	13765	10-Aug	0.0	0.0	1.7
Mycogen	**8H449DM**	HO	1259	47.3	5.8	32.9	47.0	12952	10-Aug	1.7	1.7	5.3
Triumph	**657**	NuSun	1246	46.6	5.6	29.1	49.4	10861	12-Aug	3.3	0.0	11.3
Pioneer	**MH6640**	NuSun	1226	44.4	5.5	30.9	43.9	13126	10-Aug	3.3	2.3	1.0
Mycogen	**8N510**	NuSun	1191	42.5	5.7	30.2	40.0	14172	11-Aug	0.0	0.0	1.7
Triumph	**s878HO**	HO	1171	43.9	5.9	31.7	36.9	10745	14-Aug	0.0	4.3	4.3
Triumph	**664**	NuSun	1160	44.4	5.7	29.9	48.0	10571	12-Aug	0.7	0.7	3.3
Dekalb	**37-31**	NuSun	1154	44.1	5.5	31.8	46.2	11500	10-Aug	2.3	7.0	2.7
Triumph	**820HO**	HO	1104	45.4	5.3	31.5	45.9	13707	5-Aug	2.3	1.7	10.7
Mycogen	**8N187**	NuSun	1099	42.4	5.5	29.9	38.9	11848	9-Aug	0.0	4.3	9.3
Mycogen	**8N433DM**	NuSun	1098	45.8	5.5	29.8	43.7	12894	8-Aug	0.7	0.0	2.0
Pioneer	**64H41**	HO	1032	42.9	5.6	30.4	50.3	12197	10-Aug	0.0	0.0	6.0
Triumph	**s671**	NuSun	1027	45.1	5.4	32.4	30.8	12661	13-Aug	1.7	4.7	8.0
Mycogen	**8H419CL**	HO	1002	42.6	5.7	29.3	41.4	11790	10-Aug	3.3	2.7	2.0
Triumph	**845HO**	HO	996	44.7	5.7	28.8	42.2	11326	10-Aug	1.7	0.3	0.7
Mycogen	**8H288CLDM**	HO	952	44.8	5.4	31.0	43.4	10512	6-Aug	5.0	2.0	7.7
Triumph	**s655**	NuSun	637	44.2	5.5	31.4	32.3	11442	13-Aug	0.0	19.3	16.3
	Average		**1116**	**44.6**	**5.6**	**30.9**	**42.9**	**12181**		**1.4**	**2.9**	**5.4**
	CV (%)		**11**	**1.6**	**2.3**	**2.2**	**3.6**	**11**				
	$LSD_{0.05}$		**211**	**1.2**	**0.2**	**1.1**	**3.3**					

[1] CL = Clearfield herbicide resistant; DM = Downy mildew resistant

[2] NS = NuSun (mid-oleic); HO = High-oleic
[3] Seed and oil yields adjusted to 10% moisture

Trial Information:

Planted:	June 2, 2009
Harvested:	November 4 & 5, 2009
Seeding rate:	Target: 15,488 seeds/ac (13.5" seed spacing on 30-in rows)
Previous crop:	Summer fallow
Soil type:	Wetherill silty clay loam
Tillage:	Fall moldboard plowed/disked/field cultivator
	Row cultivation on July 7, 2009
Fertilizer:	50 lb N/ac + 20 lb P_2O_5/ac on May 1, 2009
Soil test (0-18 in):	Nitrate-N: 7 ppm, Mehlich-3 P: 29.6 ppm, pH: 7.1, OM: 0.9%
Herbicide:	Sonalan PPI @ 2.0 pt/ac on May 6, 2009
Deer repellant:	PlantSkydd on July 17, August 4, and August 18, 2009
Precipitation:	3.3 in (Jun-Oct) or 43% of normal

Comments:

1. Season precipitation was well below average but good soil moisture at planting helped achieve decent seed yields. Seed oil concentration was exceptionally high.
2. Triumph hybrid s655, a short stature hybrid, incurred substantial deer, elk, and bird damage.

Table 19. Results of the 2008 Dryland Sunflower Variety Performance Trial

Entry Name[1]	Oil Type[1]	Seed Yield[2] (lb/ac)	Oil Content[2] (%)	Moisture (%)	Test Weight (lb/bu)	Height (in.)	Plants/ac	50% Heading Date
Monsanto MH7633	NuSun	1873	37.5	6.2	32.5	53.5	14099	8/11
Triumph R657	NuSun	1843	40.5	6.1	28.3	55.5	14927	8/13
DeKalb DKF37-31 NS	NuSun	1761	39.0	5.7	32.2	50.0	12749	8/16
Garst 4596HO	HO	1741	36.2	6.5	32.7	54.5	13155	8/13
DeKalb DKF 4-33 NS/DM	NuSun	1726	40.9	5.8	32.6	49.5	13809	8/13
DeKalb DKF38-45 NS	NuSun	1628	40.5	6.2	31.8	50.0	11805	8/13
Garst 521	NuSun	1549	35.7	6.2	31.0	48.5	15246	8/09
Croplan 3080 DMR, NS	NuSun	1545	39.8	6.0	31.2	47.0	14636	8/09
DeKalb DKF29-30 NS/DM	NuSun	1525	37.9	6.2	28.8	52.0	13431	8/09
Mycogen 8H449DM	HO	1500	38.9	5.7	34.5	53.0	13329	8/13
Mycogen 8H350DM	HO	1481	38.7	6.9	31.0	51.5	14535	8/11
Mycogen 8N510	NuSun	1467	36.4	5.7	30.5	47.5	16016	8/13
Mycogen 8N358CL	NuSun	1458	39.4	6.5	31.3	46.5	15072	8/13
Garst 454	NuSun	1457	38.5	7.0	31.9	54.5	13591	8/13
Triumph 658	NuSun	1455	37.9	5.8	27.9	53.5	9598	8/13
Triumph 820	HO	1455	40.3	5.6	32.5	49.5	15478	8/09
Monsanto MH6640	NuSun	1447	39.5	5.7	32.2	46.5	14810	8/13
Pioneer 63M91	NuSun	1423	39.9	6.1	31.7	57.0	15217	8/11
Triumph s678	NuSun	1392	39.0	6.7	32.8	40.5	15536	8/18
Croplan 369 DMR,NS	NuSun	1388	40.1	5.8	30.3	51.0	20226	8/13
Mycogen 8N337DM	NuSun	1375	41.9	5.5	32.6	49.5	15841	8/11
Garst 450	NuSun	1374	39.1	5.7	32.0	42.5	17105	8/13
Pioneer 63M80	NuSun	1334	39.4	5.7	31.4	56.5	14128	8/09
Monsanto MH6643	NuSun	1334	38.3	6.5	30.1	52.5	14709	8/11

Entry Name[1]	Oil Type[1]	Seed Yield[2] (lb/ac)	Oil Content[2] (%)	Moisture (%)	Test Weight (lb/bu)	Height (in.)	Plants/ac	50% Heading Date
Pioneer 63N82 (ExpressSun)	NuSun	1333	37.4	5.6	30.9	56.5	17366	8/11
DeKalb DKF39-80 CL	NuSun	1305	35.2	6.4	29.1	55.5	12995	8/13
Triumph s672	NuSun	1301	38.9	6.4	31.7	29.5	13736	8/15
Seeds 2000 Blazer CL	NuSun	1282	35.7	6.5	31.4	50.5	14520	8/13
Mycogen 8N270	NuSun	1281	37.1	5.7	29.8	41.5	14346	8/09
Croplan 378 DMR, HO	HO	1264	34.6	7.1	28.5	51.5	13910	8/13
Advanta F30294 NS, Rust	NuSun	1245	37.4	5.9	30.9	54.5	15870	8/13
Seeds 2000 Sierra	HO	1198	31.4	6.5	27.8	48.0	17511	8/15
Triumph 636	NuSun	1196	40.7	6.2	27.8	49.0	12269	8/13
Garst 4651NS	NuSun	1191	35.7	6.0	28.6	52.5	13765	8/13
DeKalb DKF34-80 NS/DM	NuSun	1164	37.6	5.8	28.9	52.5	12821	8/11
Triumph s675	NuSun	1149	39.0	5.7	32.0	32.5	15696	8/18
Triumph 859CL	HO	1127	34.6	6.6	30.7	54.5	18266	8/18
Dekalb IS 7120 HO/DM	HO	1122	37.2	5.7	29.9	50.5	13663	8/11
Pioneer 64H41	HO	1104	35.8	6.7	32.5	56.5	16669	8/13
Advanta F30008 NS, CL	NuSun	1089	34.7	6.4	29.3	51.0	13373	8/13
Garst 4704 NS	NuSun	1043	35.2	6.8	29.3	47.0	14389	8/09
Mycogen 8N453DM	NuSun	1042	41.7	6.2	35.3	51.5	11979	8/11
Advanta F10046 HO	HO	1032	36.3	5.9	30.6	50.5	10890	8/13
Triumph 845	HO	883	38.0	6.1	28.3	48.5	14999	8/13
Garst 4668 NS/CL	NuSun	851	33.8	5.8	28.6	52.5	13155	8/13
Mean		**1350**	**37.9**	**6.1**	**30.8**	**50.0**	**14472**	
CV (%)		**18**	**-**	**9.3**	**1.6**	**3.3**	**9**	
$LSD_{0.05}$		**491**	**-**	**1.1**	**1.0**	**3.3**	**2648**	

[1] NS = NuSun (mid-oleic); HO: High-oleic, CL = Clearfield; DM or DMR = Downy mildew resistant; IS: Interstate

[2] Seed and oil yields adjusted to 10% moisture

Trial Information:

Planted: June 3, 4, and 6, 2008
Harvested: November 13 thru November 19, 2008
Seeding rate: Target: 17,280 seeds/ac (12.1 inch seed spacing on 30-in. rows)
Previous crop: 2007: oats; 2006: pinto beans
Soil type: Wetherill silty clay loam
Tillage: Fall 2007 moldboard plowed; field cultivated on July 13, 2008
Fertilizer: 50 lb N/ac
Herbicide: Sonalan PPI @ 2.0 pt/ac
Precipitation (rain + snow)
Jan.-May: 4.1 in. (approximate)
June-Oct.: 5.0 in.

Comments:

1. Seed yield averaged 1350 lb/ac with a large spread between the lowest (851 lb/ac) and the highest yield (1873 lb/ac). Above average precipitation in the winter and spring helped fill the root zone, thus soil moisture at planting was good to excellent. Rainfall during the growing season was below average except August which received 2.2 in.
2. Oil concentration ranged from 31 to 42 % with an average of 38 %.
3. Plant population was below what would be expected based on the seeding rate. The gaps in the sunflower stand were caused by poor germination, which was due to poor contact between the seed and the soil. Better seed-soil contact and a better stand may have been achieved by harrowing the soil shortly after (or during) planting. This would have helped fill the narrow gap created by the planter shoe since the soil was fairly moist at planting.
4. The 2008 sunflower crop was relatively healthy plus there was little damage from game animals such as deer and elk, which may have been partly due to aerial spraying (once) the field edge with LiquidFence. LiquidFence contains rotten eggs and garlic extracts.
5. There was some loss of seeds due to bird feeding.

Table 20. Results of the 2008 Limited-Irrigation High Oleic Sunflower Variety Performance Trial

Entry Name[1]	Oil Type	Seed Yield[2] (lb/acre)	Oil Content[2] (%)	Test Weight (lb/bu)	Moisture (%)	Height (in)	Plants/Acre	50% Heading Date
Garst 4596HO	High Oleic	1836	35.5	32.0	5.6	63.3	14898	8/14
Triumph 820 HO	High Oleic	1742	38.1	31.3	5.2	57.0	19617	8/09
Pioneer 63M80	NuSun	1621	38.7	30.9	5.3	65.3	17061	8/13
DeKalb IS 7120 HO/DM	High Oleic	1610	35.4	29.5	5.4	56.7	13562	8/13
Mycogen 8H449 DM, HO	High Oleic	1605	40.1	35.8	5.4	68.7	17017	8/17
Mycogen 8H350 DM, HO	High Oleic	1548	38.3	31.0	5.4	62.0	13852	8/13
Garst 4651NS	NuSun	1519	34.4	27.8	5.6	67.0	16219	8/16
DeKalb DKF38-45 NS	NuSun	1514	38.3	31.6	5.3	53.7	16074	8/15
Pioneer 64H41	High Oleic	1447	35.1	31.9	5.5	68.0	17453	8/15
Croplan 378 DMR, HO	High Oleic	1430	33.1	27.1	5.7	67.3	16524	8/18
Triumph 636	NuSun	1308	38.5	28.5	5.3	64.3	14999	8/16
Advanta F10046 HO	High Oleic	1249	36.6	32.2	5.6	58.0	14927	8/16
Triumph 845 HO	High Oleic	1164	37.8	27.3	5.6	64.3	18702	8/18
Seeds 2000 Sierra HO	High Oleic	1054	32.0	27.8	5.8	60.3	15972	8/20
Triumph 859 HO, CL	High Oleic	859	33.9	30.5	5.6	66.3	18876	8/20
Mean		**1434**	**36.4**	**30.3**	**5.5**	**62.8**	**16383**	
$LSD_{0.05}$		**265**	**-**	**1.1**	**0.1**	**3.8**	**3057**	
CV (%)		**11**	**-**	**2.2**	**1.6**	**3.6**	**11**	

[1] NS = NuSun (mid-oleic), CL = Clearfield, DM or DMR = Downy mildew resistant, HO = High-oleic

[2] Seed and oil yields adjusted to 10% moisture

Trial Information:

Planted: June 9, 2008
Harvested: November 20, 2008
Seeding rate: Target: 25,344 seeds/ac (8.25 inch spacing on 30-in. rows)

Previous crop: Alfalfa
Tillage: Spring moldboard plowed / field cultivator / roller harrow
Fertilizer: 50 lb N/ac
Herbicide: Sonalan PPI @ 2.0 pt/ac
Irrigation: 7.8 inches (including 2.2 inches preplant) wheel-line
Precipitation (rain + snow)
Jan.-May: 4.1 in. (approximate)
June-Oct.: 5.0 in.
Soil type: Wetherill silty clay loam

Comments:

1. Seed yield averaged 1434 lb/acre (859 to 1836 lb/ac), which was below the average achieved in 2007 (2232 lb/ac) with limited irrigation and only slightly higher than the average of the 2008 dryland variety trial. There was a good reserve of water in the soil profile at planting due to a pre-plant irrigation application and above normal precipitation in the winter and spring of 2007-2008. This, along with two more irrigations, caused rapid vegetative growth. No more irrigation water was applied after late July due to the fact that some hybrids were taller than the sideroll. This caused severe water stress at a time when sunflower needed water the most e.g., during flowering and grain fill.
2. Oil concentration ranged from 32 to 40 % with an average of 36 %.
3. Plant population was much below what would be expected based on the seeding rate of 25,344 seeds/ac. The gaps in the sunflower stand were caused by poor germination, which was due to poor contact between the seed and the soil. Better seed-soil contact and a better stand may have been achieved by harrowing the soil shortly after (or during) planting. This would have helped fill the narrow gap created by the planter shoe since the soil was fairly moist at planting.
4. The 2008 sunflower crop was relatively healthy plus there was little damage from game animals such as deer and elk, which may have been partly due to aerial spraying (once) of the field edge with LiquidFence. LiquidFence contains rotten eggs and garlic extracts.
5. There was some loss of seeds due to bird feeding.

Table 21. Results of the 2007 Limited-Irrigation Sunflower Performance Trial[1]

Entry[2]	Yield[3] (lb/ac)	Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	Plant Density (plants/ac)	Oil Content[3] (%)
Triumph 658 NuSun	2663	7.3	26.2	70	12807	41.7
Croplan Genetics 356NS	2459	7.5	29.7	65	13387	40.5
Triumph 665 NuSun	2454	7.5	28.5	72	14898	40.9
Triumph 636 NuSun	2416	7.3	27.3	67	11616	41.8
Dekalb DKF38-45 NS	2362	6.2	29.7	57	11935	42.5
Dekalb DKF35-10 NS	2249	7.7	29.7	63	12574	36.6
Triumph s672 NuSun	2224	6.6	28.7	36	16204	42.6
Croplan Genetics 3080DMR,NS	2099	5.7	28.2	62	12865	41.9
Triumph s678 NuSun	2071	8.5	29.5	52	13910	41.8
Croplan Genetics 378DMR,NS	2031	10.6	24.2	66	11732	34.5
Dekalb DKF37-31 NS	1523	8.9	28.0	52	6534	37.8
Average	**2232**	**7.6**	**28.1**			**40.2**
CV (%)	**9.0**					
$LSD_{0.05}$	**341**					

[1] Plot size—1st replication: 8 rows (20 ft.), 2nd and 3rd replications: 4 rows (10 ft). The length of each plot was 1,300 ft.

[2] NS: Nu Sun, DMR: Downy mildew resistant

[3] Yield and oil content are reported at 10% moisture.

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Spring grains; two-years ago: dry beans
Seeding rate:	Target: 22,000 seeds/ac (9.5-in seed spacing on 30-in rows)
Planted:	June 7, 2007
Harvested:	October 28, 2007
Planter:	Monosem pneumatic (furrow openers, double-disk openers)
Tillage:	Spring moldboard plowed; field cultivator; roller harrow; tine harrow
Fertilizer:	32 lb N/ac (urea) broadcast May 30, 2007
Herbicide:	Trifluralin 1.33 pt/ac incorporated June 4, 2007
Insecticide:	Warrior 3.0 oz/ac - sunflower moth/banded sunflower moth August 10, 2007
Row cultivation:	July 13, 2007
Irrigation:	11.5 inches (5 passes wheel-line sprinkler)

Precipitation: October 1, 2006 thru September 30, 2007: 14.8 inches
(long-term average 15.9 inches)

Comments:

Total precipitation received for the 12 months prior to harvest was 14.8 in (93% of the long-term average). Irrigation water was applied thru a wheel-line sprinkler system. Irrigation water applied preplant was 2.25 in. with an additional 9.25 in. applied prior to the start of flowering. Sunflower plant height prevented further irrigation with the wheel-line during the reproductive stage. At the start of flowering, the field received 1.0 in. of rain. Entering the reproductive stage, soil moisture was near field capacity.

Average seed yield was 2,232 lb/ac and average oil content 40.2%. The sunflowers were at physiological maturity when the first fall freeze occurred on Sept. 30 (27.1°F). None of the entries lodged nor was there any significant wildlife damage. Triumph s678 was infected with white mold head rot. Sclerotia were easily seen in the combine bin at harvest. This field has a history of white mold disease in dry beans. White mold was not observed in any of the other sunflower entries.

Sunflower head moth and banded sunflower moth activity was monitored with pheromone traps. The number of sunflower head moths captured was above the economic threshold (4 or more moths per night) at the start of flowering (reproductive stage R-5). The field was aerially sprayed for the moths on August 10 (R-5). Bee activity was still low at this stage when the field was treated.

Table 22. Results of the 2006 Dryland Oil Sunflower Variety Performance Trial[1]

Entry[2]	Type	Yield[3] lb/ac	Moisture %	Test Weight lb/bu	50% Flowering date	Plant Height in	Oil Content[2] %
Garst 454	Mid-Oleic	544	5.6	32.5	8/9	32	38.5
Garst 4420NS	Mid-Oleic	519	5.6	32.5	8/9	35	39.3
Dekalb DKF35-10 NS	Mid-Oleic	473	5.6	31.0	8/3	34	34.5
Triumph 636 NuSun™	Mid-Oleic	468	5.5	31.5	8/9	30	39.6
Dekalb DKF38-30 NS	Mid-Oleic	459	5.5	32.5	8/9	32	37.1
Croplan Genetics 356NS	Mid-Oleic	458	5.3	33.0	8/6	30	41.3
Garst 521	Mid-Oleic	447	5.5	33.0	8/3	34	37.9
Croplan Genetics 378DMR	High Oleic	441	5.7	28.5	8/9	32	36.0
Triumph 545A	Traditional	432	5.4	33.0	8/6	30	41.5
Garst 4651NS	Mid-Oleic	410	5.6	31.5	8/9	36	38.4
Garst 4665HO	High Oleic	405	5.7	33.0	8/3	31	34.8
Garst 4668NS/CL	Mid-Oleic	386	5.6	32.0	8/9	33	37.0
Triumph 820HO	High-Oleic	382	5.5	32.0	8/3	35	36.5
Croplan Genetics 308NS	Mid-Oleic	381	5.5	34.0	8/3	32	40.3
Dekalb DKF37-31 NS	Mid-Oleic	380	5.6	32.5	8/6	30	37.5
Garst 4704NS	Mid-Oleic	349	5.7	29.5	8/6	32	34.7
Average		**433**	**5.6**	**32.0**			**37.8**
CV%		**20.5**					
$LSD_{(0.05)}$		**NS**[4]					

[1] Plot size: 2 rows (5 ft.) wide by 100 to 200 ft. long

[2] NS: Nu Sun, HO: High-Oleic, CL: Clearfied herbicide resistant, DMR: Downy mildew resistant

[3] Yield and oil content are reported at 10% moisture.

[4] Not significant (yields are not statistically different)

Site Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Winter wheat
Planted:	May 31, 2006
Seeding rate:	Target: 15,042 seeds/ac (13.9-in seed spacing on 30-inch rows)
Planter:	Monosem Pneumatic (furrow openers and double-disk seed openers)
Harvested:	November 7, 2006
Tillage:	Fall moldboard plowed; field cultivator in spring 2006
Fertilizer:	50 lb N/ac (urea) broadcast May 10, 2006
Herbicide:	Trifluralin 1.33 pt/ac incorporated May 4, 2006
Row cultivation:	July 18, 2006
Precipitation:	October 1, 2005 thru September 30, 2006: 10.6 inches (long-term average 15.9 inches)

Table 23. Results of the 2006 Irrigated Oil Sunflower Variety Performance Trial[1]

Entry[2]	Type	Yield[3] (lb/ac)	Oil Content[3] (%)	Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	50% Flowering date
Triumph 636 NuSun™	Mid-Oleic	2494	40.1	8.0	25.0	56	8/11
Garst 4651NS	Mid-Oleic	2383	34.5	11.4	25.5	57	8/09
Croplan Genetics 356NS	Mid-Oleic	2342	38.8	8.4	30.0	52	8/11
Croplan Genetics 378DMR	High Oleic	2310	34.8	11.3	24.5	56	8/09
Triumph 545A	Traditional	2274	44.4	5.8	31.0	66	8/06
Dekalb DKF38-30 NS	Mid-Oleic	2271	38.4	9.3	29.8	56	8/11
Garst 4420NS	Mid-Oleic	2195	38.2	9.7	28.5	66	8/14
Triumph 820HO	High Oleic	2100	41.0	6.1	32.0	48	8/02
Dekalb DKF37-31 NS	Mid-Oleic	2070	38.0	7.3	28.5	48	8/09
Dekalb DKF35-10 NS	Mid-Oleic	2007	35.4	8.6	29.0	54	8/09
Garst 8048	Confection	1865	--	12.1	23.0	58	8/06
Average		**2210**	**38.3**	**8.9**	**27.9**		
CV (%)		**7.3**					
$LSD_{0.05}$		**274**					

[1] Plot size: Four rows (two rows in the third replication) for each entry. The length of each plot varied from 530 ft. to 600 ft. depending on the curvature of the outside wheel track of the center pivot.

[2] NS: Nu Sun, HO: High-Oleic, DMR: Downy mildew resistant

[3] Yield and oil content are reported at 10% moisture

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Canola; two-years ago: dry beans
Seeding rate:	Target: 19,008 seeds/ac (11-in seed spacing on 30-in rows)
Planted:	June 5, 2006
Harvested:	November 3, 2006
Planter:	Monosem pneumatic (furrow openers, double-disk seed openers)
Tillage:	Fall moldboard plowed; field cultivator in spring 2006
Fertilizer:	40 lb N/ac broadcast May 29, 2006
Herbicide:	Trifluralin 1.33 pt/ac incorporated June 1, 2006
Row cultivation:	July 17, 2006
Irrigation:	8.25 in center pivot
Precipitation:	October 1, 2005 thru September 30, 2006: 10.6 in (long-term average 15.9 in)

Overview of the 2006 Sunflower Variety Trials

The dryland trial (Table 22) yielded 433 lb/ac with an average oil content of 37.8%. Soil moisture was the limiting factor for yield. Total precipitation received for the 12 months prior to harvest was 10.6 inches (67% of the long-term average). The previous crop was winter wheat which depleted the soil moisture profile. Due to a very dry winter and spring, dry soil conditions at planting resulted in erratic seedling emergence. The sunflowers also incurred significant wildlife damage (birds, deer, and rabbits). The erratic stand and wildlife damage resulted in a high CV% (measure of variability) for the trial. None of the entries lodged and no disease or insect damage was observed.

The irrigated trial (Table 23) yielded 2,210 lb/ac with an average oil content of 38.3%. The cause of the relatively low oil content (less than 40%) is not clear. Low soil moisture may have played a role. Total irrigation water applied through the center pivot was 8.25 in. with 1.5 in. applied prior to planting. The field also had a heavy infestation of volunteer canola which competed for soil moisture. The first fall freeze occurred on Sept. 17 and may have prevented the sunflower plants from completing physiological maturity.

In the irrigated trial, none of the entries lodged nor was there any wildlife damage. The Garst 8048 confection entry exhibited heat stress/sun scald (leaf blotches) in mid-July but the plants quickly recovered. Triumph 820HO was infected with white mold head rot. Sclerotia were readily seen in the combine bin at harvest. This variety headed in early August the same time that an adjacent dry bean field with a history of white mold was flowering. The field had also previously been planted to canola and dry beans which increases the risk of white mold. White mold was not observed in any of the other sunflower entries.

Table 24. Results of the 2005 Dryland Sunflower Strip Trial

Entry	Type	Yield (lb/ac)	Oil (%)	Moisture (%)	Test Wt. (bu/ac)	Plant Ht. (in)	Planting Date	Heading Date
Triumph 645	NuSun	1138	37.7	<7.0	31.0	42	5/27	8/12
Triumph s672	NuSun	1105	38.8	<7.0	35.5	36	5/27	8/12
Triumph s675	NuSun	1326	39.0	<7.0	36.0	33	5/27	8/12
Hysun 454	NuSun	1184	38.4	<7.0	36.0	50	5/27	8/12
Pioneer 63M91	NuSun	1302	38.9	<7.0	36.0	52	5/27	8/05
Triumph 620 CL	NuSun	710	33.5	<7.0	31.5	46	5/27	8/05
AgriPro AP 2098	Traditional	1432	34.1	7.1	27.0	48	6/16	8/18
Triumph 540	Traditional	1074	35.4	9.2	29.0	54	6/16	8/22
Triumph 567DW	Traditional	1305	34.3	11.1	27.0	54	6/16	8/16
Average		**1175**	**36.7**		**32.1**	**46**		

Trial Information:

Planting date: May 27, 2005 and June 16, 2005
Planting rate: Target: 17,424 seeds/ac (12-in seed spacing on 30-in rows)
Harvested: November 14-16, 2005 (1st freeze <28F occurred on Nov. 15, 2005)
Soil type: Wetherill clay loam
Previous crop: Dry beans; 2-years ago: winter wheat
Tillage: Field cultivator in spring 2005 (wet conditions prevented any fall 2004 tillage)
Fertilizer: 50 lb N/ac (urea) + 13.5 lb S/ac on April 23, 2005
Herbicide: Trifluralin 1.25 pts/ac incorporated with field cultivator (1x) followed with a roller-harrow (1x) on May 20, 2005
Precipitation: October 2004 thru September 2005: 17.8 in. (long-term average 16.0 in.)

Comments:

1. Yields are reported "as is" and not adjusted to 10% moisture.
2. Oil content is reported at 10% seed moisture.
3. Triumph 620 CL exhibited head rot (10%). No other disease or insect problems were observed.
4. Triumph 645 showed a tendency to lodge (approx. 10%). No other entries lodged.
5. The 2005 growing season had an unusual fall where the first hard freeze (<28F) did not occur until Nov. 15.
6. The first hard freeze in our area usually occurs by mid-October.
7. The late planting date (June 16) may not provide sufficient time for sunflowers to mature in a normal year. Planting in corners of the center pivot resulted in split planting dates.

Sunflower Planting Date x Seeding Rate x Hybrid Trial at Yellow Jacket, Colorado

Abdel Berrada

Table 25. Results of the 2009 Dryland Sunflower Planting Date x Seeding Rate x Hybrid Trial

Planting Date	Target Seeding Rate (seeds/ac)	Sunflower Hybrid[1]	Plant Population (plants/ac)	Seed Yield[2] (lb/ac)	Seed Yield[2,3] (lb/ac)	Oil[2,4] (%)	Plant Height[5] (in)	Moisture (%)	Test Weight (lb/bu)	Deer & Bird Damage (%)
19-May	11,000	DK38-45	9757	989	999	.	41.5	5.7	32.3	20.0
19-May	11,000	M8H449	9874	1149	1045	.	40.5	5.8	33.7	6.3
19-May	11,000	T657	7725	1195	1125	.	48.0	5.7	30.6	10.3
19-May	14,000	DK38-45	10861	853	921	.	42.5	5.6	32.3	27.0
19-May	14,000	M8H449	14346	1148	994	49.8	42.0	5.8	34.5	0.3
19-May	14,000	T657	9002	1170	1096	49.9	45.2	5.7	31.3	10.0
19-May	17,000	DK38-45	13010	920	1040	.	42.3	5.6	31.9	33.3
19-May	17,000	M8H449	16262	1118	1031	49.0	44.5	5.8	34.8	8.3
19-May	17,000	T657	12661	1165	1152	50.4	41.7	5.6	32.1	17.3
1-Jun	11,000	DK38-45	6389	768	894	.	44.0	5.9	30.8	34.0
1-Jun	11,000	M8H449	8828	1333	1188	.	38.8	6.1	32.1	1.3
1-Jun	11,000	T657	5576	1081	972	.	44.2	6.2	28.8	5.7
1-Jun	14,000	DK38-45	9583	991	1000	.	41.5	5.8	31.5	20.0
1-Jun	14,000	M8H449	11442	1176	1039	47.5	41.2	5.9	32.5	2.3
1-Jun	14,000	T657	8305	1271	1173	46.2	46.5	6.0	29.2	7.0
1-Jun	17,000	DK38-45	12371	1165	1070	.	39.8	5.8	31.3	7.3
1-Jun	17,000	M8H449	15333	1393	1262	48.1	45.8	5.9	33.3	3.0
1-Jun	17,000	T657	9002	1320	1214	47.7	47.7	5.8	29.4	6.0
12-Jun	11,000	DK38-45	5924	316	810	.	44.2	6.6	28.9	78.3

Planting Date	Target Seeding Rate (seeds/ac)	Sunflower Hybrid[1]	Plant Population (plants/ac)	Seed Yield[2] (lb/ac)	Seed Yield[2,3] (lb/ac)	Oil[2,4] (%)	Plant Height[5] (in)	Moisture (%)	Test Weight (lb/bu)	Deer & Bird Damage (%)
12-Jun	11,000	M8H449	9002	1068	964	.	39.5	7.0	30.0	6.3
12-Jun	11,000	T657	6098	903	835	.	44.9	7.3	26.9	10.7
12-Jun	14,000	DK38-45	10338	462	884	.	41.0	6.5	28.7	69.7
12-Jun	14,000	M8H449	9467	1140	1081	45.1	39.2	6.5	30.1	11.7
12-Jun	14,000	T657	10396	1157	1053	45.1	43.9	6.7	27.4	6.3
12-Jun	17,000	DK38-45	11035	364	839	.	41.0	6.2	30.4	76.0
12-Jun	17,000	M8H449	13997	1173	1097	45.1	38.7	6.4	31.1	9.7
12-Jun	17,000	T657	11326	1085	1093	45.0	47.0	6.3	27.0	19.7
		Average	**10293**	**1032**	**1032**	**47.4**	**42.8**	**6.1**	**30.9**	**18.8**
		CV (%)	**19**	**15**	**.**		**4.6**	**3.2**	**2.7**	**81.6**
Analysis of Variance[6]										
		Source	Pr > F	Pr > F	Pr > F	Pr > F	Pr > F	Pr > F	Pr > F	Pr > F
		Date	0.02	0.00	0.09	0.00	NS	0.00	0.00	0.00
		Rate	0.00	0.07	0.00	NS	NS	0.00	0.01	NS
		D x R	NS	0.07	0.07	0.09	NS	0.01	NS	NS
		Var	0.00	0.00	0.03	NS	0.00	0.00	0.00	0.00
		D x V	NS	0.00	NS	0.08	NS	NS	0.10	0.00
		R x V	NS	NS	NS	NS	0.04	NS	NS	NS
		D x R x V	NS	NS	NS	NS	0.03	NS	NS	NS

[1] DK38-45 is Dekalb 38-45 NS (NuSun), M8H449 is Mycogen 8H449DM HO (High-Oleic), T657 is Triumph 657 NS

[2] Adjusted to 10% moisture

[3] Seed yield with deer & bird damage as covariance

[4] No oil content data for DK38-45 or the low seeding rate

[5] Height at the highest point of the plant. The height of bent plants may not reflect their true height

[6] NS: Non-Significant at Pr > 0.10

Cultural Practices:

Harvested plot size:	5 ft (middle 2 rows) by 160 ft
Harvested:	November 4, 2009
Seeding rate:	Target: 15,563 seeds/ac (13.5-in seed spacing on 30-in rows)
Previous crop:	Summer fallow
Soil type:	Wetherill silty clay loam
Tillage:	Fall moldboard plowed/disked/field cultivator
	Row cultivation on July 7, 2009
Fertilizer:	50 lb N/ac + 20 lb P_2O_5/acre on May 1, 2009
Soil test (0-18"):	Nitrate-N: 7 ppm, Mehlich-3 P: 29.6 ppm, pH: 7.1, OM: 0.9%
Herbicide:	Sonalan PPI @ 2.0 pt/ac on May 6, 2009
Deer repellant:	PlantSkydd on July 17, August 4, and August 18, 2009
Rain (Jun-Oct):	3.3 inches (gross amount) or 43% of normal

Comments:

1. Summer precipitation was well below average but good soil moisture at planting helped achieve decent seed yields. Seed oil concentration was exceptionally high.
2. The latest planting date (June 12, 2009) resulted in the lowest seed yield, oil content, and test weight and the highest deer and bird damage. The hybrid Dekalb 38-45 suffered the most damage and had the lowest seed yield. Most of the damage was caused by deer and elk.
3. The final plant population was much lower than the seeding rate, particularly at the second and third planting date. Plant population averaged 82%, 68%, and 69% of the seeding rate, respectively for the 1st, 2nd, and 3rd planting date.
4. Triumph 657 had the tallest plants and the lowest test weight. Mycogen 8H449 had the highest plant population and the least damage by deer & elk.

Dryland Safflower Variety Performance Trials at Yellow Jacket, Colorado

Abdel Berrada and Mark Stack

Table 26. Results of the 2009 Dryland Safflower Variety Performance Trial

Entry	Company	Primary oil type	Seed Yield[1] (lb/ac)	Oil Content (%)[2]	Test Weight (lb/bu)	Seed Moisture (%)	Plant Height (in)	50% Bloom Julian Day
STI 01	STI[3]	?	1218	37.3	41.4	5.8	25.0	208
CW88OL	Cal/West Seeds	Oleic	1208	41.0	39.3	5.5	22.5	211
3151*	SeedTec	Oleic	1137	40.0	41.0	5.7	22.4	209
MT3538	STI	?	1109	36.9	41.7	5.9	23.8	211
7313*	SeedTec	Oleic	1063	37.8	43.4	6.6	25.1	213
CW99OL	Cal/West Seeds	Oleic	1050	41.3	39.3	5.6	24.6	209
STI 90	STI	?	997	34.0	43.1	6.1	23.0	208
CW1221	Cal/West Seeds	Linoleic	994	41.9	39.7	5.7	23.4	209
MT7446	STI	?	979	37.3	41.5	5.7	23.3	209
S-345	SeedTec	Oleic	940	41.5	39.9	5.6	25.3	210
STI 50	STI	?	923	44.6	35.8	4.9	23.6	209
3125*	SeedTec	Oleic	900	41.8	41.8	6.2	23.4	211
2106*	SeedTec	Oleic	861	42.8	40.6	5.3	21.9	207
Average			**1029**	**39.9**	**40.6**	**5.7**	**23.6**	**209**
CV (%)			**11**	**1.0**	**2.7**	**4.6**	**5.9**	**1**
$LSD_{.05}$			**161**	**0.6**	**1.5**	**0.4**	**2.0**	**2**

[1] Adjusted to 10% moisture

[2] Oil content at 0% moisture/Oil analysis courtesy of Art Weisker of SeedTec

[3] Safflower Technologies International, LLC

* Not available for sale

Trial Information:

Planted: May 7, 2009
Harvested: September 25, 2009
Seeding rate: 25 lb/ac on 12 in row spacing
Previous crop: Summer fallowed in 2007 and 2008
Fertilizer: 50 lb N/ac + 20 lb P_2O_5/ac on May 1, 2009
Herbicide: Sonalan PPI @ 2 pt/ac on May 6, 2009
Precipitation (rain + snow):
Jan.-Apr.: 1.8 in. (40% of normal)
May-Sept.: 4.5 in. (67% of normal)

Comments:

Soil moisture at planting was excellent, partly because the ground was summer fallowed for two consecutive years. Winter and spring precipitation was below average as was July and August rainfall. Seed yields were comparable to 2008. None of the entries lodged. Seed shattering was negligible. Grasshoppers were plentiful in the area but did not seem to cause much damage to safflowers.

Table 27. Results of the 2008 Dryland Safflower Variety Performance Trial

Hybrid	Company/brand	Primary Oil Type	Seed Yield[1] (lb/ac)	Oil Content[1] (%)	Test Weight (lb/bu)	Seed Moisture (%)	Plant Height (in)
STI01H	Safflower Technologies International	?	1210	33.5	41.8	6.5	19.1
CW99OL	Cal-West	Oleic	1124	37.2	41.4	5.8	20.3
S-345	SeedTec/California Oils Corp	Oleic	1069	37.5	40.5	5.9	20.3
3151	SeedTec/California Oils Corp	?	1040	35.7	41.5	6.2	18.1
CW88OL	Cal-West	Oleic	1032	36.2	41.8	5.8	17.9
S-719	SeedTec/California Oils Corp	?	1027	36.6	43.1	6.0	18.3
S-541	SeedTec/California Oils Corp	Linoleic	1017	38.3	42.0	6.1	19.6
Finch	Mountain States Oilseeds	Linoleic	934	33.7	45.3	6.2	18.8
S-344	SeedTec/California Oils Corp	Oleic	924	36.3	41.4	5.8	18.1
2106	SeedTec/California Oils Corp	?	891	37.6	40.9	5.7	18.3
STI01MT	Safflower Technologies International	?	868	33.4	43.5	6.0	17.8
	Mean		1012	36.0	42.1	6.0	18.8
	CV (%)		8.5	1.2	1.8	4.7	3.2
	LSD.05		**124**	**0.7**	**1.1**	**0.4**	**0.9**

[1] Adjusted to 10% moisture

Trial Information:

Planted: May 12, 2008
Seeding rate: 25 lb/ac (except the hybrid STI01H was planted at 15 lbs/ac) in 12” row spacing
Harvested: October 8, 2008
Previous crop: Fallowed in 2007; alfalfa in 2006
Tillage: Chisel plow in the fall of 2007 and field cultivator in the spring of 2008
Fertilizer: 48 lb N/ac April 29, 2008
Herbicide: Sonalan PPI @ 2 pt/ac

Precipitation: Jan.-Apr.: 3.4 in., May-Sept.: 4.5 in. (from rain & snow)

Comments:

1. Good soil moisture at planting
2. A lower planting rate (15 lb/ac) was recommended for hybrids by Safflower Technologies International, LLC.
3. Below average precipitation during the growing season except 2.2 in. August
4. No lodging and no noticeable disease or insect damage

Table 28. Results of the 2005 Dryland Safflower Variety Performance Trial

Entry	Source	Type	Yield (lb/ac)	Plant Height[1] (in)	Flowering Date[2] (date)	Oil (%)
S-345	SeedTec	Oleic	1869	19	8/17	41.0
S-344	SeedTec	Oleic	1581	16	8/11	40.6
Finch (bird seed)	Mountain States Oilseeds	Linoleic	1533	16	8/17	35.9
3103	SeedTec	Linoleic	1527	15	8/11	37.4
S-208	Wheatland Seed	Linoleic	1512	15	8/11	38.4
Montola 2003	Montana State University	Oleic	1476	16	8/11	38.0
Montola 2000	Montana State University	Oleic	1387	15	8/11	40.5
Nutrasaff	Montana State University	Linoleic	1367	16	8/11	45.6
3148	SeedTec	Linoleic	1337	16	8/17	35.5
Average			**1510**	**16**		**39.2**
CV (%)			**6.0**			
$LSD_{0.05}$			**133**			

[1] Plant height measured at harvest

[2] Date when 50% of the plants have flowered

Trial Information:

Soil type: Wetherill silty clay loam
Previous crop: Dry beans; two-years ago: winter wheat
Tillage: Field cultivator in spring 2005 (wet conditions prevented any fall tillage in 2004)
Seeded: May 27, 2005
Harvested: November 3, 2005
Fertilizer: 50 lbs N/ac + 13.5 lbs S/ac broadcast on April 23, 2005
Herbicide: Trifluralin 1.25 pts/ac incorporated with a field cultivator and followed with a roller-harrow to firm the seedbed
Precipitation: October 2004 thru September 2005: 17.8 in. (long-term average 16.0 inches)

Comments:

The variety trial was planted in late May due to wet field conditions that delayed spring tillage. The normal planting date is late April for safflower in southwestern Colorado. The year 2005 had an unusual fall where the first hard freeze <28°F did not occur until November 15. This late fall allowed a full-season entry such as S-345 to mature. The average yield of 1510 lb/ac for the variety trial is attributable to very good deep soil moisture at planting. The fall and winter precipitation prior to planting was above average. Trifluralin provided excellent weed control. Nutrasaff is a hulless variety from Montana State University.

National Winter Canola Variety Trials at Yellow Jacket, Colorado

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Table 29. Results of the 2009 Limited-Irrigation Winter Canola Variety Performance Trial

Entry	Seed Yield[1] (lb/ac)	Seed Oil Content (%)	Seed Moisture (%)	Plant Height (in.)	50% Flowering (date)	Fall Stand (0-10)	Winter Survival (%)	Seed Shattering (%)	Plant Lodging (%)
Sitro	4738	41.3	5.4	51.7	5-May	10.0	96.7	0.3	0.3
Safran	4486	40.6	5.2	53.0	6-May	10.0	96.0	0.3	0.0
BSX-6242	4168	39.7	5.4	52.7	5-May	10.0	97.7	0.3	0.0
Hornet	4079	41.0	5.2	57.0	7-May	9.6	95.3	0.3	0.0
Visby	3969	41.3	5.2	49.3	4-May	9.4	95.0	0.3	0.3
Dimensio	3968	44.2	5.2	51.0	4-May	9.9	96.3	1.0	0.0
Baldur	3818	40.5	5.2	53.3	4-May	9.8	95.7	0.3	0.0
BSX-6271	3770	41.1	5.2	51.3	4-May	9.9	96.0	0.3	0.3
KS3254	3732	40.6	5.3	54.7	8-May	9.7	92.0	0.3	0.0
DKW45-10	3725	38.5	5.3	47.3	5-May	9.5	94.7	0.7	0.3
HyClass1	3707	40.5	5.3	52.3	6-May	10.0	97.3	0.7	0.0
BSX-6406	3683	42.2	5.3	52.7	7-May	9.8	97.3	0.3	0.0
Flash	3680	41.2	5.4	54.7	7-May	10.0	90.0	3.3	0.0
KS4022	3647	41.5	5.2	54.3	7-May	9.7	93.3	0.3	0.0
KS4158	3632	43.5	5.2	48.3	5-May	9.4	91.7	1.0	0.0
CWH633	3586	40.7	5.2	52.7	6-May	9.7	98.0	0.7	0.0
NPZ0604	3564	40.9	5.2	49.0	4-May	9.5	99.0	3.3	0.0
KS4085	3520	40.7	5.3	55.0	7-May	9.7	96.3	2.3	0.0

Entry	Seed Yield[1]	Seed Oil Content	Seed Moisture	Plant Height	50% Flowering	Fall Stand	Winter Survival	Seed Shattering	Plant Lodging
BSX-501	3493	40.9	5.5	52.3	7-May	9.9	97.0	1.7	0.0
DKW47-15	3491	41.4	5.2	50.7	6-May	9.2	92.7	0.3	0.7
Kronos	3471	41.5	5.5	52.7	5-May	9.9	94.3	12.0	0.0
Wichita	3467	40.0	5.4	49.7	7-May	9.9	95.0	1.3	0.3
BSX-6131	3446	39.2	5.3	55.7	10-May	9.7	96.0	0.7	0.0
DKW46-15	3357	40.8	5.0	49.0	7-May	9.5	96.0	0.3	0.3
Sumner	3352	41.6	5.2	46.7	4-May	9.1	93.7	0.3	0.7
Virginia	3228	40.6	5.4	45.0	4-May	10.0	94.0	3.7	0.3
Kiowa	3131	41.1	5.2	52.3	8-May	9.8	92.0	0.7	0.3
CWH111	2946	40.8	6.8	45.7	3-May	10.0	85.0	8.7	0.3
DKW41-10	2710	39.0	5.2	41.3	3-May	9.7	92.0	0.3	4.0
Mean	**3640**	**40.9**	**5.3**	**51.1**	-	**9.7**	**94.8**	**1.6**	**0.3**
CV (%)	**14**	**3.0**	**4.5**	**5.6**	-	**3.9**	**5.4**	-	-
$LSD_{.05}$	**840**	**NS**	**0.4**	**4.6**	-	**NS**	**NS**	**NS**	

[1] Seed Yield adjusted to 9% moisture

Trial Information:

Planted: August 27, 2008 at 5.0 lb/ac on 8-in rows
Harvested: July 28, 2009
Herbicide: Trifluralin PPI @ 1.5 pt/ac
Insecticide: None
Irrigation: 12.3 in
Precipitation: 7.9 in from planting to harvest (from rain and snow)
Previous crop: Winter wheat
Fertilizer: 16 gallons of 32-0-0/ac (57 lb N/ac) in the fall
Soil type: Wetherill silty clay loam

Comments:

There was good rainfall in August 2008 and in the spring of 2009. Total planting-to-harvest precipitation from rain and snow was 7.9 in. An additional 12.3 in. was applied through a sideroll. The last application was in mid-May after which the canola crop was too tall to move the sideroll through it. There were few pest problems except for a grasshopper invasion in late June and some bird damage (mostly at the edges of the trial) close to harvest. There was little seed shattering or plant lodging except from bird damage. Fall stand and winter survival were generally excellent. Seed yields were among the highest we have had at the research center.

Reference:

2009 National Winter Canola Variety Trial. Report of Progress 1026. Kansas State University Agric. Exp. Stn. and Cooperative Extension Service. *Seed yields reported in progress report 1026 were not adjusted to 9% moisture.*

Table 30. Results of the 2008 Irrigated Winter Canola Variety Performance Trial

Entry	Seed Yield[1] (lb/ac)	Seed Oil Content (%)	Seed Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	Seed Shattering (%)
Hornet	2296	42.1	9.8	50.7	46.7	0.0
KS3254	2174	42.9	9.0	49.7	45.0	1.7
Kronos	2163	39.3	8.5	49.0	44.3	1.7
KS7436	2150	43.3	7.9	50.5	44.3	3.0
Sitro	2134	41.9	9.6	48.2	43.0	0.7
Rally	2120	40.1	12.5	48.7	46.0	0.0
DSV07102	2109	39.6	11.1	47.0	38.7	0.3
Kadore	2108	41.3	8.9	49.2	39.3	0.3
CWH095	2070	38.7	8.7	48.5	42.0	0.7
KS3074	2030	41.1	6.6	49.3	43.0	0.7
Baldur	2005	37.3	9.3	47.5	44.3	1.0
CWH630	2001	41.4	5.9	48.5	42.7	1.0
Visby	2000	41.3	8.3	48.5	39.7	0.7
CWH633	1968	38.3	7.8	47.5	44.0	1.0
CWH631	1947	40.8	8.1	47.5	41.7	1.0
Satori	1936	41.2	8.3	48.0	39.3	0.0
KS3132	1914	38.9	7.1	48.2	46.3	2.3
CWH081	1901	41.4	8.7	48.2	41.3	2.3
KS3018	1901	40.0	7.8	46.3	45.0	1.7
Hybristar	1875	39.9	11.9	47.3	39.0	0.3
KS4158	1827	41.4	8.2	48.2	41.0	0.7
Forza	1821	38.8	12.0	45.2	37.3	0.3
BSX-501	1812	38.5	7.3	45.5	42.3	0.0
ARC98007	1803	41.6	9.7	48.2	44.0	2.7
ARC98015	1790	41.3	7.9	48.0	47.7	3.0
ARC97018	1788	40.8	8.0	48.2	43.3	1.0
HyClass107W	1757	41.6	6.9	46.5	45.0	1.0
MH604001	1754	39.8	13.2	47.0	44.0	1.3
DSV07100	1726	40.8	12.8	48.0	46.3	6.7
KS9135	1717	39.1	8.3	48.2	44.7	2.3
KS4022	1687	40.6	9.0	47.5	40.3	2.3
Ceres	1683	39.7	7.9	48.7	42.3	6.0
MH903383	1672	43.4	9.3	48.3	42.0	1.3
KS3077	1671	39.0	6.8	47.0	40.3	0.7
Wichita	1658	40.3	7.7	46.5	39.0	0.7

Entry	Seed Yield[1]	Seed Oil Content	Seed Moisture	Test Weight	Plant Height	Seed Shattering
KS4085	1657	40.1	7.7	46.5	44.7	1.7
CWH116	1655	39.6	10.3	44.3	39.0	0.3
Abilene	1646	42.2	8.9	50.0	43.0	0.7
Taurus	1608	38.5	10.4	49.2	42.0	1.3
ARC2180-1	1587	43.2	12.1	48.6	42.0	1.7
CWH632	1587	37.9	6.4	44.5	40.0	1.3
DKW13-69	1565	41.5	8.8	48.7	42.3	1.0
Sumner	1544	38.3	6.1	44.2	39.7	0.0
DSV07101	1535	41.2	10.6	45.7	41.7	2.7
KS3302	1509	37.6	7.1	47.5	44.0	0.3
ARC97019	1461	41.5	10.5	47.2	46.3	5.3
NPZ0791RR	1460	40.3	10.1	46.2	40.0	4.7
CWH688	1437	38.3	10.5	46.8	39.3	0.7
CWH686	1413	37.6	8.7	46.0	37.0	2.0
BSX-567	1370	37.8	7.4	46.8	42.0	0.7
Flash	1345	43.0	18.0	47.3	43.3	0.3
NPZ0391RR	1324	39.7	10.9	45.3	39.3	0.7
CWH687	1319	38.6	11.6	45.3	37.3	1.0
Virginia	1295	37.1	12.1	43.0	35.7	0.3
CWH111	1253	36.8	16.8	40.3	38.7	0.0
Plainsman	718	39.5	11.9	47.3	47.0	10.7
Jetton	683	36.9	11.7	46.0	44.0	10.7
Mean	**1721**	40.1	**9.5**	**47.3**	**42.2**	**1.7**
CV (%)	**19**	**NS**	**20.6**	**4.2**	**7.6**	-
$LSD_{.05}$	**525**	**2.1**	**3.2**	**3.2**	**5.2**	-

[1]Seed yield adjusted to 9% moisture

Trial Information:

Planted: August 17, 2007
Harvested: July 30, 2008
Seeding rate: 6.5 lb/ac (8-in. row spacing)
Previous crop: 2007 Fallow; 2006 Sunflower
Fertilizer: 46 lb N/ac + 100 lb P_2O_5/ac + 21 lb S/ac
Herbicide: Trifluralin PPI @ 1.5 pt/ac
Irrigation: 16.5 inches center pivot of which 4.5 in were applied in the fall 2007
Precipitation: Approximately 11.6 in. (moisture from snow may not be accurate)

Comments:

The Yellow Jacket winter canola variety trial included 57 entries. Mean seed yield was 1,721 lb/acre with significant differences among entries. There was deer/elk damage to some of the plots. No lodging (plants that have fallen over) was recorded. Some pod/seed shattering was observed.

Reference:

2008 National Winter Canola Variety Trial. Report of Progress 1009. Kansas State University Agric. Exp. Stn. and Cooperative Extension Service.

Spring Canola Variety Trials at Yellow Jacket, Colorado

Mark Stack and Abdel Berrada

The Spring Canola Variety Trial from 2007 is not included in this report because there was essentially no viable crop due to severe damage from herbicide (Pursuit) carryover. Canola is extremely sensitive to Pursuit herbicide which is used for weed control in alfalfa and dry bean fields in SW Colorado.

Table 31. Results of the 2008 Limited-Irrigation Spring Canola Variety Performance Trial

Variety	Seed Yield (lb/ac)[1]	Seed Moisture (%)	Test Weight (lb/bu)	Plant Height (in)	Heading Date	Pod Shattering (%)	Lodging (%)
JOZ-7146	2029	5.0	49.3	41.8	7/19	5.3	1.8
JOZ-8920	1789	5.0	49.2	44.3	7/19	6.3	3.8
DKL30-42	1749	5.1	50.4	45.0	7/31	7.5	1.3
JOZ-8376	1525	5.0	48.6	50.3	7/28	10.0	0.4
JOZ-7784	1456	4.9	49.8	47.8	7/28	13.1	1.3
IS7145	1380	5.1	49.9	48.8	8/3	31.9	41.3
Hyola 357	1284	5.4	48.3	42.5	8/1	8.8	8.9
Hyola 401	1227	5.3	48.9	42.0	7/31	13.8	6.3
V2010	1196	5.2	45.9	47.8	8/2	30.6	1.3
V1031	1122	5.3	47.9	52.0	8/2	24.4	76.3
V1035	1048	5.2	49.4	46.0	7/29	38.8	20.0
45P70	1036	5.3	47.8	49.5	8/2	35.0	22.5
DKL38-25	913	5.5	47.3	54.0	8/4	37.5	0.0
V2015	838	5.2	46.9	53.3	8/4	35.0	3.8
SW Patriot	756	5.2	47.9	53.3	8/4	40.0	11.3
DKL52-10	744	5.2	49.6	55.3	8/4	47.5	0.0
SW Marksman	629	5.2	46.7	56.5	NA	62.5	1.3
V1030	477	5.2	48.9	55.3	8/4	76.3	9.4
Average	**1178**	**5.2**	**48.5**	**49.2**	**-**	**29.1**	**11.7**
CV (%)	**16**	**3.7**	**2.1**	**6.2**	**-**	**49.0**	**-**
$LSD_{0.05}$	**271**	**0.3**	**1.4**	**4.3**	**-**	**20.3**	**-**

[1] Seed yield adjusted to 9% seed moisture (test weight is not adjusted for seed moisture)

Trial Information:

Planted: June 2, 2008
Harvest date: October 16 and 17, 2008

Seeding rate: 7.0 lb/ac
Previous crop: Alfalfa
Tillage: Spring moldboard plowed / field cultivator / roller harrow
Fertilizer: 68 lb N/ac + 22 lb S/ac
Soil test: 40 lb N/ac
Herbicide: Sonalan PPI @ 2.0 pt/ac on May 29, 2008
Insecticide: None
Total moisture: 20.2 in.
Irrigation: 15.2 inches (including 2.2 in preplant) wheel-line
Rain: 5.0 in.
Plot size: 4 ft x 30 ft

Comments:

There was a lot of pod shattering before harvest due to wind and bird feeding, which caused substantial yield losses to some of the entries. Lodging was minimal except for entries 'V1031', 'IS7145', and to a lesser extent '45P70' and 'V1035'.

Table 32. Results of the 2006 Irrigated Spring Canola Variety Performance Trial

Entry[1]	Company	Seed Yield[2] (lb/ac)	Test Weight (lb/bu)	Plant Height (in)	Flowering Date[3]	Oil Content (%)	Oil Yield (lb/ac)
DKL38-25 RR	DeKalb	4027	49.4	55	7/10	46.8	1883
Hyclass 712 RR	Croplan Genetics	3959	48.4	58	7/11	48.6	1926
DKL52-10 RR	DeKalb	3707	52.3	55	7/7	44.9	1665
IS7145 RR	Interstate	3563	51.3	50	7/7	49.8	1772
Hyola 357 Mag. RR	Interstate	3518	48.8	42	6/29	44.8	1574
SW Marksman RR	Interstate	3469	47.6	55	7/10	47.6	1653
Hyclass 767 SW RR	Croplan Genetics	3364	50.7	54	7/7	46.8	1574
Hyola 401	Interstate	3319	50.2	43	6/30	45.7	1517
Hyclass 905 RR	Croplan Genetics	3316	47.6	58	7/12	47.9	1590
Farmer (br. mustard)	-	3296	52.1	51	6/26	42.9	1412
Hyclass 431 RR	Croplan Genetics	3281	49.7	53	7/8	46.9	1540
SW Titan RR	Interstate	3260	51.0	55	7/5	45.3	1476
SW Patriot RR	Interstate	3192	49.7	54	7/3	46.8	1493
HyLite 618 CL	Interstate	3150	48.9	51	7/7	45.9	1445
DKL34-55 RR	DeKalb	3094	49.7	50	7/7	47.2	1461
IS3465 RR	Interstate	2640	50.0	51	7/7	46.5	1227
Arid (brown mustard)	Blue Sun	2582	48.7	44	6/24	40.2	1036
Dahinda (br. mustard)	Blue Sun	2302	51.8	49	6/26	37.7	868
Average		**3280**	**49.9**	**51**		**45.7**	**1506**
CV (%)		**10.4**					
$LSD_{0.05}$		**486**					

[1] Clearfield (CL) canola (non-GMO variety with tolerance to 'Beyond' herbicide). RR = Roundup Ready

[2] Yield is reported at 9% moisture
[3] Date when 50% of the plants have flowered

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Fallow; two-years ago: spring wheat
Seeding rate:	7.0 lb/ac
Planted:	May 8, 2006
Harvested:	October 4, 2006
Fertilizer:	35 lb N/ac + 40 lb S/ac broadcast Sept. 13, 2005
Herbicide:	Trifluralin 1.33 pt/ac incorporated May 4, 2006
Insecticide:	None
Irrigation:	Center pivot 15.0 in
Precipitation:	January 1, 2006 thru August 31, 2006: 6.9 in (long-term average 9.7 in)

Comments:

The irrigated spring canola yield averaged 3280 lb/ac and 49.9 lb/bu test weight average. Oil content averaged 45.7%. Hyola 401 was the only non-GMO canola variety in the trial. The brown mustard (Brassica *juncea* L.) entries Arid and Dahinda had lower yields with lower oil contents. None of the entries lodged. There was no disease or insect damage observed. Center pivot irrigation allowed for timely irrigation. The crop was never stressed.

Table 33. Results of the 2005 Irrigated Spring Canola/Brown Mustard Variety Strip Trial

Entry[1]	Seed Yield (lb/ac)	Planting Rate[1] (lb/ac)	Plant Height (in)	Moisture (%)	Test Weight (lb/bu)
Roundup Ready (Canola)	2940	9.9	32.0	9.2	50.0
Hyola 401 (Canola)	2988	6.2	38.0	9.5	50.5
blue-01-001 (Brown mustard)	1972	5.0	42.0	9.9	51.5
blue-01-003 (Brown mustard)	1633	6.5	44.0	9.8	51.5
phi-04-01 (Brown mustard)	1589	4.5	46.0	8.6	52.5
Blend (Canola + Brown mustard)	1928	6.0	47.0	8.9	52.0
Average	**2175**		**41.5**	**9.3**	**51.3**

[1] Seed provided by Blue Sun Biodiesel, LLC, Fort Collins, CO.

[2] The target seeding rate was 5-6 lb/ac. A Great Plains drill with double disks, press wheels, and depth control on 8-in row spacing was used to plant the canola and brown mustard.

Trial Information:

Planted: May 25, 2005
Harvested: October 17, 2005
Soil type: Wetherill silty clay loam
Previous crop: Dry beans; two-years ago: oats
Tillage: Field cultivator (2x) in spring (wet conditions prevented any 2004 fall tillage)
Herbicide: Trifluralin 1.3 pt/ac incorporated on May 21, 2005
Fertilizer: 50 lb N/ac (urea) on May 23, 2005
Insecticide: Warrior 3.84 oz/ac (false chinch bug)
Precipitation: October 2004 thru September 2005: 17.8 in
(long-term average 16.0 in.)
Irrigation: Center pivot: 16.4 in. (17 passes)

Spring Canola Irrigation Trial at Yellow Jacket, CO—Result Summary

Abdel Berrada

Table 34. The Effects of Supplemental Irrigation on Three Spring Canola Hybrids in 2009

Irrigation treatment	Spring canola hybrid	Biomass dry matter yield (lb/ac)[1]	Biomass moisture at harvest (%)	Plant height (in)
I-0	DKL52-41	1033	56.7	25.3
I-0	HyClass 906	715	59.0	22.0
I-0	V1035	964	52.0	24.8
I-1	DKL52-41	2174	46.3	37.0
I-1	HyClass 906	2254	45.3	39.0
I-1	V1035	2165	40.3	38.8
I-2	DKL52-41	1965	56.3	37.7
I-2	HyClass 906	2410	48.7	39.5
I-2	V1035	2159	47.7	37.7
I-3	DKL52-41	2998	64.3	39.8
I-3	HyClass 906	3548	62.0	49.0
I-3	V1035	3064	56.7	42.7
Mean		2121	52.9	36.1
CV (%)		13.1	8.6	6.7
$LSD_{0.05}$				
Irrigation		277	0.05	2.4
Hybrid		NS[2]	0.04	2.1
Irr. x Hyb.		NS	NS	HS[3]

[1] The biomass yield is adjusted to 0% moisture
[2] Non significant at alpha = 0.05
[3] Significant at alpha = 0.02

Planted: May 12, 2009
Harvested: September 9, 2009
Seeding rate: 7.0 lb/ac
Previous crop: Winter wheat
Tillage: Spring plowed, disked, cultivated, and packed
Fertilizer (May 1, 2009): 100 lb N/ac (as urea) + 40 lb P_2O_5/ac (as 11-52-0)
Pesticides: Sonalan PPI @ 2 pt/ac on May 6, 2009
Aphid control: Released one gallon of ladybugs on July 30, 2009

Precipitation amounts:

Growth stage	Irrigation treatment/system	Application depth (inches) 5/12 thru 8/18/09			
		I-0	I-1	I-2	I-3
Germination-emergence	Sprinkler	3.3	3.3	3.3	3.3
Vegetative	Surface drip	0.0	3.0	3.0	5.1
Flowering	Surface drip	0.0	2.2	4.9	7.2
Grain fill	Surface drip	0.0	0.0	0.0	10.6
	Total (gross)	**3.3**	**8.5**	**11.2**	**26.2**
	Total (net)	**2.5**	**6.9**	**9.2**	**22.0**
	Rainfall (5/12 thru 8/31/09)[4]				2.9
	Reference ET (5/12 thru 8/31/09)				30.4
	Small grain ET (5/12 thru 8/31/09)				18.8

[4] The normal precipitation from May through August is 5.0 inches.

Comments:

Spring canola seed production was decimated by finches. There was also some defoliation due to grasshoppers, cabbage aphids, and cabbageworms. The driest treatment (I-0) had the lowest dry matter due to low rainfall during the growing season. As would be expected, the full-irrigation treatment (I-3) had the highest dry matter (3204 lb/ac) yield while I-1 and I-2 averaged about 2200 lb/ac dry matter. The canola hybrid 'HyClass 906' had the shortest plants at I-0 and the tallest plants at I-3. The three hybrids produced similar dry matter yields when averaged over all the irrigation treatments. More testing will be needed to determine the effects of limited irrigation on spring canola in SW Colorado.

Camelina Research at Yellow Jacket in 2008 and 2009

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Table 35. Results of the 2009 Dryland Camelina Variety Performance Trial

Company/Source	Variety	Yield[1]	Plant Height	Pod Shattering[2]	Oil content
		lb/ac	in	0-10	%
Blue Sun Biodiesel	**BSX B02**	714	24	0.7	31.9
Blue Sun Biodiesel	**BSX G72**	697	22	1.7	31.7
Blue Sun Biodiesel	**BSX B01**	670	20	0.3	31.8
Blue Sun Biodiesel	**BSX G22**	618	22	0.7	32.4
Montana State University	**Suneson**	610	23	1.3	31.5
Great Plains Oil Company	**Bear Paw**	587	23	0.3	31.2
Montana State University	**Calina**	583	22	1.0	22.7
Europe	**Celine**	566	22	0.3	31.1
IPK	**IPK739**	560	21	0.7	32.4
Blue Sun Biodiesel	**BSX G21**	538	23	1.0	31.2
Blue Sun Biodiesel	**BSX G24**	502	22	0.7	31.9
Blue Sun Biodiesel	**BSX G51**	501	22	0.0	31.8
Great Plains Oil Company	**Yellow Stone**	496	23	1.0	32.7
Montana State University	**Blaine Creek**	491	23	1.3	31.7
Blue Sun Biodiesel	**BSX G43**	484	24	1.0	31.8
Blue Sun Biodiesel	**Cheyenne**	441	24	0.3	32.1
Blue Sun Biodiesel	**BSX G74**	437	23	0.3	30.3
Europe	**Ligena**	421	23	0.3	32.1
Blue Sun Biodiesel	**BSX G37**	410	22	1.0	31.1
Blue Sun Biodiesel	**BSX G76**	374	22	1.3	31.0
Average		**531**	**22**	**0.77**	**31.2**
$LSD_{.05}$		**159**	**2.2**	**NS**	**NS**

[1]Seed yield adjusted to 8.5% moisture
[2]Scale from 0 to 10: 0 no shattering; 10 heavy shattering

Trial Information:

Planting date: May 7, 2009
Harvesting date: August 12, 2009
Seed moisture: 5.3% ave.
Soil type: Wetherill silty clay loam

Previous crop:	Fallow
Seeding rate:	7.6 lb/ac (12-in. row spacing) except entry ‘IPK739’ (3.0 lb/acre)
Soil test:	NO_3-N: 7.0 ppm; Mehlich-3 P: 29.6 ppm, pH: 7.1, OM: 0.9%
Fertilizer:	50 lb N + 20 lb P_2O_5/ac broadcast on May 1, 2009
Herbicide:	Sonalan PPI @ 2.0 pt/ac on May 6, 2009
Insecticide:	None
Precipitation:	Planting to harvest: 2.2 in.

Comments:

Subsoil moisture at planting was good to excellent. However, some of the seeds (example the ones in the outside rows behind the tractor wheels) stayed on the soil surface and did not germinate until after it rained on May 21-24. The recommended seeding depth for camelina is “no more than ¼ inch with at least some seeds visually apparent on the soil surface after planting”. There was little precipitation (0.4 in.) in July through harvest and only 2.2 inches for the season. Fifty percent flowering occurred in late June to early July. Some pod shattering was observed. It was caused mostly by birds. There was a moderate infestation by grasshoppers, resulting in some defoliation.

Table 36. Results of the 2009 Irrigated Camelina Variety Performance Trial

Company[1]	Entry	Seed Yield[2]	Oil Content	Plant Height	Pod Shattering	50% Bloom	Lodging	Stand
		lb/ac	%	in	0-10[3]	date	0-10[3]	0-10[4]
Great Plain	Yellow Stone	1678	34.2	35.3	2.7	6/29	0.6	9.9
Europe	Ligena	1090	34.6	34.3	6.1	6/29	1.0	10.0
Blue Sun	BSX G21	1060	33.6	35.7	7.0	6/29	0.0	9.0
Blue Sun	BSX B01	1043	33.9	34.8	7.8	6/29	1.7	8.7
Blue Sun	BSX G22	1023	35.7	29.7	7.4	6/29	1.5	10.0
Blue Sun	BSX G43	974	34.5	33.8	6.9	6/29	0.2	9.7
Blue Sun	Cheyenne	940	34.8	32.0	6.8	6/29	0.6	9.9
IPK	IPK739	880	34.5	32.3	7.9	6/29	0.2	9.6
Blue Sun	BSX G51	876	34.8	32.7	5.2	6/30	0.8	9.6
Blue Sun	BSX B02	842	32.3	35.0	7.7	6/29	2.5	9.7
MSU	Calina	836	32.4	35.0	6.9	6/30	2.1	8.7
Blue Sun	BSX G72	825	33.6	36.2	8.1	6/29	1.7	9.9
Great Plain	Bear Paw	789	33.8	35.7	7.9	6/29	1.5	10.0
Europe	Celine	784	34.8	35.2	7.0	6/29	0.8	10.0
Blue Sun	BSX G24	746	33.6	36.3	7.8	6/29	3.5	9.6
MSU	Suneson	728	34.1	31.7	8.1	7/01	0.0	9.4
Blue Sun	BSX G37	673	33.8	35.3	8.3	6/30	0.6	9.4
MSU	Blaine Creek	631	32.3	34.5	7.9	6/29	0.8	9.8
Blue Sun	BSX G74	609	32.3	34.3	9.3	7/01	1.7	8.8
Blue Sun	BSX G76	502	32.6	35.8	8.7	7/01	0.0	8.6
Average		**876**	**33.8**	**34.3**	**7.3**		**1.1**	**9.5**
$LSD_{.05}$		**341**	**NS**	**4**				

[1] Great Plain Oil Company, Blue Sun Biodiesel, Montana State University (MSU)

[2] Seed yield adjusted to 8.5% moisture

[3] Scale from 0 to 10: 0 no shattering or lodging; 10 equals heavy shattering or lodging.

[4] Stand establishment: scale from 0 to 10; 0 = no stand, 10 = fully established. Note: This data was recorded after harvest.

Trial Information:

Planting date:	May 11, 2009
Harvesting date:	August 27, 2009
Seed moisture:	5.3% ave.
Soil type:	Wetherill clay loam
Previous crop:	Fallow
Seeding rate:	7.6 lb/ac (12-in row spacing) except entry 'IPK739' (3.0 lb/ac)
Soil test:	NO_3-N: 7.0 ppm; P: 29.6 ppm, pH: 7.1, OM: 0.9%
Fertilizer:	50 lb N + 20 lb P_2O_5/ac broadcast on May 1, 2009
Herbicide:	Sonalan PPI @ 2.0 pt/ac on May 6, 2009

Insecticide: None
Precipitation: Planting to harvest: 18.8 in. (including 2.2 in. from rain)

Comments:

The camelina irrigated trial experienced severe pod shattering which was caused by wind and a rain storm on 23-24 August. There was also extensive feeding by birds, mostly finches. Three entries had over 20% lodging. Lodging was caused by deer, wind, irrigation, or the sideroll (for example when the sideroll wheels do not follow the same path at each irrigation run). There was a substantial grasshopper invasion in early summer. This was not a good year for irrigated camelina at Yellow Jacket!

Table 37. Results of the 2008 Limited-Irrigation Camelina Variety Performance Trial

Source[1]	Variety	Yield[2]	Days to 50% Flowering
		lbs/ac	day
MSU	**Celine**	2386	51
GPO	**Pear Paw**	2182	53
Blue Sun	**BSX G72**	2145	56
Blue Sun	**BSX G37**	2134	58
Blue Sun	**BSX G43**	2121	56
MSU	**Calina**	2055	53
MSU	**MT1**	2053	59
Blue Sun	**BSX G02**	2040	57
GPO	**Jungle Gold**	2035	60
MSU	**MT5**	1983	54
Blue Sun	**BSX G24**	1974	55
Blue Sun	**Cheyenne**	1966	53
MSU	**Ligena**	1951	60
Blue Sun	**BSX B01**	1870	53
Blue Sun	**BSX G51**	1834	55
GPO	**Yellow Stone**	1783	50
Blue Sun	**BSX G21**	1779	55
Blue Sun	**BSX G22**	1739	52
Average		**2002**	**55**
CV (%)		**5.5**	
$LSD_{(0.05)}$		**182**	

[1] GPO is Great Plains Oil Company. MSU: Montana State University. Blue Sun Biodiesel Inc.
[2] Yield adjusted to 8.5% moisture

Trial Information:

Previous crop:	Alfalfa
Planted:	May 30, 2008
Harvested:	September 25, 2008
Preplant-incorporated herbicide:	Sonalan PPI @ 2.0 pt/ac
Fertilizer application (32-0-0):	May 27, 2008
Irrigation:	15.2 in., including 2.2 in. pre-plant

Comments: The crop looked good. There was no noticeable disease or insect damage.

Table 38. Results of the 2008 Limited-Irrigation Camelina Agronomy Trial

Variety	Seeding Rate (lb/ac)	Nitrogen Rate (lbs/ac)[2]			Average Yield Seeding Rate (lb/ac)
		22	82	142	
		Yield (lb/ac)			
Calina	2	1561	1755	1652	1656
Calina	5	2026	1999	2019	2014
Calina	8	2089	2044	1872	2002
Calina	11	2071	2176	1977	2075
Calina	14	2025	2106	1849	1993
Average Calina		**1954**	**2016**	**1874**	**1948**
Cheyenne	2	1575	1516	2275	1789
Cheyenne	5	1916	1891	1575	1794
Cheyenne	8	1822	1887	1941	1884
Cheyenne	11	1784	1910	1776	1823
Cheyenne	14	1863	1819	1815	1833
Average Cheyenne		**1792**	**1805**	**1876**	**1824**
Average N		1873	1910	1875	
CV (%)					14
$LSD_{(0.05)}$					139
Trial Average					1886

[1] Trial conducted at the Southwestern Colorado Research Center. Planted on 5/30/08 and harvested on 9/25/08. Data summarized by Jean-Nicolas Enjalbert.
[2] Nitrogen rate include residual NO_3-N (22 lb/ac) in 0- to 8-in soil depth

Trial Information:

Previous crop:	Alfalfa
Tillage:	Spring moldboard plowed/field cultivated/roller harrow
Soil test (NO_3-N):	22 lb in 0- to 8-in soil depth and 18 lb in 8- to 24-in depth
Fertilizer:	32-0-0 applied on May 27, 2008
Herbicide:	Sonalan PPI @ 2.0 pt/ac on May 29, 2008
Irrigation:	12.4 in (including 2.2 in pre-plant) sprinkler wheel-line
Rainfall:	3.76 in (planting to harvest)

Comments:

There were no significant differences in seed yield between N rates, which would indicate adequate N availability (40 lb NO_3-N in the top 2 ft. of soil)--relative to the seed production level obtained, prior to N fertilizer application. The variety 'Calina' produced similar yields at seeding rates of 5 to 14 lb/acre. Seeding rates of 2 to 14 lb/acre had no significant effect on the yield of 'Cheyenne'. Irrigation application was stopped when the adjacent spring canola crop became too tall to move the wheel-line (sideroll) sprinkler system through it. Both varieties were at the 50% flowering stage by 7/21/08.

Grain Legumes

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

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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 15.6 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 and 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 2005, 18,100 acres of non-irrigated pinto beans were harvested with an average yield of 395 lb/acre in Dolores and Montezuma Counties. In 2006 and 2007, 8,300 and 13,600 acres of non-irrigated dry beans, respectively, were harvested with average yields of 295 and 310 lb/acre. In 2006, 8,700 acres were planted but not harvested due to a prolonged dry period prior to and after planting (http://www.nass.usda.gov/Statistics_by_State/Colorado).

Figure 16. Pinto bean field at the SWCRC in 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 (Wood et al., 1983). Cahone is still the predominant pinto grown on dryland in southwestern Colorado. In 1994, ‘Fisher’ pinto bean was released by Colorado State University (Fisher et al., 1995). Fisher is more sensitive to local environmental conditions than Cahone and is not widely planted.

The goal of the breeding program at the Southwestern Colorado Research Center has been 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 bean farmers if contaminated seed is planted or summer storms move bacteria in rain showers. A summary of the dry bean research program at the SWCRC is available in our 2004 research report (Stack and Brick, 2006).

In 2006, the Colorado Dry Bean Administrative Committee withdrew their support for dry bean research at the SWCRC and the Western Colorado Research Center at Fruita. The CSU dry bean breeding program was also impacted by the reduced level of CDBAC funding. The 2008 and 2005 dryland variety trials (Tables 39 and 40) are the results for the last advanced generation lines developed by the CSU dry bean breeding program for SW Colorado. New funding sources and renewed emphasis will be required to reinvigorate the dry bean breeding program.

Irrigated dry 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 dry beans require less water than alfalfa and may be a fit for some growers. From 2005 through 2007, an average of 3,100 irrigated acres with an average yield of 1,800 lb/acre were harvested in Dolores and Montezuma Counties (http://www.nass.usda.gov/Statistics_by_State/Colorado).

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 2005 was the seventh consecutive year the uniform trial was planted at Yellow Jacket. Table 41 lists the 2005 irrigated uniform pinto bean variety trial results. Results from all locations in 2005 are reported by the CSU Crops Testing Program (Johnson et al., 2005). The irrigated uniform pinto bean variety trial has continued at two sites in eastern Colorado. Dry bean testing and research results are available by year on the CSU Crops Testing website (http://www.csucrops.com).

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

Dry Bean Variety Trials at Yellow Jacket, Colorado

Table 39. Results of the 2008 Dryland Pinto Bean Variety Trial

Entry	Seed Yield (lb/ac)	Seeds/lb	Seed Moisture (%)	Test Weight (lb/bu)	Notes
30068	1094	1301	10.8	57.2	
30047	1024	1445	11.2	57.8	
30052	950	1284	11.1	57.3	Upright
30048	940	1271	11.6	58.7	Maintains color in storage
30046	929	1355	11.3	58.4	Late
438	929	1372	10.8	57	
432	927	1349	10.8	57.4	Maintains color in storage
Fisher	884	1152	11.2	56.7	
90436-2-3	824	1376	10.5	57.1	Late
10031	808	1448	11.2	60.2	
Cahone	363	1349	10.9	56.4	
Average	**879**	**1337**	**11**	**57.7**	
CV (%)	**11**	**4**	**2.1**	**1**	
$LSD_{.05}$	**135**	**76**	**0.3**	**0.8**	

Trial Information:

Soil type:	Wetherill silty clay loam
Planting date:	June 12, 2008
Seeding rate:	23,232 seeds/ac (9 in. spacing on 30-in rows)
Planter:	Monosem vacuum planter
Harvested area:	5 ft x 25 ft per plot
Harvest date:	September 23 thru 25, 2008
Previous crop:	Canola, fallow
Bactericide:	Kocide at 4.5L copper August 20, 2008 (common bean blight prevention)
Precipitation:	3.6 in from planting to harvest (June thru September long-term average 7.4 in.)

Comments:

The Yellow Jacket pinto bean variety trial included eight entries from the 2005 dryland variety trial, one entry (‘10031’) from the 2005 advanced generation nursery, and two check varieties, Cahone and Fisher. Mean yield was 879 lb/acre with significant differences among entries. The variety Cahone had very low yield, probably due to poor seed germination. The trial benefited from above normal precipitation in August (2.2”). Dry beans (mostly pintos) are still an

important crop in southwestern Colorado. The acreage has declined over the last several years, especially since 2006 when sunflowers were introduced to this area. However, strong bean prices in 2008 and 2009 may trigger more bean acreage in the future! 15,300 acres of dry beans were harvested in 2008 in Dolores and Montezuma counties compared to 23,600 acres in 2004 (http://www.nass.usda.gov/Statistics_by_State/Colorado).

Table 40. Results of the 2005 Dryland Pinto Bean Variety Trial

Entry	Yield (lbs/ac)	Maturity[1] (days)
CO438	893	-3
Montrose	890	-5
CO30046	864	same
Fisher	817	+3
Cahone	813	--
CO30048	806	same
CO90436	707	-3
CO90432	704	same
San Juan Select	687	same
UI126	685	-5
Bill Z	681	same
CO30068	680	same
CO432	664	same
CO30051	638	+5
CO30047	538	same
Average	**738**	
CV (%)	**11.6**	
$LSD_{0.05}$	**122**	

[1] Maturity relative to Cahone: - = earlier, + = later

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Winter wheat
Tillage:	Fall moldboard plowed
Seeding rate:	23,232 seeds/ac (9-in spacing on 30-in rows)
Planted:	June 10, 2005
Cut:	September 14, 2005
Threshed:	October 7, 2005
Fertilizer:	50 lb N/ac
Herbicide:	Pursuit 3 oz/ac (pre-plant incorporated with roller-harrow)
Bactericide:	Kocide (4 applications) for common bean blight prevention
Precipitation:	October 1, 2004 thru September 30, 2005: 17.8 in. (long-term average 16.0 in.)

Table 41. Results of the 2005 Irrigated Uniform Pinto Bean Variety Trial

Variety	Yield (lbs/ac)	Seeds/lb
Poncho	3345	1098
00211	3193	1043
Myconate-Non-Treated	2995	1227
Canyon	2947	1200
00218	2939	1146
Bill Z	2915	1166
Buckskin	2853	1182
Montrose	2846	1254
Myconate-Treated	2844	1198
99195MR	2828	1501
99236	2818	1411
CO12613	2637	1077
Grand Mesa	2614	1212
CO12531	2583	1059
01223	2555	1340
00185	2438	1211
03222	2042	1307
Average	**2788**	**1214**
CV (%)	**7.0**	
$LSD_{0.05}$	**327**	

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Oats
Tillage:	Fall moldboard plowed
Seeding rate:	85,000 seeds/ac (2.5-in spacing on 30- in rows)
Seeded:	June 13, 2005
Cut:	October 15, 2005
Threshed:	November 3, 2005
Fertilizer:	50 lb N/ac + 13.5 lb S/ac
Herbicide:	Pursuit 3 oz/ac (pre-plant incorporated with roller-harrow)
Bactericide:	Kocide (1 application) for common blight prevention
Irrigation:	14.2 in (5 sprinkler applications)
Precipitation:	October 1, 2004 thru September 30, 2005: 17.8 inches (long-term average 16.0 inches)

Table 42. Results of the 2005 Dryland Chickpea Variety Trial

Entry	Yield (lbs/ac)	Maturity[1]	Notes
CA0090B347C	850	same	upright, med. size plant, good pod load
Dwelley	772	earlier	
CA188587C	760	later	small size plant, green at harvest
CA9990B1579C	729	same	good pod load
CA0190B839C	674	later	large size plant, green at harvest
Sierra	672	0	
CA9990I604C	660	same	small size plant
CA9990I895C	603	earlier	upright, good pod load
CA0090B015W	530	later	prostrate plant, green at harvest
CA0090I875W	490	later	prostrate plant, green at harvest
CA9890233W	471	later	prostrate plant, green at harvest
CA9783163C	443	later	poor pod load, green at harvest
Average	**638**		
CV (%)	**20**		
$LSD_{0.05}$	**184**		

[1] Maturity relative to Sierra

Trial Information:

Soil type:	Wetherill silty clay loam
Previous crop:	Winter wheat; 2-years ago: fallow
Tillage:	Fall moldboard plowed
Seeding rate:	29,850 seeds/ac (7-inch spacing on 30-inch rows)
Seeded:	June 2, 2005
Cut:	October 15, 2005
Threshed:	November 4, 2005
Fertilizer:	50 lb N/ac + 13.5 lb S/ac
Herbicide:	Pursuit 3 oz/ac applied on June 1, 2005 (incorporated with roller-harrow)
Precipitation:	October 2004 thru September 2005: 17.8 in. (long-term average 16.0 in.)

Comments:

The chickpea variety trial was planted late due to a wet spring. There was very good soil moisture at planting but the weather turned dry during the growing season. October was unusually wet. The chickpeas did not flower until late in the growing season. The year 2005 was unusual in that the first hard freeze <28°F did not occur until November 15. The late fall allowed some of the chickpea entries to mature. The chickpeas were undercut with bean knives and threshed with a Hege plot combine.

Entries CA0090B347C, CA9990B1579C, and CA9990I895C warrant additional testing. The entry CA188587C performed well in previous years at Yellow Jacket but this year it had green leaves at harvest. Many of the entries had green leaves and pods when they were cut on Oct. 15. Dwelley and Sierra currently are the recommended varieties to be planted in Southwestern Colorado.

Figure 17. Chickpea field at the SWCRC in 2005

Fruit Tree & Vineyard Project
2009 Growing Season Fruit Tree Evaluations

Dan Fernandez, Dolores County Director
Colorado State University Extension

Figure 18. Fruit tree pruning workshop in March 2008

Table 43. 2009 Fruit Production Information

Variety	Tree Count	lbs. / tree	Total Production (lbs.)
APPLES *		ESTIMATE	ESTIMATE
Scarlet Gala	20	400	8000
Nured Jonathan	0	0	0
Lustre Elstar	4	150	600
Super Jon	5	75	375
Red Jonagold	5	100	500
Golden Delicious	10	350	3500
Honey Crisp	5	100	500
Red Fuji	16	0	0
Swiss Gourmet	16	100	1600
Royal Empire	16	100	1600
Liberty	16	100	1600
Mor-Spur McIntosh	5	100	500
Improved Red Delicious	5	75	375
Royal Gala	5	100	500
Rubinstar	4	50	200
Ida Red	4	50	200
Gravenstein	0	0	0
Lodi	0	0	0
Myra Fuji	8	25	200
Sun Fuji	5	25	125
Galaxy Gala	5	100	500
Improved Gala	5	100	500
Pacific Gala	5	100	500
Pinova	5	125	625
Cameo	5	50	250
Improved Golden Delicious	5	75	375
Golden Supreme	5	75	375
Nured Jonathan Sport	18	50	900
Improved McIntosh	5	40	200
Buckeye Gala	5	75	375
TOTAL APPLES	**212**	**2,690**	**24,975**

Variety	Tree Count	lbs. / tree	Total Production (lbs.)
PEACHES		ESTIMATE	ESTIMATE
Suncrest	4	200	800
Flamin' Fury	5	200	1000
Red Globe	5	200	1000
Starfire FA11	5	200	1000
TOTAL PEACHES	**19**	**800**	**3,800**
PEARS		ESTIMATE	ESTIMATE
Max Red Bartlett	5	150	750
D'Anjou	3	150	450
Bronz Beauty	3	125	375
DuComice	5	125	625
TOTAL PEARS	**16**	**550**	**2,200**
PLUMS		ESTIMATE	ESTIMATE
Improved Duarte	5	0	NA
Empress	5	0	NA
President	5	0	NA
TOTAL PLUMS	**15**	**0**	**NA**
TOTAL FRUITS	**262**	**1,350**	**30,975**

APPLE VARIETIES--Descriptions, Evaluations, and Ratings

SCARLET GALA - EMLA 7: 1992 planting. ****** RATING**

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 & 9th seasons, several trees began leaning requiring support. Root sprouts have become a real issue requiring two prunings per season. Matures early to mid September. Very consistent yearly fruiting. Rating dropped ½ point due to tree leaning and sprout problems. Large crop in 2009.

NURED JONATHAN - MARK: This variety was replaced with an improved version in 2000.

SWISS GOURMET - EMLA 7: 1995 planting. ***** RATING**

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 may be a little too vigorous for a trellis on EMLA 7. Large crop in 2005 but minimal crop in 2006 & 2007 due to freezes. Due to excessive growth, half of these trees were removed from the project. Good crop in 2009.

ROYAL EMPIRE - EMLA 7: 1995 planting. ****** RATING**

Superior, 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 with excellent storage capacity. Excellent tree development on trellis system. Large crop in 2005 but minimal crop in 2006 & 2007 due to freezes. Good crop in 2008 & 2009.

LIBERTY - EMLA 7: 1995 planting. ***** RATING**

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. 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. Large crop in 2005 and same in 2006, 2007, 2008 & 2009.

GOLDEN DELICIOUS - EMLA 26: 1994 planting. ****** RATING**

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 recently excellent crops with good size even through the adverse weather conditions. Mid to late September harvest. Large crop in 2005, 2006, 2007, 2008 & 2009.

HONEY CRISP - EMLA 7: 1995 planting. *****1/2 RATING**

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 early in its development with this variety. 2000 Powdery Mildew outbreak did not affect this variety. Tree also tends to initially grow upright and requires substantial limb training during early development. Mid September harvest. This was the only variety to have a significant crop in 2002. Large crop in 2005, 2006, 2007 & 2008 but very inconsistent prior to 2005. Rating raised ½ point in 2008 and another ½ point in 2009.

RED FUJI - EMLA 9: 1995 planting. ***** RATING**

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. Heavy crop requires proper thinning to avoid limb breakage. Big market potential. Good crop in 2007 but 2008 crop was lost due to freeze. Again, due to late maturity, most of this crop was not harvested. Rating lowered a full point due to continuing bloom and late maturity problems.

RED JONAGOLD - EMLA 7: 1994 planting. ***** RATING**

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 with several seasons of fairly consistent, but light, fruiting even through the adverse weather conditions. Large crop 2005, minimal crop in 2006 and good crop in 2007, 2008 & 2009.

LUSTRE ELSTAR - EMLA 26: 1994 planting. ***** RATING**

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 adverse weather conditions. In 2007, lowered rating ½ point due to continued limb breakage. Large crop in 2005, but minimal crop in 2006 due to May freeze. Moderate crop in 2007, 2008 & 2009.

SUPER JON - EMLA 7: 1994 planting. ***** RATING**

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. Three freezes in early 2002 eliminated the crop. Hail in 2003 eliminated the crop. Hail in July 2004 damaged the crop. Large crop in 2005 and moderate crop in 2006, 2007, 2008 & 2009.

MOR-SPUR McINTOSH - EMLA 7: 1996 planting. ***** RATING**

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. Large crop 2005, minimal crop in 2006, good crop in 2007, and moderate in 2008 & 2009. For the third year in a row, we had "unexplained" significant fruit drop prior to harvest, but not as bad as 2008. This situation is being monitored.

IMPROVED RED DELICIOUS - EMLA 7: 1996 planting. ***** RATING**

Campbell strain that is highly striped with strong red color. Consistent medium to very large fruit that is mid-bloom. Upright tree growth that initially requires substantial limb training. This tree has had limited tree growth 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. Rating increased another ½ point in 2004 because of consistent, exceptional large fruit. Large crop 2005, minimal crop in 2006, and good crop in 2007. Large crop in 2008 & 2009.

ROYAL GALA - EMLA 26: 1997 planting. *****½ RATING**

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. Large crop 2005, minimal crop in 2006, and good crop in 2007, 2008 & 2009.

MYRA RED FUJI - EMLA 26: 1997 planting. ***** RATING**

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. Large crop 2005, minimal crop in 2006, and good crop in 2007. No crop in 2008 due to freeze and late maturing, crop in 2009 was not harvested. Lowered rating by ½ point.

GRAVENSTEIN - EMLA 26: 1997 planting. **** RATING**

Large, red-striped, crisp and juicy. Excellent for cooking and pies. Hardy tree with very good tree development. But it is important to note that this variety does mature up to 3 weeks earlier - last part of August to 1st week in September and is never harvested as part of our regular U-Pick operation. Susceptible to Bitter Pit which is a calcium deficiency. Large crop 2005, minimal crop in 2006, and good crop in 2007. No crop in 2008. ***Due to very early maturity which did not fit into our production scheme, these 8 trees were eliminated from the project. Final rating was also lowered one point.***

IDARED - EMLA 26: 1997 planting. ***½ RATING**

A solid, beautiful bright red apple. Tree development has slowed rapidly as the bud union is starting to swell considerably. This tree on EMLA 26 is better suited to a trellis system. Lowered rating again in 2007 as poor tree development and limited crop does not make this variety very appealing. It really needs a more vigorous rootstock like EMLA 7. Heavy crop in 2008 & 2009.

LODI - EMLA 111: Yellow fruit, large in size, with very early maturity - mid to late August. On EMLA 111, there is excessive growth on the 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.

Note: These trees have been removed from the project.

RUBINSTAR JONAGOLD - EMLA 26: 1997 planting. ***** RATING**

Intense red coloration that is uniform throughout the tree. Tree development has been moderate throughout its development. Matures one week ahead of Jonagold and is less susceptible to sunburn. There are signs of Bitter Pit susceptibility. Good crop in 2005, minimal crop in 2006, and good crop in 2007 & 2008. Heavy crop in 2009.

SUN FUJI - EMLA 7: 1999 planting. ***** RATING**

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. Tree development has been excellent. Large crop 2005, minimal crop in 2006, and good crop in 2007. No crop in 2008 due to freeze and late maturity in 2009 resulted in these trees not being harvested. Lowered rating by 1 point.

GALAXY GALA - EMLA 7: 1999 planting. ****** RATING**

This Gala's big difference to Royal Gala 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. Tree development is excellent. Large crops 2005, 2006, 2007, 2008 & 2009.

IMPROVED GALA (Mitchell Cultivar) - EMLA 7: 1999 planting. ****** RATING**

Bright red stripes over yellowish undercolor. Multiple pick apple. Noted for its increased color stability. Medium sized fruit. Outstanding flavor. Tree development is excellent. Large crops 2005, 2006, 2007, 2008 & 2009.

PACIFIC GALA - EMLA 7: 1999 planting. ****** RATING**

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. Tree development is excellent. Large crop 2005, 2006, 2007, 2008 & 2009.

PINOVA - EMLA 7: 1999 planting. ***** RATING**

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. Large crop in 2005, minimal crop in 2006, and good crop in 2007. Good crop in 2008, but it matured in mid October. Excellent crop in 2009.

CAMEO - EMLA 7: 1999 planting. **** RATING**

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. Fair crop in 2006 & 2007. No crop in 2008 due to the need to perform early spring corrective pruning. Good crop in 2009 due to effects of 2008 corrective pruning.

IMPROVED GOLDEN - EMLA 7: 2000 Planting. **** RATING**

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, but limb growth has to be controlled early in its development to avoid congestion. Limited crop in 2005, good crop in 2006, small crop in 2007. Large crop in 2008 & 2009.

GOLDEN SUPREME - EMLA 7: 2000 Planting. **** RATING**

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, but limb growth has to be controlled early in its development to avoid congestion. Good crop in 2006 and fair in 2007. Large crop in 2008. Good crop in 2009 but there was a noticeable amount of early drop – monitoring this situation.

NURED JOHNATHAN SPORT - EMLA 7: 2000 Planting. **** ½ RATING**

Dark red small fruit that is excellent for cooking. Excellent storage capabilities. Requires heavy thinning and is very cold hardy. Tree development has been good but tends to sucker and requires significant training every season. Small to medium fruit size suited for pie apples. If tree growth and fruiting characteristics do not improve in 2008, the rating will be lowered in 2008. Limited crop in 2005, 2006 & 2007. Lowered rating by ½ point in 2008 due to moderate crop and tree training issues. Good crop in 2009.

IMPROVED MCINTOSH - EMLA 26: 2002 Planting. **** ½ RATING**

Early maturing, mid September, with very deep red color. A trellis planting. Tree growth and shape have been excellent. Limited fruit in 2006, 2007 & 2008. Good crop in 2009.

BUCKEYE GALA - EMLA 7: 2002 Planting. *****½ RATING**

The fruit is full size with good flavor and quality. Color is a superior deep red with a light yellow stripe. Tree growth and shape have been excellent. These trees were badly damaged in the 2003 hail storm and have fully recovered in 2008. Fair crop in 2007 and a good crop in 2008. With excellent color and taste, rating was raised by one point. Excellent crop in 2009

SEPTEMBER WONDER FUJI – NIC 29: 2009 Planting

Formerly known as Jubilee Fuji, is the earliest Fuji on the market today. Reddish blush color with a creamy white flesh with Fuji flavor and keeping qualities similar to Gala's. Planted 18 inches apart as part of our "Super High Density" trial, and initial growth is excellent. No Rating at this time.

HONEY CRISP – NIC 29: 2009 Planting

Excellent color with a scarlet red over a yellow background. Mid-bloom, large fruit, keeps well in storage-high quality. Planted 18 inches apart as part of our "Super High Density" trial, and initial growth is excellent. No Rating at this time.

Rating scale:

5 stars *** Excellent potential**
4 stars ** Very good potential**
3 stars * Good potential**
2 stars ** Poor potential
1 star * Forgetaboutit

Refer to Table 43 for specific yield information

APPLE ROOTSTOCKS

NIC 29: Produces a tree that is 35-40% of a standard tree or semi dwarf, does well in heavy soil and wet conditions, does produce a more expansive root system, but needs mechanical support throughout the life of the tree, large fruit.

EMLA 9: Similar to NIC 29, 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 13 year old Scarlet Galas on EMLA 7 that have started to lean requiring support.

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

Mark: Not advisable to use in SW Colorado due to bud-union incompatibility.

Coming in 2010 – 3 new varieties:

- Scarlet Spur on EMLA 26
- Improved Golden on NIC 29
- Spartan on NIC 29

PEAR VARIETIES--Descriptions, Evaluations, and Ratings

MAX RED BARTLETT: 1996 Planting. ***** RATING**

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. Three 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. Large crop in 2005. Late freeze did not affect the large crop in 2006 & 2007. Limited crop due to 2008 freeze, large crop in 2009 but late maturing.

DU COMICE: 1996 Planting. ***** RATING**

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. Large crop in 2005 raised rating ½ point. Late freeze did not affect the large crops in 2006, 2007 & 2008. Large but late maturing crop in 2009.

D'ANJOU: 1997 Planting. ****½ RATING**

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. Large crop in 2005 and raised rating ½ point. Late freeze did not affect the large crop in 2006 but did reduce the 2007 crop. Good 2008 crop and large 2009 crop but late maturing.

BRONZE BEAUTY: 1997 Planting. ****½ RATING**

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. Large crop in 2005 and 2006 with a moderate crop in 2007. Good 2008 crop and large late maturing crop in 2009.

Notes:

- In 2009, we had a very cool May and June which apparently delayed the maturity of the pears nearly 4 weeks with a late September harvest.
- We did have a small outbreak of Fire Blight in 2007, but immediate action of pruning out the infected wood, complete cleanup of leaves and debris and several applications of Streptomycin have apparently taken care of the problem for now. We did not see any evidence of the disease in 2009.
- All pear varieties are subject to severe attacks from the Pear Slug. Regular pest monitoring and timely sprays must be applied to avoid leaf skeltonization and defoliation.
- It is also important to remember that pears take several years to come into production. It may take 6 to 7 years after planting before you see the first significant crop.

PEAR 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):

Rating scale:

5 stars *** Excellent potential**
4 stars ** Very good potential**
3 stars * Good potential**
2 stars ** Poor potential
1 star * Forgetaboutit

Refer to Table 43 for specific yield information

PEACH VARIETIES-- Descriptions, Evaluations, and Ratings

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: 1996 Planting. ***** RATING**

Firm yellow flesh with good flavor. Has a bright skin color and is excellent for canning and freezing. Fruit tends 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. Large crop in 2005 & 2006. Limited crop in 2007 and large crop in 2008. Large crop in 2009 but late harvest mid September – see notes.

FLAMIN' FURY SERIES PF#15A: 1996 Planting. ***** RATING**

Large red fruit that has good flavor and shipping qualities. The trees are very winter hardy and fruit tends to mature in MID 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. Large crop in 2005 & 2006. Limited crop in 2007 and large crop in 2008. Large crop in 2009 but late harvest mid September – see notes.

STARFIRE, (FA 11): 1999 Planting. ****½ RATING**

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. Fruit tends to mature in LATE August. 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. Large crop in 2005 & 2006. Limited crop in 2007 and large crop in 2008. Large crop in 2009 but late harvest mid September – see notes.

SUNCREST: 1999 Planting. ***** RATING**

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. Fruit tends to mature in LATE August. 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. Large crop in 2005 & 2006. No

crop in 2007 and large crop in 2008. Large crop in 2009 but late harvest mid September – see notes.

Notes:

- In 2009, we had a very cool May and June which apparently delayed the maturity of the peaches nearly 3 weeks with a mid September harvest.
- Also in 2009, we are starting to see advancing trunk damage on many of the peaches due to Cytospora Canker. This will eventually limit the lifespan of these trees.
- Only use ½ inch caliper or less nursery stock for new plantings.
- The only rootstock currently being evaluated on all varieties is Certified Peach.

Rating scale:

- **5 stars ***** Excellent potential**
- **4 stars **** Very good potential**
- **3 stars *** Good potential**
- **2 stars ** Poor potential**
- **1 star * Forgetaboutit**

Refer to Table 43 for specific yield information

PLUM VARIETIES-- Descriptions, Evaluations, and Ratings

EMPRESS – Myro: 2008 Planting
Large fruit similar to President but a better blue color. Yellow flesh with fine texture and late ripening. Initial growth is very good and still evaluating for a rating.

IMPROVED DUARTE – Myro: 2008 Planting
Extra large fruit, heart shaped with a flesh that is blood red. Initial growth is very good and still evaluating for a rating.

PRESIDENT – Myro: 2008 Planting
Large fruit with blue skin and yellow fine textured flesh. Initial growth is very good and still evaluating for a rating.

Rating scale:

5 stars *** Excellent potential**
4 stars ** Very good potential**
3 stars * Good potential**
2 stars ** Poor potential
1 star * Forgetaboutit

Refer to Table 43 for specific yield information