Technical **Report** TR01-13

Agricultural Experiment Station | Cooperative Extension | Western Colorado Research Center: Fruita, Orchard Mesa, Rogers Mesa | December 2001

Western Colorado Research Center 2001 Research Report

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Knowledge to Go Places

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Introduction

Agriculture on the Western Slope is certainly in a time of change. Low commodity prices and raising land values are making farmers consider new ideas in farm management, types of crops grown, and how to better market their crops to maximize farm-gate returns. The Western Colorado Research Center (WCRC) is well aware of these issues and continues to work within its areas of expertise to meet its mission statement of planning, implementing, and conducting research and outreach programs to address the needs of farmers in the region.

Like the farming community around us, we are focusing our resources in areas where we can generate the most benefit. Investment in our new program areas of Sustainable/Organic Agriculture, New Crops, Viticulture and Ornamental Nursery Production is having significant payoffs. Faculty have been very active, successfully developing new joint projects with eight, out of state research institutions, six on-campus faculty as well as local Cooperative Extension agents. Significant new external funding was received from a number of these projects. Funding agencies included the Dept of Energy, SARE, Washington Tree Fruit Commission, Colorado Division of Wildlife, Bureau of Reclamation, and the Organic Farm Research Foundation. You can look forward to reading the outcome of this work in this, and future annual reports.

To improve our outreach programs we are making much greater use of the internet. As more and more farmers adopt computers as a management tool, they have access to a wealth of free information from the worldwide web. We have updated our web page and now make use of the Tri County Cooperative Extension web page, as well as "Agfacts" and the new "FruitFacts" listserves to post pertinent information for farmers in the region.

I would personally like to thank the entire WCRC faculty for their efforts this year and acknowledge the effort that support staff have made in ensuring the successful completion of this years' projects. A lot of the redirection of WCRCs' objectives would not have been possible without their cooperation or the support of the Colorado Agricultural Experiment Station and the department heads associated with this center.

While individual researchers will acknowledge sponsors in their own reports, I would like to mention a few who have made significant contributions this year, through me, to the center as a whole. These include Van Wells Nursery, Colorado Organic Crop Management Association, Rohm and Haas and members of the Western Colorado Horticultural Society.

This publication marks the 4th year of the formation of the Western Colorado Research Center.
The reports enclosed in this publication give an indication of the breadth of research conducted at our three locations in 2001. A comprehensive list of 2001 findings will be available on our web site in April 2002. I trust you will enjoy this report and contact the authors with any questions.

Shane Max
Western Colorado Research Center Manager

Western Colorado Research Center Station Descriptions

Fruita Location:

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

The Fruita site 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, and a dry bean conditioning facility/ storage building. A comprehensive range of agronomic equipment is based at the site.

Orchard Mesa Location:

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

The Orchard Mesa site is located seven miles east and south of Grand Junction on B 1/2 Road and south of Clifton. It lies at an elevation of 4,750 feet with Mesa clay loam and Hinman clay loam soil types. High temperatures average 92° F in July and 37° F in January. Lows average between 63° F in July and 16° F in January. Readings of 100° F or higher are infrequent, and about one-third of the winters have no readings below 0° F. Relative humidity is very low during the summer. 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 and propane orchard heaters. Irrigation is by mini-sprinkler and gated pipe systems supplied by ditch water from the Colorado River. Facilities at the Orchard Mesa Center include the regional office, conference room and several labs. Other buildings include a workshop and greenhouse. Approximately 20 of the center's 80 acres are devoted to experimental orchards, principally apples, peaches and grapes. Smaller plantings of pears and cherries are also grown.

Rogers Mesa Location:

3060 Highway 92
Hotchkiss, CO 81419
(970) 872-3387
(970) 872-3397 fax

Rogers Mesa Research Center 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 88° F in July and 42° F in January. Lows average 57° F in July and 18° F in January. Frost protection is provided by wind machines and propane orchard heaters. Irrigation methods used include drip, mini-sprinklers, gated pipe and open ditch, all supplied from the Fire Mountain canal water. Facilities at the Rogers Mesa Research Center include offices, several laboratories and a conference room. Other buildings include workshop, machine shed, barn, and greenhouse. Approximately 20 of the 80 acres are planted with experimental orchards. Apples and peaches are the main crops. A small acreage is also devoted to sweet cherries and vegetable production. An arboretum was planted in 2001.

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ADVISORY COMMITTEE

The members of our Advisory Committee should be acknowledged for their time and input into our planning processes. Maylon Peters, the committee chairman, in particular has put a lot of time and commitment into ensuring the group had an active voice in our programmatic decisions. 2001 saw the resignation of Curtis Talley and two members came onto the committee, Dennis Hill from Bookcliff Gardens and Larry Traubel from Grand Mesa Discount.

The committee's role is to suggest, provide input, promote, and influence research planning that is conducted at WCRC centers. The outreach role is to work in conjunction with other committee members, research scientists and experiment station administrators to promote the interest of agriculture and the Agricultural Experiment Station within the region and to inform politicians, service groups, and the general public of current research being conducted at WCRC centers.

Present members of the committee are listed below. Should you have any questions or comments about WCRCs' programs please feel free to contact them.

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1994 Dwarf Apple Rootstock Trial (NC-140 Regional Project)

Ron Godin, Research Scientist / Sustainable Agriculture, WCRC – Rogers Mesa

Summary

At the end of eight years of growth, none of the trees are growing vigorously at this site. Terminal growth is not excessive and leaf size is small. For 2001, PAJAM 1 and B.469 had the highest yields (Table 1). To date, Pajam2 has produced the greatest cumulative yield, but this is based on only 4 years worth of yield. The trees with the largest trunk diameter are PAJAM 2 and V.1; however, several rootstocks are very similar in size. PAJAM 1 and P.16 had the highest average fruit weight. It is too early for conclusions, and no recommendations should be made at this time

Introductions and Objectives

Choice of a suitable rootstock could make the difference between an economically viable orchard and one that loses money for the orchardist. 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 several dwarfing (M.9 size) rootstocks would perform over a range of climates. The objectives of this trial were to determine the adaptability of differing dwarfing apple rootstocks to Western Colorado and to determine if any of these rootstocks perform better than existing rootstocks.

Materials and Methods

This trial was planted in Block 11D at the Western Colorado Research Center – Rogers Mesa site in 1994. The trial consisted of 16 rootstock clones from the semi-dwarf M.26 EMLA to the very dwarfing M.27 EMLA. The scion variety chosen was Gala (Treco Red Gala #42). It was planted in a randomized complete block design with 10 replications. Trees were supported and trained to a modified vertical axe training system. The site chosen was a replant-site with no fumigation. Trees were watered by microsprinkler irrigation. Similar plantings are replicated at 21 other sites across the U.S.

Results and Discussion

The results for the 2001 growing season are presented in Table 1. Making recommendations after only 8 years worth of data is not wise. The rootstock Mark was highly promoted after the preliminary 5-year report; it looked like the best rootstock. It had size control, lots of fruiting, and no staking needed. However, after 10 years, a soil-line swelling similar to crown gall made this rootstock unacceptable. With that stated, it appears that the largest trees were on PAJAM 2 and V.1; the smallest trees were on B.491 and P.22. The most suckering was on PAJAM 2 and M.9 RN29, but differences between rootstocks were small. Greatest cumulative yield occurred on PAJAM 2 and M.9 RN 29. The least cumulative yield occurred with P.22.

Acknowledgments

Colorado Agricultural Experiment Station provided funding that supported data collection and analysis. Special thanks to George Osborn and Bryan Braddy for data collection.

Table 1. Several growth parameters for the 2001 growing season in the 1994 NC-140 dwarf apple rootstock planting at the Western Colorado Research Center Rogers Mesa site (Block 11D).

Rootstock -	Trunk Circumference (in)	Average rootsuckers (number/tree)	Yield/tree (lbs)	Cumulative Yield (lbs)	Average Fruit wt. (oz)[1]
M.9 EMLA	6.2	8.0	3.3	65.3	4.4
M.26 EMLA	6.1	2.3	8.7	66.7	4.1
M.27 EMLA	4.0	3.3	2.9	18.9	4.0
M.9 RN29	6.9	12.9	4.1	88.1	5.3
PAJAM 1	6.1	7.2	9.5	61.5	6.2
PAJAM 2	7.2	13.6	3.3	91.3	5.5
B.9	6.2	4.2	7.5	67.5	3.9
B.491	4.3	7.7	7.5	33.5	4.3
O.3	6.0	6.1	5.6	58.6	4.4
V.1	7.4	6.0	4.5	63.5	4.3
P.2	5.8	0.4	3.2	57.2	5.9
P.16	4.7	9.5	4.2	31.2	4.4
MARK	5.5	10.8	4.7	42.7	3.9
P.22	3.1	1.7	1.3	14.3	3.2
B.469	6.4	4.3	9.4	51.4	4.8
NAKBT 337	5.7	9.9	6.4	54.4	4.3

1 An average fruit weight of 4/4 ounces is the equivalent of a 150 count size.

1994 Peach Rootstock Trial (NC-140 Regional Project)

Ron Godin, Research Scientist / Sustainable Agriculture, WCRC – Rogers Mesa; and
Harold J. Larsen, Assoc. Prof. of Horticulture / Research Fruit Pathologist /
Extension Fruit Disease Specialist, WCRC-Orchard Mesa

Summary and Recommendations

At the end of eight years of growth, the trees are very similar in all growth aspects. It is too early in this planting to draw conclusions; no absolute recommendations should be made at this time. However, it would appear that any of the rootstocks in this trial seem well adapted to western Colorado and could be considered for a trial planting.

Introductions and Objectives

Choice of a suitable rootstock can make the difference between an economically viable orchard and one that loses money for the orchardist. 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 evaluate performance of these relatively new peach rootstocks over a range of climates. The objectives of this trial were to determine the adaptability of differing peach and Prunus hybrids rootstocks to western Colorado and determine if any of these rootstocks perform better than existing rootstocks.

Materials and Methods

This trial was planted in Block 8B at the Western Colorado Research Center – Orchard Mesa site in 1994. The trial consisted of 17 seedling and clonal Prunus rootstocks. The scion variety chosen was Redhaven. It was planted in a randomized complete block design with eight replications. Trees were trained to an open-vase system and watered by furrow irrigation. Similar plantings are replicated at 17 other sites across the U.S. At the normal harvest time, all fruit on the tree were counted, weighed, and an average fruit weight calculated; trunk circumference and the number of rootsuckers were also recorded.

Results and Discussion

The 2001 crop was the second full crop in this planting. Results for the 2001 growing season are presented in Table 1. Making recommendations after only 8 years worth of data is not wise. After 8 years, the rootstocks seem to be very similar in yield, growth, and root suckers. The Lovell and Myran rootstocks apparently had some problems at the supplying nursery, and all loss of trees on these rootstocks occurred during the first year.

Acknowledgments

Colorado Agricultural Experiment Station provided funds that supported data collection and analysis. John Wilhelm, Bryan Braddy, Gary Valpando, Claude Wilkerson, and Rod Sharp assisted with data collection.

Table 1. Several growth parameters for the 2001 growing season in the 1994 NC-140 peach rootstock planting at the Western Colorado Research Center - Orchard Mesa site (Block 8B).

Rootstock	No. trees planted	No. surviving	Trunk Circumference (inches)	Average rootsuckers (no./tree)	Yield/tree (pounds)	Average Fruit wt. (ounces)[1]
Lovell	8	2	18.0	0	86	6.8
Bailey	8	8	15.8	0	66	6.9
Tenn. Natural	8	6	16.7	0	94	6.8
GF 305	7	6	16.7	0	115	6.7
Higama	8	7	16.8	0	81	7.0
Montclar	8	8	17.1	0	102	6.4
Rubira	8	7	15.2	0	70	6.7
Ishtara	8	5	15.3	0	117	7.1
Myran	8	1	20.9	0	89	7.6
S 2729	8	7	17.6	0	60	6.8
Chui Lum Tao	4	4	14.3	<1	78	6.8
Tzim Pee Tao	4	4	15.9	<1	82	7.1
H 7338013	8	8	17.3	0	67	7.3
H 7338019	4	4	16.6	0	153	6.9
BY 520-8	7	6	17.6	0	111	6.2
BY 520-9	8	8	17.4	0	108	6.5
Ta Tao 5	6	6	16.1	0	101	6.1

1 A 9.7 ounce peach results in a 42 count 25 pound box while a 6/2 ounce peach results in a 70 box.

1993 Cornell-Geneva Apple Rootstock Trial (NC-140 Regional Project)

Ron Godin, Research Scientist / Sustainable Agriculture, WCRC – Rogers Mesa

Summary and Recommendations

After nine years of growth, the CG.13 rootstock trees have produced the greatest cumulative yield. The trees with the largest trunk diameter are also the CG.13. Smallest trees were produced on CG.202 and CG.222. It is still too early for general recommendations, but CG.13 and CG.30 seem to have promise as rootstocks similar in size to M.7 EMLA. These could be planted by growers in trial plantings if they become commercially available.

Introductions and Objectives

Choice of a rootstock could make the difference between an economically viable orchard and one that loses money for the orchardist. One major disease of apple is fireblight. The Cornell-Geneva (CG) breeding program began breeding apple rootstocks with the goal of developing fireblight resistant rootstocks. 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 several of these CG rootstocks would perform over a range of climates. The objectives of this trial were to determine the adaptability of the CG apple rootstocks to Western Colorado and to determine if any of these rootstocks perform better than existing rootstocks.

Materials and Methods

This trial was planted in Block 13 at the Western Colorado Research Center – Rogers Mesa site in 1993. The trial consisted of 5 rootstock clones from the Cornell Geneva breeding program. The scion variety chosen was Liberty. It was planted in a randomized complete block design with 8 replications. Trees were supported and trained to a modified vertical axe training system and trees were watered by microsprinkler irrigation. Similar plantings are under evaluation at other sites across the U.S.

Results and Discussion

The results for the 2001 growing season are presented in Table 1. The largest trees based on trunk diameter were on CG.13; the smallest trees were on CG.202 and CG.222. The most suckering was on the CG.30 and CG.210. Greatest cumulative yield occurred on CG.13 with two others yielding similarly. The least cumulative yield occurred with CG.202.

Acknowledgments

Colorado Agricultural Experiment Station provided funding that supported data collection and analysis. Special thanks to George Osborn and Bryan Braddy, for data collection.

Table 1. Several growth parameters for the 2001 growing season in the 1993 NC-140 Cornell-Geneva apple rootstock planting at the Western Colorado Research Center Rogers Mesa site (Block 13).

Rootstock	Trunk Circumference (in)	Average rootsuckers (number/tree)	Yield/tree (lbs)	Cumulative Yield (lbs)	Average Fruit wt. (oz)[1]
M.7 EMLA	12.2	19	26.2	407	3.8
CG.13	14.1	12	37.0	426	5.0
CG. 30	9.8	22	16.0	417	4.2
CG. 202	7.3	10	22.3	179	4.5
CG.210	9.7	21	12.8	385	3.9
CG.222	7.9	16	8.7	239	4.2

1 An average fruit weight of 8.4 ounces is the equivalent of a 88 count size while 12.5 ounces is a 56 count size.

1998 Sweet Cherry Rootstock Trial (NC-140 Regional Project)

Ron Godin, Research Scientist / Sustainable Agriculture, WCRC – Rogers Mesa

Summary and Recommendations

This is the end of the fourth year of the planting. The trees are still too young to draw conclusions and no recommendations should be made at this time.

Introductions and Objectives

Until a few years ago, there had not been a good dwarfing rootstock for cherry. Several Prunus species and crosses have been made that have 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. Similar plantings are under evaluation at several other sites across the U.S.

Materials and Methods

This trial was planted in Block 31 at the Western Colorado Research Center – Rogers Mesa site in 1998. The trial consisted of 13 Prunus rootstocks with a Bing scion. It was planted in a randomized complete block design with seven replications. Trees were trained to a central leader. Trees were watered by furrow irrigation until 1999 when microsprinklers were installed. On 16 November, trunk circumference and the number of rootsuckers were counted.

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. It is unclear why more loss has occurred in the Mazzard rootstock. The possibility is that they were weaker trees from the nursery. The results for tree growth parameters are presented in Table 1. Making recommendations after only 4 years worth of data is not wise. However, it is apparent that some trees are inducing dwarfing in this planting as seen in trunk diameter. Whether those particular rootstocks will be productive is yet to be determined.

Acknowledgments

Colorado Agricultural Experiment Station provided funds that supported data collection and analysis. Special thanks to George Osborn and Bryan Braddy for data collection.

Table 1. Several growth parameters for the 2001 growing season in the 1998 NC-140 sweet cherry rootstock planting at the Western Colorado Research Center - Rogers Mesa site (Block 31).

Rootstock	No. still alive[1]	Trunk Circumference (inches)	Average Fruit Weight (lbs/tree)	Average no. rootsuckers (no./tree)
Mazzard	4	10.9	3	1
Mahaleb	7	9.3	2.5	1
148/1	6	10.1	1.8	0
148/2	5	7.5	2.2	0
148/8	6	8.7	1.5	7
195/20	7	9.4	2.6	0
209/1	7	6.6	1	0
Edabriz	6	7.1	1.7	0
W10	7	9.1	2.3	9
W13	5	9.9	1.9	16
W53	6	7.6	2.7	8
W72	6	8.0	1.7	4
W158	7	8.3	3.5	4

[1] Out of seven originally planted trees.

2001 Research Projects

Robert Hammon

Evaluation of 'Yieldgard' Corn - Fruita and Farmington NM
Cooperators: Mick O'Neill, New Mexico State University Farmington Science Center
Funding: Grand Valley Hybrids; Pioneer Hi-Bred International

Onion Varietal Response to Onion Thrips
Cooperators: Curtis Swift, Colorado State University Cooperative Extension Service
George Novotny, Olathe CO.

Sustainable Dryland Cropping Systems for Southwest Colorado
Project leader: Abdel Berrada, Southwest Colorado Research Center
Funding: USDA/SARE

Evaluation of Russian Wheat Aphid Spring Barley Breeding Lines
Cooperators: Phil Bregitzer, USDA-ARS, Aberdeen ID
Mark Stack, Southwest Colorado Research Center

Evaluation of Russian Wheat Aphid Resistant Winter Barley Breeding Lines
Cooperator: Do Mornhinweg, USDA-ARS, Stillwater OK

Impact of Seed Treatments and Planting Dates on Establishment of Bitterbrush at Maybell Co
Cooperators: Gary Noller, Upper Colorado Environmental Plant Center, Meeker CO
Funding: Colorado Division of Wildlife Habitat Partnership Program

Survival of Japanese Beetles under Western Colorado Conditions
Cooperators: Lou Bjostad, Erich Fromm, Jason Bishop, Bioagricultural Science and Pest Management
Funding: USDA/APHIS

Insect Survey - cereal leaf beetle, exotic fruit insects, Japanese beetle, exotic wood boring beetles
Project Leaders: Lou Bjostad, Elisa Bernklau, Bioagricultural Science and Pest Management
Funding: USDA-CAPS

Insecticide trials:
Sap beetles in sweet corn, Western flower thrips in dry beans
Funding: FMC Corporation
Thrips in onions - Two trials at Fruita, one at Delta
Western flower thrips in alfalfa
Lygus bugs in seed alfalfa

Evaluation of Biological Seed Treatment for Control of Seedling Disease in Chickpeas
Cooperator: Abdel Berrada, Southwest Colorado Research Center

Insects Affecting Production of Reclamation Plant Seed
Cooperators: Walter Henes, Southwest Seed, Dolores CO
Upper Colorado Environmental Plant Center, Meeker CO

Cereal Leaf Beetle Survey in Western Colorado

Robert Hammon

Summary

Surveys for Cereal leaf beetle, *Oulema melanopus*, have been conducted on a formal basis in western Colorado since 1999, and informally since 1988. Its presence in Colorado was detected for the first time in 2001, in Routt County. Cereal leaf beetle larvae were found in small grain fields east of Hayden during mid-June 2001 surveys. Small grain production areas in all other areas surveyed appeared to be uninfested during the 2001 growing season. Cereal leaf beetle populations were well below economic injury levels in all fields, and were not a production concern during the 2001 growing season.

Introduction

Cereal leaf beetles are an European native pest of small grains first identified in eastern North America in 1962. It was first found in Utah in the late 1980's. Western states that have reported cereal leaf beetle infestations are Washington, Oregon, Idaho, Nevada, Utah, Montana, and Wyoming. Small grain production areas of western Colorado have been inspected for the presence of cereal leaf beetle on an informal basis in the course of surveys for other pests since 1988. A formal survey for cereal leaf beetle funded by USDA Cooperative Agricultural Pest Survey has been conducted throughout western Colorado, with emphasis on northwestern Colorado since 1999.

Adult cereal leaf beetles are brilliant metallic blue, with a red "neck".

Cereal leaf beetle feeding damage appears as a linear streak on the upper surface of the leaf

Methods

Oat, wheat and barley fields in several counties were inspected for cereal leaf beetle presence during stem elongation to early heading growth stage. Fields were visually inspected for at least ten minutes, and at least 100 sweeps with a 15 inch sweep net were taken to locate cereal leaf beetle larvae and adults. Voucher specimens from all infested fields are stored at the Western Colorado Research Center.

Results and Discussion

Survey results, summarized by county are displayed in Table 1. Cereal leaf beetle larvae were found in six fields surveyed in the vicinity of the Hayden power plant, approximately three miles west of town. No adult beetles were seen in any of three visits to the infested fields in June and early July. Infestation levels were no more than two larvae per 100 sweeps in any infested field. Economic infestations would have at least several larvae per sweep.

Small grain producers in northwestern Colorado must be prepared to scout fields for cereal leaf beetles, and take action before populations reach economic levels. Producers in other parts of the state must be aware that it probably a matter of time before cereal leaf beetles become a small grain production concern.

Table 1. Summary of fields surveyed specifically for cereal leaf beetle

County	Fields	Acres	CLB
Moffat	12	1840	none
Routt	8	690	6 of 8
Montezuma	3	370	none
Dolores	3	440	none
Mesa	4	90	none

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

Robert Hammon and Abdelfettah Berrada

Summary

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

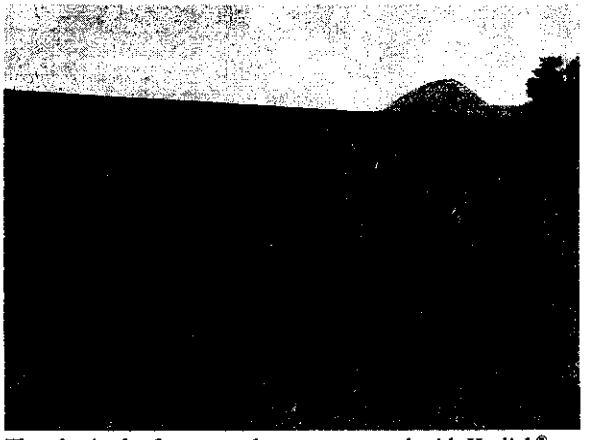
Introduction and Objectives

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

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

Materials and Methods

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



The plot in the foreground was not treated with Kodiak® while that directly behind it was treated.

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

Results and Discussion

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

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

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

Onion Variety Tolerance to Thrips Feeding, Fruita CO

Robert Hammon

Summary

Twenty onion varieties were planted in a replicated trial to determine relative tolerance to thrips feeding. One half of the plots were treated with Vydate L to control thrips, while thrips were allowed to feed and reproduce in the remaining half of the plots. Varietal response to the insecticide was quite variable, with increased yield and bulb size in some, no change in some, and decreased yield and size in others. Thrips control varied with variety. The response of onion varieties to the Vydate L applications cannot be attributed solely to thrips control, but was probably due in part to growth regulator characteristics of the compound. Further research is necessary to characterize onion varietal tolerance to thrips feeding.

Introduction and Objectives

Approximately 2000 acres of onions are grown in western Colorado. Onion thrips, *Thrips tabaci*, is a primary pest of onion production in the region. They had been managed with organophosphate insecticides prior to 1990, when the thrips population began showing signs of resistance. Pyrethroid insecticides were used extensively during the 1990's with good control achieved for the most part. About 1999 the onion thrips population began showing signs of resistance to pyrethroid insecticides, and by 2001 control failure was experienced with them much of the time. Carbamate insecticides have also been used, but onion thrips are now showing signs of resistance to them. Onion varieties are known to vary in their tolerance to thrips feeding, and knowledge of the characteristics of particular varieties can be important in determining a management program.

The objectives of this research are:

1) Evaluate onion varieties grown in western Colorado for tolerance to onion thrips feeding.

2) Evaluate onion varieties for yield potential under conditions at Fruita Colorado.

Methods

Twenty varieties of onions (Table 1) were planted at the Western Colorado Research Center at Fruita on 3 April 2001. The experiment was arranged as a randomized complete block, split plot, with four replications. Variety was arranged as main plot (plot size 5 ft x 15 ft) and insecticide as sub-plot (plot size 2.5 ft x 15 ft).

Onions were planted in 2 rows per 30" bed with 10" spacing between rows. Seed was planted at a rate of 1 seed/row inch, then hand-thinned to 1 plant per 2-3 inches on 17 May 2001. Two hundred lb/A of 11-52-0 fertilizer was incorporated prior to planting, and 160 lb/A N (32-0-0) top dressed with hand held applicator. 40 lb/A was applied weekly during the last week of May and the each of the first three weeks of June. The field was furrow irrigated. Three irrigations were applied to germinate seed and control soil crusting, followed by eleven irrigations during the season . Irrigations ranged from 8 to 16 hour sets depending on soil and weather conditions and water availability. May through September precipitation for Fruita was recorded at 3.68 inches.

Table 1. Onion variety characteristics, thrips counts, onion yield and size distribution. All data presented in this table is the average over insecticide treated and untreated plots. Means within a column followed by the same letter are not significantly different (LSD P=0.05).

Variety	Company	Days	Market Class	Spacing inches	Thrips per plant	Marketable[1] CWT/A		% Medium		% Jumbo +	
Outrigger	Asgrow	107	Export	2.1	29.75 ab	206.57	GHI	48.94	ABCD	9.41	GHI
Tamara	Bejo	115	Export	2.1	34.12 ab	224.20	FGHI	58.56	A	2.90	I
X351	Palmer	102	Hard globe	2	13.12 ab	144.11	HIJ	37.81	CD	6.38	HI
Husky X302	Palmer	90	Hard globe	2.5	15.18 ab	180.39	HI	47.77	ABCD	12.39	GHI
Kodiak X400	Palmer	112	Spanish x hard globe	2.7	27.75 ab	303.11	DEFG	43.02	ABCD	33.49	CDE
Sharon	Bejo	100	Spanish storage	2	44.38 b	127.37	IJ	41.22	BCD	1.20	I
Arsenal	Asgrow	102	Spanish storage	1.8	31.38 ab	116.23	IJ	38.18	CD	0.00	I
Pinnacle	Petoseed	110	Spanish storage	1.8	20.38 ab	469.20	BC	48.08	ABCD	30.03	DEF
Spinnaker	Asgrow	110	Spanish storage	2.1	24.12 ab	176.63	HI	50.56	ABCD	5.63	HI
Teton	Petoseed	110	Spanish storage	2.2	38.25 b	363.59	CD	55.54	AB	22.36	DEFG
Gunnison	Bejo	113	Spanish storage	1.9	33.00 ab	245.22	EFGH	53.84	ABC	6.22	HI
Tioga	Petoseed	115	Spanish storage	2.1	16.00 ab	475.61	BC	38.53	CD	45.83	ABC
X333	Palmer	102	Full Spanish	2.7	21.75 ab	312.33	DEFG	59.18	A	19.49	EFGH
Mira	Asgrow	105	Full Spanish	1.8	21.38 ab	390.29	CD	53.40	ABC	20.13	EFGH
Regiment	Asgrow	110	Full Spanish	2.1	16.38 ab	338.96	DE	50.39	ABCD	22.67	DEFG
Vision	Petoseed	117	Full Spanish	2.5	33.75 ab	556.67	B	35.85	DE	53.75	A
Mesquite X202	Palmer	120	Full Spanish	2	14.62 ab	678.35	A	38.63	BCD	49.84	AB
Raptor	Seedworks	120	Full Spanish	2	15.00 ab	514.85	B	42.42	ABCD	36.41	BCD
Caballero	Petoseed	95	Intermediate	2.1	4.50 a	326.56	DEF	58.99	A	15.24	FGHI
Gallatin	Bejo	95	Intermediate	1.9	2.675 a	48.23	J	19.26	E	0.00	I
			LSD (0.05)		32.7	114.1		17.01		15.37	

[1] Marketable onions are medium and larger in size.

Herbicides were applied with a CO_2 pressured, rickshaw type sprayer. Buctril (14 oz/A; 0.22 lb a.i./A) plus Goal 2XL (12 oz/A; 0.19 lb a.i./A) were applied 3 May, 18 May and 21 May. Buctril plus Prowl 3.3 EC (1.8 pt/A; 0.75 lb a.i./A) was applied on 1 June. Goal 2XL plus Prowl 3.3 EC was applied on 29 June. The plots were hand weeded twice.

Vydate L was applied three times: 28 June, 12 July, and 2 August. All applications were at a rate of 4 pt/A (1.0 lb a.i./A) using a hand held CO_2 pressured sprayer calibrated to apply 18 gal/A of finished spray material. Non ionic spreader sticker (Activator 90, Loveland Industries) was added to all applications at a rate of 2 pt/100 gal.

The onion thrips population was sampled once during the growing season (26 & 27 July) by choosing five random plants per plot and counting the thrips in the field. The average number of thrips per plant was used in the analysis of variance.

The onions were undercut with a double rod weeder on 20 September, and onions left to cure in the field. Plots were evaluated for yield on September 27-29, after one week of field curing. One row (13 row-ft) was chosen for evaluation and onions sorted by size: boiler < 1.75"; pre-pack 1.75"-2.25"; medium 2.25"-3.0", jumbo 3.0-4.0"; colossal >4.0". The number and total weight of onions in each size class was recorded.

Analysis of variance was conducted on all data. Yield by size categories, percentage of yield within a size category and thrips counts were subjected to a two way, split plot analysis (Table 1). Variety response to insecticide application was calculated by subtracting the untreated from treated data for each data category and conducting a one way analysis of variance on the difference. If a variety mean was within two standard errors of zero, it was categorized as having no response. If the mean was greater than two standard error values from zero, the variety was considered to have either a positive or negative response to the insecticide treatment (Table 2.).

Table 2. Onion variety response to insecticide applications. Greater values denote larger differences between treated and untreated plots. Cells with light shading had a statistically significant positive response to insecticide application. Those with dark shading had a significant negative response to insecticides. Unshaded cells had no significant response to insecticide. Means within a column followed by the same letter are not significantly different (LSD, P=0.05 column 3, P=0.10 column 4)

	CWT/A		% of MJC
	Med +[1]	Jum +[2]	% Jum +[3]
Outrigger	7.23	-6.79 cd	-4.58 cdef
Tamara	91.75	20.95 bcd	4.73 abcd
X351	123.90	39.68 bcd	12.62 ab
Husky	90.57	16.96 bcd	2.70 abcde
Kodiak	48.68	47.05 bcd	7.29 abcd
Sharon	11.06	8.85 bcd	3.15 abcde
Arsenal	-11.21	0.00 cd	0.00 bcdef
Pinnacle	78.47	87.32 abc	3.40 abcde
Spinnaker	-39.09		
Teton		-89.68 d	-9.57 ef
Gunnison	24.04	20.95 bcd	4.97 abcd
Tioga	-28.17	67.85 abcd	7.91 abc
X333	40.56	-17.85 cd	-4.26 cdef
Mira	-69.92	-54.58 cd	-9.71 ef
Regiment	-27.44	70.65 abcd	5.53 abcd
Vision	69.33	169.92 ab	9.29 ab
Mesquite	171.99	218.45 a	9.25 ab
Raptor	216.97	234.97 a	15.80 a
Caballero	-55.46	-41.74 cd	-5.62 def
Gallatin	12.10	0.00	0.00 bcdef
LSD		168.3	13.4
P-Value	0.2296	0.0180	0.0519

[1] Treated medium, jumbo, and colossal minus untreated medium, jumbo, and colossal CWT/A.
[2] Treated jumbo and colossal minus untreated jumbo and colossal CWT/A.
[3] Treated percentage jumbo and colossal of marketable onions minus untreated percentage.

Results and Discussion

Thrips counts, yield, and size class distribution of onions are displayed in Table 1. Thrips counts were reduced only slightly by Vydate treatments, from an average of 24.6 per plant in the untreated to 21.1 in the treated, but the difference was statistically significant (P<0.0001). The thrips sample was taken two weeks after the second Vydate application. The thrips population was sampled only once, so the exact size of late season infestations are unknown. The greatest yields were in the long season full Spanish varieties 'Mesquite' and 'Raptor', and Spanish storage varieties 'Tioga' and 'Pinnacle'. The greatest percentage of jumbo's tended to be in the longer season full Spanish varieties, although 'Tioga' had a greater percentage of jumbo's than other Spanish storage varieties.

Onion variety response to insecticide applications is displayed in Table 2. Some varieties show a relatively large response which did not calculate to be significant because of variability in the data and resultantly large standard error. The full Spanish varieties tended to show the greatest positive response to the insecticide. 'Spinnaker' and 'Teton' showed a negative response to the insecticide applications.

Onion response to Vydate L applications are probably due more to the growth regulator effects of the compound than to reduction in thrips populations. Visual surveys of the thrips late in the season showed that populations never reached the levels that many western Colorado growers have experienced.

More research will be necessary to confirm varietal response to insecticide treatments. Contact and non-systemic insecticides should be compared with systemic carbamates such as Vydate L to determine exactly what growth regulator effect exists and to separate these effects from those of thrips feeding.

Acknowledgments

George Novotny (Olathe Co.) and Curtis Swift (Colorado State University Cooperative Extension, Grand Junction) chose the onion varieties and acquired seed. Melissa Foley assisted in field work and thrips sampling. Fred Judson and Lot Robinson assisted with field preparation, planting, and irrigation and Shane Max assisted with harvest.

Field Evaluation of 'YieldGard' Corn for Corn Earworm Control

Robert Hammon

Summary

Corn varieties that have been genetically modified with YieldGard® technology have been evaluated for corn earworm control at Fruita CO since 1999 and Farmington NM since 2000. This technology was tested at these same locations in 2001, using corn varieties from two production companies. Damage from corn earworm was reduced by an average 72.8% in Grand Valley Hybrids varieties at Fruita. This compares with 72.7% reduction recorded with the same varieties at Fruita in 2000. Corn earworm damage was reduced by 68.4% with the two Grand Valley Hybrids varieties at Farmington, which recorded much greater earworm pressure than Fruita. Yield of YieldGard® modified corn was 12.9% and 7.3% greater than the unmodified Grand Valley Hybrids varieties at Fruita and Farmington respectively. Corn earworm damage was reduced by 65.6% and 19.1% in two Pioneer Hi-Bred varieties at Farmington. Yield was not affected by YieldGard® modification in the Pioneer Hi-Bred varieties at Farmington. Three years of testing has shown that YieldGard® technology protects grain from damage from corn earworm, but the degree of protection differs with variety.

Introduction and Objectives

YieldGard®is a registered product of the Monsanto Corporation, and is based on a genetic event referred to as Mon810. YieldGard®corn has been genetically modified by inserting a gene from a bacterium, *Bacillus thuringensis* (*Bt*), into the corn plant, which directs it to produce a protein that is toxic to larvae of many lepidoptera. *Bt* modified corn products are typically used to manage European corn borer, *Ostrina nubilalis*, which is not present in western Colorado or northern New Mexico. Corn earworm, *Helicoverpa zea* (CEW), is the primary lepidoptera pest of corn in the intermountain region of western Colorado and northern New Mexico. Western bean cutworm, *Loxigrotis albicosta*, is also present in the region, but at a lower population level than CEW. These insects are primarily kernel feeding pests, which are present after silking. The absence of European corn borer and other stalk boring lepidoptera in the intermountain region presents a unique opportunity for field evaluation of the efficacy of YieldGard® and other genetically modified corn products against corn earworm. Experiments designed to determine the impact of YieldGard® corn on corn earworm damage, and the impact of corn earworm on yield of field corn were performed during the 1999 growing season at Fruita, Colorado. These experiments were repeated at Fruita and Farmington, New Mexico during the 2000 and 2001 growing seasons. The objective of the 2001experiment was to determine the effectiveness of YieldGard® technology in controlling corn earworm.

Materials and Methods

The experiments were performed at the Western Colorado Research Center near Fruita, Colorado (Mesa County), and the New Mexico State University Agricultural Science Center near Farmington, New Mexico (San Juan County). Agronomic data for the two experiment sites is shown in Table 1. The design of these experiments was identical to that used in 1999 and 2000 plots. The same two Grand Valley Hybrids corn varieties were planted at each site, and two Pioneer Hi-Bred International varieties were also planted at Farmington. The Grand Valley Hybrids and Pioneer Hi-Bred International evaluations were conducted as separate experiments. Each variety was represented by the standard and YieldGard® modified forms. The plots were designed as a two factor (variety, *Bt*) randomized complete block with six replications. Plot size was four 30" rows by 50 ft at Fruita. Within each plot, two rows were designated as sample rows and two as harvest rows. Destructive sampling was done in the rows designated for sampling. Harvest was with a modified Gleaner combine

with on-board scales. Plot size at Farmington was two 34" rows by 350 ft. Sampling was done within the two plot rows at Farmington. The entire 350 ft plot was harvested at Farmington, and weight measured with a weigh wagon.

Fifty random ears were harvested from each plot to evaluate corn earworm feeding damage. This was done on 23 August 2001 at Fruita and 18 September 2001 at Farmington. The corn was fully dented at each site when the plots were sampled. Each ear was examined for CEW feeding damage, and the amount of damage, in terms of feeding-galley-inches was recorded for each damaged ear. Any caterpillars found during the evaluation process were identified to species. A relative damage rating (RDR) was calculated for each plot by multiplying the average number of feeding-galley-inches per damaged ear by the percent damaged ears. The relative damage rating is an estimate of the overall feeding-galley-inches per ear.

Statistical analysis of all data was done within the factor sub-routine of MSTAT-C. The experiment was treated as a two factor randomized complete block. Separation of means was with the LSD test with a significance factor of P=0.05 or P=0.10.

Results and Discussion

Data generated by the 2001 experiments is displayed in Tables 2-4. All of the caterpillars recovered from the Fruita evaluation were corn earworm. Ninety-five percent of the 122 caterpillars recovered during the evaluation at Farmington were corn earworm, with the remainder being western bean cutworm. YieldGard® technology was effective in reducing corn in all varieties at both sites. Both percent infested ears and feeding damage per infested ear was in all cases reduced by YieldGard® corn.

Corn earworm pressure was 3.35 times greater at Farmington than Fruita, using the relative damage rating as an indicator. At Fruita, the overall reduction in damage was calculated to be 69.2% and 77.0%, with an average of 72.8%. This was virtually identical to the 72.7% calculated for the same two varieties at Fruita in 2000. Damage reduction was 80.8% and 56.0% for the two Grand Valley Hybrids varieties at Farmington, for an average of 68.4%. The one variety planted in both 2000 and 2001 at Farmington reduced ear damage by 64.6% and 80.8% respectively.

The reduction in percent-infested ears was dramatic in one, and minimal in one of the varieties from each company at Farmington. The two Grand Valley Hybrids varieties reduced percent-damaged ears by 10.6% and 22.0% at Fruita and 51.4% and 18.7% at Farmington. The reduction in percent-infested ears was 42.7% and 1.3% in the Pioneer Hi-Bred varieties at Farmington. The reduction in feeding damage per damaged ear was 59.9% and 52.0% at Fruita and 58.2% and 45.4% at Farmington for the two Grand Valley Hybrids varieties. The reduction in feeding damage per infested ear was 32.1% and 18.2% for the two Pioneer Hi-Bred varieties at Farmington.

Corn yield at Fruita was reduced by nitrogen stress during the growing season. Some nitrogen was leached because of over irrigation. Yield of Grand Valley Hybrids corn was greater in the YieldGard® modified varieties at both sites. This is in contrast to previous years when the unmodified varieties outyielded their YieldGard® counterparts. There were no differences in yield between the modified and unmodified Pioneer Hi-Bred varieties at Farmington. Test weight was not impacted by YieldGard® modification, but there was a slight difference in moisture with YieldGard® modification in the Farmington trials.

Three years of research leave no doubt that YieldGard® is effective in reducing ear feeding damage from corn earworm. Percent infestation and feeding damage per infested ear are both reduced by YieldGard®. There is also little doubt that the performance of YieldGard® technology varies considerably with corn variety. Each variety should be tested for corn earworm control before any conclusion about efficacy of YieldGard® technology can be made.

Acknowledgments

This research was conducted with the financial assistance of Grand Valley Hybrids and Pioneer Hi-Bred International. Mick O'Neill, Curtis Owen and Kenny Kohler conducted the fieldwork at Farmington. Melissa Foley assisted in all phases of the experiment at Fruita, and Tom Hooten assisted with the evaluation of the Farmington plots. Wayne Cooley allowed the use of his weigh wagon for harvest of Farmington plots.

Table 1. Agronomic data from 2001 experiments at Fruita CO and Farmington NM.

Location	Plant date	Harvest date	Fertilizer	Herbicide	Miticide	Irrigation
Fruita	2 May	24 Oct	200 lb/a 11-52-0 PPI 180 lb/a N (32-0-0) side dressed 7 Jun 2000	Bladex 4L PPI 2 qt/a 30 April 2001	Comite II 2 1/4 pt/a 11 July 2001	8 furrow irrigations 3.68" precip
Farmington	15 May	27-28 Nov	200 lb/a 6-26-30 PPI 150 lb/a N (32-0-0) through center pivot	Bicep Lite II Magnum 1.5 qt/a Clarity 1/8 pt/a 23 May 2001	none	30" center pivot irrigation 2.99" precip.

Table 2. Fruita 2001 - Grand Valley Hybrids varieties

	% CEW infested ears	Galley inches/ infested ear	Relative Damage Rating[1]	% Damage Reduction	Yield bu/A	Test Weight lb/bu	% Moisture
GVX 0258	36.0	1.94	0.728		145.8 b	58.8 a	11.5 b
GVX 8937	31.7	1.68	0.614		164.6 a	58.1 b	12.2 a
P-value (variety)	0.3533	0.1021	0.3068		0.0038	0.0002	<0.0001
Bt -	42.0 a	2.52 a	1.056 a		145.8 B	58.4	11.8
Bt +	25.7 b	1.10 b	0.287 b	72.8	164.6 A	58.5	11.9
P-value (*Bt*)	0.0026	<0.0001	<0.0001		0.0771	0.7785	0.3298
GVX 0258	41.3	2.77	1.113		141.5	58.7	11.5
GVX 0258 *Bt*	30.7	1.11	0.343	69.2	150.1	59.0	11.5
GVX 8937	42.7	2.27	0.998		158.5	58.1	12.1
GVX 8937 *Bt*	20.7	1.09	0.230	77.0	170.7	58.1	12.3
P-value (var. X *Bt*)	0.2295	0.1288	0.9921		0.7180	0.4094	0.3298

Means within a column group followed by different letters are significantly different. Lower case letters denote a significance level of P=0.05, while upper case letters denote a significance level of P=0.10 (LSD)

[1] Calculated by % infested ears X Galley inches/infested ear

[2] Adjusted to 60 test weight and 15.5% moisture

Table 3. Farmington 2001 - Grand Valley Hybrids varieties

	% CEW infested ears	Galley inches/ infested ear	Relative Damage Rating[1]	% Damage Reduction	Yield bu/A	Test Weight lb/bu	% Moisture
GVX 0258	69.0 a	2.54	2.02 a		137.0 a	55.0 a	13.3 a
GVX 8937	86.7 b	2.80	2.52 b		203.5 b	56.2 b	14.4 b
P-value (variety)	<0.0001	0.1783	0.0219		<0.0001	<0.0001	<0.0001
Bt -	95.3 b	3.61 b	3.45 b		164.2 a	55.5	13.7 A
Bt +	60.3 a	1.74 a	1.09 a	68.4	176.2 b	55.7	13.9 B
P-value (*Bt*)	<0.0001	<0.0001	<0.0001		0.0190	0.3842	0.0773
GVX 0258	94.7 c	3.59	3.39 C		129.7	54.7 c	13.1
GVX 0258 *Bt*	43.3 a	1.50	0.65 A	80.8	144.4	55.3 b	13.4
GVX 8937	96.0 c	3.63	3.50 C		198.8	56.3 a	14.4
GVX 8937 *Bt*	77.3 b	1.98	1.54 B	56.0	208.1	56.0 a	14.4
P-value (var. X *Bt*)	<0.0001	0.2512	0.0626		0.5620	0.0109	0.0773

Table 4. Pioneer Hi-Bred varieties

	% CEW infested ears	Galley inches/ infested ear	Relative Damage Rating[1]	% Damage Reduction	Yield bu/A	Test Weight lb/bu	% Moisture
35R57/58	63.3 a	1.88 a	1.27 a		166.8	58.1	14.3 b
34M94/95	94.7 b	2.84 b	2.70 b		162.5	57.9	13.9 a
P-value (variety)	<0.0001	<0.0001	<0.0001		0.3120	0.1639	<0.0001
Bt -	90.0 b	2.68 b	2.44 b		166.3	58.1	14.0 A
Bt +	68.0 a	2.04 a	1.54 a	36.9	163.0	57.9	14.1 B
P-value (*Bt*)	<0.0001	0.0002	<0.0001		0.4404	0.1639	0.0771
35R57 Bt-	84.7 b	2.24	1.89		166.2	58.1	14.2 B
35R58 Bt+	42.0 a	1.52	0.65	65.6	167.5	58.0	14.4 C
34M94 Bt-	95.3 c	3.13	2.99		166.4	58.0	13.9 A
34M95 Bt+	94.0 bc	2.56	2.42	19.1	158.6	57.8	13.9 A
P-value (var. X *Bt*)	<0.0001	0.5744	0.424		0.2895	1.0000	0.0771

Means within a column group followed by different letters are significantly different. Lower case letters denote a significance level of P=0.05, while upper case letters denote a significance level of P=0.10 (LSD)

[1] Calculated by % infested ears X Galley inches/infested ear

[2] Adjusted to 60 test weight and 15.5% moisture

List of Research Projects – 2001

Dr. Harold Larsen

Cropping reliability research:
- Bloom Delay / Bud burst delay studies
- Frost Net studies

Disease control studies
- Grape powdery mildew studies
  - (Development of a validated disease model for Colorado grape growers, efficacy trials)
- Tree fruit powdery mildew studies (efficacy trials, etc.)

Fruit virus studies (peach mosaic disease: peach and nectarine cv. susceptibility studies)

Dr. Horst Caspari

Cropping reliability research:
- Bud burst studies

Integrated grape management:
- Start on developing integrated grape production guidelines for Colorado grape growers
- Grape irrigation management
- Hail damage study

Grape variety evaluations

Partial root zone irrigation project (apple and pear)

List of Publications – 2001

Western Colorado Research Center Annual Report 2000 (H. Larsen)
(http://www.colostate.edu/programs/wcrc/annrpt/)

Colorado Organic Crop Management Association Research Report 2000. (H. Larsen)

Western Phytoworks (Spring, 2001)

Western Phytoworks (Fall, 2001

Fruit Growers Newsletter (http://www.colostate.edu/Depts/CoopExt/NWR/fruit.htm)
All six issues (Jan., Mar., May, July, Sept., Nov.)

Proceedings of the 1st National Organic Fruit Tree Symposium. (H. Larsen)

+ additional papers by H. Caspari (listing unavailable at time of preparation – H. Larsen)

Cropping Reliability and Powdery Mildew Disease Control Studies During 2001

Harold J. Larsen & Horst Caspari

Summary

Particle film materials (kaolin clay, Surround) delayed bloom in peach by 2 to 6 days. No bloom delay was observed in apple or pear in trees treated with Surround or any of the other materials tried (dilute white latex paint, soybean oil, and an alginate + sucrose mixture). Soybean oil reduced the number of flower clusters that opened, possibly due to phytotoxicity of the soybean oil treatment. In grape, response to treatments varied with the cultivar. The alginate/sucrose mixture delayed bud burst in Cabernet franc and Cabernet sauvignon, slightly delayed bud burst in Siegerrebe, and did not affect bud burst in Vignoles. In a trial in Utah, Stylet-Oil increased bud and vine mortality on Chardonnay grape but not on other cvs.; soybean oil delayed bud burst by 5 days, but the bud and vine mortality are cause for concern. Further study is needed.

Fall applications of the biocontrol fungus, *Ampelomyces quisqualis* (AQ10), reduced overwintering apple powdery mildew infection to 11% of buds compared to 34% for non-treated control trees in a Jonathan cv. 'Lucky Jon" apple orchard with high disease pressure. Delay in appearance of grape powdery mildew infections until after a 1" rainfall event supported the suggestion that grape powdery mildew sprays may be reduced by delaying control applications until after occurrence of infection periods. Use of such IPM strategies could reduce amounts of control chemicals used, the impact of spray programs on the environment, and the seasonal costs to the growers.

Introduction

Colorado's fruit growers face a number of challenges in consistent production of high quality fruit. Two of these are cropping reliability and powdery mildew disease control. Spring freeze damage directly impacts cropping reliability and has reduced both tree fruit and vine crops over the past 10 years with discouraging frequency (1990, 1995, 1996, 1997, & 1999). Economic impacts for apples alone have ranged from $6 million to $8 million per year of occurrence. Peaches have experienced similar losses to spring freeze. Wine grapes, although less subject to such incidence because of their later timing for initiation of growth in the spring, also have experienced loss – especially in the colder locations where vineyards have been established.

Protection against spring freeze damage can be accomplished directly (through means to raise bud temperatures in th field) or indirectly (through means to reduce the damage threshold temperatures). The current work has focused on indirect protection by delay of bud break and bloom, with other studies on direct protection on

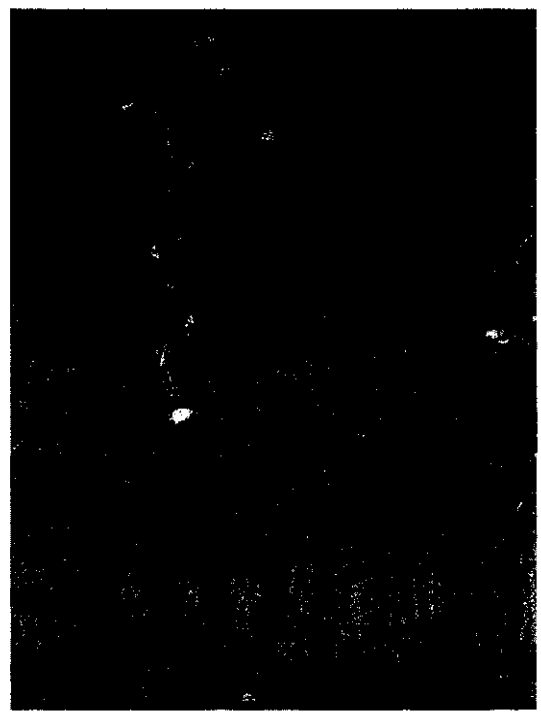


Figure 1. Ruby Jon apple shoot growth in early spring. Left shoot, healthy; right shoot with overwintering powdery mildew infection that delays bud break and reduces bud survival. (Photo by H. J. Larsen, 4/16/201).

a secondary level (e.g., the use of woven aluminized shade cloth to act as an artificial cloud to raise bud temperatures beneath the canopy during frost events). This report will emphasize the work on delaying bud break in the spring.

Powdery mildew is an annual disease problem faced by all fruit growers with susceptible crops. Apples and grapes tend to be the most impacted crops because the cultivars of each that are commonly grown here in Colorado are ones that have the higher levels of susceptibility – Gala, Fuji, and Golden Delicious apple and almost all of the wine grape cultivars, but especially Chardonnay. Control options for these crops are available, but these currently depend greatly on materials not currently acceptable for organic production. As increasing numbers of growers express interest in organic production, new technology needs to be evaluated for performance under Colorado's growing conditions. Soft control technologies for powdery mildew , including organically acceptable options, need to be identified. Organic control options for control of powdery mildew of fruit crops in western Colorado have been limited to programs based on the use of sulfur or natural crop oils. Sulfur has the potential for crop phytotoxicity when applied at temperatures of 80 - 85 °F or above. The biocontrol fungus *Ampelomyces quisqualis* (AQ10™) lacks this problem, but it has been found effective in environments where the humidity throughout the growing season typically would be higher than the 10 - 30% typical of orchard sites in the arid and semi-arid west (such as in western Colorado). Whether the AQ10 would survive and multiply to provide the powdery mildew biocontrol under such arid or semi-arid conditions is a question to be answered. Disease management approaches need to be included within overall crop management systems as part of an overall integrated crop production system using integrated pest management (IPM) principles and approaches. Such integrated crop production systems are under development for both apple and grape in Colorado, and the studies reported for 2001 were intended to help identify options and information for both crops.

Materials and Methods / Procedures

Delay of Bud Break:

Tree fruits: Study plots were established at WCRC - OM on apple (Gala, Ruby Jon, and Granny Smith), pear (Bartlett), and peach (BerendaSun, Glohaven, and Red Globe). Six replicates were used (individual branches for all except Gala apple). Treatments 2-4 were applied to drip by handgun or airblast sprayer, treatment 5a to a thin coating by airless paint sprayer and then treatment 5b to slight drip by hand pump sprayer, and treatment 6 to drip by hand pump sprayer. Treatments included: 1) non-treated control, 2) purified soybean oil (10% vol/vol, applied 2/6/01), 3) Surround WD (0.5 lb / gal spray, 2/2/01), 4) dilute white latex paint (10% vol/vol, applied 2/7/01), and 5) (a) alginate mixture (sodium alginate 3% wt/vol + sucrose 15% wt/vol +white latex paint 5% vol/vol + glycerol 1% vol/vol, applied at early bud swell 3/27/01) followed immediately by (b) calcium cloride (3% wt/vol) to lock part (a) in position. On Gala and Granny Smith apple and Red Globe peach, a sixth treatment was included: Frost Block II (5% vol/vol; a de-icer compound applied to open blossoms on 4/12/01, just before an expected freeze to evaluate capability to protect against freeze damage). Bloom observations were made daily as the crops neared and proceeded through bloom, and the day of the year (Julian date) recorded that the trees reached full bloom (defined as 80% of the blossoms open on the North side of the tree). In pear, the number of viable flower clusters per tree were counted on 4/19/01 (=JD 110) when it became apparent that there were differences during the initial observations. All data was analyzed via SAS and means separated by Duncan's MRT only when analysis revealed significance at the $p<0.05$ level.

Grapes: Study plots were established at WCRC – OM on Cabernet franc, Cabernet savignon, Sigerrebe, and Vignoles cvs. of wine grape. A second study was established by Michael Johnson (Utah St. Univ. Coop. Ext., Moab, UT) at a grower cooperator site in the Monument Valley area East of Moab, Utah on Chardonnay grape. Treatments at WCRC – OM

included: 1) Non-treated control, 2) soybean oil (10% vol/vol, applied 3/20/01), 3) Surround WD (0.5 lb/gal, applied 3/19/01), 4) dilute white latex paint (10% vol/vol, applied 2/7/01) and 5) alginate mixture (sodium alginate 3% wt/vol + sucrose 0.5 M + white latex paint 5% vol/vol + glycerol 1% vol/vol, applied 3/24/01) followed immediately by calcium cloride (3% wt/vol). Treatments at the Utah site were the same except that Stylet-Oil (5% vol/vol) replaced the alginate treatment and that all treatments were applied 3/9/01. Six replicates of one whole vine per treatment were used at WCRC – OM for Cabernet franc and Cabernet sauvignon, four replicates for Vignoles, and a single replicate for Siegerrebe. At the Utah site, five replicates of one whole vine of Chardonnay were used per treatment. Bud burst observations were made through the bud burst period and the number of buds reaching first exposure of green leaf tissue (BBCH stage 9) recorded on each date. All data was analyzed via SAS and means separated by Duncan's MRT only when analysis revealed significance at the $p<0.05$ level.

Powdery Mildew:

Apple: This study examined overwinter survival of powdery mildew in infected terminal and spur buds at the grower cooperator site (Silver Spruce Orchard) for non-treated control trees and for trees treated in September 2000 with AQ10 at 1 oz / acre. The study was done with Jonathan apple cv. 'Lucky Jon' at a grower cooperator orchard (Silver Spruce Orchard) near Hotchkiss, CO. A randomized complete block design was used in both studies with replicates consisting of multiple whole row or partial row units. Fifty terminals and 50 buds for each treatment replicate were evaluated 4/19/2001 for powdery mildew infection symptoms. Data analysis was done using SAS and means separated via Duncan's MRT only where $p<0.05$.

Grapes: Three studies were done at WCRC – OM using Chardonnay grape planted at 5 ft. in-row X 10 ft. aisle spacing. In studies 1 and 2, six whole panel replicates (8 vines per panel) were used for each treatment. In study 3, five whole panel replicates were used for each treatment. In studies 1 and 2, treatments were applied 5/9 (2" shoot growth), 6/7, 6/29, and 7/24 at 50 gal spray/acre. In study no.3, no applications of materials were made until after first observation of any mildew infection in the vineyard (which occurred 7/23). Study no. 1 treatments included: 1) non-treated control, 2) a standard sulfur program (Thiolux 80DF @ 5 lb/acre), 3) a DMI / sulfur / strobilurin / sulfur rotation (Nova 40W @ 5 oz/acre / Thiolux 80DF @ 5 lb/acre / Sovran 50 WDG @ 4 oz/acre / Thiolux 80DF @ 5 lb/acre), 4) a DMI / Bacillus subtillis / strobilurin / Bacillus subtillis rotation (Nova 40w @ 5 oz/acre / Serenade @ 6 lbs/acre / Sovran 50WDG @ 4 oz/acre / Serenade @ 6 lbs/acre), and 5) a biocontrol mix rotation (AQ10 @ 1 oz/acre + Rubigan 1E @ 2 fl.oz/acre / AQ10 @ 0.5 oz/acre / AQ10 @ 1 oz/acre + Serenade @ 6 lb/acre / AQ10 @ 1 oz/acre + Serenade @ 6 lb/acre); Latron B-1956 spreader/sticker was included in all sprays at 1 fl.oz/100 gal. Study no. 2 treatments included: 1) non-treeated control, 2) a strobilurin / sulfur rotation (Flint 50WDG @ 2 oz/acre / Thiolux 80DF @ 5 lbs /acre / Flint 50 WDG @ 4 oz/acre / & Thiolux 80DF @ 5 lbs/acre), 3) a DMI / sulfur rotation (Procure 50W @ 6 oz/acre / Thiolux 80DF @ 5 lbs/acre / Procure 50W @ 6 oz/acre / Thiolux 80DF @ 6 lbs/acre), 4) a biocontrol / sulfur rotation (Serenade @ 6 lbs/acre / Thiolux 80DF @ 5 lbs/acre / Serenade @ 6 lbs/acre / Thiolux 80DF @ 5 lbs/.acre), and 5) a Stylet-Oil program (Stylet-Oil @ 1.5% vol/vol for each of the four sprays); Latron B-1956 spreader/sticker was included in all sprays (except the Stylet-Oil sprays) at 1 fl.oz/100 gal. Study no. 3 treatments included: 1) a non-treated control, 2) jojoba oil (Erase @ 1% vol/vol), 3) Stylet-Oil @ 2.0% vol/vol, and 4) an AQ10 + Rubigan tank mix (AQ10 @ 0.5 oz + Rubigan 1E @ 1.5 fl.oz/acre); all sprays were applied at 50 gal/acre on 7/27/01. Powdery mildew infection incidence and severity was evaluated 10/4/01 after harvest (observations were made through the season on incidence, but no formal ratings done earlier). A 1-10 subjective rating system was used for both incidence and severity assessment. For incidence ratings, percentage of leaves / canes infected was estimated and divided by 10. For

severity ratings, estimated leaf / cane surface area infected was divided by 10. Two age categories were used: early growth (leaf nodes 1 - 10) and late season (growth for the last 10 nodes). Data was analyzed via SAS and means separated using Duncan's MRT only where $p<0.05$.

Results and Discussion / Conclusions

Delay of Bud Break:

Tree fruits: None of the treatments had any effect on bloom dates in apple or pear (Table 1). However, the number of flower clusters that opened in pear was reduced 64% on the trees treated with 10% soybean oil. Whether this might be useful for thinning pears remains to be seen in future trials. Flowers treated with Frost Block 2 tended to have scorched petals and no better survival than untreated blossoms after exposure to a 29°F freeze event on 4/13/01. In peach, dormant application of Surround delayed bloom only in BerendaSun (by six days, Table 3). Soybean oil treatment tended to advance bloom (by one to two days). Although it would appear there might be other differences, they are not statistically significant. It is worth noting that the treatment with Surround consisted on one spray date, Feb. 2, 2001 with two applications that allowed only a short 2 hour interval between them. This resulted in the trees (for all crops) having a general whitish appearance, but not being coated as well as they could have been with applications repeated three or more times over a three day period to allow thorough drying between applications. A more thorough white coating (whether Surround or white latex paint) might provide a longer delay.

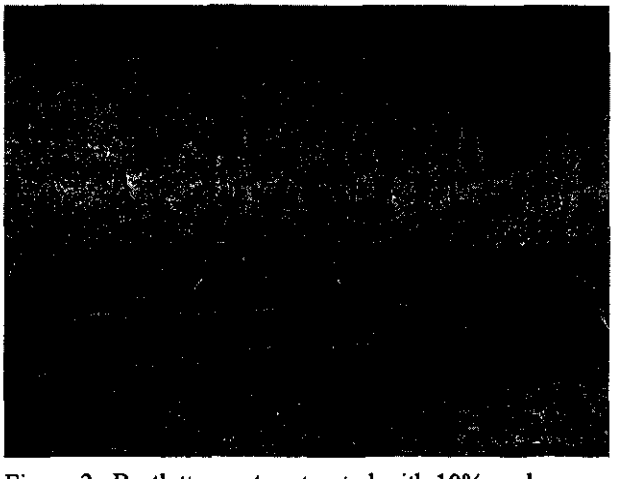


Figure 2. Bartlett pear tree treated with 10% soybean oil 2/6/01 showing reduced flowering. (Photo by H.J. Larsen, 4/16/01).

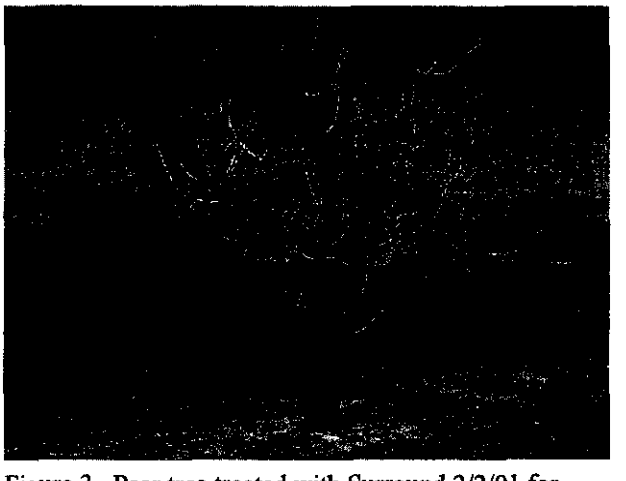


Figure 3. Pear tree treated with Surround 2/2/01 for possible delay of bloom. Photo by H.J.Larsen, 4/19/01.

Table 1. Effect of dormant treatments in winter and spring on delay of bloom and number of flower clusters per tree in pears in a western Colorado orchard during 2001.

Trt No.	Treatment	Jul Date of 80% Bloom +/- Std. Dev.	No. flower clusters/tree +/- Std. Dev.[1]
1	Non-Treated Control	108.2 +/- 0.8	140.5 +/- 39.9 a
2	Soybean oil, 10% vol/vol	109.0 +/- 0.6	52.7 +/- 28.7 b
3	Surround WP, 0.5% wt/vol	108.5 +/- 0.5	135.0 +/- 37.5 a
4	Dilute white latex paint, 10% vol/vol	108.7 +/- 0.8	154.2 +/- 69.1 a
5	Alginate mixture	107.5 +/- 0.8	118.7 +/- 27.6 ab

[1] Values with the same letter do not differ at $p<0.05$.

Table 2. Effect of dormant treatments in winter and spring on delay of bloom in BerendaSun, Glohaven, and Red Globe peach in a western Colorado orchard during 2001.

Trt No.	Treatment	Julian Date of 80% Bloom					
		BerendaSun	Std. Dev.	Glohaven	Std. Dev.	Red Globe	Std. Dev.
1	Non-Treated Control	99.2 a	2.2	98.2	2.6	100.2	4.1
2	Soybean oil, 10% vol/vol	97.8 a	1.6	97.0	2.2	98.0	3.8
3	Surround WP, 0.5% wt/vol	105.5 b	2.3	100.2	3.0	104.5	2.2
4	Dilute white latex paint, 10% vol/vol	103.5 ab	3.6	98.5	2.5	102.2	3.3
5	Alginate mixture	101.0 a	2.4	99.7	3.3	102.2	3.3

Grapes: Response to the treatments varied with the cultivar. At WCRC – OM, alginate delayed bud burst most in the two Cabernet cvs., but only slightly in Siegerrebe and the later cv. Vignoles. The oil treatments both delayed bud burst in Cabernet sauvignon, but not the other cvs. Stylet-Oil seemed to accelerate bud development in Siegerrebe. Surround had little or no effect except in Siegerrebe in which it tended to accelerate bud development.. No bud mortality was observed in any of the treatments at WCRC – OM, in contrast to the Utah study. In Utah, both the oil treatments reduced bud and vine survival; soybean oil did delay bud burst by 5 days, but the bud and vine mortality are cause for concern.

The alginate treatment may be hopeful, but further study is needed on all treatments.

Table 3. Effect of dormant treatments in winter and early spring on delay of bud burst in four cultivars of wine grape in western Colorado during 2001.

Trt. No.	Treatment	Percentage of buds at BBCH stage 9 on 4/27/'01				
		Obs. 4/27/2001				Obs. 5/2/2001
		Cabernet franc	Cabernet sauvignon	Siegerrebe	Vignoles	Vignoles
1	Non-treated control	85	77	55	10	56
2	Soybean oil	80	41	63	20	61
3	Stylet-Oil	75	41	89	22	63
4	Surround	84	62	72	12	62
5	Alginate	51	43	44	11	39

Table 4. Effect of late dormant treatments applied 3/9/01 on bud burst timing and bud and cane survival at a vineyard near the Monument Valley, located East of Moab, UT in spring 2001.

Trt No.	Treatment	Julian Date of:			% Bud Survival as of 5/15/01	Cane Survival as of 5/15/01
		25% Bud Burst	50% Bud Burst	80% Bud Burst		
1	Non-treated control	117	118	120	75 ab	3/5 ab
2	Surround WD, 0.5 lb / gal spray	114	118	119	80 a	4/5 a
3	Soybean oil, 10% vol/vol	124	125	125	55 ab	1/5 bc
4	Stylet-Oil, 5% vol/vol	122	131	.	29 b	0/5 c
5	White latex paint, 10% vol/vol	116	118	120	60 ab	3/5 ab

Powdery Mildew:

Apple: September application of AQ10 reduced carryover infection in infected terminals and total infected buds although overwintering spur infections did not differ between treatments (Table 5). Fall applied AQ10 reduced mildew survival to 33% that in non-treated controls. This may be due to the inactivity of the powdery mildew fungus at that time in initiating new colonies that the AQ10 would need to keep up with. In addition, the AQ10 fungus has a longer time to seek out and parasitize the mildew fungus before it becomes active. Even though the variability in numbers of infected spurs was too great to provide statistical differences for that category, the infected terminal counts and the total infected (combined) bud counts overall allowed differences between the AQ10-treated and non-treated tree infections to be identified. The observed differences are sufficient to suggest that fall application of AQ10 might help reduce overwintering inoculum in other orchards in arid conditions and worth further study.

Table 5. Effect of application of AQ10 September 2000 on survival of overwintering powdery mildew infection in buds of Jonathan apple cv. 'Lucky Jon' at Silver Spruce Orchard, Hotchkiss, CO as assessed 4/19/2001. Values without letters and values with the same letters do not differ at the $p<0.05$ level.

Treatment	Infected Spurs (50 count)	Infected Terminals (50 count)	Total Infected Buds (100 count)
Non-treated Control	10.3	23.8 A	34.2 A
AQ10 @ 1 oz/acre, applied 9/2000	3.8	7.5 B	11.3 B

Grapes: Grape powdery mildew did not appear at WCRC – OM until after the first significant rainfall event of the season occurred July 15, 2001. Infections were observed July 23, eight days later. Sprays in studies 1 and 2 were applied at 21 - 29 day intervals beginning with 2" shoot growth on May 9 and ended at veraison in early August; this resulted in four spray applications for the season, three of which were applied prior to observation of any infections. Based on observations in the vineyard, none of the first three sprays were necessary for mildew control in 2001, and the fourth spray (applied one day after mildew infection was first observed in the vineyard) did not fully control the disease subsequently. Had it been applied within a day or two of the first significant rainfall event, better control might have been obtained. Also, continued protective sprays until several weeks prior to harvest (determined by the required preharvest spray interval for whatever chemistry was used) likely would have provided better late season control.

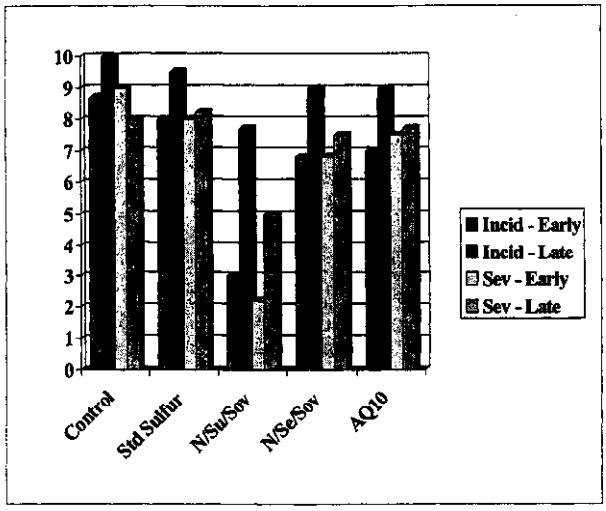


Figure 4. Comparative early and late season foliar powdery mildew infection incidence and severity ratings on Chardonnay grape, Study 1, 2001.

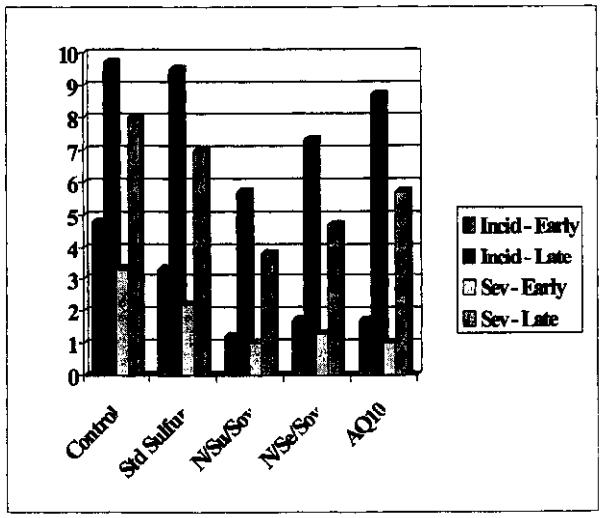


Figure 5. Comparative early and late season cane powdery mildew infection incidence and severity ratings on Chardonnay grape, Study 1, 2001.

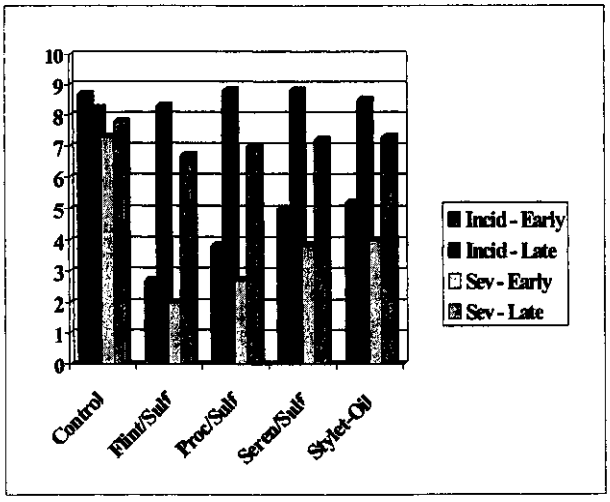


Figure 6. Comparative early and late season foliar powdery mildew infection incidence and severity ratings on Chardonnay grape, Study 2, 2001.

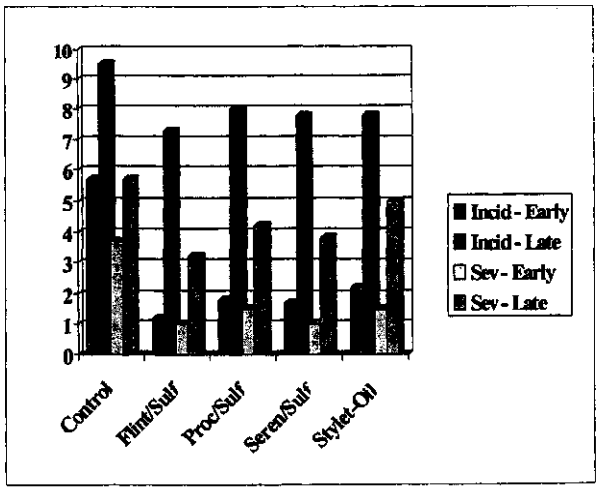


Figure 7. Comparative early and late season foliar powdery mildew infection incidence and severity ratings on Chardonnay grape, Study 2, 2001.

Acknowledgments:

Assistance of S. Ela (Silver Spruce Orchard), of Michael Johnson (Utah St. University Coop. Ext., Moab, UT), and of the WCRC – OM staff in applying the treatments is deeply appreciated. Funding and/or materials for the studies were provided by: Colorado Organic Crop Management Association (COCMA), the Colorado Apple Administrative Committee, the Colorado Wine Industry Development Board, Rohm & Haas Chemical Co., Uniroyal Chemical Co., BASF Chemical Co., Michael Johnson (Utah St. University Coop. Ext., Moab, UT), AgraQwest Chemical Co., Bayer Chemical Co., JMS Flower Co., IJO Products, LLC, and ISP Alginates Inc.

2001 Research and Related Activities

Dr. Calvin H. Pearson

Water-use efficiency of cool-season turf grass species in western Colorado - Fruita (City of Grand Junction, Bureau of Reclamation, Arkansas Valley Seed Solutions, and Barenbrug)

Winter wheat cultivar performance tests - Fruita, Hayden (Mike and Dutch Williams, Dr. Scott Haley, Dr. Jerry Johnson, C.J. Mucklow)
Spring wheat and barley cultivar performance tests - Hayden (Mike and Dutch Williams, Dr. Jim Quick, Dr. Jerry Johnson, C.J. Mucklow)

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 tests, 1999-2001 and 2002-2004 - Fruita (Dr. Jerry Johnson, seed companies, breeding companies, private industry)
Alfalfa germplasm evaluations, 2000-2002 and 2002-2004 tests - Fruita (Dr. Peter Reisen, Forage Genetics)
Field evaluation of baler liner in alfalfa hay - Fruita (L.D. Ag Machinery, L.L.C.)

Pasture grass species evaluation - Fruita (seed companies)
Pasture grass, forage legume, and mixed species evaluation studies - Meeker (Plant Materials Center) and Hotchkiss (Rogers Mesa Research Center personnel)

Dry bean uniform nursery test - Fruita [Colorado Dry Bean Administrative Committee (CDBAC), Dr. Mark Brick and Barry Ogg, CSU Dry Bean Breeding Project]
Pinto bean cultivar performance test - Fruita (CDBAC, Dr. Jerry Johnson)

Effect of Agro polymer on water stress in corn - Fruita, Hayden (Lloyd Garner of Stockhausen, Bureau of Reclamation)
Evaluation of Golden Harvest and Pioneer corn hybrids for BES - Fruita (Wayne Fithian of J.C. Robinson Company)
Hybrid poplar performance tests - Fruita, Orchard Mesa, and Hotchkiss (Dr. Matt Rogoyski, Shane Max)
Edamame soybean seed production in western Colorado (Dr. Shaoke Wang of Seedex)
Evaluation of spring peas and chickpeas as alternative crops in northwest Colorado - Hayden (Dutch and Mike Williams)
Sunflower cultivar performance test - Katrina Cornish (USDA-ARS, Western Regional Research Center, Albany, CA)

*Cooperators/collaborators/sponsors noted in parentheses.

Performance of Hybrid Poplar in Agroforestry at Fruita, Colorado 2001

Dr. Calvin H. Pearson

Summary

Hybrid poplars are suitable for a number of uses including pulp, lumber and plywood, fuel, conservation, and ornamental plantings. A hybrid poplar clone evaluation study consisting of eight hybrid entries was initiated in 2000 at the Western Colorado Research Center (WCRC) at Fruita. Growth of hybrid poplars in 2001 after two years of production was exceptional. Tree height, averaged across all hybrids, was 22.1 feet. Poplar Hybrids NM6, 52225, and OP367 were taller than the other five poplar hybrids with average heights of 24.5, 26.5, and 25.9 feet, respectively. Poplar Hybrids 52225, OP367, Norway, and Noreaster had trunk diameters at the base of 3.8 to 4.0 inches. At a meter height, 52225 and OP367 maintained the largest trunk diameters at 3.2 inches. Hybrid poplar studies at the Western Colorado Research Center (WCRC) are projected to continue for four more years.

Introduction

Hybrid poplars are suitable for a variety of uses including pulp, lumber and plywood, fuel, conservation, and ornamental plantings. The initial focus of the agroforestry research in western Colorado was to produce hybrid poplar for use in manufacturing oriented strand board (OSB) at the Louisiana-Pacific (L-P) facility in Olathe, Colorado. This initial interest in hybrid poplar under agroforestry was the result of decreased access to timber resources on public lands in western Colorado and surrounding areas, and increased hauling costs to transport logs over long distances from harvest sites to manufacturing facilities. With the closure of the L-P facility at the end of October 2001the future of this potential market is in question. The closure of the L-P facility was announced to be temporary, but many people in the area are skeptical that L-P will reopen. Other markets for hybrid poplar grown in western Colorado are needed. The impressive growth of the poplars to date in this study at Fruita has created substantial interest from the public.

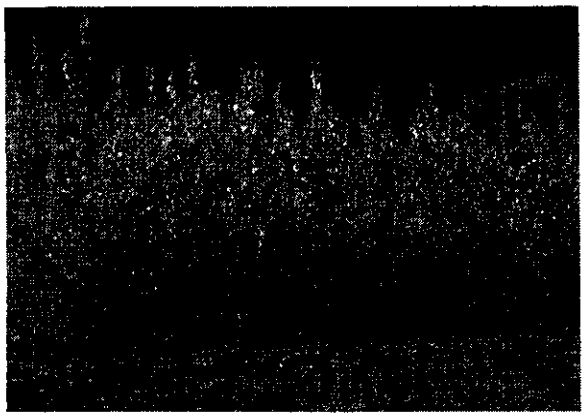


Fig. 1. Dr. Calvin Pearson assessing poplar growth at Fruita, Colorado. November 7, 2001. Photo taken by Daniel Dawson.

Materials and Methods

A hybrid poplar clone evaluation study was initiated in 2000 at the Western Colorado Research Center at Fruita. The experiment is a randomized complete block with four replications. Each plot consists of 36 trees planted on an 8x8-foot spacing. One row of trees surrounds the plot area. Research results for the first year of hybrid poplar production is available at the website: www.colostate.edu/programs/wcrc. Click on "Annual Research Report" when new screen appears click on "2000 Annual Report."

Roundup (glyphosate) herbicide was applied twice during 2001 on May 14th and again on June 6th using a backpack sprayer. These applications controlled early summer weed flushes. After that time poplar trees were large enough and provided sufficient shading that weeds were not a concern.

On June 25, 2001, 100 lbs N/acre of ammonium nitrate were hand-applied by placing a measured amount of fertilizer in the furrow next to each tree. In 2001, the poplar field was

irrigated seven times during the growing season, averaging 11.8 hours per irrigation set.

Of the 36 trees in each plot, the interior 16 trees were used for data collection. Tree height was measured from the soil surface to the top of the tree (leaves not included) using a surveyor's measuring rod (Fig 2). Trees were measured during late fall after leaves had fallen. Trunk diameter was measured at the base of the tree and at a one meter height using calipers.

Fig. 2. Fred Judson and Daniel Dawson measuring poplar tree height, November 14, 2001. Photo by Calvin Pearson.

Results and Discussion

Of the total number of trees measured, most hybrid clones had only one or two missing trees (Table 1). The exception to this was 14274 which had 20 trees missing or were not suitable for measurements. Poplar Hybrid 14272 had five missing trees, while all 64 trees were present and measured for OP367 and Noreaster.

Growth of the hybrid poplars for the two years of production has been exceptional (Figs. 1, 3). Tree height, averaged across all hybrids was 22.1 feet. Poplar Hybrids NM6, 52225, and OP367 were taller than the other five poplar cultivars with heights at 24.5, 26.5, and 25.9 feet, respectively. Hybrid 14274 had the lowest average tree height at 17.0 feet. Hybrid 14272 also had a low tree height of 19.1 feet, compared to other poplar hybrids.

Poplar Hybrids 52225, OP367, Norway, and Noreaster had tree diameters at the base of 3.8 to 4.0 inches. Poplar hybrids with the smallest diameters at the base of the trunk were NM6 and 14272 at 3.4 and 3.3 inches, respectively.

At a meter height, both 52225 and OP367 maintained the largest tree diameters at 3.2 inches. Hybrids 14274 and 14272 had the smallest tree diameters at a meter height of 2.4 and 2.5 inches, respectively. Other hybrids were intermediate for trunk diameter at a meter height.

There was significant variability among the poplar hybrids for range in measurements for tree height, trunk diameter at the soil surface, and at a one-meter height (Table 1).

Notes and observations about spring and fall growth for each of the eight hybrid poplar clones are presented in Table 2.

Hybrid poplar studies at the WCRC will continue for four more years when marketable trees are expected to be achieved.

Recommended Reading

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Acknowledgments

Appreciation is expressed to Shane Max (WCRC manager), Lot Robinson and Fred Judson (WCRC support staff), and Daniel Dawson (part-time hourly employee) who assisted with this research. We express special appreciation to Randy Moench (Greenhouse Manager, Colorado State Forest Service, Fort Collins, CO) who provided technical assistance, helped with planting the trees, and for his support and involvement in this project. Thanks to Carroll Bennett for digitizing and manipulating the pictures used in this report.

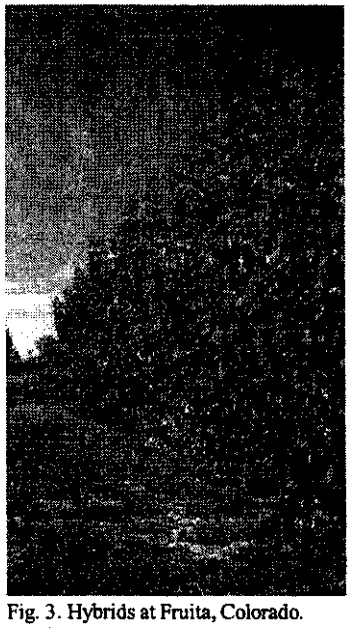

Fig. 3. Hybrids at Fruita, Colorado. October 15, 2001. Photo by Calvin Pearson.

Table 1. Plant performance of eight hybrid poplar clones during the second year of growth at Fruita, Colorado 2001.

Hybrid Clone	Total trees measured	Tree Height	Range (max-min) of tree ht	Tree dia. at soil surface	Range of tree dia. at soil surface	Tree dia. at 1 m (3.3 ft)	Range of tree dia. at 1 m
	no.	-------- feet ---------		---------- inches ----------			
NM6	63	24.5	4.1	3.4	1.1	2.9	1.4
52225	62	26.5	4.7	3.8	1.1	3.2	0.9
OP367	64	25.9	4.1	4.0	1.4	3.2	1.3
Norway	63	21.0	4.0	4.0	1.2	2.6	1.1
Noreaster	64	20.9	4.5	4.0	1.4	2.7	1.2
Raverdeau	62	21.9	3.7	3.7	1.4	2.9	1.3
14274	44	17.0	4.5	3.5	1.3	2.4	1.1
14272	59	19.1	6.8	3.3	2.1	2.5	1.9
Ave.	60	22.1	4.6	3.7	1.4	2.8	1.3
LSD (0.05)		1.2	2.7	0.2	0.8	0.2	0.6
CV (%)		3.7		2.9		4.6	

Table 2. Notes and observations on hybrid poplar clones at Fruita, Colorado taken on November 7, 2001 at the end of the second year of growth.

Hybrid Clone	Notes and Observations
NM6	Began spring growth March 26, 2001. Trunks are somewhat wavy. Some secondary trunk development has occurred. Compared to other hybrids, bark is quite green.
52225	Began spring growth April 4, 2001. Main trunk is somewhat wavy. Dormancy is later than most other hybrids in the test. Some trees have horizontal basal branching.
OP367	Began spring growth April 17, 2001. Trees are very erect and plant architecture is columnar. Trees are uniform with regard to shape and growth. Pleasing yellow fall leaf color. Some late fall leaf retention.
Norway	Began spring growth April 11, 2001. Many large branches with a sprawling plant architecture.
Noreaster	Began spring growth April 13, 2001. Many large branches with a sprawling plant architecture.
Raverdeau	Began spring growth April 14, 2001. Trees are erect and plant architecture is columnar. Some trees have basal branching.
14274	Began spring growth April 3, 2001. Architecture is good for high populations in agroforestry. Tree growth is variable for this hybrid. Some trees have secondary trunk development and basal branching.
14272	Began spring growth April 9, 2001. Architecture is good for high populations in agroforestry. Tree growth is variable for this hybrid. Some trees have secondary trunk development.

Water-Use Efficiency of Cool-Season Turf Grasses in Western Colorado

Dr. Calvin H. Pearson

Summary

The population of western Colorado continues to increase, causing the demand for water to increase. Along with a larger population and increased demand for water, competition occurs among the various users of water. Water use efficiency of turf grasses is often low because of inadequate education and operation by irrigators. Additionally, turf grasses need to be identified and planted that have increased water use efficiencies. A turf grass study was planted during fall 2000 and established during the 2001 growing season. The objectives of this research are: 1) to identify turf grass species/varieties that have desired turf quality characteristics, and 2) to identify species/varieties of turf that exhibit improved water-use efficiencies. Several improvements and modifications will be made in this experiment in preparation for the 2002 growing season. Data collection and evaluations during 2002 will include winter appearance, weed growth, spring green up, fall dormancy date, color, stand uniformity, disease incidence, biomass production, plant canopy temperatures, turf color, soil moisture content, and water application rates.

Introduction

Turfgrasses are of importance worldwide in enhancing and maintaining the function and beauty of natural and man-made landscapes. Turfgrasses enhance the landscape by contributing to aesthetic and practical aspects. The end result of this contribution is that turfgrasses add significant economic value to properties. Because of the diversity of species and varieties, turfgrasses can be used in various applications and conditions.

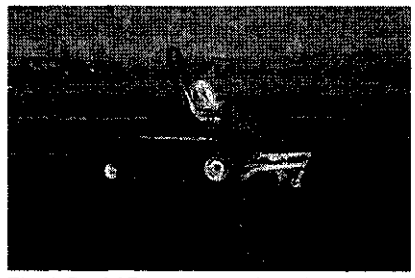

Fig. 4. Daniel Dawson operating John Deere Lawnmower. This piece of equipment was provided by the City of Grand Junction for this research project.

Turfgrasses have three main functions: 1) they provide *utility* in applications such as dust and erosion control; glare reduction, and for safety needs such as on air fields and along roads; reclamation and stabilization; and improvement of degraded, natural areas and spots adversely impacted by anthropogenic activities, 2) they are used for *recreation* on various types of sports fields, parks, and playgrounds. Turfgrasses for recreational uses can be for athletic activities, exercise and physical conditioning, therapeutic needs, and for improvement of general healthy living, and 3) they are widely used for *beautifying* all types of surroundings. In any particular application, turfgrasses generally contribute to more than one function. Turfgrasses impact our daily lives and in our pursuit of a comfortable lifestyle (Watson et al., 1992).

The population of western Colorado continues to increase, causing the demand for water to increase. Along with a larger population and increased demand for water, competition occurs among the various uses of water. Thus, as water becomes a more valuable and limited resource, this situation often creates conflict and controversy over water and how to use it.

Water applied to plants, such as crops and urban landscapes, is under increased scrutiny to increase irrigation water use efficiency. Water use efficiency of turf grasses is often low because of inadequate education and operation of irrigation systems. Additionally, turf grasses need to be identified and planted that have increased water use efficiencies. The objectives of this research are: 1) to identify turf grass species/varieties that have desired turf quality characteristics, and 2) to identify species/varieties of turf that exhibit

improved water-use efficiencies. An additional objective of this research is to provide clientele with quantitative information obtained from this research to help them select turf species and varieties to meet individual needs.

Materials and Methods

The entries in this study were limited to cool-season grasses. The 36 turf grass entries being evaluated in this study are listed in Table 3.

Plot size is 5-feet wide by 20-feet long. The experiment design is a randomized, complete block with three replications. Land space allowed for the testing of 36 turf grass entries (varieties). Differential irrigation water application amounts were applied using the line source sprinkler plot irrigation system developed by Hanks et al. (1976). Irrigation water application amounts were determined by placing plastic rain gauges throughout the plot area. Water use efficiencies will be determined for representative entries for the turf types included in the study (bluegrass, fescue, ryegrass, etc.).

Plots were planted on September 27, 2000 at a seeding rate ranging from 2 to 10 lbs per 1000 sq. ft. as specified by the seed supplier for a particular entry. Data collection will include winter appearance, weed growth, spring green up, fall dormancy date, color, stand uniformity, disease incidence, biomass production, soil moisture content, and water application rates. The expected duration of this experiment is three to five years.

Results and Discussion

During the 2001 growing season plots established well. However, the bentgrasses (creeping, colonial, and velvet) became increasingly invasive into plots of other grasses. Because of this contamination the bentgrass plots were sprayed with Roundup. These plots will be replaced with other entries in spring 2002. New turf species will include two additional bluegrass entries, two additional fescue entries, and 'Fults" alkaligrass.

During the 2001 growing season we made several improvements to the irrigation system. We installed a pressure transducer, selenoid value, and control clock. The system was programmed to irrigate for a preset time automatically. The irrigation system was also evaluated for its performance to meet the needs of the experiment. Considerable time during the summer was spent checking irrigation water distribution. This was done to determine if the irrigation water amounts applied across the plots would impose the desired water deficits. Various adjustments were made to the irrigation system to achieve improved irrigation water amount differentials across the plots. It was concluded that additional irrigation system modifications are needed to achieve the desired irrigation water distribution levels in this experiment. Those modifications are being made during winter and early spring 2001-2002.

Fig. 5. Dr. Calvin Pearson and Daniel Dawson determining biomass in turf plots on August 1, 2001 at Fruita, Colorado. Photo taken by Fred Judson.

A new lawnmower was purchased during 2001 for use to determine biomass production of the turf entries. Biomass was determined once during the 2001 season (Fig. 5, Table 1). There was considerable variation in the biomass data. The lawnmower is being modified during winter 2001-2002 with an electronic weighing system. With the new system, plot weights can be determined on-the-fly and only a small biomass sample will be collected to determine moisture content.

During 2002 additional data will be collected. Plant canopy temperatures will be determined for each of the turf entries. Measuring canopy temperatures will determine how the plant canopy of each of the species is affected by deficit irrigation water application.

Turf color varied considerably among the entries. Determining turf color of the entries will provide people with more complete information when selecting a variety to plant. Historically, turf color has been determined by visual assessment. Visual assessment has been the routine method for turf color determination. Turf color can also be determined quantitatively

using instruments (Landschoot and Mancino, 2000). Quantitative determinations eliminate subjectivity that often occurs when using visual assessments, but the instrument recommended for determining turf color is expensive ($6,500). Because of the high cost of the instrument, visual assessment of color for the turf entries in 2002 will be performed based on color comparisons to a Munsell chart. An important consideration when using visual assessment for turf color determination is to have the same person perform the evaluations.

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Acknowledgments

Thanks to Shane Max, Lot Robinson, Fred Judson (Western Colorado Research Center staff), and Daniel Dawson (part-time hourly employee) for their assistance with this study. We also express appreciation to Dick Bettale of Arkansas Valley Seed Solutions, Seed Research of Oregon, Inc., and Barenbrug for supplying the seed used to plant this study. Thanks to Carroll Bennett for digitizing and manipulating the pictures used in this report. Special thanks to the Bureau of Reclamation and the City of Grand Junction for their support of this research.

Table 3. Biomass production of 36 turf grass entries at Fruita, Colorado. August 8, 2001.

Turf Entry	Biomass mg/ft^2/day
1. Kentucky bluegrass 'Barblue'	553
2. Kentucky bluegrass 'Bariris'	390
3. Kentucky bluegrass 'Baronie'	622
4. Kentucky bluegrass 'Bartitia'	588
5. Kentucky bluegrass 'Freedom II'	334
6. Kentucky bludegrass 'Newport'	366
7. Tall fescue 'Barlexas'	601
8. Tall fescue 'Barrera'	509
9. Tall fescue 'Grande'	737
10. Tall fescue 'Survivor'	597
11. Perennial ryegrass 'Barclay'	706
12. Perennial ryegrass 'Barlennium'	489
13. Perennial ryegrass 'Champion'	575
14. Perennial ryegrass 'Pirouette'	575
15. Perennial ryegrass 'Premier II'	433
16. Creeping bentgrass 'SR1019'	439
17. Creeping red fescue 'Barcrown	607
18. Creeping red fescue 'Seabreeze'	527
19. Creeping red fescue 'SR5200E'	599
20. Chewings fescue 'Bargreen'	657
21. Chewings fescue 'Bridgeport'	534
22. Chewings fescue 'SR5100'	583
23. Colonial bentgrass 'SR7100'	564
24. Creeping bentgrass 'Regent'	565
25. Creeping bentgrass 'SR1119'	525
26. Velvet bentgrass 'SR7200'	468
27. Blue fescue 'SR3200'	466
28. Canada bluegrass 'Reubens'	532
29. Hard fescue 'SR3100'	602
30. Koeleria 'Barkoel'	466
31. Sheep fescue 'MX-86'	520
32. Tufted hairgrass 'SR6000'	538
33. Low Grow mix	460
34. Nature's Choice mix	442
35. Premium Lawn mix	496
36. Sports Turf mix	614
Ave.	536

Seed Production of Edamame Soybean in Western Colorado

Dr. Calvin H. Pearson

Summary

Edamame soybean is a popular food in Japan and its popularity as a specialty food is increasing in the U.S. Seed for planting is expensive, costing as much as $12.00 per pound. Seed costs are high because of the difficulty encountered when producing seed crops. The primary difficulty for seed production is severe seed shattering that occurs when plants approach maturity. Edamame soybean was grown at the Western Colorado Research Center at Fruita in 2001. This project was conducted in cooperation with Seedex, Inc. of Longmont, Colorado. Excessive seed shattering of edamame soybean occurred at Fruita, Colorado during the 2001 growing season, resulting in low harvested seed yield. Overcoming crop production constraints of edamame soybean, mainly seed shattering, would provide farmers in western Colorado with a profitable, alternative crop. Novel approaches are being considered for the 2002 growing season to reduce harvest losses from seed shattering and increase harvested seed yields of edamame soybean.

Fig. 6. Edamame field at Fruita, Colorado on August 9, 2001.

Introduction

Edamame soybean is a popular food in Japan and its popularity as a specialty food is increasing in the U.S. Edamame soybean pods are harvested with a partially developed seed similar to when gardens peas are picked. Soybean pods are prepared for eating by cooking them in boiling salt water for a short time. Following cooking, pods are opened and seeds are eaten. Edamame soybean is considered by many people to be a healthy, tasty snack food.

Edamame soybean seed for planting is expensive, costing as much as $12.00 per pound. Seed costs are high because of the difficulty encountered when producing seed crops. The primary difficulty for seed production is severe seed shattering that occurs when plants approach maturity. Currently, seed production in North America is limited mainly to Windsor, Canada. Windsor is located on a peninsula between Lake Huron and Lake Eerie just across from Detroit. Considerable water surrounds the Windsor area which helps to maintain higher relative humidity. Higher humidity helps reduce seed shattering, although seed losses at Windsor often exceed 20% in many years. Furthermore, these higher humidites at Windsor often promote disease development in edamame soybean.

There are additional challenges for edamame soybean production. Obtaining uniform and adequate plant populations is often difficult. Early seedling mortalities can be high in some years as a result of disease. Germination and emergence of edamame soybean is slow. The time from planting to seedling emergence generally takes several days longer than most other field crops. At Fruita, Colorado the time from planting to emergence can take up to two weeks. Seedlings planted too deep or soil crusting during emergence can reduce plant stands significantly. However, with careful management at planting and during seedling emergence, adequate plant stands can often be achieved (Fig. 6).

Overcoming crop production constraints of edamame soybean, mainly seed shattering, could

provide farmers in western Colorado with a profitable, alternative crop.

Fig. 7. Applying Spodnam to edamame soybeans on September 7, 2001 at Fruita, Colorado. Photo by Calvin Pearson.

Materials and Methods

An experiment was conducted to evaluate the performance of two products developed to reduce shattering of various seed crops. The products were Spodnam (Miller Chemical Company, Hanover, PA) and Shattering Guard (Precision Applications, Madras, OR). Spodnam was applied at a rate of 1.5 pints/acre in 46 gallons of water per acre. Shattering Guard was applied at a rate of 200 grams of product per acre in 46 gallons of water per acre. Applications were made with a CO_2 small plot, backpack 2-liter pop bottle sprayer. The first application of both products was made on September 7, 2001 and the second application was made on September 10, 2001. Applications of Spodnam were also made to non-plot areas of the field (Fig. 7.)

The objective of the study was to determine the efficacy of these two products to reduce seed shattering in edamame soybean. The experiment was a randomized complete block with four replications and 5 treatments (two products x two application timings and a non-treated check).

Plot size was 10-feet wide by 25-feet long. The field was irrigated prior to planting and herbicide application. Frontier herbicide (6.0 lb/gal. formulation) at 16 oz/acre at 22 gallons water/acre preplant broadcast on May 21, 2001 and incorporated by rollerharrowing once, followed by spike tooth harrowing. Also, Prowl was applied at 2 pints/acre on May 21, 2001 after beds were formed.

Planting occurred on May 29, 2001 with a Buffalo-till planter. A foliar fertilizer application was made on July 17, 2001 at a rate of 12 lbs/acre of nitrogen, 2.4 lbs/acre of P_2O_5, and 0.4 lbs/acre of K_2O.

Plots were cut on September 21, 2001 with a Pickett One-Step™ rod cutter windrower (Pickett Equipment Co., Burley, Idaho) and threshed on September 25, 2001 using a Hege small plot combine equipped to harvest dry beans. Bulk areas of the field were harvested with a commercial combine equipped for threshing dry beans and adjusted for soybeans (Fig. 8).

Results and Discussion

Seed moisture contents at harvest averaged 11.4% (Table 4). Desired seed moisture content at harvest is 12%. Harvesting at 12% was not possible because plant material was still too green for threshing when seeds were at 12% moisture content.

Application of Spodnam and Shattering Guard was ineffective in reducing shattering. Seed shattering was severe in this study (Fig. 9). Average harvested seed yield was 5.7 bushels/acre. Yield losses from seed shattering were estimated to be 90-95% (Table 4).

To increase harvested seed yields of edamame soybean novel management strategies will need to be developed. New approaches are being considered for 2002 to reduce harvest losses caused by seed shattering of edamame soybean.

Acknowledgments

Appreciation is expressed to Shane Max (WCRC manager), Lot Robinson and Fred Judson (WCRC support staff), and Daniel Dawson (part-time hourly employee) who assisted with this research. Thanks also to Shaoke Wang and Akiel Suzuki of Seedex for their interest in this project. Thanks to Carroll Bennett for digitizing and manipulating the pictures used in this report.

Fig. 8. Combining edamame plants at Fruita, Colorado on Sept. 21, 2001.

Fig. 9. Shattered edamame seed after harvest on Sept. 21, 2001.

Table 4. Effect of Spodnam and Shattering Guard on reducing seed shattering of edamame soybean at Fruita, Colorado in 2001.

Seed Shattering Product	Moisture	Yield		Test Weight
	%	lbs/acre	bu/acre	lbs/bu
1 application - Spodnam	11.7	375.8	6.3	55.3
2 applications - Spodnam	11.6	344.3	5.7	55.1
1 application - Shatter Guard	11.1	269.3	4.5	48.6
2 applications - Shatter Guard	11.8	351.0	5.9	51.1
Check	11.2	357.3	6.0	51.4
Ave.	11.5	339.5	5.7	52.3
LSD (0.05)	NS	NS	NS	NS
CV (%)	3.5	23.1	23.1	7.5

Research Projects 2001

Rick Zimmerman

Nutrient Availability for Apple Trees from Chicken Manure and Compost

Collaborators: Dr. Jessica Davis (Dept. of Soil and Crop Sciences, Colorado State University, Steve Ela (Silver Spruce Orchards); Kevin and Kris Kropp (First Fruit Orchard)

Funded: Colorado Agricultural Experiment Station
Colorado Organic Crop Management Association

Investigations on the Influence of Green Manures and Weed Mat on Soil Biota and Tree Growth in Organic Peach Tree Orchards

Collaborators: Dr. John Moore (Dept. Biology, Univ. Northern Colorado)
Dr. Ron Godin (Soil and Crop Sciences, Colorado State University)
Dr. Jessica Davis (Soil and Crop Sciences, Colorado State University)

Funded: Colorado Agricultural Experiment Station
Colorado Organic Crop Management Association
The Organic Farming Research Foundation

Effects of Organic Alternatives for Weed Control and Ground Cover Management on Tree Fruit Growth Development and Productivity

Collaborators: Dr. Curt Rom (Dept. Horticulture, Univ. Arkansas)
Dr. Ron Godin (Dept. Soil and Crop Sciences, Colorado State University)
Steve Ela (Silver Spruce Orchards)
Larry Traubel (Traubel Family Orchards).

Funded: Colorado Agricultural Experiment Station
Colorado Organic Crop Management Association
The Organic Farming Research Foundation.

Insecticide Evaluations:

Actara 25WG Trial (Syngenta Crop Protection, Inc.)	Target Pests: European Red Mite, *Panonychus ulmi* Two Spotted Spider Mites, *Tetranychus urticae* White Apple Leafhopper, *Typhlocyba pomaria* Rosy Apple Aphid, *Dysaphis plantaginea* Green Apple Aphid, *Aphis pomi* Codling Moth, *Cydia pomonella*
Calypso 4F (Bayer Corporation)	Target Pest: Codling Moth, *Cydia pomonella*
Danitol 2.4 EC (Valent USA Corporation)	Target Pest: Codling Moth, *Cydia pomonella*
Esteem 0.86 EC (Valent USA Corporation)	Target Pest: Pear Psylla, *Cacopsylla pyricola*
Intrepid 4F (Rohm and Haas Company)	Target Pest: Codling Moth, *Cydia pomonella*
Avaunt WG 30	Target Pest: Codling Moth, *Cydia pomonella*

Kabocha Squash Variety Trial: Year 1

Rick Zimmerman, Ph. D.

Introduction

Kabocha squash, *Cucurbita moschata*, is an important cash crop for western Colorado. Over 350 acres of Kabocha squash was planted in Delta and Montrose counties in 1998, 1999 and 2000. Almost all of the Kabocha squash produced in Western Colorado is exported to Japan. Colorado Kabocha producers receive a premium price for their squash due to its high Brix levels. However, to remain competitive, growers need to continue to evaluate new varieties of Kabocha.

In 2001, six commercial varieties of Kabocha were obtained from the Kyowa Seed Co., (Tokyo, Japan). The varieties were "Cutie", "Ajehei", "Ajehei No. 107", "Ajihei No. 331", " Ajihei No. 335" and "Emiguri". The varieties "Ajehei No. 331" and "Ajihei No. 335" have replaced the older "Ajihei" variety for commercial production. According to the Kyowa Seed Co., "Ajihei No. 335" and "Ajihei No. 331" have larger fruit and dryer flesh than the older "Ajehei" variety. "Cutie" is significantly smaller than the other 5 varieties tested in this trial.. Small families are the main consumers for "Cutie".

Methods

This is the first year of a two year variety trial. This trial was conducted at the Rogers Mesa site of the Western Colorado Research Center. Rogers Mesa is located 20 miles east of Delta, Colorado. The elevation is 5640 feet. The growing season is approximately 150 days. The field was prepared by disking followed by rototilling to a depth of 6 inches. The mulch and drip tape was laid with a Buckeye combination mulch layer, drip tape applicator and bed shaper. Beds were 42 inches wide. Squash rows were six feet between centers. The drip tube used for irrigation was T-Tape™ TSX-51030-340 (T-Systems International, San Diego, California). The T-Tape was laid two - three inches below the surface of the soil in the center of the bed. The beds and T-Tape were laid in mid-May. The seeds were planted into black plastic mulch.

Irrigation water was filtered through four Amiad™ 120 mesh filters followed by two Spin-Klin™ 140 mesh filters. Water line pressure was maintained at 9 PSI. Fertilizers were injected via a Chem Feed™ C600P pump. Approximately 15 gallons of Uran (32% nitrogen) and 21 gallons of 5-5-5 (5% nitrogen, 5% phosphate and 5% potash) was applied over the course of the growing season. The Kabocha seeds were planted on June 11.

The trial was set up in a randomized block design. There were four blocks with six varieties per block. Row orientation was north to south. Each plot consisted of four parallel rows, with each row 20 feet long. In row plant spacing was two feet, between row spacing was six feet. Forty seeds were planted per plot. Harvest was conducted in the second week of September 2001. Each squash was individually weighed and evaluated as being marketable or non-marketable. Squash were considered non-marketable, based on the following criteria: 1) sunburn, 2) excessive scarring (scarring would include raised warts and ridges on squash surface).

Results and Conclusions

Germination was poor for all varieties. Reasons for the poor germination could not be ascertained at the time of the study. A possible

reason could have been high soil temperatures, however soil temperatures were not measured during this study. However, the plants compensated for the missing plants and covered the entire plots with leaf canopy. "Cutie" had a significantly higher average number of fruit per plant than the other varieties (Table 1). There were no significant differences in the total pounds of squash produced per acre between the varieties.

Total tonnage of squash per acre for all varieties was higher than the average yield (5-6 tons/a) seen in commercial fields in Delta County. Drip irrigation may have played a significant role in increasing production of squash per acre compared with furrow irrigation. A two year study found that drip irrigation produce significantly more squash than those plants which were furrow irrigated (Zimmerman, R. J. and M. Alam 2000). In Delta and Montrose County, commercial squash growers use furrow irrigation. A second year of trials is planned for the summer

Table 1: 2001 Kabocha variety trial at the Western Colorado Research Center, Hotchkiss, Colorado.

Variety	Number Plants [a]	Number Fruit[a]	Squash Produced (lbs) [a]	Number Fruit/ Plant[a]	Fruit per Plant (lbs)[a]	Yield lbs/ac[b]
No. 107	21.5	32.0b[c]	129.1ab[c]	1.59b[c]	6.6a[c]	18480a[c]
Emiguri	17.5	49.3b	163.3a	2.88b	9.5a	26600a
Ajihei	17.5	37.3b	146.3ab	2.29b	9.1a	25480a
Ajihei No. 331	17.3	40.5b	149.5ab	2.43b	9.1a	25480a
Ajehei No. 335	21.3	36.0b	137.5ab	1.78b	6.7a	18760a
Cutie	14	83.8a	93.2b	6.14a	6.7a	18760a

[a] These are mean numbers from four plots per variety. Each plot consisted of four rows with each row being 20 feet long. Plant spacing was two feet in row and six feet between rows. There was a ten foot buffer between plots. [b] Yield estimation based on a commercial planting of 2800 plants per acre. [c] Lower case letters in the same column, if different, denote significant differences $P < 0.05$.[c]

Table 2: 2001 Kabocha variety trial at the Western Colorado Research Center, Hotchkiss, Colorado: Fruit size distribution.

Variety	Number Fruit[a]	Fruit (%) 0.0- 0.8lb[a]	Fruit (%) 1.0- 1.8lb[a]	Fruit (%) 2.0- 2.8lb[a]	Fruit (%) 3.0- 3.8lb[a]	Fruit (%) 4.0- 4.8lb[a]	Fruit (%) 5.0- 5.8lb[a]	Fruit (%) 6.0- 6.8lb[a]
No. 107	32.0b[b]	0	3.1	19.5	24.2	28.1	17.9	6.3
Emiguri	49.3b	0	9.1	21.8	42.6	23.3	2.5	0.5
Ajihei	37.3b	0	3.3	15.4	30.8	28.8	17.4	3.4
Ajihei 331	40.5b	0	4.3	16.1	36.4	33.3	9.2	0.6
Ajehei 335	36.0b	0	5.6	15.3	32.6	26.4	18.75	1.4
Cutie	83.8a	25.1	52.8	0.6	0	0	0	0

[a] These are mean numbers from four plots per variety. Each plot consisted of 4 rows with each row being 20 feet long. Plant spacing was 2 feet in row and 6 feet between rows. There was a 10 foot buffer between plots. [b] Lower case letters in the same column, if different, denote significant differences $P < 0.05$.

of 2002.

There was no significant differences in percentage of total fruit produced from 3.0 to 6.8 pound range between the new varieties of "Ajihei" No. 331 (79.5%) and No. 335 (79.1%) and the old commercial variety "Ajihei" (80.4 %) (Table 2). In the Japanese fresh wholesale market, Kabocha squash is sold in 22 pound cartons. The preferred number of squash per carton is 5-6, with each squash weighing 3.7 to 4.4 pounds. The marketplace may seek a desired weight range of squash depending on the variety. The target weight for "Ajihei" is 2.2 to 3.7 pounds with growers typically delivering squash in the range of 3.3 to 4 pounds. The targeted weights for "Ajihei No. 107", "Ajihei No. 331" and "Ajihei No. 335" is 2.2 to 3.7 pounds. The optimum size for "Cutie" in supermarkets is 1.1 pounds (personal communication, Masafumi Wakushima, Kyowa Seed Company).

References

Zimmerman, R. J. and M. Alam. 2000. Influence of Plastic Mulch and Subsurface Drip Irrigation on Yield and Brix Levels of Kabocha Squash. Annual Report. Western Colorado Research Center. http://www.colostate.edu/programs/wcrc/annrpt/