Technical Report TR06-06 April 2006

Agricultural Experiment Station

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Insets: Bottom left: "Apricots" – File photo
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Technical Report TR06-06

Agricultural Experiment Station	Cooperative Extension	Western Colorado Research Center: Fruita Orchard Mesa Rogers Mesa	June 2006

Western Colorado Research Center 2005 Research Report

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Colorado State University
Knowledge to Go Places

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Introduction

Change is the one constant faced by agriculture on a continuing basis. Low commodity prices and rising land values encourage farmers to look at new and alternate crops, alternate management approaches (including organic production), and marketing. The Western Colorado Research Center (WCRC), which is part of Colorado State University's network of Agricultural Experiment Stations, continues its mission of planning, implementing, and conducting research and outreach programs to address regional agricultural needs and help farmers find new answers and alternatives.

But we, too, face change on a continuing basis. Our second WCRC manager, Frank Kelsey, stepped down August 31st, 2005 and took another job with industry. During Frank's all too brief tenure at WCRC, the center had begun to settle into a more deliberate pace to address the issues above. We were winding down on the hybrid poplar agroforestry and grape bud burst delay projects, completing studies on water harvesting techniques for use in producing ornamental plants, moving ahead on the Uncompaghre revegetation projects, continuing to work on the sunflower latex rubber studies, shifting focus in the grape powdery mildew control studies to look at spot treatment options, and looking at new and alternative options for orchard replant problems. The viticulture project continues to expand as does the wine grape acreage within the state. And we also began to consider a more focused approach to organic production of fruit crops.

With Frank Kelsey's departure, Dr. Frank Johnson stepped in to serve as interim manager (an addition to his already busy job as Associate Director of the Colorado Agricultural Research Station at the main campus). In December 2005, the decision was made to not fill the manager position on a permanent basis, but to do so on a shorter-term interim basis with a full-time individual to be based at WCRC – Orchard Mesa. I was asked to serve in this capacity for the next 3 years remaining before I retire; after discussions with department heads and campus administration, I decided to accept this re-assignment. Hence it is now my responsibility to prepare this introduction to the WCRC Annual Report for 2005.

The 2005 calendar year also saw the departure of Lot Robinson, Support Staff at Fruita, after nearly 16 years of service.

We continue to update and expand our web page and link to the Tri-River Cooperative Extension web pages for other information. This is increasingly important as more farmers adopt computers as an information management tool. We realize they have access to a wealth of free information on the worldwide web, and we are trying to do our part to provide information of value to them in that venue.

I gratefully acknowledge the effort that support staff and faculty have made in ensuring the successful completion of this years' projects. The accomplishments reported herein would not have been possible without their cooperation & effort, as well as that of the Colorado Agricultural Experiment Station and the department heads associated with this center. And funding support has been provided by many sources; most, if not all, of these are acknowledged in the individual reports by the authors.

Harold Larsen
Interim Manager, Western Colorado Research Center (effective Jan. 1, 2006)

Agricultural Experiment Station - Western Colorado Research Center Site Descriptions

Fruita Location: 1910 L Road
Fruita, CO 81521
(970) 858-3629
(970) 491-0461 *fax*

WCRC - Fruita is an 80-acre property 15 miles northwest of Grand Junction. Site elevation is 4510 feet, average precipitation is slightly more than 8 inches, with an annual frost-free growing season of up to 175 days. Average annual daily minimum and maximum temperatures are 41° F and 64° F respectively. The primary soil types are Billings silty clay loam and Youngston clay loams. Irrigation is by way of gated pipe and furrows with ditch water from the Colorado River. Facilities at the Fruita site include an office building, shop, equipment storage building, field laboratory, tissue culture laboratory, and a dry bean conditioning facility. The Colorado State University Foundation Bean Project operations are managed at WCRC - Fruita. A comprehensive range of agronomic equipment is based at the site to facilitate research on a variety of agronomic crops.

Orchard Mesa Location: 3168 B 1/2 Road
Grand Junction, CO 81503
(970) 434-3264
(970) 434-1035 *fax*

WCRC - Orchard Mesa is located seven miles east and south of Grand Junction on B 1/2 Road. It lies at an elevation of 4,750 feet with Mesa clay loam and Hinman clay loam soil types. High temperatures average 93° F in July and 39° F in January. Lows average 64° F in July and 18° F in January. While the frost-free growing season averages 182 days, spring frost damage is frequent enough to be a production problem. Frost protection is provided by wind machines. Irrigation is by pressurized drip, micro-sprinkler and gated pipe systems supplied by ditch water from the Colorado River. Facilities at the Orchard Mesa site include an office-laboratory building with labs for plant pathology and viticulture research. Other buildings include a conference room, shop, and separate climate controlled and retractable roof greenhouses. Approximately twelve of the center’s 80 acres are devoted to experimental orchards, principally apples, peaches and pears. Three acres are dedicated to wine grape variety trials and research. The balance of acreage is utilized for hybrid poplar research, grass and alfalfa production, and small demonstration plantings of tree fruits including sweet cherry, sour cherry, apricot, and plum. Additional acreage is also utilized annually for dry bean variety trials and seed increases in conjunction with the CSU dry bean breeding project and Foundation Seed Project.

Rogers Mesa Location: 30624 Highway 92
Hotchkiss, CO 81419
(970) 872-3387
(970) 872-3397 *fax*

WCRC - Rogers Mesa is located 17 miles east of Delta and 3 miles west of Hotchkiss on Colorado Highway 92. Site elevation is approximately 5,800 feet, average annual precipitation is about 12 inches, and the average frost-free growing season is 150 days. The soil type is clay loam. High temperatures average 90° F in July and 38° F in January. Lows average 56° F in July and 17° F in January. Frost protection is provided by wind machines. Irrigation methods used include drip, micro-sprinklers, and furrow, all supplied from the Fire Mountain canal water. Facilities include an office-laboratory-conference room building, shop, residence, and greenhouse. Experimental orchards occupy approximately 8 acres, approximately half of which is managed organically. An organic table grape variety trial was planted in spring 2003, and wine grapes were planted in spring 2004. Research plots for seed production of native forages and shrubs were established in 2004. Research efforts on conventional vegetable production began in 1998 and have since expanded to include organic options.

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[1]Former Research Associate, resigned 2 December, 2005
[2]Former WCRC Manager, resigned 31 August, 2005
[3]Former Research Associate, resigned 28 March, 2005
[4]Former Support Staff, resigned 23 September, 2005

Advisory Committee

The Western Colorado Research Center (WCRC) Advisory Committee has two roles - advocacy and advisory. The advocacy role is to actively promote WCRC research and outreach activities with policy makers, producers, and the general public. Advocacy is the primary mission of the Committee. The advisory role is to provide input and feedback on research and outreach activities conducted through the programs of the Western Colorado Research Center.

The members of the WCRC Advisory Committee for 2005 are listed below. Committee members serve voluntarily without compensation. WCRC Advisory Committee meetings are open to the public. For the current memberhip list please visit our web page (http://www.colostate.edu/programs/wcrc/).

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Application of crop modeling for sustainable grape production

Horst W. Caspari[1] and Harold J. Larsen[2]

Summary

Based on observations in previous years (2002-2004) that powdery mildew infections within study vineyards might arise from “hot spots”, we investigated the potential to use GPS technology to a) identify and delineate infected versus non-infected areas, and b) target spray applications to the infected areas (plus a buffer zone) only. This alternative control strategy was evaluated on two commercial vineyards as well as Colorado State University's research vineyard. All sites were located within the Grand Valley AVA, Colorado. On the commercial vineyards, approximately half of a mature Chardonnay block received the grower's standard spray program ("grower") while the other half was managed according to powdery mildew modeling and the results of weekly, GPS-referenced disease assessments ("model"). At the CSU vineyard, the entire block was managed according to the "model" approach.

Powdery mildew incidence varied greatly between the three Chardonnay blocks used in the study. On one site, mildew was present and widespread in early June and required a season-long spray program. At the second site, a localised powdery mildew infection was found in the "model" block in early July and controlled by treating the "model" block only. Similar control of powdery mildew was achieved with three fungicide applications in the "model" block compared to five applications in the "grower" block. At the CSU vineyard, the first (mid June) and second (early July) application was restricted to infected areas, treating 56 and 37 % of the vineyard area, respectively, while the final application in late July was to the entire vineyard.

The results from the first season illustrate both the potential and limitations of this alternative control strategy. Early, widespread disease pressure at one site required a continuous spray program with no advantage of the "model" over the "grower" standard. On the other hand, excellent control of powdery mildew was achieved with a reduced ("model") spray program at one site while the targeted fungicide applications at the CSU vineyard resulted in the elimination of the equivalent of one spray. However, failure to treat infection "hot spots" resulted in a rapid expansion of infection from the "hot spot" area once the fungicide protection ran out. Timely analysis of GPS data and proper identification of spray target areas is likely to reduce the risk of re-infection from non-treated "hot spots".

Introduction

Grape powdery mildew is the primary disease of *Vitis vinifera* grapes in Colorado. Historically, the typical grape powdery mildew control program in western Colorado vineyards has been preventative in nature. Growers began applying prophylactic sprays when shoots were about 4-6 inch long and continued through veraison at intervals determined by the spray longevity of the materials used. This approach has historically resulted in four to as many as eight sprays applied each season.

Our previous studies have investigated the combined use of weather monitoring, computer modeling for grape powdery mildew risk based on the collected weather data and crop development stage, field scouting, and prescribed fungicide sprays when powdery mildew infection is found. We have shown that it is possible to substantially reduce the number of pesticide applications to control grape powdery mildew by basing the applications on model assessment of mildew infection risk and observed infection confirmation (Caspari and Larsen, 2005). As a result, much of the wine grape industry in western Colorado has reduced the number of mildewcide applications through adoption of our recommendations to apply

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mildewcides only when needed, not simply on a calendar basis. For example, survey data from 2004 indicate that growers used on average only 2.6 fungicide sprays to control powdery mildew on producing vineyards, while preliminary data for 2005, a year with a higher disease pressure, show an average of 3.4 sprays.

In the previous studies it was observed that powdery mildew infections within the study vineyards might arise seasonally from vineyard "hot spots." The infection then spreads to other parts of the vineyard if not controlled by fungicide sprays. Once an infection is noticed, growers then typically apply fungicide sprays to the entire vineyard to protect developing fruit from infection. This vineyard-wide application results in spray materials being applied to substantial portions of the vineyard that have no observable infection. In this current study we are investigating whether it might be possible to further reduce the amount of fungicides applied by use of closer field monitoring with the "hot spots" identified within the plots by fine discrimination GPS coordinates tied to prompt application of effective fungicides to these "hot spots."

Materials and Methods

Two cooperator vineyards were identified with a minimum 2 acres of Chardonnay. The blocks are the same that we have used continuously since 2002 for our previous study. Grower cooperators were to use their choice of control programs (grower's standard control program) for grape powdery mildew control on one half of the block (minimum of 1 acre) and to use the control program designated by the researchers for the other half of the block (minimum of 1 acre, which included the site of a remote weather station described below). The two different blocks/treatments will be referred to as "grower" and "model" (Fig. 1). In addition, Colorado State University's entire research vineyard was managed according to the researchers' protocol. The spray programs varied from three to five sprays per season between sites (Table 1-2).

Table 1. Powdery mildew spray programs used at cooperator vineyard B during the 2005 season.

Grower's Standard Mildew Program			Integrated Disease Management Program		
Date	Materials & rates used	Cost[z]	Date	Materials & rates used	Cost[z]
5/10	Thiolux 80DF @ 6 lbs/a	$5.10	5/10	Thiolux 80DF @ 6 lbs/a	$5.10
5/23	Rubigan @ 3.5 oz./a	$8.26			
6/14	Sovran @ 4 oz./a	$25.75			
7/5	Stylet-Oil @ 1.5%	$19.50			
			7/11	Rubigan @ 6 oz./a + Sulfur 6L @ 7 pts/a	$14.16
8/5	Nova 40W @ 4 oz./a + Sulfur 6L @ 5 pts/a	$22.20	8/5	Nova 40W @ 4 oz./a + Sulfur 6L @ 5 pts/a	$22.20
Total Spray Program Cost		**$80.81**	Total Spray Program Cost		**$41.46**

[z] Costs per acre for spray material only.

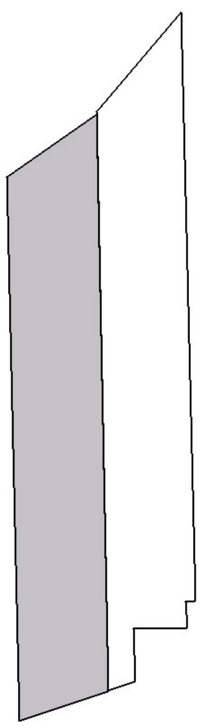
Table 2. Powdery mildew spray programs used at the CSU vineyard during the 2005 season.

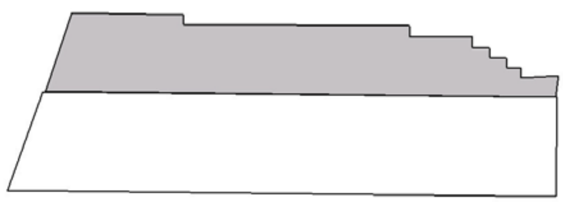
Date	Materials & rates used	Cost[z]	Area treated (%)
6/17	Pristine 38WDG @ 8 oz./a + Stylet-Oil @ 1 %	$39.60	56
7/7	Nova 40W @ 5 oz./a + Thiolux 80DF @ 5 lbs/a	$25.75	37
7/27	Pristine 38WDG @ 11.5 oz./a + Stylet-Oil @ 1.5 %	$57.74	100
	Total Spray Program Cost	**$123.09**	

[z] Costs per acre for spray material only.

Automated Adcon weather stations were installed at the three sites in 2002. Each station is equipped with sensors to measure air temperature, humidity, leaf wetness, precipitation, wind speed and direction, and solar radiation. Data was relayed back to a base station at CSU's Western Colorado Research Center via radio telemetry on 15-minute intervals. The base station database was then accessed using the Thomas-Gubler powdery mildew disease model to assess mildew infection risk.

As in previous years, field scouts assessed powdery mildew infection incidence and severity on variable intervals, typically once a week. Incidence and severity of powdery mildew infections on leaves were recorded from late May to mid August 2005 (about veraison). Similar to 2004, samples included both basal (near the fruit zone) and more apical leaves at each sampling time. Contrary to 2004, sampling was at random although an effort was made to sample all areas of the blocks. At each sampling date, the incidence and severity of powdery mildew was determined on two leaves per vine on a total of 50 vines per plot (i.e. 100 samples per plot, and 200 samples per site). In 2005, field scouts were equipped with a Global Position System receiver (Trimble *Ag*GPS 114 receiver connected to a HP iPAQ handheld computer). The *Ag*GPS 114 receiver uses Differential GPS to achieve high, submeter accuracy. The use of this system allowed the calculation of a 3D position (latitude and longitude, altitude, and time) of the disease data. After downloading the field data to a desktop PC, the sample locations as well as the disease incidence could then be visualised using a dedicated software program (FarmGIS, Red Hen Farming Systems, Fort Collins, CO), and maps showing the distribution of powdery mildew (if present) by severity were created using MapCalc software (Red Hen Farming Systems, Fort Collins, CO). This information on distribution and severity was then used to determine if a fungicide application should be applied, and to what areas of the "model" plot. Although we provided information about powdery mildew severity and distribution to the cooperating growers, any fungicide application in the "grower" plot was always to the entire plot.





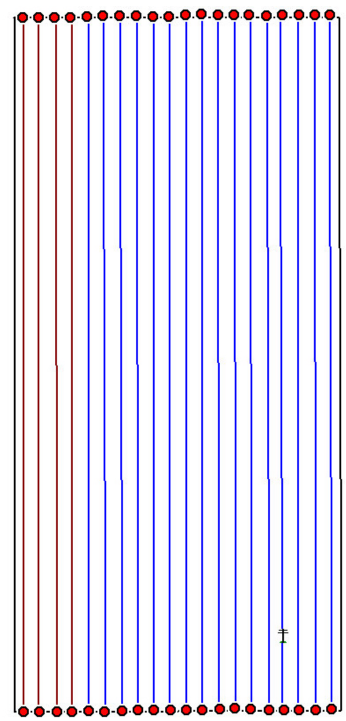


Fig. 1: Boundary maps (not to scale) of vineyard A (left) and B (top), and CSU's research vineyard (right). Vineyards A and B are Chardonnay, and the "model" plot is shown in gray. The eastern 16 rows (blue lines) of the CSU vineyard are Chardonnay while the western four rows (brown lines) contain 20 different varieties. The entire CSU vineyard was managed according to the "model" approach.

Results and Discussion

Weather conditions in the spring of 2005 differed slightly from those of 2004. While there were frequent precipitation events in late April and early May, they apparently did not cause a primary infection. This lack of early-season infection is likely due to a combination of insufficient wetness duration, insufficient rainfall, and/or low temperatures. The first half of June was rather cool and there were six days with measurable precipitation. Powdery mildew was not found in any of the monitored vineyards until early June (vineyard A) or early July (the other two sites).

Although sampling was at random, there was good overlap and thus good representation of the plots between sampling dates. For example, Figure 2 shows the sample locations for two successive sampling dates at vineyard B. There are 100 observation points in both the "grower" and "model" plot for each date.

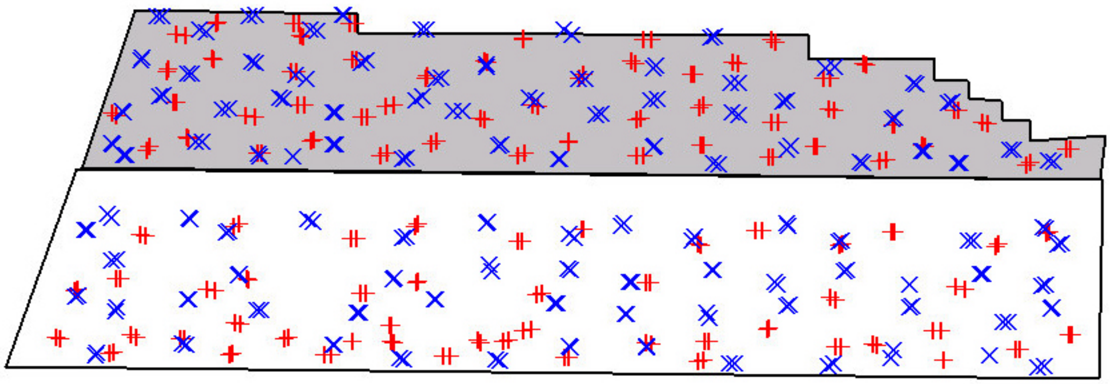


Fig. 2: Locations of powdery mildew assessments at vineyard B on two successive sampling dates (13 (+) and 20 (**x**) July 2005). The gray area is the "model" plot. Note that due to close overlap not all locations are visible. This close proximity of observations may cause darkening or blurriness of symbols due to scale.

The onset and spread of powdery mildew differed both between vineyards and between treatment plots within vineyards. At vineyard A, the first powdery mildew was observed on June 1 in the "model" plot only. Two fungicide applications (June 3 and 13) in the "model" plot reduced incidence and severity of powdery mildew, but did not eliminate it. In fact, due to operator error one row was not treated during the second application, and the incidence and severity of powdery mildew increased quickly from this "hot spot". The distribution along the row as well as the spread can be clearly seen in Figure 3 (compare maps from 15 to 27 June). In contrast, there was no powdery mildew in the "grower" plot until 22 June. It appears that two early-season fungicide applications, which were not applied in the "model" plot, did provide protection in the grower plot.

With the exception of the "hot spot" in the non-treated row, the severity of powdery mildew was generally low in both the "model" and "grower" plots and there was no infection of fruit. However, some fruit infection was found in the "hot spot". A final, pre-veraison fungicide application in both plots provided reasonable control of powdery mildew.

At vineyard B, the first powdery mildew was found on 7 July in the "model" plot only (Fig. 4). Similar to vineyard A, there was no mildew observed in the "grower" plot at that time. However, the "grower" plot had received three additional fungicide applications (Table 1). An application in the "model" plot provided initial control, but powdery mildew was again found nine days after the application. It is interesting to note that the areas where mildew was found were very similar (Fig. 4, compare the top two maps on the left). The fact that scouts did not find any powdery mildew one week later (27 July) although no further spray was applied suggests that high temperatures in July inhibited and likely even reduced fungal growth. A few infected leaves were found in the "grower" plot in early August but no mildew was found in either plot on the last observation following the final, pre-veraison spray. Overall, few infected leaves were found and the severity of powdery mildew was low. Similar good control was achieved in both plots but with two less sprays and at approximately half the pesticide costs in the "model" compared to the "grower" treatment (Table 1).

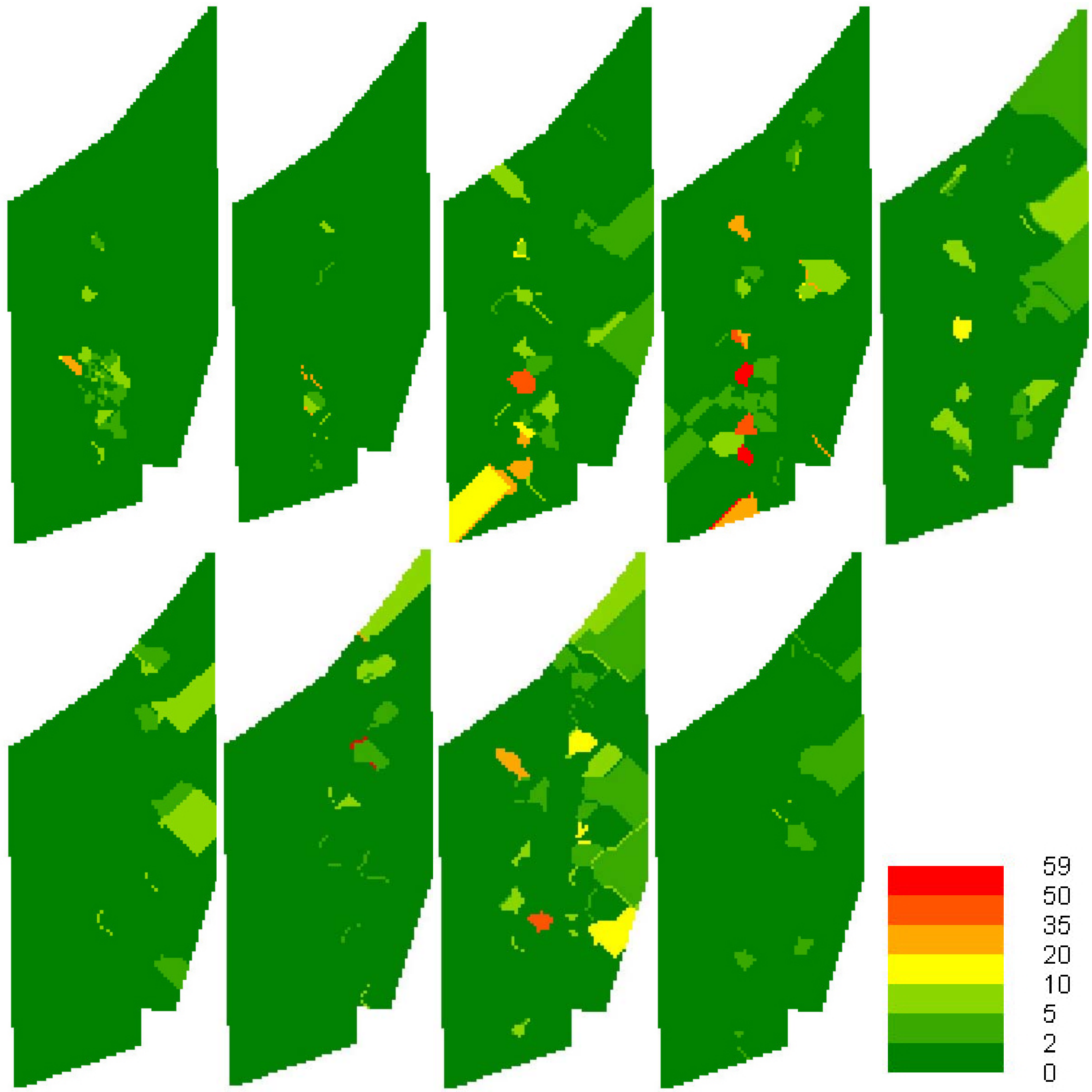
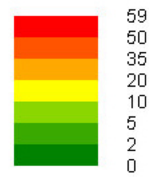


Fig. 3: Distribution and severity of powdery mildew on Chardonnay grape leaves at vineyard A. From left to right: 1, 15, 22, & 27 June, 6 July (top), 12 & 26 July, 1 & 11 August 2005 (bottom).

Fig. 4: Distribution and severity of powdery mildew on Chardonnay grape leaves at vineyard B. From left to right: 7 & 13 July (top), 20 & 27 July (middle), 1 & 9 August 2005 (bottom). Note that maps for five earlier dates are not shown as no mildew was found.



The pest management approach at CSU's research vineyard differed slightly from the commercial vineyards. First, the entire vineyard was managed as a "model" plot; and second, the first two fungicides were applied to only those areas that had powdery mildew infection (plus a buffer zone). Initially, the scouts only recorded positive observations - in other words, leaf samples and locations that did not have mildew infections were not recorded - which then did not allow us to create the maps of mildew distribution and severity for the first three observation dates. However, the locations of infected leaves are shown in the top left diagram of Figure 5a. There were four (1 and 7 June) and nine (15 June) infected leaves out of a total of 200 samples. The first mildew spray was applied on 17 June to those areas where infected leaves had been found, leaving about 44 % of the total vineyard area non-treated. This non-treated area is highlighted in gray in the second diagram in Fig. 5a. Ten days after the spray, powdery mildew was found in three isolated areas, two in the treated area and one in the non-treated area (Fig. 5a, top right). However, mildew was found in only one of those areas at the next observation date. Again, it is likely that high temperatures in July could have caused dieback of mycelium on the leaf surface, thus making it more difficult to identify infected leaves.

Observations on 5 July of powdery mildew infections at a relatively high severity in the previously non-treated area (Fig. 5a, bottom left) triggered a second fungicide application. Again, this spray was targeted towards infected areas only, treating approximately 37 % of the vineyard area. Treated rows or row segments are shown in the diagram in Figure 5a (bottom row) as red lines. It is worth noting that the treated area more or less equals the non-treated area of the first application (compare diagrams in second column of Fig. 5a). This spray provided good control in the treated area, however a "hot spot" developed in an area that had not been covered by the first and second spray (Fig. 5a, bottom right). The final pre-veraison spray was then applied to the entire vineyard and provided adequate control (Fig. 5b). In 2005, late-season powdery mildew infection was much less than in previous years, and no fruit infection was found.

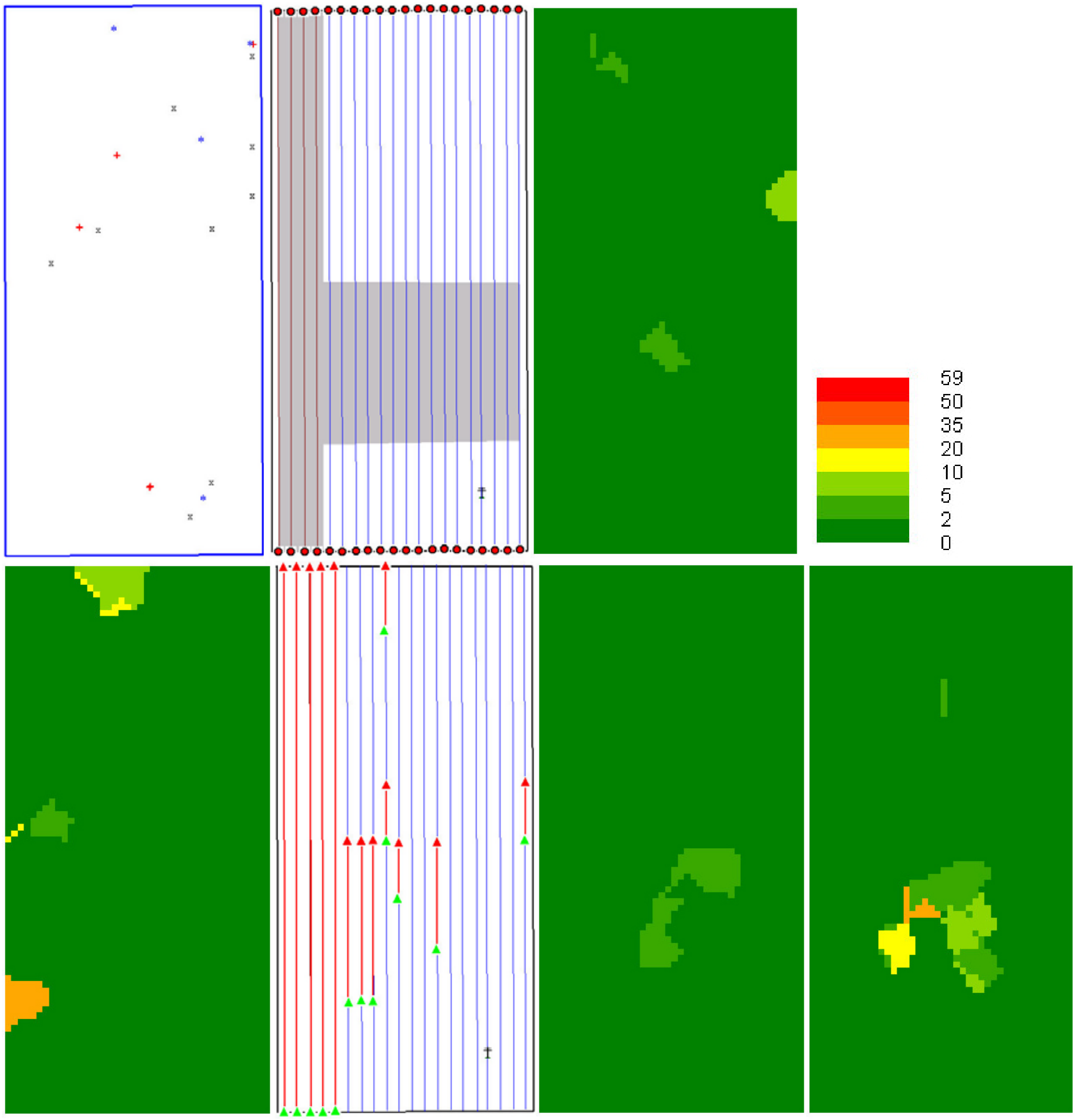


Fig. 5a: Distribution and severity of grape powdery mildew at the CSU research vineyard, and diagrams of areas where fungicide applications were applied. Top row from left: locations were powdery mildew was observed on 1 (+), 7 (*), and 15 (x) June; area treated in response to mildew observations (gray area was not treated); and map of powdery mildew distribution on 27 June 2005. Bottom row from left: Map for 5 July; diagram of treatment area (red lines bordered by green and red triangle represent treated areas); and maps for 11 and 18 July 2005.

This year's data confirm the results from the previous three years that grape powdery mildew can be effectively controlled with a spray program that is reactive rather than preventative in nature. Using such a program can lead to significant reductions in both spray applications and the costs for spray materials, as shown in Table 1 for vineyard B. However, when powdery mildew establishes early in the season, as was the case in the "model" plot at vineyard

A, an effective control strategy might require as many applications as a preventative program. It is worth noting that over the past four years we have always found powdery mildew infections at vineyard A earlier in the season than at vineyard B, and the incidence and severity were generally higher.

The strategy of treating only infected areas ("hot spots") identified through GPS-assisted field scouting was applied at the CSU research vineyard only, but not on the commercial vineyards. Limiting spray applications to "hot spots" obviously was not an option at vineyard A due to the widespread infection, but could have been used at vineyard B. However, limitations in both software and operator training prohibited us from analysing the GPS data in a timely manner, and all the data was processed and analysed post-harvest. Based on the positive results from the CSU research vineyard we now feel more comfortable to apply the same strategy on the vineyards of our commercial collaborators during the 2006 season.

Following further software training in early January 2006, we now also have a better system for data sampling and analysis and will be able to process the data shortly after it has been collected. This will allow us to provide collaborators detailed information if and where fungicide sprays might need to be applied within one or two days of data collection.

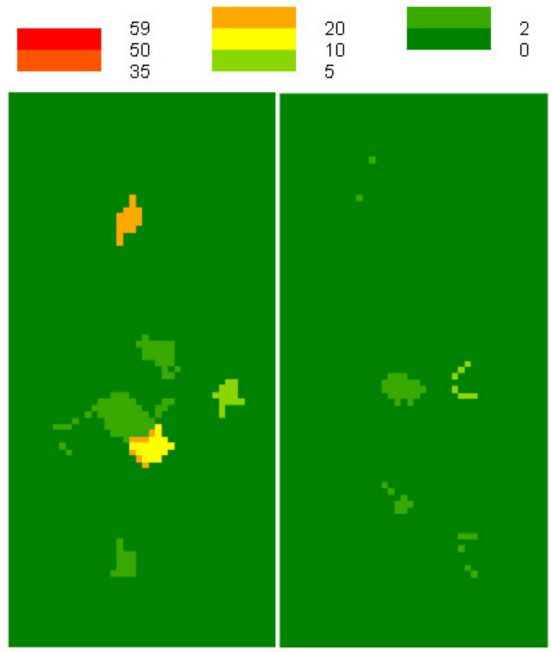


Fig. 5b: Distribution and severity of grape powdery mildew at the CSU research vineyard. From left to right: 27 July and 11 August 2005.

Acknowledgments

Field evaluations were done by Tana and Christa Hawk, Sarah Hammelman, and Bruce Culver. Sprays were applied by the field staff of the cooperating vineyards: Canyon Wind Cellars and Grande River Vineyards (Riverview Vineyard). Cooperation was provided by Norm Christianson and Ben Parsons (Canyon Wind), and Jim Mayrose and Stephen Smith (Riverview Vineyard).

The weather station network was initially established using partial funding from the Rocky Mountain Association of Vintners and Viticulturists (RMAVV), and through partial funding from the Colorado Specialty Crops Program granted to RMAVV. Funding for the technicians/scouts and GPS hardware and software has been obtained through an EPA grant that was awarded in July 2002, and amended in July 2004.

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Effects of Irrigation Water and Soil Acidification on High pH Soils and Crop Quality

Ron Godin[1], John Harold[2], Kim Schultz[3], and Jim Rhode[3]

Summary

More than 9,000 acres of sweet corn are grown annually in western Colorado with a farm-gate value of approximately $16 million. Over the past decade growers and extension agents have noticed a steady increase in soil pH along with an increase in micronutrient deficiencies with some yield reductions. Preliminary soil tests on this calcareous soil showed pH ranged from 7.5 to 8.0. Irrigation water pH is high and increases through the season, in early May irrigation water pH is near 7.8 and increases to 8.3 in the latter part of the growing season. Water analysis showed bicarbonate levels in the irrigation water range from 650 ppm to 900 ppm. This study was initiated to determine if acidification of the irrigation water and/or amending the soil with compost or elemental sulfur could reduce soil pH thus improving the soil nutrient availability and therefore improve crop yield and quality. This was an on-farm study using standard commercial sweet corn growing and harvesting practices. The design was a split plot with acidification/no acidification as the main plot treatments and compost (10 tons ac^{-1}), elemental sulfur (1/2 ton ac^{-1}) and a control as the sub-plot treatments, for a total of six treatments. The first year's results in 2004 did not show any significant differences in any soil or crop parameter tested. However, in year two there were significant differences in soil pH, phosphorus and potassium levels. There were also significant differences in the number of marketable ears per acre and corn brix levels. Following the second year of this three-year study we can conclude that irrigation water acidification and compost additions are improving a number of soil and crop parameters.

Introduction

Sweet corn grown in the Uncompahgre Valley of western Colorado is a high value crop with more than 9,000 acres of sweet corn grown annually with a farm-gate value of approximately $16 million (CASS, 2004). The calcareous soils in the Uncompahgre Valley have been under irrigated agriculture for more than one hundred years. Growers in the area have been noticing a decline in soil quality and productivity over the last 10 to 15 years. This decline is probably due in part to rising soil pH levels that reduce crop nutrient availability which leads to reduced crop health, vigor and yield. Preliminary investigations showed the irrigation water and soil have high pH levels. Initial measurements of irrigation water pH ranged from pH = 7.8 to 8.3 and soil pH from 7.5 to 8.0. High levels of bicarbonate in the irrigation water are probably responsible of exacerbating the situation with levels between 650 – 900 ppm. This study was initiated to determine if acidification of the irrigation water and/or amending the soil with acidifying soil amendments could reduce soil pH and improve the soil and crop quality. Typically, soil in the Uncompahgre Valley contain from 1.5 to 5% lime and are therefore highly buffered (Swift, 2005). Many researchers have studied the use of sulfuric acid added directly to the soil to reduce soil pH in calcareous soils and as an aid to reclamation of sodic and alkaline soils (Miyamoto, et al., 1974; Miyamoto, et al., 1975c; O'Connor and Lee, 1978; and Stroehlein and Pennington, 1986) or used compost for the same purpose (Avnimelech et al., 1994). However, the lack of application equipment, cost of direct soil application of sulfuric acid and high irrigation water bicarbonate levels necessitate the application of acid into the irrigation water in order to possibly remedy the situation. Some researchers have studied the effects of sulfuric acid additions to irrigation water on soil properties and nutrient availability

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(Miyamoto, 1977; and Mohammed, et al., 1979). However, few researchers have studied the effects of irrigation water acidification and compost addition alone or in combination on vegetable yield and quality on calcareous soils. This three-year study was begun in 2004 in cooperation with John Harold, a commercial sweet corn grower in Olathe, Colorado to determine the effects of irrigation water acidification and in combination with compost or S applications on crop yield and quality and crop nutrient availability. This study used six treatments, acidification or no acidification of the irrigation water coupled with compost, sulfur or no soil amendment (control). The first year's results showed no significant differences in any soil or crop parameters tested, however, there were trends towards lower soil pH and increased nutrient availability in the treatments that had either the irrigation water acidification or compost added or both. In 2005 there were significant differences in many soil and crop parameters indicating that treatments are beginning to have some effect on these highly buffered soils.

Materials and Methods

This on-farm research was conducted in cooperation with John Harold in Olathe, Colorado in the Uncompahgre Valley in 2004 and 2005. Sweet corn (*Zea mays* L.) var. Chief Ouray (Mesa Maize, Olathe, Colorado) an 85 day relative maturity super-sweet corn was planted in the first week of June and harvested either the last week of August or the first week of September, 2004 and 2005 respectively. Plant populations were 26 400 ac^{-1} (8 inches between plants on 30 inch row spacing). All plots were side-dressed at the six-leaf stage with 150 lbs N ac^{-1} using liquid 28-0-0. The corn was furrow irrigated approximately every week to ten days as needed throughout the season. Irrigation sets were 12 hours long. There were 13 irrigations in 2004 and 14 irrigations in 2005. Reference ET for 2004 was 24.1 inches and 23.3 inches for 2005, determined at a Colorado State University meteorological station approximately 3 miles from the study field. Cooler temperatures in 2005 lengthened the growing season necessitating the additional irrigations. The soil is a Cherylade clay loam [fine-loamy, mixed, mesic, Typic Haplargid]. The experimental design is a split plot design with two main plot factors, acidification or no acidification of irrigation water and three sub-plot factor of soil amendments of composted chicken manure (10 tons ac^{-1}), elemental sulfur (S) (1/2 ton ac^{-1}), or no amendment (control) for a total of six treatments and three replications. The 18 plots are 16 rows wide by 1100 feet long for a total of one acre per plot. Treatments were: 1) no irrigation water acidification and compost added (NAC), 2) no acidification and S added (NAS), 3) no acid control (no soil or water treatment imposed as a check, this is also standard farmer practice) (NACon), 4) irrigation water acidification and compost added (AC), 5) irrigation water acidification and S added (AS) and 6) irrigation water acidification only (ACon).

Irrigation water samples were taken throughout the season at each irrigation and monitored for pH. Irrigation water acidification was done using commercially available concentrated sulfuric acid, approximately 17.5 molar concentration, dripped into the irrigation ditch to reduce irrigation water pH to approximately pH = 6.5. Sulfuric acid use was approximately 40 gals ac^{-1} for the season at a cost of $2 per gallon.

Twenty soil cores were taken randomly from the surface foot from each plot and composited, air dried and sent to a commercial soil testing lab for complete analysis. Soil samples were taken from each of the 18 plots prior to planting, at mid-season and following harvest each year. Yields were determined by counting the number of 48 ear boxes (standard commercial container) harvested per plot. Harvesting was done using commercial sweet corn harvesting crews and equipment. Two sweet corn parameters were used to define quality, the average ear weight and brix, or percent soluble solids, a standard measure of sweetness in the fruit industry. Although ear weight and brix are not criteria for grading provided the ear is of marketable size and sufficiently developed, they are critical marketing criteria. A standard hand-held refractometer was used to measure brix (McCormick Fruit Tech, Yakima, WA). At harvest, 10 ears were taken at random from each plot, and all husk and cob containing no kernels was removed, to determine an average ear weight. To determine brix, kernels were cut from the 10 ears, mixed thoroughly and the juice pressed onto the refractometer lens using a hand garlic press. The reading was repeated three times and the readings were averaged for each plot. All crop and soil data was analyzed statistically at a least significant difference of 0.1 or 90% certainty level (SAS, 1985). There were no water treatment by soil amendment interactions; therefore all treatments were analyzed together.

Following harvest the residue was grazed by cattle for approximately 2 weeks and then the stubble was disced into the soil the following spring as part of the field preparations.

Results and Discussion

Irrigation Water

Irrigation water pH was taken at the field at each of the irrigations throughout the growing season and ranged from 7.8 to 8.3, from planting to harvest, respectively, and averaged a pH = 8.1. The principle reason for the high pH in the irrigation water is due to dissolved bicarbonates in the water. Bicarbonate levels ranged from 650 – 900 ppm through the growing season.

The amount of sulfuric acid needed to neutralize the high irrigation water pH (to pH = 6.5) averaged 18 gallons per acre-foot of irrigation water. The estimated water application for both years was approximately 2.25 acre-feet ac^{-1}.

Sweet Corn Yield, Quality and Revenue

The sweet corn yields were higher in the three treatments receiving acidified irrigation water than the non-acidified treatments, however, the yields were only significantly higher than the NACon treatment (Table 1). It appears that the sweet corn yields are responding to treatments, with the most response due to acidification of the irrigation water as opposed to soil treatments alone. There has been little work done on the effects of high soil pH on corn productivity or the maximum soil pH tolerated by corn before yield declines occur. However, it appears that although the soil pH in the top foot of soil has not been significantly reduced in all acid treatments (data presented below), the reduced pH of the irrigation water is having a positive effect on sweet corn yields by possibly, temporarily reducing the pH in the crop root zone.

Table 1. Sweet corn yield, ear weight, Brix, income and revenue.

Treatment	**Yield** (boxes ac^{-1})	**Ear Weight** (g)	**Brix** (% sol. solids)	**Income** (@\$8 box^{-1})	**Cost of Acid** (@ \$2 gal^{-1})	**Net Revenue** (\$ gain over NACon)
NAC	460ab†	294a†	20a†	$3680	$0	$104‡
NAS	457ab	288ab	19ab	$3656	$0	$80
NACon	447b	272c	17b	$3581	$0	$0
AC	475a	280abc	20a	$3803	$80	$144
AS	476a	270c	19ab	$3805	$80	$152
ACon	494a	274bc	19ab	$3949	$80	$296

† numbers followed by different letter significantly different at $P < 0.1$.
‡ Net revenue = (treatment income – (NACon income + cost of acid).

Sweet corn ear weights were significantly higher in the NAC treatment than the NACon and AS treatments with other treatments falling in-between (Table 1). There is no discernable pattern or trend and the reason for these results is not apparent at this time. The sweet corn brix was significantly higher in both compost treatments than the NACon treatment (Table 1). Higher soil K in the compost treatments may be directly responsible higher brix in the sweet corn in those treatments. The K in plants aids in sugar translocation from the leaves to the fruit, the higher the plant K the more sugars are translocated (Marschner,1995).

The wholesale price for sweet corn in 2004 and 2005 averaged approximately \$8 box^{-1} (John Harold, personal communication). Calculations for the increases in production cost of acidifying the irrigation water were approximately \$80 ac^{-1} using a cost of \$2 gal^{-1} for sulfuric acid. The revenue generated by the increase in corn yield for non-control treatments over the NACon (control) treatment is given in Table 1. This calculation does not take into account the added time/labor costs of irrigation water acidification that averaged an additional half hour of labor per irrigation or the additional input costs of the S or compost. These calculations show that the acidification of irrigation water in combination with or without soil amendments increased grower revenue from between \$144 and \$296 (Table 1). This suggests that the farmer standard practice may be detrimental to the soil and the farmer's bottom line.

Soil Quality

The soil quality parameters that were examined for this study include soil pH, EC, soil organic matter (SOM), and essential crop nutrients. Significant differences were observed in some of the soil parameters examined in 2005, showing that the treatments were starting to have an effect on soil quality in the second year of the study. These results also show that the soil system is well buffered.

The soil pH prior to the start of the study in 2004 averaged pH = 7.9. As of the fall of 2005 soil pH had dropped in all treatments, however, a significant drop in soil pH was seen in the treatments where the irrigation water was acidified and compost was added to the soil as was anticipated (Table 2). The reason for the slight reduction in the NACon treatment is not know but may be due to field and sampling variability.

Soil salinity (EC) did not show any significant difference between treatments; however, the average salinity was higher in fall 2005, at 1.0 mmhos, than in spring 2004, at 0.5 mmhos. This increases is probably due to soil deposition of salts contained in the irrigation water. It was expected the acidified treatments would have significantly higher salinity levels because of the reaction of soil lime with the acidified irrigation water. However, calcium has the beneficial effect of flocculating soils, making the soil more porous, this in turn may have allowed more water infiltration and movement of salts below the soil sampling zone.

Although the compost treatments had slightly higher SOM there were no significant differences in SOM levels for 2005 and averaged 1.23%. The SOM level prior to the start of the study was 1.18%.

Table 2. Sweet corn soil parameters.

Treatment	**Soil pH**	**P** (ppm)	**K** (ppm)	**Zn** (ppm)
NAC	7.6b†	97a†	372a†	8.5a†
NAS	7.7ab	41c	248b	7.4bc
NACon	7.8a	38c	243b	7.4bc
AC	7.7ab	84b	327a	8.1ab
AS	7.8a	40c	228b	6.9c
ACon	7.8a	39c	234b	6.9c

† numbers followed by different letter significantly different at $P < 0.1$.

There were no significant differences in soil nitrate-nitrogen (NO3-N) following this year's harvest and residual soil NO3-N averaged 50 ppm. Available soil phosphorus (P) did show significant differences for 2005 with the compost treatments having significantly higher soil P than any other treatments (Table 2). These higher levels are due to the additions of P from the compost. Approximately 250 lbs P ac^{-1} was added from the compost in 2005. Soil potassium (K) levels were significantly higher in the compost plots than in any of the other treatments. This is also due to the potassium contained in the compost (Table 2). Approximately 350 lbs K ac^{-1} was added from the compost in 2005. Soil zinc (Zn) was significantly higher in the treatments receiving compost than the AS and ACon treatments

(Table 2). The lower Zn levels in the AS and ACon treatments may be due to their higher yields uptaking more zinc than the lower yielding treatments. Soil manganese, copper, sulfur, iron and boron did not show any significant differences between treatments. It is possible that these parameters will begin to show some differences following next year's work.

Conclusions

The soil pH was lower where acid and compost treatments were imposed. Soil phosphorus (P) and potassium (K) levels are significantly higher in compost-amended treatments, as would be expected. Marketable yields were highest where acid was added to the irrigation water. Brix measurements were highest where compost was added. In general, second year results showed improvements in soil quality and corn yield and quality where irrigation water acidification and compost treatments were applied.

These results show significant differences in many of the crop and soil parameters tested. The results indicate that the soil and crop is responding to treatments following a second year of treatment applications. It appears from these results that the compost is enriching the soil more than other treatments and that the acidification is enhancing the benefits of all inputs and improving the soil quality in general.

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Pinto Bean Variety Performance Test at Montrose, Colorado 2005

Calvin H. Pearson[1], Mark A. Brick, Jerry J. Johnson, J. Barry Ogg, and Cynthia L. Johnson[2]

Summary

A pinto bean variety performance test was conducted at the Keith Catlin Farm in Montrose, Colorado during the 2005 growing season. Similar studies were conducted at the Keith Catlin Farm in 2003 and 2004. Seed yields in the 2005 trial averaged 1340 lbs/acre and yields ranged from 1737 lbs/acre for 00218 to a low of 677 lbs/acre for 03222. Average seed yield in 2003 was 2878 lbs/acre and in 2004 yields averaged 1673 lbs/acre. A powerful hailstorm damaged the plot area on 16 Aug 2005 and significantly reduced plot yields.

Introduction

Data obtained from dry bean variety performance tests are important to provide Colorado farmers and others with information that has been obtained under local conditions in the dry-bean producing areas of the state. It is also important to test yield performance of dry bean varieties in the seed-producing areas of Colorado. Seed growers must know if yields of popular dry bean varieties will be profitable for seed production.

Variety yield performance data can be used by various people- farmers when selecting varieties to plant on their farms, seedsmen in knowing which varieties to grow for seed production, companies to determine which varieties to market and in which locations varieties are best adapted, and university personnel in developing new dry bean varieties and in educating people about them. Dry bean variety performance trials conducted at several locations around the state are also important because data can be obtained from several environments in a single year. This provides considerable information in a short amount of time about the performance of dry bean lines and varieties in diverse environments.

Materials and Methods

A dry bean variety performance test was conducted at the Keith Catlin Farm in Montrose, Colorado during 2005. The trial location was at N 38° 29.035', W 107° 54.865' and at an elevation of 5868 feet. The experiment was a randomized complete block with three replications. Seventeen entries were included in the 2005 trial. Plot size was 5-feet wide by 35-feet long (2, 30-inch rows). The previous crop was pinto bean. Fertilizer banded at planting time was 22 gallons/acre of 10.7-30-0-2.5S.

Lasso MicroTech herbicide at 2.0 qt/acre and Sonalan at 1.0 pt/acre as a tank mix was applied preplant broadcast and incorporated. Planting occurred on 3 June 2005 with an air planter modified for planting plots. Seeding rate was approximately 89,302 seeds/acre. Dimethoate (1pt/acre) was applied sidedress at planting to control insects.

The experiment was furrow-irrigated with siphon tubes approximately ten times during the

Dry bean harvest at Fruita, Colorado. Sept 28, 2000.

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growing season. Plots were cut with a Pickett One-Step™ rod cutter windrower on 14 Sept. 2005 and threshed on 3 Oct. 2005 using a Hege small plot combine equipped to harvest dry beans.

Results and Discussion

Weed control across the plot area was good. The 2005 cropping season in western Colorado was mild and longer compared to many other years. Adequate irrigation water was available during the growing season and, thus, was not a limiting factor for crop production. A severe thunderstorm with nickel-sized hail occurred on 16 August 2005 and severely damaged the plots.

Average seed yield in 2005 was 1340 lbs/acre and yields ranged from 1737 lbs/acre for 00218 to a low of 677 lbs/acre for 03222 (Table 1). Six entries yielded more than the other eleven entries. Two entries were particularly low yielding. CO12613 yielded only 815 lbs/acre and 03222 yielded only 677 lbs/acre. These two varieties may have been particularly more vulnerable to the hailstorm that occurred on 16 August.

Average seed size in the 2005 trial was 1315 seeds/lb (Table 1). Average seed size in 2003 and 2004 was 1393 and 1190 seeds/lb, respectively. Seeds/lb in 2005 ranged from a large seed size of 1180 seeds/lb for Poncho to a small seed size of 1432 seeds/lb for Grand Mesa.

For more information and results on dry bean testing in Colorado visit the web site at: http:www.csucrops.com.

Acknowledgments

We thank Keith Catlin for allowing us to conduct this study on his farm. Appreciation is also extended to Lot Robinson (formerly CSU) and Fred Judson (Western Colorado Research Center staff), and Daniel Dawson (part-time hourly employee) who assisted with this research. We express appreciation to the Colorado Dry Bean Administrative Committee for funding this research.

Table 1. Pinto Bean Variety Performance Trial at Montrose[1] in 2005.

Variety	Yield	Seed/lb
	lb/ac	No.
00218	1737	1271
99195 MR	1716	1356
Buckskin	1697	1330
Myconate - Treated	1665	1230
00211	1605	1211
Canyon	1554	1336
Myconate - Non-Treated	1509	1320
Montrose	1484	1323
99236	1401	1395
01223	1266	1369
00185	1253	1327
Bill Z	1195	1300
Poncho	1146	1180
CO12531	1059	1228
Grand Mesa	1002	1432
CO12613	815	1243
03222	677	1510
Average	**1340**	**1315**
$LSD_{(0.30)}$	220	

[1]Trial conducted on the Keith Catlin farm; seeded 6/3 and harvested 10/3.

NC-140 Fruit Tree Rootstock Trials 2005 Reports

1998 Sweet Cherry Rootstock Trial

Ron Godin[1]

Summary

This is the end of the seventh year (eight leaf) of this planting. The trees are maturing well with size and yield differences evident in the data. The NC-140 committee decided that as of the fall of 2004 the trees should no longer be kept on central leader training but be pruned to commercial open vase architecture. Although a spring freeze did reduce yields the Weiroot 13 (W13), Weiroot 158 (W158) and Edabriz rootstocks performed well with the W13 significantly out-yielding the others. The Weiroot rootstocks, in general, have a more open rather than upright scaffolding with large numbers of fruiting buds.

Introduction

Until a few years ago, there had not been a good dwarfing rootstock for cherry. Several Prunus species and crosses have been made that resulted in potential dwarfing rootstocks for sweet cherry. The Gisela® series is one such example. This trial was initiated in the NC-140 committee (NC-140 is composed of tree fruit researchers across the U.S. and Canada that do research on tree fruit rootstocks) to see how these relatively new Prunus rootstocks would perform over a range of climates. The objectives of this trial were to determine the adaptability of differing Prunus rootstocks to western Colorado, to determine if these rootstocks induce dwarfing, and to determine if any of these rootstocks perform better than existing rootstocks (see Table 1). Similar plantings are under evaluation at several other sites across the U.S. This trial is also evaluating the several of the Weiroot (*P. cerasus*) rootstocks that were originally selected from a wild sour cherry from the Bavarian mountain region.

Materials and Methods

This trial was planted in Block 4A at the Western Colorado Research Center – Rogers Mesa site in 1998. The trial consisted of 13 *Prunus* rootstocks with a Bing scion. The study was planted in a randomized complete block design with seven replications. Trees were originally trained to a central leader. Trees were watered by furrow irrigation until 1999 when microsprinklers were installed. Trees were harvested on June 16 and trunk circumferences and the number of rootsuckers were counted in mid-November.

Results and Discussion

Most of the tree loss so far in this planting is due to late fall/early winter damage in the first year of the planting. A warm March in 2005 induced an early bloom. A subsequent hard freeze (19°F, -7°C) on April 1st, when many of the trees were approaching full bloom, severely reduced the crop on most rootstocks. However, visual observations and harvest data shows that some rootstocks had a delayed full bloom and had relatively good yields. Bloom initiation and time of full bloom will be watched more closely in 2006 to determine if some rootstocks have a delayed bloom which could be important information for area growers. The harvest results and tree growth parameters are presented in Table 1. This data shows that some rootstocks are inducing dwarfing in this planting as seen in trunk diameter. However, the smallest rootstocks are too small and spindly to carry an adequate crop load. The W13, W158 and Edabriz are the best yielding trees, considering the warm March and freeze, are also some of the stouter trees. With good pruning these trees can be kept to workable size from the ground (Table 1). One drawback is that these higher yielding rootstocks are also producing a large number of rootsuckers (Table 1).

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CSU Agricultural Experiment Station provided funds that supported this study. Special thanks to Jim Rohde, Kim Schultz, and Bryan Braddy for tree maintenance, harvest and data collection assistance.

Table 1. 1998 NC-140 sweet cherry rootstock planting at the Western Colorado Research Center - Rogers Mesa, 2005 growth parameters.

Rootstock	Survival[1]	Average Trunk Circumference (inches)	Average Fruit Weight (lbs/tree)	Average no. rootsuckers (no./tree)
Mazzard	4	15.6	0.3	17
Mahaleb	6	16.6	3.2	2
148/1	6	16.4	3.3	0
148/2	7	11.4	1.7	1
148/8	7	13.3	1.3	27
195/20	7	15.8	3.6	4
209/1	3	10.2	0.3	0
Edabriz	7	13.2	4.4	33
W10	7	16.1	2.0	58
W13	7	16.5	6.6	54
W53	6	12.6	3.7	35
W72	6	12.7	2.1	26
W158	7	14.6	4.7	27

[1]Out of seven replicates originally planted.

NC-140 Fruit Tree Rootstock Trials 2005 Reports

2001 Peach Rootstock Trial

Summary

This is the end of the fifth year (sixth leaf) of this planting. The trees are maturing well with size and yield differences evident in the data. To date, the Cadaman, SLAP and Bailey rootstocks have out-yielded the standard, Lovell. Originally, the trees were not very strong when received from the nursery but most have recovered well. The poor performing rootstocks both in tree size and yields are P30-135, K146-43 and the VVA-1. The Hiawatha, in general, is not growing or performing well. From this short-term data we cannot recommend these varieties. This study will continue for a total of ten years.

Introduction

This trial was initiated in the NC-140 committee to see how these relatively new peach rootstocks performed on alkaline soils and a range of climates. This study and the 2002 Peach Rootstock Study (see following report) were selected for their tolerance to alkaline soils. Alkaline soil tolerance is important in western Colorado because yellow peach tree syndrome is caused by micronutrient deficiencies caused by high pH soils. Thus far we have seen no yellowing but survival has been spotty. The objectives of this trial were to determine the adaptability of differing rootstocks to western Colorado, to determine if these rootstocks induce dwarfing, and to determine if any of these rootstocks perform better than existing rootstocks (see Table 2). Similar plantings are under evaluation at several other sites across the U.S.

Materials and Methods

This trial was planted in Block 4 at the Western Colorado Research Center – Orchard Mesa site in 2001. The trial consisted of 12 peach rootstocks including Lovell, with a Cresthaven scion. It was planted in a randomized complete block design as tree numbers allowed. Production problems reduced many of the rootstocks from the intended eight replications to six or four replications (Table 2). This is the first crop for these trees. Due to a freeze there was no yield in 2004.

Results and Discussion

Most of the tree loss so far in this planting is due to weak trees from the nursery. The harvest results and tree growth parameters are presented in Table 2. This data shows that some rootstocks are inducing dwarfing in this planting as seen in trunk diameter, however, the smallest rootstocks are too small and spindly to carry an adequate crop load. The Cadaman, SLAP and Julior have out-yielded the Lovell. These trees are also some of the stouter trees (Table 1). The Julior rootstock also produces large numbers of rootsuckers.

Acknowledgments

CSU Agricultural Experiment Station provided funds that supported data collection and analysis. Special thanks to Bryan Braddy, John Wilhelm, and Frank Kelsey for tree maintenance, harvest and data collection assistance.

Table 2. 2001 NC-140 peach rootstock planting at the Western Colorado Research Center - Orchard Mesa, 2005 growth parameters.

Rootstock	Survival	Average Trunk Circumference (inches)	Average Fruit Weight (lbs/tree)	Average no. rootsuckers (no./tree)
BH-4	4*	28.3	28.7	0.3
SLAP	8†	29.2	36.5	0.0
SC17	7†	26.9	25.4	0.3
Bailey	6‡	27.0	32.8	0.0
Julior	8†	27.4	23.9	37.5
P30-135	7†	15.1	3.5	0.0
Jaspi	6‡	24.8	8.2	9.2
Hiawatha	4†	21.6	14.3	0.3
K146-43	5†	17.0	10.6	0.0
VVA-1	2*	18.4	17.2	2.0
Cadaman	4*	29.7	37.7	0.8
Lovell	4†	27.6	31.1	0.0

* Only four tree in original planting; ‡ six trees originally; † eight trees originally.

NC-140 Fruit Tree Rootstock Trials 2005 Reports

2002 Peach Rootstock Trial

Summary

This is the end of the third year (fourth leaf) of this peach planting. The scion for these eight rootstocks is Cresthaven. The tree growth is good although some rootstocks are having a pronounced dwarfing effect on the scion (VSV-1 and VVA-1). The MRS 2/5 rootstock is not sufficient to hold up the tree and all the trees are leaning or have fallen over. The Adesto 101 rootstock appears to be the sturdier and better-shaped tree. The Lovell out-yielded the Cadaman and Adesto 101 in this trial. However, this is the first year there was sufficient fruit to harvest.

Introduction

This trial is also examining rootstocks for alkaline soil tolerance (also see 2001 Peach Report) with four of the rootstocks different from the 2001 Peach trial. To date we have not seen any yellowing but these symptoms don't typically appear until the fifth or sixth leaf, probably due to tree size. The objectives of this trial were to determine the adaptability alkaline soil tolerant rootstocks to western Colorado and to determine if these rootstocks induce dwarfing (Table 1).

Materials and Methods

This trial was planted in Block 2A at the Western Colorado Research Center – Rogers Mesa site in 2002. The trial consists of 9 rootstocks with a Cresthaven scion. It was planted in a randomized complete block design with eight replications. Fruit was harvested over several days in early to mid-August.

Results and Discussion

The harvest results and tree growth parameters are presented in Table 3. The Lovell rootstock was the highest average yielding rootstock on the largest tree, followed by Cadaman and Adesto 101. The VVS-1 had the most rootsuckers. Recommendation cannot be made on a particular rootstock with just one year's data. This trial will continue for ten years.

Acknowledgments

Colorado Agricultural Experiment Station provided funds that supported data collection and analysis. Special thanks to Bryan Braddy, John Wilhelm, and Frank Kelsey for tree maintenance, harvest and data collection assistance.

Table 3. 2002 NC-140 peach rootstock planting at the Western Colorado Research Center - Rogers Mesa, 2005 growth parameters.

Rootstock	Survival (of 8 planted)	Average Trunk Circumference (inches)	Average Fruit Weight (lbs/tree)	Average no. rootsuckers (no./tree)
Adesoto101	8	9.7	3.7	9
MRS 2/5	8	9.9	3.3	10
Penta	8	7.0	2.6	17
VSV-1	8	3.2	0.7	72
VVA-1	6	3.6	1.2	19
Pumiselect	4	6.8	1.9	6
Cadaman	8	8.9	4.2	6
Lovell	8	11.4	5.5	1

Agronomic Performance of Canola at Fruita, Colorado 2005

Calvin H. Pearson[1]

Summary

Biodiesel has recently attracted interest because of the increasingly high cost of petroleum diesel. Biodiesel has similar properties, can improve air quality, and is safer to handle than petroleum diesel. Several oilseed crops, including canola, are suitable for biodiesel production. Canola is a desirable for biodiesel because its seed oil content is higher than that of many other oilseed crop species. The objective of the agronomic research conducted at the Western Colorado Research Center at Fruita during 2005 was to evaluate twenty-eight canola entries (cultivars and breeding lines) for seed yield and related agronomic characteristics and to assess the potential for commercial production of canola in western Colorado. Canola was fall-planted in 2004. Plants established well, survived the winter in good condition, and reached the flowering stage of development at approximately 109 days (Julian). Plant height of canola entries averaged nearly 64 inches. Plant lodging, across all entries, was quite low at only 8.8% and seed shattering for the twenty-eight canola entries averaged only 1.8%. The standard test weight value for canola is 50 lbs/bu; however, test weights for the twenty-eight canola entries averaged only 36.1 lbs/bu. A severe infestation of false chinch bugs occurred during the growing season and could have negatively impacted test weights. Seed moisture content averaged across all entries was 6.3%. There were significant differences among entries for seed yield. Seed yield averaged 2323.5 lbs/acre and ranged from a high of 3027.3 lbs/acre for 'Baldur' to a low of 1542.8 lbs/acre for KS2098. Seed oil content averaged only 35.3%, much lower than is typically produced by canola. Canola production in western Colorado appears promising based on the one year of agronomic data obtained at Fruita in 2005. Additional years of field research will be needed to determine if low seed oil contents and low test weights will be an ongoing problem and if false chinch bugs will continue to be a problem for production of canola in western Colorado.

Introduction

Biodiesel has recently attracted interest because of the increasingly high cost of petroleum diesel. Tri-glyceride seed oils, found in crop plants such as canola, mustards, sunflower, cotton, safflower, soybean, corn, and also in used cooking oils, fats, and tallows can be converted into biodiesel (Eidman, 2005).

Biodiesel fuel is formed by transesterification when an alcohol such as methanol or ethanol is added to the plant oil along with an alkaline catalyst such as sodium hydroxide or potassium hydroxide (Ma and Hanna, 1999).

Biodiesel has many fuel properties that are similar to petroleum diesel (Brown, 2003; Hofman, 2003); however, engine power output of biodiesel is reported to be 5 to 7% less per gallon than petroleum diesel (Whitman, 2005). Biodiesel can be used as a fuel in its pure form or it can be blended in any amount with petroleum diesel (Hofman, 2003). Biodiesel is likely best used as a fuel extender for petroleum diesel, rather than as a complete fuel. The most popular blend is an 80/20 mix of petroleum diesel to biodiesel.

Petroleum diesel flashes at 125°F while biodiesel flashes at a much higher temperature, approximately 300°F. This makes biodiesel safer for shipping, handling, and storing than petroleum diesel; however, oxidation occurs more rapidly with biodiesel, which reduces fuel quality as storage time increases (Eidman, 2005). Chemical treatments may be needed to prevent bacterial growth in storage tanks. Additional disadvantages of biodiesel and biodiesel blends are higher freezing points and

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poorer cold flow properties than petroleum diesel (Eidman, 2005). Some of these undesirable properties of biodiesel can be remedied with additives; however, this increases the cost of the fuel.

Engine warranties are a concern when using biodiesel (Whitman, 2005). Widespread acceptance of biodiesel for use in various vehicles and engines by various manufacturers has not occurred. Owners of vehicles who decide to use biodiesel should check with the vehicle manufacturer to determine if burning biodiesel voids any aspect of their vehicle warranty.

Biodiesel has greater lubricating properties in engines even when small quantities are blended with petroleum diesel (Eidman, 2005).

From a health standpoint, skin cracking is a common problem mechanics experience when bare skin is exposed to petroleum diesel. Mechanics have reported that biodiesel does not cause the skin to crack (Mazza, 2002).

Air quality improves when burning biodiesel by reducing exhaust emissions containing carbon monoxide, hydrocarbons, air particulates, and various air toxins compared to burning petroleum diesel; however, nitrogen oxides emissions are generally higher when using biodiesel than when petroleum diesel is combusted (Hofman, 2003).

With a yield of 2500 lbs/acre and a seed oil content of 38%, an acre of canola will produce 950 lbs of oil. Canola oil weighs 7.65 pounds per gallon, and a gallon of vegetable oil will produce about 1 gallon of biodiesel (Hofman, 2003). Under these conditions, an acre of canola will produce approximately 124 gallons of biodiesel.

Currently, there is an effort underway to build a biodiesel production facility in southwest Colorado by the San Juan Biodiesel Cooperative. A feasibility study for the project has been completed and other various preliminary activities are being conducted. Construction of the biodiesel production facility is anticipated in the near future. Successful completion of such a facility would open up the possibility of growing canola, along with other suitable crops, in western Colorado to supply vegetable oil for the biodiesel plant. Canola is often a desirable source of vegetable oil because of the high seed oil content (40-45%). A concise history of the development of canola as a crop, along with aspects of crop production have been reported by Rife and Salgado (1996) and Rife and La Barge (2005).

The objective of our research was to evaluate twenty-eight canola entries for seed yield and related agronomic characteristics to assess the potential for commercial production of canola in western Colorado.

Materials and Methods

A winter canola cultivar performance test was conducted at the Western Colorado Research Center at Fruita, Colorado during 2005. The experiment was a randomized complete block with three replications. Twenty-eight canola entries (released cultivars and breeding lines) were included in the trial. Plot size was 5-feet wide by 30-feet long (2, 30-inch rows). The previous crop was soybean.

Fred Judson standing in a research block of canola at the Western Colorado Research Center at Fruita. May 3, 2005. Photo by Calvin H. Pearson.

Treflan herbicide was applied just prior to planting at a rate of 1.5 pts/acre and incorporated twice with a roller harrow on 8 Sept. 2004. Seeding rate was 4.5 lbs/acre and planting occurred on 8 Sept. 2004 with a cone planter.

Canola was irrigated twice in the fall. A germination irrigation was applied on 9 Sept. 2004 in a 12.5 hour irrigation set and another irri gation was done on 29 Oct. 2004 for 9 hours. Canola was top-dressed with 74 lbs N/acre using ammonium nitrate on 28 Mar. 2005. The experiment was furrow-irrigated with 1.25-inch siphon tubes. Canola was irrigated three times during the 2005 growing season and averaged 12 hours per irrigation.

Fred Judson (driving Hege combine), and Lot Robinson (blue shirt) and Jerry Fry (white tee shirt) forking plant material during harvest of canola at the Western Colorado Research Center at Fruita. July 26, 2005. Photo by Calvin H. Pearson.

Plots were harvested 26 July 2005 using a Hege small plot combine. Data were collected for fall establishment, winter survival, bloom date (date at which 50% of the plants had one or more open flowers), plant height, plant lodging, shattering, seed moisture at harvest, test weight, and seed yield. Seed moisture and test weight were obtained using a Seedburo GMA-128 seed analyzer.

Results and Discussion

The 2005 cropping season in western Colorado was mild. In 2005, there were 10 days during the summer when temperatures reached or exceeded 100 ºF. In 2004, there were only 2 days when temperatures were at or above 100 ºF, but in 2003 there were 27 days when temperatures reached or exceeded 100 ºF. The average growing season for Fruita is 181 days. The 2005 growing season was 199 days. Adequate irrigation water was available during the growing season for crop production and was not a limiting factor for canola production.

A visual rating of the stand for each canola entry was conducted in the fall. Plots were rated after canola had sufficient time to become established but before winter. The rating scale was from 0 to 10 with 0 = no stand and 10 = excellent. All entries were rated higher than 8.0 (Table 1). Three entries were rated between 8.0 and 8.9. They were 'Casino' (8.7), KS7436 (8.7), and 'Virginia' (8.3). Another three entries were rated at 10. They were ARC92007-2, KS2169, and NPZ0326. Other entries were rated between 9.0 and 9.9.

Winter survival is a visual estimate of how plants, planted in the fall, survived through the winter months and began growth in early spring. The rating scale for winter survival was from 0 = no survival to 100% = total plant survival. All entries were rated at 100% survival with the exception of KS2064, which was rated at 96.7% (Table 1).

The average number of days to reach first bloom was 108.6 days (Table 1). The canola entries to flower first were KS2185, KS7436-055, 'Baros,' and 'Sumner.' 'Plainsman' required the most time to reach the flowering stage at 112 days. Other canola entries were intermediate in the number of days they needed to flower.

Plant height of canola entries averaged 63.7 inches and the tallest ones were 'Ceres' (69.6 inches), Plainsman (68.4 inches), KS9135 (68.4 inches), ARC92004-1 (68.0 inches), KS2098 (68.0 inches), and KS2064 (66.8 inches) (Table 1). The shortest entries were 'Jetton' (57.6 inches), KS7436-055 (58.0 inches), Baros (60.0 inches), KS7436 (60.0 inches), and Virginia (60.8 inches).

Plant lodging among canola entries varied; however, lodging averaged across all entries was only 8.8% (Table 1). Entries with the most lodging were Baros (31.7%), KS9135 (21.7%), VSX-2 (20.0%), NPZ0326 (16.7%), and ARC92007-2 (14.0%). Numerous other canola entries exhibited only a small amount of lodging and Ceres and Jetton had no lodging.

Seed shattering for the twenty-eight canola entries averaged 1.8% (Table 1). Overall, canola entries exhibited low amounts of shattering; however, there were significant differences among entries for shattering. KS2098 (7.3%) and ARC92004-1 (4.3%) shattered more than other entries. 'Titan' and Virginia did not shatter at all. Many other canola entries shattered only slightly.

The standard test weight value for canola is 50 lbs/bu; however, test weights for the twenty-eight canola entries averaged only 36.1 lbs/bu. There were significant differences among the canola entries for test weights. Test weights ranged from a high of 43.4 lbs/bu for Baldur to a low of 29.8 lbs/bu for KS3018 (Table 1).

Seed moisture content averaged across all entries was 6.3% (Table 1). Seed moisture ranged from a high of 7.7% for ‘Kronos’ to a low of 5.6% for KS7436. Seven canola entries (Kronos, Jetton, NPZ0326, KS7436-055, KS2169. ARC2189-1, Titan) had higher seed moisture contents at harvest than other entries.

Seed yield for the canola entries averaged 2323.5 lbs/acre (Table 1). There were significant differences among entries for seed yield. Seed yields ranged from a high of 3027.3 lbs/acre for Baldur to a low of 1542.8 lbs/acre for KS2098. Ten of the twenty eight canola entries were high yielding and six entries (KS2098, Plainsman, KS2064, KS9124, ‘Casino,’ and KS3018) were low yielding.

Seed oil content averaged 35.3%, much lower than the 40-45% that is typically produced by canola. Oil contents ranged from a high of 37.7% for ARC92007-2 to a low of 32.4% for Casino.

In summary, most canola entries established well, survived the winter without plant loss, exhibited good growth, and lodged somewhat. Many canola entries also produced good seed yields, had low seed moisture contents at harvest, but seed oil content of canola was lower than expected. Canola production in western Colorado appears promising based on the one year of agronomic data obtained at Fruita in 2005; however, most canola entries had low test weights. Weed control in canola grown at Fruita was excellent, but the incidence of false chinch bugs in 2005 was severe.

Additional years of field research will be needed to determine if low test weights in canola will be an ongoing problem and if false chinch bugs will be a problem for canola production in western Colorado.

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Table 1. Agronomic performance of twenty-eight canola cultivars grown at Fruita, Colorado in 2005.

Entry	Fall Stand[1]	Winter survival[2]	Bloom date[3]	Plant height[4]	Plant ldg[5]	Seed shatter[6]	Test weight	Seed mois.[7]	Seed yield	Oil content
		%	Days	in.	%	%	lbs/bu	%	lbs/acre	%
Abilene	9.3	100.0	108.3	62.4	10.0	1.0	37.5	6.0	2199.8	33.4
ARC2180-1	9.7	100.0	108.7	66.0	5.0	4.3	34.3	6.4	2221.5	35.8
ARC2189-1	9.7	100.0	109.3	66.0	11.7	2.3	34.5	6.6	2384.5	35.3
ARC92004-1	9.7	100.0	109.0	68.0	10.0	4.3	34.2	6.1	2271.2	35.6
ARC92007-2	10.0	100.0	109.0	64.4	14.0	1.7	36.9	6.3	2497.2	37.7
Baldur	9.3	100.0	108.0	63.6	11.7	0.7	43.4	5.7	3027.3	37.3
Baros	9.7	100.0	106.7	60.0	31.7	2.0	38.9	6.4	2554.4	36.3
Casino	8.7	100.0	109.7	64.8	1.7	2.0	34.1	6.3	1936.3	32.4
Ceres	7.7	100.0	109.3	69.6	0.0	0.7	37.1	7.0	2586.9	37.4
KS7436-055	9.3	100.0	106.3	58.0	5.3	1.0	37.7	5.8	2532.3	36.9
KS3018	9.3	100.0	108.0	62.4	3.3	1.7	29.8	5.7	2006.9	33.4
Jetton	9.7	100.0	109.0	57.6	0.0	1.3	40.7	7.4	2834.4	37.2
Kronos	9.0	100.0	108.3	65.2	6.7	1.7	38.2	7.7	2854.4	35.2
KS2064	9.0	96.7	108.7	66.8	8.0	2.7	36.9	6.2	1769.3	34.9
KS2098	9.7	100.0	110.7	68.0	10.0	7.3	30.4	6.4	1542.8	33.4
KS2169	10.0	100.0	108.3	62.4	11.7	1.3	35.1	6.7	2134.1	33.8
KS2185	9.3	100.0	105.7	61.6	3.3	1.7	35.0	5.9	2244.1	33.4
KS7436	8.7	100.0	108.0	60.0	4.3	1.3	36.2	5.6	2086.9	36.5
KS9124	9.7	100.0	109.3	63.6	12.3	0.7	34.0	6.2	1856.9	33.1
KS9135	9.0	100.0	110.0	68.4	21.7	1.7	36.9	5.8	2104.5	35.9
NPZ 0326	10.0	100.0	109.3	64.0	16.7	2.3	37.7	7.1	2602.3	35.5
Plainsman	9.7	100.0	112.0	68.4	2.7	0.7	32.1	6.4	1597.4	32.9
Rasmus	9.7	100.0	108.0	61.6	3.3	1.0	39.5	5.9	2989.0	36.9
Sumner	9.7	100.0	106.7	62.0	7.7	2.7	35.2	5.8	2367.3	34.3
Titan	9.0	100.0	108.0	64.8	1.7	0.0	35.1	6.6	2867.2	36.1
Virginia	8.3	100.0	109.0	60.8	3.3	0.0	39.3	5.8	2659.3	37.2
VSX-2	9.7	100.0	109.7	62.4	20.0	1.0	38.5	6.2	2170.6	36.1
Wichita	9.7	100.0	108.0	62.0	8.3	2.0	32.5	6.1	2160.6	34.2
MEAN	9.4	99.9	108.6	63.7	8.8	1.8	36.1	6.3	2323.5	35.3
CV	7.7	1.1	0.6	3.2	129.6	106.2	8.0	11.9	14.0	
LSD	1.2	1.8	1.1	3.3	18.6	3.2	4.7	1.2	533.3	

[1]Visual rating based on a 0 to 10 scale with 10= excellent and 0=no stand.
[2]Visual estimate of the percent of established plants that survived the winter.
[3]Date at which 50% of canola plants that have one or more open flowers.
[4]Average plant height from the soil surface to the top of plants.
[5]Plant lodging, a visual estimate of the percent of plants that have lodged.
[6]Visual estimate just prior to harvest of the percent of seed lost due to shattering.
[7]Seed moisture content.

Dr. Horst W. Caspari

2005 Research Projects

Viticulture and enology programs for the colorado wine industry (Colorado Wine Industry Development Board; H. Larsen, R. Zimmerman)*

Short- and long-term effects of Partial Rootzone Drying on tree physiology, fruit quality and yield of apples (Washington Tree Fruit Research Commision; M. Whiting, Washington State University)

Methods to delay bud break in grape (Viticulture Consortium East; H. Larsen & C. Stushnoff, CSU, and I. Dami, Ohio State University)

Methods to delay bud burst in grape, apple, and peach (Valent Biosciences Corp.; H. Larsen)

Application of crop modeling for sustainable grape production (United States Environmental Protection Agency; H. Larsen)

*Sponsors/Cooperators are noted in parentheses.

2005 Publications

Refereed Publications:

Leib, B.G, H.W. Caspari, C.A. Redulla, P.K. Andrews, J.D. Jabro. 2006. Partial rootzone drying and deficit irrigation of 'Fuji' apples in a semi-arid climate. Irrig. Sci. 24:85-99 (published online Oct 2005).

Conference papers:

Einhorn, T.C., H.W. Caspari, S. Green, and G. Litus. 2005. An approach-grafted, split-rooted apple system to evaluate the effects of partial rootzone drying and deficit irrigation on tree water relations. 102nd Annual ASHS Conference, 18 - 21 July 2005, Las Vegas, NV, USA. HortScience 40:1037. (Abstr.).

Einhorn, T.C., H.W. Caspari, and S. Green. 2005. ABA, hydraulics, and gas exchange of split-rooted apple trees. 102nd Annual ASHS Conference, 18 - 21 July 2005, Las Vegas, NV, USA. HortScience 40:1097. (Abstr.).

Client Reports

Caspari, H.W. and H.J. Larsen. 2005. Application of crop modeling for sustainable grape production. Annual Report 2004, Pesticide Special Study X988712-01, US-Environmental Protection Agency, 8 pp.

Caspari, H.W. and H.J. Larsen. 2005. Methods to delay bud burst in grape, apple, and peach. Annual Report, Valent BioSciences Corporation, 14 pp.

Technical Reports

Larsen, H.J. and H.W. Caspari. 2005. Application of crop modeling for sustainable grape production, pp. 27-33. In: Western Colorado Research Center Research Report 2004. Colorado State University Agricultural Experiment Station Technical Report TR05-08. Fort Collins, Colorado.

Norton, A.P., H.J. Larsen, and H.W. Caspari. 2005. Integrating control strategies for powdery mildew, pp. 35-40. In: Western Colorado Research Center Research Report 2004. Colorado State University Agricultural Experiment Station Technical Report TR05-08. Fort Collins, Colorado.

Outreach/Extension Reports

Fifteen articles updated or added to the Viticulture web page. For details visit www.colostate.edu/programs/wcrc/Vithome.htm

Dr. Ron Godin

2005 Research Projects

Organic green beans for seed variety trial (Dr. Mark Brick, CSU)*
Organic seedless table grapes variety trial
Organic brewing hops variety trial
Organic pickling cucumber variety trial
Organic colored sweet pepper earliness variety trial
Organic soybeans for livestock feed
Cover crop rotations for building organic soil fertility
Investigating organic weed control methods in vegetables (United States Environmental Protection Agency)
1998 NC-140 Cherry rootstock trial: Rogers Mesa
2001 NC-140 Peach rootstock trial: Orchard Mesa
2002 NC-140 Peach rootstock trial: Rogers Mesa
Native seed production for crop diversification (Western Sustainable Agriculture Research and Education; Uncompahgre Plateau Project, USFS, BLM, CDOW, Public Lands Partnership, CSU Cooperative Extension, Carl and Cindy Roberts, Dave and Pam Herz, Kenny Hines).
Water and soil acidification for improved vegetable production and quality: (Del Mesa Farms, John Harold, Uncompahgre Valley Irrigators, NRCS, CSU Cooperative Extension)

*Sponsors/Cooperators are noted in parentheses.

2005 Publications

Technical Reports

Godin, R.E., Ela, S., Max, S., Schultz, K., and Rohde, J. 2005. Effects of organic alternatives for weed control and ground cover management on apple tree growth, fruit size and productivity. pp. 19-26. In: Western Colorado Research Center Research Report 2004. Colorado State University Agricultural Experiment Station Technical Report TR05-08. Fort Collins, Colorado.

Dr. Harold J. Larsen

2005 Research Projects

Application of crop modeling for sustainable grape production (United States Environmental Protection Agency; H. Caspari)*
Methods to delay bud break in grape (Viticulture Consortium East; H. Caspari, I. Dami, C. Stushnoff)
Methods to delay bud burst in grape, apple, and peach (Valent Biosciences Corp.; H. Caspari)
Nematode control materials (Eden Research, Valent Biosciences Corp.)
Remediation of stone fruit replant problems in Colorado Orchards (Arvesta Corp., Eden Research)
Viticulture and enology programs for the Colorado wine industry (Colorado Wine Industry Development Board; H. Caspari, R. Zimmerman)

*Sponsors/Cooperators are noted in parentheses.

2005 Publications

Technical Reports / Other Publications / Written Works:

Larsen, H., Caspari, H., and Sharp, R. 2005. Specialty Crops Final Report: Application of crop modeling for sustainable grape production. 8 pp. Published as a PDF file on the W. Colo. Research Center's Viticulture web page: http://www.colostate.edu/programs/wcrc/Viticulture/pm2004annreport.pdf

Larsen, H.J. 2005. Grape Disease Management. (Talk handouts for Grape Pest Management Workshop, 5/13/2005). 16 pp. Available on web (pp. 14-29) at: http://www.colostate.edu/programs/wcrc/Viticulture/grapepestmgmtwkshop.pdf

Larsen, H.J. 2005. Grape Pest Management Guide, 2005. 3 pp Published on web at: http://www.colostate.edu/programs/wcrc/Viticulture/GrapePestMgmtGuide05.pdf

Larsen, H.J. 2005. Looking for alternatives to methyl bromide for orchard renovation. 2 pp. In: Western Phytoworks (WCRC Newsletter), Fall, 2005. Published as a PDF file on the W. Colo. Research Center's Outreach / Research Reports web page: http://www.colostate.edu/programs/wcrc/infopages/Fall2005web.pdf

Larsen, H.J. 2005. Fruit industry outlook. 2 pp in: Weitzel, D. (Ed.) 2005. 2005 Colorado Agricultural Outlook Forum.

Larsen, H.J. and Caspari, H.W. 2005. Application of crop modeling for sustainable grape production. pp. 27-33. In: Western Colorado Research Center Research Report 2004. Colorado State University Agricultural Experiment Station Technical Report TR05-08. Fort Collins, Colorado.

Norton, A.P, Larsen, H.J., and Caspari, H.W. 2005. Integrating control strategies for powdery mildew. pp. 35-39 In: Western Colorado Research Center Research Report 2004. Colorado State University Agricultural Experiment Station Technical Report TR05-08. Fort Collins, Colorado.

Dr. Calvin H. Pearson

2005 Research Projects

Winter wheat cultivar performance test – Hayden (Mike Williams, Dr. Scott Haley)*
Spring wheat cultivar performance test – Hayden (Mike Williams, Dr. Scott Haley)
Using polyacrylamide to increase yield in spring wheat – Hayden (Mike Williams)
Long season corn grain hybrid performance test – Fruita (Dr. Jerry Johnson, seed companies)
Short season corn grain hybrid performance tests – Fruita, Delta (Wayne Brew, Dr. Jerry Johnson, seed companies)
Corn forage hybrid performance tests – Fruita, Olathe (Earl Seymour, Dr. Jerry Johnson, seed companies)
Alfalfa variety performance test (2005-2007) – Fruita (Dr. Jerry Johnson, seed companies, breeding companies, private industry)
Alfalfa germplasm evaluations, 2004-2006 – Fruita (Dr. Peter Reisen of Forage Genetics)
Evaluation of Roundup-Ready alfalfa, 2005-2007 – Fruita (Forage Genetics and Monsanto)
Pinto bean cultivar performance test – Montrose (Keith Catlin, CDBAC, Dr. Jerry Johnson)
Hybrid poplar performance tests – Fruita, Orchard Mesa, and Hotchkiss (Dr. Matt Rogoyski, Dr. Ron Godin, and staff)
Canola cultivar performance test – Fruita (Dr. Jerry Johnson, Kansas State Univ.)
Nuna advanced breeding line seed increases and evaluation – Fruita (Dr. Mark Brick and Barry Ogg)
Colorado sweet corn inbred flowering trial – Fruita (Syngenta)
Performance of three plant species grown in three potting mixes – Grand Junction
Sunflower ecological fitness study – Fruita (Dr. Allison Snow)
Volunteer sunflower seed longevity study – Fruita (Dr. Allison Snow)
Development of sunflower as an industrial, natural rubber-producing crop (Drs. Katrina Cornish and Colleen McMahan, USDA-ARS, Albany, CA; Dr. Jay Keasling, U.C. Berkeley; Dr. Dennis Ray, University of Arizona; Dr. John Vederas, University of Edmonton, USDA-CSREES)

*Cooperators/collaborators/sponsors are noted in parentheses.

2005 Publications

Cornish, K., McMahan, C.M., Pearson, C.H., Ray, D.T., and D.K. Shintani. 2005. Biotechnological development of domestic rubber producing crops. Rubber World 233:40-44.
Cornish, K., McMahan, C.M., Pearson, C.H., Ray, D.T., and D.K. Shintani. 2005. Biotechnological development of domestic rubber-producing crops. Presented at the spring 167th Technical Meeting of the Rubber Division of the American Chemical Society, San Antonio, TX, May 16-18, 2005.
Johnson, J. J., Schweissing, F.C., Pearson, C.H., Hain, J.P., and C.L. Johnson. 2005. Making Better Decisions: 2004 Colorado Corn and Sunflower Variety Performance Trials. Colorado State University, Agricultural Experiment Station and Cooperative Extension, Technical Report TR05-04. Fort Collins, Colorado.
Pearson, C.H. 2005. Letter from the Editor. Agron. J. 97:343-344.
Pearson, C.H. (Information Resource and conducted the cultivar performance test at Montrose, CO) 2005. Making Better Decisions: 2005 Dry Bean Variety Performance Trials. Colorado State University, Agricultural Experiment Station and Cooperative Extension, Technical Report TR05-11. Fort Collins, Colorado.
Pearson, C.H. 2005. Winter Wheat Variety Performance Test at Hayden, Colorado 2004. p. 17-19. In: Making Better Decisions: 2004 Colorado Winter Wheat Variety Performance Trials. Colorado State University, Agricultural Experiment Station and Cooperative Extension, Technical Report TR05-09. Fort Collins, Colorado.

Rath, D.J., Pearson, C.H., Cornish, K., McMahan, C.M., and D.J. Scott. 2005. Quantifying natural rubber in *Helianthus annuus* L. using the Dionex ASE 200. Presented at the spring 167th Technical Meeting of the Rubber Division of the American Chemical Society, San Antonio, TX, May 16-18, 2005. ISSN:1547-1977.

Snow, A.A. and C.H. Pearson, 2005. How and why to confine novel transgenes in field-based research. Oral presentation made by Snow at the ASA-CSSA-SSSA Annual Meetings in Salt Lake City, Utah. Tuesday, 8 Nov. 2005.