Colorado State University

# Western Colorado Research Center

## 1999 Research Report

# WESTERN COLORADO RESEARCH CENTER

1998
Annual
Research Report

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# Western Colorado Research Center
## Regionalization Note

The Western Colorado Research Center (WCRC) was created in 1998 through the combination of 3 existing research centers on the western slope: Fruita Research Center at Fruita; Orchard Mesa Research Center at Grand Junction; and Rogers Mesa Research Center at Hotchkiss. Prior to July 1995, the agricultural research centers at Colorado Sate University were administered by specific Departments in the College of Agricultural Sciences. The programs of individual centers became focused in the discipline of the Department. In addition, resources necessary to keep centers reasonably up-to-date in terms of facilities and equipment were limited at the department level.

In July 1995, the Director of the Agricultural Experiment Station (AES) resumed responsibility for programs and infrastructure (operational/administrative support, land, buildings and equipment) of these centers. The reorganization intended to accomplish several objectives:

- To conduct research and outreach at centers from a multi-disciplinary perspective by coordinating activities through the Director's Office.
- To identify and prioritize infrastructural needs; identify operational and administrative efficiencies that might be attained to derive internal funds for programs; and develop external funding sources.
- To develop the support to faculty necessary to deliver high quality and timely research information to clientele.

In the fall of 1995, the AES Director asked the scientists and staff of the Fruita, Orchard Mesa and Rogers Mesa Research Centers to consider the potential benefits of reorganizing the centers under a single management. Scientists and staff developed several resolutions and recommendations for regionalizing these centers including the appointment of a single manager to oversee the operations and administration of all three sites.

The WCRC serves scientists, support staff, and students by providing facilities, equipment, land, and technical and administrative support services for field instruction, research, and outreach activities. Researchers at WCRC also cooperate with campus research. The principal users of WCRC are scientists from the Colorado State University (CSU) College of Agricultural Sciences. Specifically, the Departments of Horticulture and Landscape Architecture, Soil and Crop Sciences, Bioagricultural Sciences and Pest Management derive regular use from WCRC's facilities. Cooperative programs are conducted with Cooperative Extension, and United States Department of Agriculture, Agricultural Research Service (USDA-ARS), private industry, and other local, state, and federal agencies Campus based scientists are also involved in research projects at WCRC.

Discussion on regionalizing the research centers at Fruita, Orchard Mesa, and Rogers Mesa was initiated at the request of the Agricultural Experiment Station. Following meetings of center personnel in1996, scientists and staff at each of the three research centers were overwhelmingly in favor of regionalizing the three centers. Advantages provided by regionalization were seen to be:

- more relevant research in the region.
- provide more timely execution and delivery of research results.
- improved interaction among personnel.
- increased operation efficiency.

It was agreed that changes should be sensitive to the needs of research center personnel, but that the regionalization process should occur as quickly as possible, making the most of opportunities for needed change as they arise.

# Physical Resources

**Fruita:** The Fruita site is an 80 acre property 10 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 41EF and 64EF respectively. The primary soil types are Billings silty clay loam and Youngston clay loams. Furrow irrigation is by gated pipe open ditches with siphon tubes with 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:** The Orchard Mesa site is located seven miles east and south of Grand Junction on B ½ 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 92E F in July and 37EF in January. Lows average between 63E F in July and 16E F in January. Readings of 100EF or higher are infrequent, and about one-third of the winters have no readings below 0EF. 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. Irrigation is by mini-sprinkler and gated pipe systems supplied by ditch water from the Colorado River.

Facilities at the Orchard Mesa Center include an office-laboratory building with separate labs for entomology, plant pathology and horticulture research. Other buildings include an insectary, shop and greenhouse. Twenty-two of the center's 80 acres are devoted to experimental orchards, principally apples, peaches and grapes. Smaller plantings of pears, apricots, cherries are also grown. Bulk plantings of alfalfa and corn have been made on the remainder of the stations property

**Rogers Mesa:** 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 88EF in July and 42EF in January. Lows average 57EF in July and 18EF in January. Irrigation methods used include mini-sprinklers, gated pipe and open ditch.

Facilities at the Rogers Mesa Research Center include an office-laboratory-classroom building, shop, machine shed, barn, and greenhouse. Twelve 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, Asian pears, and nectarines. Forage grasses, oats and some vegetables have been grown since regionalization occurred.

## Management of Alfalfa Stem Nematode and Alfalfa Weevil with Furadan 4F

**Bob Hammon, Entomologist**

**Summary:** **Yield response to 1.0 lb a.i./a of Furadan 4F was observed in the third year of production in a experiment at the Fruita Research Center. The yield response was greater in an alfalfa stem nematode resistant variety than in a susceptible variety. Economic response was negative in the susceptible variety, and positive in the resistant variety. Use of the 1.0 lb a.i./a rate of Furadan 4F may be justified under some conditions.**

**Background:** Alfalfa stem nematode, *Ditylenchus dispaci*, chrysanthemum foliar nematode, *Aphelenchoides ritzema-bosi*, and alfalfa weevil, *Hypera postica*, are major pests of alfalfa production in western Colorado. All primarily affect first cutting, although there may be some effects on later harvests. Insecticides are the main control measure for alfalfa weevil, with Furadan 4F used extensively at the 0.25 and 0.5 lb/a rate one or two weeks before first cutting. Furadan 4F, used at the 1 lb a.i./a rate has shown to dramatically improve alfalfa growth in some circumstances when compared to traditional insecticides, including the 0.5 lb a.i. rate of Furadan 4F. The growth response to the high rate of Furadan 4F has not been observed in all circumstances.

**Method:** An alfalfa management experiment was initiated in 1996 to determine if the traditional use of Furadan 4F could be modified to control alfalfa stem nematode as well as alfalfa weevil. We included ASN resistant and susceptible varieties, to see if chemical management strategies would be the same with different resistance levels in host plants. The experiment was arranged in a randomized complete block, split plot design. The main plot was variety (resistant - WL323; susceptible - Ranger) and sub plots were chemical treatment. The field was seeded Sep.12, 1995, with the first harvest during the 1996 growing season. Each year, harvests have been conducted using a modified John Deere 2280 swather with on-board scales. Hay moisture was calculated from data obtained by air-drying samples taken at harvest. This information was used to calculate tons/acre of air dry hay from the raw plot weight data. Alfalfa weevil density was measured by taking 5 180" sweeps with a standard 15" net prior to first cutting. All sprays were applied with a $CO_2$ pressured pop bottle type sprayer calibrated to apply 20 gal/a spray material over a 10 ft spray pattern. The 1 lb/a Furadan treatments were applied on April 20, 1998 when spring regrowth was 6"-8" tall. The 0.5 lb/a Furadan and Lorsban treatments were applied on May 4, 1998, 16 days before the May 20 harvest.

**Results:** Results from the first 1998 cutting are presented in Table 1. Several conclusions can be drawn from the data:

1) Furadan, applied at either the 0.5 or 1.0 lb/a rate, was effective in controlling alfalfa weevil. The 0.5 lb/a rate of Furadan, applied 2 weeks before harvest, was slightly more effective in controlling alfalfa weevil than the 1.0 lb/a rate applied 4 weeks before harvest. Lorsban was less effective than Furadan in controlling alfalfa weevil, but larvae counts were significantly less than the untreated control.

2) There does not appear to be a cumulative effect of Furadan applied at the 1.0 lb/a rate year after year in increasing yield. Areas treated with the high rate of Furadan yielded better than other treatments in both varieties. Given the slightly poorer control of alfalfa weevil in the 1.0 lb/a treatments, one may assume that the yield differences between the two rates may be due, in part to ASN control.

3) Economic return from the insecticide application was negative for Ranger, but positive for WL323 (Table 2). Economic return was greatest at the high rate of Furadan in WL323, but loss was greatest in the same treatment in Ranger. Some of the varietal differences can be attributed to the lower yield potential of Ranger.

4) While insecticide performance may remain relatively consistent, plant response to the insecticide may vary between varieties. One would expect that response to the control of ASN would be greatest in Ranger, the susceptible variety. The data illustrates exactly the opposite. The Ranger alfalfa may have been irreparably harmed by alfalfa stem nematodes.

Many other factors affect economic and biological performance of Furadan, many of which are still unknown. The one conclusion that can be drawn from this experiment is that Furadan applied at 1.0 lb/a, early in the season, can give greater economic return than that expected when it applied strictly for alfalfa weevil control. This return is not guaranteed, and more needs to be learned about factors controlling plant response to the insecticide.

| Treatment | Yield t/a | | | Alfalfa weevil/sweep | | |
|---|---|---|---|---|---|---|
| | Ranger | WL323 | Both | Ranger | WL323 | Both |
| Furadan, 1 lb/a year 1,2,3 | 1.28 ef | 2.02 ab | 1.65 ab | 0.75 ab | 0.40 ab | 0.57 ab |
| Furadan, 1 lb/a year 2,3 | 1.47 de | 1.95 b | 1.71 ab | 0.20 a | 0.15a | 0.17 a |
| Furadan 1 lb/a year 3 | 1.41 ef | 2.20 a | 1.80 a | 0.50 ab | 0.00 a | 0.25 a |
| Furadan 0.5 lb/a | 1.34 ef | 1.82 bc | 1.58 bc | 0.20 a | 0.00 a | 0.10 a |
| Lorsban 0.5 lb/a | 1.28 ef | 1.66 cd | 1.47 c | 1.30 ab | 2.60 cb | 1.95 b |
| Untreated | 1.19 f | 1.42ef | 1.30 d | 8.85 c | 13.5 d | 11.18 c |
| P-value | 0.0078 | | <0.0001 | 0.0195 | | <0.0001 |
| LSD | 0.22 | | 0.16 | 2.27 | | 1.60 |

**Table 1.** Results from the first 1998 cutting of the four year chemical control study at the Fruita Research Center. Means within a shaded area, or a column labeled both followed by the same letter are not significantly different (LSD á=0.05)

| Treatment | Cost/a[1] | Ranger | | WL323 | |
|---|---|---|---|---|---|
| | | Yield Benefit t/a | $ Return | Yield Benefit t/a | $ Return |
| Furadan 1.0 lb/a | $25.00 | .2 | -$7.00 | 0.63 | $31.70 |
| Furadan 0.5 lb/a | $15.00 | .15 | -$1.50 | 0.40 | $21.00 |
| Lorsban 0.5 lb/a | $12.00 | .09 | -$3.90 | 0.24 | $9.60 |

**Table 2.** Cost benefit analysis for insecticide applications. [1] Calculated using the following criteria 1 lb/a Furadan=$20.00, 0.5 lb/a Furadan=$10.00, 0.5 lb/a Lorsban=$7.00, application cost=$5.00, alfalfa value=$90.00/ton

## Management of High Plains Disease in Western Colorado Sweet Corn

**Bob Hammon, Entomologist**

**Summary:** **This research has shown that high risk fields can be identified by the following characteristics: 1) Sweet corn grown for seed. Inbreds vary considerably in their resistance to the disease, but the high value of the crop makes even low level infection economically significant. 2) Commercial sweet corn planted near winter annual weeds. 3) Late planted commercial sweet corn near maturing wheat. High risk fields can be treated with Furadan insecticide to help reduce the impact of the disease, but only after winter annual weeds are controlled on the field perimeter. Fields that are not high risk should not be treated with insecticide because of resistance concerns.**

**Background:** High plains disease (HPD) was first described about 1994 although symptoms of it have been observed in western Colorado for at least 15 years. The economic impact of HPD increased dramatically with the increase in acreage of commercial sweet corn and sweet corn grown for seed during the 1990's. HPD is transmitted by wheat curl mites.

The goal of the research program was to make scientifically based recommendations relating to the integrated management of the disease. Several projects were undertaken, including studies on the overwintering of wheat curl mites and virus sources, host range of the mite and virus particle, sweet corn planting date effects, and chemical control of the disease. Germplasm screening trials have also been conducted to determine sources of resistance for breeding into sweet corn hybrids.

**Results:** Wheat curl mites survive the winter on green grasses located on south-facing slopes, then disperse to other sites during late March and April in the Grand and Uncompaghre Valleys. We found that many winter annual grasses were sources for both the mite vector and the virus. The most important and widespread of these winter annual grasses (other than volunteer wheat) appears to be hare barley, an early maturing (early to late May) species that is an excellent wheat curl mite and virus particle host. Other winter annual grasses that play a role in the spread of the disease to sweet corn include jointed goatgrass, downy brome, cheatgrass, annual wheatgrass.

Many winter annual grasses mature during late April and May. It is at this time that sweet corn becomes infected as wheat curl mites migrate from their senescing host plants. Plants infected at an early growth stage either die or are so stunted that they make no seed. A critical aspect of high plains disease management in sweet corn involves control of the winter annual grass inoculum and vector sources before sweet corn planting. Fall control of the grasses on south-facing slopes will aid in reducing overall wheat curl mite (and banks grass mite) numbers during the following spring.

Sweet corn planting date studies have shown that late planted sweet corn near an inoculum source is very susceptible to infection. In our studies, sweet corn planted before adjacent wheat has headed was not significantly affected by the disease. Sweet corn planted after adjacent wheat had headed was severely affected by the virus.

Chemical control studies were conducted, using susceptible sweet corn inbreds planted adjacent to an inoculum/vector source under a worse case scenario. The only insecticide that was effective was Furadan 4F, applied in furrow or as a side dress at planting time. When it was applied at 1 pt/a (1 lb a.i.), Furadan 4F gave excellent control for 30 days.

**Acknowledgments:** This research was conducted with the financial and technical assistance of FMC Corporation, Mesa Maize (Olathe CO), Dr. Frank Peairs (Colorado State University), and the staff of the Fruita Research Center.

## Evaluation of Golden Harvest Corn Hybrids for Blunt Ear Syndrome

**Dr. Calvin H. Pearson, Professor of Soil and Crop Sciences and Research Agronomist**

**Summary:** **These data reinforce the importance of field testing corn hybrids for susceptibility to blunt ear symdrome (BES). When corn hybrids are determined to be susceptible to BES marketing of these hybrids can be more accurately directed to minimize the possibility of growing susceptible hybrids in areas where there is a significant potential for BES and associated yield losses. As with other agronomic studies, evaluating corn hybrids over several years will provide a more complete picture of hybrid response to BES.**

**Background:** Blunt ear syndrome, also called "beer-can ears, hand-grenade ears, and stunted ears," is a malady of corn that is characterized by normal-appearing corn plants having reduced ear lengths and fewer kernels per row. A portion of the ear tip is barren in an otherwise normal-looking husk. Yield losses from BES have ranged from minor amounts to as much as 70%. Previous research has shown that some corn hybrids are more susceptible to BES than others. Identifying corn hybrids that are susceptible to BES allows seed companies to more accurately market their hybrids. Occurrence of BES is sporadic, making it difficult to establish ongoing BES evaluation trials. The occurrence of BES from year to year in the Grand Valley of western Colorado has been more consistent than any other place in the country, making it the best location in the U.S. to evaluate corn hybrids for BES.

**Method:** Twelve Golden Harvest brand corn hybrids were evaluated for BES at the Colorado State University Fruita Research Center in 1998. The experiment was a randomized complete block with four replications. Plot size was 5 feet wide and 50 feet long. The previous crop was corn and the soil type was a Glenton very fine sandy loam. The seedbed was prepared using clean tillage. Harness was applied preplant incorporated at 1.75 pts/acre on April 30, 1998. Planting occurred on May 6, 1998 with a white air planter that had been modified for planting small plots.

Fertilizer applications were 22 lbs N/acre plus 104 lbs $P_2O_5$/acre applied preplant on April 30, 1998 and 160 lbs N/acre as urea ammonium nitrate (32-0-0) as a side-dress application on June 10, 1998. Comite II at 2.25 pts/acre and Dimethoate at 1 pt/acre were applied on July 20, 1998.

Both corn rows of each plot were counted the entire length of the plot on June 10, 1998 to determine plant populations.

Harvest occurred on November 18, 1998 using a small plot combine. Just prior to harvest, plots were rated for BES using our standard rating scale (Table 1). Grain moisture and test weights were determined with a Seedburo GMA128 moisture analyzer and grain yields were corrected to 15.5% moisture.

**Results:** The 1998 growing season was favorable for corn production in western Colorado. Weed control in the field was excellent. The only problem encountered during the growing season was deer trafficking through the plots, mainly in the alleyways, at the end of the growing season. Damage caused from the deer did not appear to affect the results of the study.

Grain moisture was significantly different among the corn hybrids (Table 2). Grain moistures for the hybrids averaged 16.2% and ranged from a high of 20.0% for H-2643 to a low of 14.5 for H-2265.

Grain yields also differed significantly among the hybrids (Table 2). H-2547 and EX-557 had the highest grain yields at 11,968 lbs/acre (214 bu/acre) and 10,805 lbs/acre (193 bu/acre), respectively, while H-2315, H-2643, and H-2309 had low yields of 6,420 lbs/acre (115 bu/acre), 5,213 lbs/acre (93 bu/acre), and 4,835 lbs/acre (86 bu/acre), respectively.

Plant populations was significantly different among corn hybrids (Table 2). H-2309 had a low plant population and was likely a result of poor quality seed. The low plant population of H-2309 was certainly a major contributing factor to the low grain yield. The planter was set to plant 35,890 seeds/acre. If small corn seed is used in this planter the plate cells can carry more than one seed, resulting in seeding rates that are higher than the intended seeding rate. This was apparently the situation that occurred for H-2493, H-2265, and H-2581.

Test weights for all 12 hybrids were greater than 56.0 lbs/bushel (Table 2). Average test weight was 58.7

lbs/bushel and ranged from a high of 60.5 for H-2382 to a low of 56.4 for H-2643.

H-2643 experienced severe lodging (Table 2). Lodging for other hybrids was less than 8%. Some of the plants that lodged may have been caused by the deer traffic.

Blunt ear syndrome in 1998 at the Fruita Research Center was not as severe as in 1997. Nevertheless, BES rating scores among corn hybrids were statistically different (Table 2). Hybrids with comparatively low scores, 7.0 to 6.5, (more BES) were H-2643, H-2547, EX-557, and H-2581. The highest ratings recorded in this study were 7.5. Hybrids with scores of 7.5 were H-2478, H-2315, and H-2377.

**Acknowledgments:** Appreciation is expressed to Lot Robinson and Fred Judson (Fruita Research Center staff), and Cheryl Whiteman, Sara Albertson, and Daniel Dawson (summer hourly employees) who assisted with the fieldwork for this study. We also appreciate Golden Harvest and their interest in Blunt Ear Syndrome and their willingness to provide financial support for this study.

**Table 1.** Rating scale for evaluating Blunt ear syndrome of corn.

9 - No visible symptoms - normal ear, cob extends the expected full length.
8 - Near normal ear with an abnormal tip.
7 - Between 8 and 6.
6 - Cob at 3/4 of a normal ear with abnormal tip.
5 - Between 6 and 4.
4 - Cob at 1/2 of a normal ear with abnormal tip.
3 - Between 4 and 2.
2 - Cob shorter than 1/4 of a normal ear with abnormal tip.
1 - Essentially little or no cob within the husk

**Table 2.** Evaluation of 12 Golden Harvest hybrids for Blunt Ear Syndrome at Fruita, Colorado 1998.

| Hybrid | Grain Moisture (%) | Grain Yield lbs/acre | Grain Yield bushel/acre | Plant Population(no.) | Test Weight (lbs/bu) | Lodging (%) | BES score[1] |
|---|---|---|---|---|---|---|---|
| H-2265 | 14.5 | 7374 | 132 | 37,389 | 60.1 | 2.9 | 7.4 |
| H-2315 | 15.2 | 6420 | 115 | 31,581 | 60.3 | 7.8 | 7.5 |
| H-2309 | 15.1 | 4835 | 86 | 16,063 | 59.5 | 7.5 | 7.1 |
| H-2377 | 15.1 | 8838 | 158 | 34,576 | 58.9 | 4.1 | 7.5 |
| H-2382 | 15.1 | 7136 | 127 | 35,211 | 60.5 | 6.7 | 7.2 |
| H-2398 | 15.8 | 8839 | 158 | 28,541 | 58.6 | 4.4 | 7.1 |
| H-2478 | 15.8 | 8729 | 156 | 31,173 | 57.4 | 3.0 | 7.5 |
| H-2493 | 15.7 | 8990 | 161 | 37,616 | 57.6 | 3.9 | 7.1 |
| EX-557 | 16.1 | 10805 | 193 | 34,122 | 59.2 | 0.7 | 6.8 |
| H-2547 | 17.6 | 11968 | 214 | 34,576 | 58.7 | 3.0 | 7.0 |
| H-2581 | 18.3 | 9776 | 175 | 36,119 | 56.8 | 7.1 | 6.5 |
| H-2643 | 20.0 | 5213 | 93 | 30,084 | 56.4 | 43.7 | 7.0 |
| Ave. | 16.2 | 8244 | 147 | 32,254 | 58.7 | 7.9 | 7.1 |
| CV (%) | 4.0 | 15.4 | 15.4 | 6.7 | 1.1 | 64.4 | 2.5 |
| LSD (0.05) | 0.9 | 1822 | 33 | 3118 | 0.9 | 7.3 | 0.2 |

[1] See Table 1 for an explanation of the rating scale.

## Evaluation of Two Corn Hybrids With Roundup-Ready® Resistance for Weed Control

**Dr. Calvin H. Pearson, Professor and Research Agronomist**

**Summary:** **These data support the use of Roundup® on Roundup®-resistant corn hybrids as an effective weed control management practice. Application of Roundup® to the Roundup®-resistant corn hybrids in this study controlled weeds very well without adversely affecting grain moisture, grain yields, plant populations, or test weights. Use of Roundup® on Roundup®-resistant corn hybrids provides growers with an excellent weed control tool. Herbicides applied postemergence, such as Roundup®, allows growers to assess weed problems in the field and apply herbicides based on the weeds present and at a time when the herbicide will provide highly effective weed control. In this study, two applications of Roundup® were used for weed control. Another study needs to be conducted to determine if one timely application of Roundup® on Roundup®-resistant corn hybrids can be used to control weeds over the entire growing season.**

**Background:** Without effective control, weeds are likely to harm yields both in terms of crop quantity and quality. Weed control efforts often require considerable inputs in order to minimize the impact of weeds on crop yields. Roundup Ready® corn was developed by Monsanto and hybrid corn seed was produced by DeKalb Genetics. Roundup Ready® corn seed became commercially available in 1998.

The development of herbicide-resistant cultivars gives growers an innovative tool to control weeds. This new weed control tool promises to have a major impact on farming. This impact will go beyond those effects just related to crop yields and weed control. For example, by planting Roundup®-resistant corn hybrids growers can more effectively control perennial weeds. Application timing of Roundup® on Roundup®-resistant corn hybrids offers growers increased flexibility to treat weeds when the control response will be the greatest. Furthermore, application of many herbicides often limits the crops that can be planted the following season. Roundup® has an open crop rotation. In other words, the crops that can be planted the year following a Roundup® application to a corn crop are not restricted. This allows farmers a wider choice of crops to grow, and they can grow them in fields that are free of perennial weeds. The objective of this research was to evaluate the efficacy of Roundup® and Harness® when applied to two DeKalb Roundup Ready® corn hybrids.

**Method:** Two Roundup Ready® corn hybrids, DeKalb 493RR and DeKalb 512RR, were evaluated at the Colorado State University Fruita Research Center in 1998. Each hybrid was established in a randomized complete block with four replications. Four herbicide treatments were evaluated: 1) Harness® only, 2) Harness® plus one application of Roundup®, 3) two applications of Roundup®, and 4) a weedy check. Plot size was 10 feet wide and 90 feet long. The previous crop was corn and the soil type was Youngston fine sandy loam. The seedbed was prepared using clean tillage. Harness® was applied preplant at 1.75 pts/acre on April 30, 1998 and incorporated to a 2 to 3-inch depth using a Lely-Roterra. Planting occurred on May 6, 1998 with a Buffalo no-till planter (Fleischer Manufacturing, Columbus, NE).

Fertilizer applications were 22 lbs N/acre plus 104 lbs $P_2O_5$/acre applied preplant on April 30, 1998 and 160 lbs N/acre as urea ammonium nitrate (32-0-0) as a side-dress application on June 10, 1998. The plot area was furrow-irrigated as needed during the season and water was not a yield-limiting factor.

The first application of Roundup Ultra™ was applied at a rate of 1 qt/acre on June 8, 1998 when corn was at the 5-leaf stage. The second application of Roundup Ultra™ was also applied at a rate of 1 qt/acre on June 22, 1998 when corn was at the 9-leaf stage and the corn canopy was 22-24 inches high.

The two middle rows of the four-row plot were counted the entire length of the plot on June 10, 1998 to determine plant population. Plots were evaluated for weed control on July 10, 1998. The percent weed control was determined as compared to the weedy check.

Harvest occurred on November 13, 1998 using a small plot combine. The two middle rows of the four-row plot were harvested the entire length of the plot. Grain moisture and test weights were determined with a Seedburo GMA128 moisture analyzer and grain yields were corrected to 15.5% moisture.

**Results:** No visible damage or phytotoxicity from the Roundup® applications was evident at any time during the season for either 493RR or 512RR. The previous crop was corn (Roundup®-susceptible) and it was interesting to note how readily the application of Roundup® killed volunteer plants in the field. Two corn plants would be growing side-by-side and following the Roundup® application, the Roundup Ready® hybrid would continue to grow normally and the susceptible corn plant died.

Weed pressure in the weedy check was moderately heavy. Weeds present were mostly flower-of-an-hour; some nightshade, pigweed, and lambsquarter; and small amounts of buffalobur and kochia. Of the three herbicides treatments, weed control was best in the Harness® + Roundup® treatment, lowest in the Harness® only treatment, and in between in the treatment with 2 applications of Roundup® (Table 1). The only treatment in which weed control was below 90% was in the Harness® only treatment for 512RR (Table 1).

Application of Harness® only and Harness® + Roundup® reduced the plant population of DeKalb 493RR by 27 and 20% , respectively, compared to the treatment of 2 applications of Roundup®. Plant populations among the four treatments of DeKalb 512RR were not statistically different. Harness® reduced plant populations in 493RR but not in 512RR. This indicates that plant populations of some corn hybrids can be reduced by Harness® application while plant populations of other hybrids are not affected. Weed pressure was such that it affected grain yield of 493RR, an earlier-maturing hybrid, but not 512RR, a later-maturing hybrid.

Grain yield of the 2 applications of Roundup® in 493RR was significantly higher than the other three treatments (Table 1). Grain yield of corn applied with two applications of Roundup® in 493RR was 24% (42 bu/acre) higher than the weedy check. Grain yields among the four treatments in 512RR were not statistically different.

Test weights among the four weed control treatments in 493RR were not statistically different (Table 1). The test weight of the weedy check of 512RR was significantly lower than in the other three treatments, averaging 1 lb/bushel lower than these other treatments.

**Acknowledgments:** Appreciation is expressed to Lot Robinson and Fred Judson (Fruita Research Center staff), and Cheryl Whiteman, Sara Albertson, and Daniel Dawson (summer hourly employees) who assisted with the fieldwork in this study.

**Table 1.** Evaluation of Roundup Ready® Corn for weed control on two hybrids at Fruita, Colorado 1998.

| Herbicide | Grain moisture | Yield lbs/acre | Yield bushel/acre | Plant population | Test weight | Weed control |
|---|---|---|---|---|---|---|
| | % | | | No. | lbs/bu | % |
| Hybrid 493RR | | | | | | |
| Harness® only | 16.7 | 10,231 | 183 | 21,904 | 58.8 | 90.7 |
| Harness® + Roundup® | 16.6 | 10,028 | 179 | 24,008 | 58.7 | 98.5 |
| 2 applications of Rdup® | 16.3 | 11,985 | 214 | 29,997 | 59.2 | 95.8 |
| Weedy check | 16.4 | 9,644 | 172 | 27,002 | 58.6 | |
| Ave. | 16.5 | 10,472 | 187 | 25,728 | 58.8 | |
| CV(%) | 2.0 | 8.8 | 8.8 | 8.1 | 1.1 | |
| LSD(0.05) | NS | 1,468 | 26 | 3,326 | NS | |
| Hybrid 512RR | | | | | | |
| Harness® only | 15.9 | 12,362 | 221 | 30,071 | 58.4 | 85.0 |
| Harness® + Roundup® | 16.1 | 12,874 | 230 | 30,220 | 58.3 | 97.2 |
| 2 applications of Rdup® | 16.1 | 12,190 | 218 | 30,492 | 58.4 | 94.5 |
| Weedy check | 16.4 | 12,019 | 215 | 29,824 | 57.4 | |
| Ave. | 16.1 | 12,361 | 221 | 30,152 | 58.1 | |
| CV(%) | 2.7 | 4.9 | 4.9 | 3.6 | 0.8 | |
| LSD(0.05) | NS | NS | NS | NS | 0.7 | |

# Using Polyacrylamide for Soil Erosion Control and Yield Enhancement in Western and Northwestern Colorado

**Dr. Calvin H. Pearson, Professor of Soil and Crop Science and Research Agronomist**

**<u>Summary:</u>** **In a field trial at Fruita, Colorado in 1998 polyacrylamide (PAM) was applied in furrows to control soil erosion. Sediment loss from the field was greatest during the early phase of the irrigation event and decreased thereafter. PAM was effective in decreasing the sediment loss during the irrigation and especially when the heavy soil losses occurred during the early phase. The results of this research showed that PAM was effective in reducing soil erosion in the furrow and applying PAM either all along the furrow or in two-split applications may be more effective than one spot application of PAM at the top of the field. In a field trial in wheat with fertilizer and AGRO (a formulation of polyacrylamide) at Hayden, Colorado in 1998, fertilizer increased grain yields in several but not every case, yet there was no consistent response for increased grain yield or AGRO application. Comparison of two, hand-held PAM applicators showed clearly the Applicator™ to be superior in design and performance that the Aqua II.**

**<u>Background:</u>** Polyacrylamide (PAM) has been shown to reduce runoff sediment from fields, increase infiltration and lateral wetting, reduce phosphorus and pesticides that could be transported in runoff water, and conserve water through increased irrigation efficiency. The beneficial effects of PAM have provided strong incentives for agriculturists to use PAM products (Sojka and Lentz, 1997). Farmers have readily recognized the value of using PAM on their farms and the use of PAM in agriculture has increased dramatically in recent years. The use of PAM in agriculture has been considered by some people to be an important tool of conservation.

Three studies were conducted in western Colorado during 1998: 1) STOCKOPAM (Stockhausen, Inc., Greensboro, NC) was evaluated for furrow erosion control by spot-applying PAM at the top of the field in the furrow, along the entire length of the furrow, and split, spot applications of PAM at the top and middle of the field; 2) STOCKOSORB AGRO (Stockhausen, Inc., Greensboro, NC) was applied with and without fertilizer with the seed at planting at two locations in western Colorado; and 3) two PAM applicators were evaluated for field use.

## <u>Method:</u>

**<u>Study #1</u>** <u>Applying PAM to Control Furrow Erosion</u>

The objective of this study was to determine the effectiveness of PAM in controlling soil erosion when PAM was applied to irrigation furrows. Two studies were conducted: 1) PAM application in corn during the germination irrigation and 2) PAM application in snap bean during the second irrigation.

In corn, the three treatments were: 1) PAM was distributed along the entire length of the furrow at a 1 lb/acre rate. PAM was applied during planting using the fertilizer boxes on the planter. Plastic tubing ran from the fertilizer boxes on the planter over to the middle of the furrow and a few inches above the soil surface, 2) PAM was spot-applied at the top of the field in the bottom of the furrow within a 2-foot length of the furrow at 1 lb/acre, 3) a check which received no PAM. Each treatment was replicated three times. The length of the field was 1050 feet. Planting and PAM application occurred on May 12, 1998. The corn hybrid was Pioneer brand 3522. The planter was a Buffalo no-till planter with Kinze planter units. The fertilizer boxes were thoroughly cleaned and calibrated prior to applying PAM treatments.

In snap beans, the three treatment were: 1) PAM spot-applied at the top of the field in the bottom of the furrow within a 2-foot length of the furrow at a 1 lb/acre rate, 2) PAM spot-applied at half the rate at the top of the field and the other half was spot-applied in the middle of the field at a total application rate of 1 lb/acre, 3) a check which received no PAM. Each treatment was replicated three times. The field length was 556 feet.

**<u>Study #2</u>** <u>Applying AGRO to Increase Crop Yields</u>

The objective of this research was to determine the effect of AGRO on grain yield. Two experiments with AGRO were conducted during 1998: 1) an experiment at Fruita, Colorado using AGRO in corn, 2) an experiment at Hayden, Colorado using AGRO and three fertilizer formulations in spring wheat.

The study at Fruita was conducted at the CSU Fruita Research Center on a soil that was part Glenton very fine sandy loam and Youngston clay loam. The three treatments were: 1) AGRO only, 2) AGRO with starter fertilizer (14-14-14), and 3) a check containing no AGRO. AGRO and AGRO with fertilizer were applied at a rate of 4 lbs/acre with the seed at planting. AGRO was applied using a Gandy applicator box. The Gandy box was thoroughly cleaned and calibrated prior to applying AGRO treatments. Each treatment was replicated three times. Seeding occurred on May 12, 1998 using a Buffalo no-till planter. Pioneer brand corn hybrid 3522 was planted in all plots.

The study at Hayden was conducted at the Dutch and Mike Williams Farm at Hayden, Colorado. The eight treatments were: 1) 34-0-0 + AGRO, 2) 18-46-0 + AGRO, 3) 34-0-0, 4) 11-52-0, 5) 18-46-0, 6) 11-52-0 + AGRO, 7) check (no AGRO, no fertilizer), 8) AGRO only. The AGRO and fertilizer were applied with the seed during planting. Planting occurred on May 8, 1998. Blanca was planted at 60 lbs/acre. Plot size was 4 feet wide x 40 feet long with six seed rows per plot. No herbicides or insecticides were applied. All fertilizers were applied at a constant rate of 30 lbs N/acre and the phosphate rate varied depending on the fertilizer formulation. AGRO was applied at a rate of 4 lbs/acre. Growing conditions at Hayden during 1998 were favorable for spring wheat production. Each treatment was replicated four times.

**Study #3** Evaluation of Polyacryamide Applicators

Two hand-held polyacrylamide applications were evaluated at the Fruita Research Center during 1998. The Applicator™ a non-mechanical, hand-held applicator manufactured by G R G Innovations, Inc., 3571 N. 1700 E., Buhl, ID 83316 Ph: 208-326-4928, Fax: 208-326-5049, and a mechanical (made from sewer parts), hand-held applicator, Aqua II, manufactured by Guy Meuheman in Rupert, Idaho were evaluated. The two applicators were evaluated for handling, performance, cost, and reliability.

## Results:

**Study #1** Applying PAM to Control Furrow Erosion

Applying PAM in corn during the germination irrigation increased control of sediment loss from the field, particularly in the first sampling time, although the differences among the three treatments were not statistically significant (Fig.1). There was considerable variability in much of the data among the three replications. Sediment loss from the field was greatest during the early phase of the irrigation event and decreased thereafter. PAM applied at the top of the furrow showed a trend to be less effective in controlling sediment loss than PAM applied along the entire length of the furrow; however, these differences were also not statistically significant.

PAM applied along the entire length of the furrow provided excellent protection against soil erosion throughout the entire irrigation. In the first sampling time, there was nearly 40 times less sediment when PAM was applied along the entire length of the field than in the check treatment. Also in the first sampling time, there was 2.5 times less sediment when PAM was spot-applied at the top of the field than in the check treatment. Averaged across sampling times, there was 7.4 times less sediment when PAM was applied along the entire length compared to the check, and spot-applying PAM at the top of the field reduced sediment loss by 16% compared to the check in which no PAM was applied.

Applying PAM in snap bean during the second irrigation showed a trend for increased control of sediment loss from the field with PAM split at the top and middle of the field compared to PAM applied at the top of the field (Fig. 2). As expected, the check had the highest level of sediment loss compared to the other two PAM treatments, particularly during the first phase of the irrigation event. Similar to that observed with the germination irrigation in corn, sediment loss in the second irrigation in snap bean also decreased during the irrigation event. There was also considerable variability in the data in snap bean as evidenced by the large standard deviations at most data points.

In the first sampling time (early during the irrigation set), PAM that was spot-applied at the top of the field reduced sediment loss by 28% compared to the check treatment. Also in the first sampling time, PAM that was spot-applied with half at the top and the other half in the middle of the field reduced sediment loss by more than 4 times as compared to the check treatment. During this first sampling, splitting spot applications between the top and the middle of the field decreased sediment loss by 3 times compared to PAM that was spot-applied only at the top of the field. Averaged across sampling times, splitting spot applications between the top and the middle of the field decreased sediment loss by 6 times compared to the check. Applying PAM at the top of the field decreased sediment loss by 44% compared to the check. Averaged across sampling time, splitting spot applications between the top and middle of the field decreased sediment loss by 70% compared to PAM that was spot-applied only at the top of the field.

**Study #2** Applying AGRO to Increase Crop Yields

In the study at Fruita, the AGRO only treatment increased corn grain moisture by more than 0.5% when compared to the check (Table 1). AGRO with starter fertilizer and AGRO without starter fertilizer significantly decreased grain yield by 19 and 21 bushels per acres, respectively. Test weight was unaffected by the AGRO treatments. The reason that AGRO decreased corn grain yields is not known. If AGRO increased water holding capacity and soil moisture retention in the root zone, it may be possible that such an increase in soil moisture conditions was actually detrimental to grain yield. Elucidation of causal factors related to corn grain yield decreases from AGRO application and verification of this initial finding will require additional experimentation.

In the study at Hayden, the lowest grain yields were obtained in the check and AGRO only treatments (Table 2). Fertilizer treatments increased grain yields in several but not every case. There was no clear response for increased grain yield at Hayden from either fertilizer source or AGRO application. The treatments at Hayden had no significant effect on grain moisture or test weight. Most fertilizer treatments increased plant height, but there was no consistent effect on plant height with the application of AGRO.

**Study #3** Evaluation of Polyacryamide Applicators

The Aqua II is a mechanical device for applying PAM (Fig. 3). It was found to dispense PAM inconsistently. It also leaked PAM readily when not in use and could easily cause spills when being transported. The applicator cost approximately $75.00 plus shipping. Given cost and performance, the Aqua II was found to be unsuitable and was returned to the company.

The Applicator™ has no moving parts and is simple and easy to use (Fig. 4). The manufacturer currently makes three models. The smaller model is lightweight and easy to use even when fully loaded. The cost is $35.00 for the small, F-100 applicator and $55.00 for the larger, F-150V applicator. The are two minor drawbacks to the F-100 design. First, the amount of PAM delivered is not adjustable on models that do not have a “V” in the model number. Second, it would be an improvement if the cap was tethered or fastened to the applicator to reduce the chance of losing it. One possible modification would be to put a small piece of velcro with one side of the velcro mounted on the cap and the other side mounted on the applicator handle. The cost for these simple applicators seems somewhat high, considering they are made with standard, readily available plastic parts. Without a doubt, the Applicator™ was superior to the Aqua II.

## References:

Sojka, R.E., and R.D. Lentz. 1997. Reducing furrow irrigation erosion with polyacrylamide (PAM). J. Prod. Agric. 10:47-52.

**Table 1.** Effect of Agro in corn grown at Fruita, Colorado 1998.

| Agro treatment | Grain moisture | Grain yield | | Test weight |
|---|---|---|---|---|
| ______ | % | lbs/acre | bushel/acre | lbs/bushel |
| Agro only | 18.2 | 10631 | 190 | 58.2 |
| Agro with fertilizer | 17.8 | 10749 | 192 | 58.7 |
| Check (no Agro) | 17.6 | 11792 | 211 | 58.6 |
| Ave | 17.8 | 11057 | 197 | 58.5 |
| CV (%) | 2.6 | 7.3 | 7.3 | 1.0 |
| LSD (0.05) | 0.5 | 866 | 15 | NS |

**Table 2.** Spring wheat variety, fertilizer, and Agro performance at Hayden, Colorado in 1998.

| Variety | Grain moisture | Grain yield | | Test weight | Plant height |
|---|---|---|---|---|---|
| _ | (%) | lbs/acre | bu/acre | lbs/bu | inches |
| 34-0-0 + Agro | 12.05 | 2414 | 40.2 | 58.6 | 24.4 |
| 18-46-0 + Agro | 11.30 | 2343 | 39.0 | 59.4 | 25.1 |
| 34-0-0 | 11.75 | 2191 | 36.5 | 58.8 | 23.6 |
| 11-52-0 | 11.88 | 2178 | 36.3 | 58.8 | 24.4 |
| 18-46-0 | 11.95 | 2064 | 34.4 | 59.0 | 24.0 |
| 11-52-0 + Agro | 12.32 | 1954 | 32.6 | 58.8 | 22.6 |
| check | 11.80 | 1698 | 28.3 | 59.4 | 22.8 |
| Agro only | 12.10 | 1458 | 24.3 | 58.4 | 22.1 |
| Ave. | 11.89 | 2037 | 34.0 | 58.9 | 23.6 |
| LSD (0.05) | NS | 320 | 5.3 | NS | 1.9 |
| CV (%) | 7.8 | 10.7 | 10.7 | 1.4 | 5.4 |

Fig. 1. Effect of PAM in controlling furrow erosion in corn at Fruita, Colorado during the germination irrigation (May 14, 1998).
Average irrigation water during the irrigation was 0.93 g sediment per liter of water.

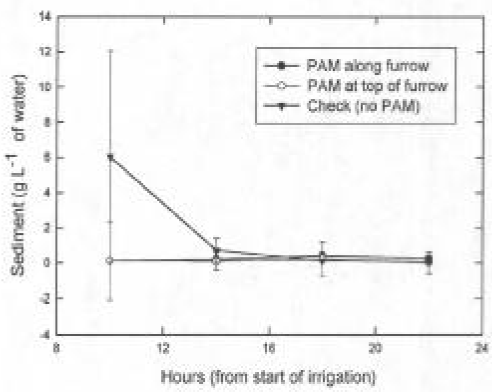


Fig. 2. Effect of PAM in controlling furrow erosion in snap beans at Fruita, Colorado during the second irrigation (June 25, 1998).
Irrigation water contained no sediment during the irrigation event.

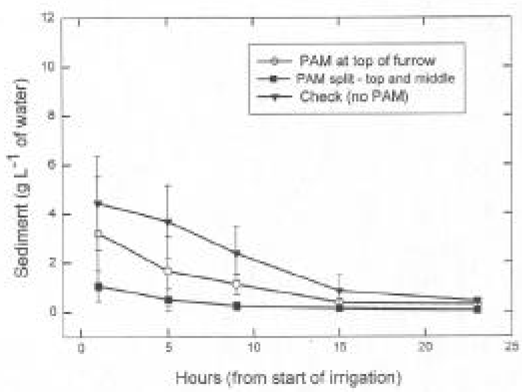


Fig. 3. Aqua II PAM applicator.

Fig. 4. The Applicator™.

## Variety Performance Test of Malting Barley in Western Colorado 1998

**Dr. Calvin H. Pearson, Professor of Soil and Crop Sciences and Research Agronomist**

**Summary:** **During 1998 sixteen malting barley varieties were grown in the field at Montrose, Colorado and evaluated for grain yield, grain moisture, plant height, test weight, lodging, necking, grain moisture at quality evaluation, grain color, and grain protein. The average grain yield for the experiment was 6235 lbs/acre (130 bu/acre). Grain yields ranged from a high of 6780 lbs/acre (141 bu/acre) for Baronesse to a low of 5800 lbs/acre (121 bu/acre) for Idagold. Unlike other years, there were no statistically significant differences among varieties for grain yield in 1998. Statistically significant differences among varieties occurred for other traits evaluated in the study. Details about the performance of these traits are presented in this report.**

**Background:** In the mid-1980's Coors Brewing Company ended a long history of contract production of malting barley with western Colorado farmers. Then in 1993, Colorado State University at the request of Coors Brewing Company began to conduct studies to re-evaluate the production potential of malting barley in western Colorado. Studies on nitrogen fertility and location performance of malting barley were conducted, but most of our studies focused on evaluating new malting barley varieties. These variety performance tests were conducted in Montrose where malting barley is better adapted than most other locations in the Uncompaghre and Grand Valleys. The data presented in this 1998 report is the last trial to be conducted for Coors. During this six-year testing period from 1993 to 1998, Coors Brewing Company is again contracting with a small number of growers to produce malting barley, and the information obtained from our tests over the years was considered to be sufficient for the time being to meet the needs of western Colorado farmers.

**Methods:** A variety performance test sponsored by the Coors Brewing Company was conducted at Montrose, Colorado on the Keith Catlin Farm during 1998. Sixteen malting barley varieties were evaluated: C14, C19, C22, C28, C32, C35, C37, C39, C40, C41, Galena, Idagold, Merit, Harrington, Baronesse, and B1202. Plot size was 5.7 feet wide and 25 feet long. The experiment was a randomized complete block with four replications. An application of 75 lbs N/acre and 75 lbs $P_2O_5$/acre was made preplant broadcast. Seeding occurred on April 20, 1998 at a seeding rate of 100 lbs/acre. Harmony Extra at 0.3 oz/acre plus 2,4-D at 0.5 pts/acre plus Disyston insecticide at 1 pint/acre was applied on May 27, 1998 by airplane. Lannate at 1.5 pts/acre was applied on July 24, 1998 also by airplane.

Plant height was measured in three random areas of each plot and was measured from the soil surface on top of the 30-inch bed to the top of the canopy. Lodging and spike necking were evaluated on the day of and just prior to harvesting the plots. Lodging scores were obtained using a lodging index: 0.2 X S X I, where S = surface area lodged (1 = none, 9 = totally lodged) and I = intensity of lodging (1 = none, 5 = totally flat). Necking was scored on a scale from 1 to 5 where 1 = spike completely erect, 2 = spike bent at a 45E angle from the erect position, 3 = spike bent at a 90E angle from the erect position, 4 = spike bent at a 135E angle from the erect position, and 5 = spike bent down parallel to the culm.

A Hege plot combine was used to harvest plots on August 11, 1998. Moisture contents of grain samples at harvest and test weights were determined using a Seedburo GMA128 moisture analyzer. Grain moisture at malting quality evaluation, color, and protein were determined by Coors personnel.

**Results:** Plots were planted three days earlier in 1998 than in 1997. The 1998 growing season was much more favorable for malting barley production than in 1997, particularly at harvest. In 1997, it was very rainy just prior to harvest which adversely affected seed quality, particularly color, and delayed harvest. Conditions at harvest in 1998 were mostly dry and warm.

Grain moisture contents of varieties at harvest averaged 11.3% and ranged from a low of 10.6% to a high of 12.6% (Table 1). The two varieties with the highest grain moisture content at harvest were Merit and Idagold. Grain moisture content at the time quality evaluations were conducted averaged 10.0% across varieties (Table 2). Although differences among varieties for grain moisture at quality evaluation were statistically different they only differed by less than 0.5%.

The average grain yield for the experiment was 6235 lbs/acre (130 bu/acre). Grain yields ranged from a high of 6780 lbs/acre (141 bu/acre) for Baronesse to a low of 5800 lbs/acre (121 bu/acre) for Idagold (Table 1); surprisingly, there were no statistically significant differences among varieties for grain yield in 1998.

The tallest varieties were Merit and Harrington and the shortest varieties were C37, C28, C32, and C39 (Table 1). Average plant height was 26.1 inches and ranged from 30.8 inches for Merit to 22.4 inches for C39. Most varieties had plant heights greater than 24 inches.

Test weights among varieties were significantly different (Table 1). Test weights ranged from a high of 52.8 lbs/bu for C35 to a low of 50.0 lbs/bu for Idagold. C14 and C35 were the only two varieties with test weights that were greater than 52.0 lbs/bu.

Lodging among the malting varieties in 1998 was low; however, differences in lodging scores among varieties were significant. C28 and C19 were the varieties with the most lodging (Table 2). C28 also had a high amount of lodging in 1997 as compared to the other varieties in that test. Ten varieties had lodging scores of 1.0 or less in 1998.

Necking scores among varieties in 1998 were significantly different (Table 2). Necking scores averaged 3.9 and ranged from a high of 4.6 to a low of 2.6. Ten varieties had necking scores of 4.0 or higher. Idagold had the lowest necking score (2.6).

Color across varieties averaged 54.3 and ranged from a high of 63.2 for C32 to a low of 44.2 for C35 (Table 2). Three varieties ( Merit, C19, and C32) had color scores of 60 or higher.

Protein content averaged across all varieties was 11.2% (Table 2). Harrington had the highest protein content (12.0%) and C19 had the lowest protein content (10.6%). Among all varieties, except Harrington, protein contents were less than 12%. Results for protein in 1998 were quite similar to those obtained in 1997.

**Acknowledgments:** We thank Keith Catlin for his excellent cooperation with this research. Keith continues to be a strong supporter of field research and malting barley production in western Colorado. My thanks to Coors for their support of malting barley production in western Colorado and for this trial.

# Evaluation of Pumpkin Cultivars

**Matt Rogoyski, Horticulturist**

**Summary:** **The most important finding of this trial was the observation that the pumpkin fruit quality problems occurring in the western Colorado are related to premature senescence of vines rather then harvesting of premature fruit as it was originally thought. Jack of all Trades cultivar proved to be the most resistant to the soft pumpkin disorder. Howden, Rocket, Aspen, and Jack of all Trades produced the highest yields ranging from 190 to 212 lb per plot. The conventional cultivars consistently outyielded the PY gene cultivars. Individual fruit weights were affected by the genetics of these cultivars. Three distinct size categories can be seen. With Howden and Aspen having largest fruit, Lumina, Rocket, Jack of all Trades, and Big Autumn the second category and Autumn Gold in the third category. It is clear from this trial and subsequent trial that control of powdery mildew and squash bug is critical to prevent premature vine senescence to allow the pumpkin fruit to mature fully. There are several powdery mildew resistant cultivars becoming available. An on farm trial planting of these cultivars is strongly recommended.**

**Background:** The findings of the nutritional and medicinal value of pumpkins and the growth in popularity of Halloween as a holiday in the last decade indicate potential for significant expansion of market for this crop.

Seven pumpkin cultivars were tested: Aspen, Autumn Gold, Big Autumn, Howden, Jack of all Trades, Lumina, and Rocket during the 1997 growing season and repeated in 1998 growing seasons; the data shown here are for the 1997 growing season. Yield, fruit weight, maturity, and spatial distribution of fruit within the plots were determined. Cultivars were evaluated for susceptibility to the soft pumpkin disorder and powdery mildew.

**Method:** The planting consisted of seven rows each containing seven plots with randomly assigned cultivars. The plot size was 6 by 30 feet with 3 feet spacing between plants. A buffer area between plots was included. The site preparation consisted of glyphosate applications and cultivation for the seed bed preparation. A soil fertility test indicated adequate levels of nutrients. The seeds were planted at the 2 inch depth on June 24, 1997. The fruit was harvested on October 10, 1997 and was stored unprotected at the planting site. The following measurements and maturity tests were conducted within several days of harvest: fruit number and weight, fruit spatial distribution, incidence of soft pumpkin disorder, and rind firmness.

**Results:** Howden, Rocket, Aspen, and Jack of all Trades produced the highest yields ranging from 190 to 212 lb per plot (180 square feet) (Table 1). The yields of cultivars with the PY gene were lower at 113 lb per plot for Autumn Gold and 130 lb per plot for Big Autumn (Table 1). The lowest yielding cultivar was Lumina at 64 lb per plot (Table 1). Observed yields of tested cultivars were comparable with those listed in literature such as Knots Handbook. The conventional cultivars consistently outyielded the PY gene cultivars.

Fruit weight was also clearly affected by the genetics of these cultivars. Three distinct size categories can be seen. With Howden and Aspen having largest fruit, Lumina, Rocket, Jack of all Trades, and Big Autumn the second category and Autumn Gold in the third category (Table 1). Weight of pumpkins grown in the western Colorado sometimes exceeds that required by mass-market buyers. The proper choice of an appropriate cultivar can eliminate the need to prematurely harvest fruit just on the basis of its size.

Fruit color was found to be poor indication of maturity index for several reasons. Under the western Colorado growing conditions characterized by warm, sunny days and cool nights the color development of fruit in general often proceeds their physiological maturity. For example cultivar with PY gene colored when fruit was soft, clearly not yet mature enough for harvesting.

Two quantitative fruit maturity indexes were examined: rind pressure and starch rating. The fruit rind firmness readings were in two categories. The first group reading ranged from 7.8 lb to 8.8 lb consisted of Lumina, Jack of all Trades, Big Autumn, Rocket, and Howden (Table 3). The two cultivar Autumn Gold and Aspen had consistently softer rind with the firmness reading of 5.9 lb and 6.7 lb respectively (Table 3). The traditional finger nail maturity test was judged to be inconsistent (data not shown), especially between different testers. The starch rating of Lumina was considerably higher than other cultivars, indicating a different genetic background of this cultivar. The starch rating of the Rocket cultivar was higher than for other cultivars. The Autumn Gold cultivar (PY gene cultivar) starch rating was the lowest (Table 3) indicating that the PY gene did not seem to enhance internal fruit maturity, its effect was only early color appearance.

As far as the resistance to soft fruit disorder is considered, one cultivar: Jack of all Trades was most resistant to this disorder and Autumn Gold being most susceptible (Table 4). When rating of powdery mildew infection is examined

Autumn Gold was most susceptible and Lumina least susceptible with other cultivar grouped together (Table 4).

This research effort indicates that the pumpkin fruit quality problems are related to premature senescence of vines rather then harvesting of premature fruit as it was originally thought. The relationship among premature vine senescence, degree of powdery mildew infection, and onset of lower temperature in late summer has been observed. The results indicate the need for powdery mildew resistant pumpkin cultivars adaptable to the western Colorado and eastern Utah growing conditions.

**Table 1.** Plant Productivity

| Cultivar | Yield/Plot | | Average Fruit Weight (lb) | |
|---|---|---|---|---|
| Big Autumn | 130 | b | 12.9 | c |
| Howden | 212 | a | 21.6 | a |
| Rocket | 201 | a | 13.8 | c |
| Jack-Of-All Trades | 190 | a | 13.9 | c |
| Aspen | 194 | a | 17.3 | b |
| Lumina | 64 | c | 14.2 | c |
| Autumn Gold | 113 | b | 8.4 | d |

Mean separation within columns by Duncan multiple range test, 5% level

**Table 2.** Fruit Maturity

| Cultivars | Firmness | | Starch Rating | |
|---|---|---|---|---|
| Big Autumn | 8.2 | a | 2.9 | bc |
| Howden | 7.8 | a | 3.7 | bc |
| Rocket | 8.1 | a | 4.2 | c |
| Jack Of All Trades | 8.4 | a | 3.7 | bc |
| Aspen | 6.7 | b | 2.7 | bc |
| Lumina | 8.8 | a | 37.5 | a |
| Autumn Gold | 5.9 | b | 1.5 | c |

Mean separation within columns by Duncan multiple range test, 5% level
Starch rating: thickness of starch layer in millimeters

**Table 3.** Resistance to diseases

| Cultivars | % Soft | Fruit | Powdery Mildew Rating | |
|---|---|---|---|---|
| Big Autumn | 11 | bc | 3.9 | b |
| Howden | 21 | abc | 4.1 | ab |
| Rocket | 23 | abc | 4.7 | ab |
| Jack of all Trades | 5 | c | 4 | ab |
| Aspen | 20 | abc | 4 | ab |
| Lumina | 31 | ab | 1 | c |
| Autumn Gold | 39 | a | 5 | a |

Mean separation within columns by Duncan multiple range test, 5% level
Powdery mildew rating: 1 (10% leaves infected) – 6 ( 100% leaves infected)

**Table 4.**Fruit Distribution

| Cultivars | Dispersion Rating | |
|---|---|---|
| Big Autumn | 3.6 | bc |
| Howden | 2.6 | cd |
| Rocket | 3.7 | bc |
| Jack of all Trades | 4 | ab |
| Aspen | 5 | ab |
| Lumina | 2.3 | d |
| Autumn Gold | 3.3 | cd |

Mean separation within columns by Duncan multiple range test, 5% level
Dispersion rating: 1 (fruits uniformly distributed throughout the plot) – 6 (most of fruit 2 feet from the seeding site)

## Spring Wheat Planting Date Studies in Western Colorado

**Bob Hammon, Entomologist**

**Summary:** **Irrigated spring wheat planting date studies were conducted in 1997 and 1998 at the Fruita Research Center and Southwest Colorado Research Center. There was a strong relationship between planting date and yield at the Fruita site, with earlier planting dates yielding more grain at higher test weight than later planting dates. There was no trend between planting date and yield or test weight at the southwest Colorado test site. High temperature during grain fill was hypothesized to be responsible for the trend at Fruita. The Southwest Colorado Research Center is located at an elevation of 7000 feet and summer temperatures rarely exceed 90" F, so grain fill is not affected by temperature. Later planting dates tended to have more Russian wheat aphid symptoms than earlier planting dates at both sites, but more aphids were found in the earlier planting dates. Yield loss in all planting dates from Russian wheat aphid was greatest at Fruita during the 1998 growing season, and in southwest Colorado during the 1997 growing season. Spring wheat should be planted before April 1 in areas with hot summers. Early planting is not as critical in higher elevation areas, but later planted spring wheat may not mature in a timely manner in these areas. Russian wheat aphid symptoms alone may not be sufficient to diagnose economic infestations. Wheat heads should be inspected for the presence of aphids before control decisions are taken.**

**Background:** Spring wheat is planted in the lower valleys of western Colorado as a rotational crop, and is severely affected by Russian wheat aphids in most years. Spring wheat acreage is increasing in the irrigated regions of southwest Colorado, and may also be affected by Russian wheat aphids. Experiments were initiated in 1997 to investigate: 1) The effect of spring wheat planting dates on yield and grain quality, and 2) The effect of Russian wheat aphids on spring wheat planted on different dates.

**Method:** Planting dates for the two experiments are displayed in Table 1. These are typical of the planting dates that are normally used in each area. 'Blanca', a soft white wheat was planted at Fruita, and 'Sylvan', a hard red wheat was planted at the Southwest Colorado Research Center. On each planting date, seed treated with Gaucho 480FS insecticide, and untreated seed was planted to control Russian wheat aphids, and leave an untreated control. The experiments were arranged in a two factor randomized complete block design with four replications. Russian wheat aphid symptoms and abundance were sampled on two occasions at each site during each year. Plots were harvested, yield and test weight recorded and analysis of variance applied to the data.

| Fruita | | Yellow Jacket | |
|---|---|---|---|
| 1997 | 1998 | 1997 | 1998 |
| March 19 | March 23 | April 23 | April 23 |
| April 2 | April 2 | April 30 | April 30 |
| April 16 | April 14 | May 7 | May 7 |
| April 30 | April 27 | May 14 | May 14 |

**Table 1.** Planting dates for 1997 and 1998 experiments.

**Results:** Figure 1 shows that yields decline in a near linear trend with planting date at Fruita. Planting date accounts for nearly all of the variation in the data. Figure 2 shows the data from the Southwest Colorado experiments. There was no planting date effect on yield, with planting dates accounting for less

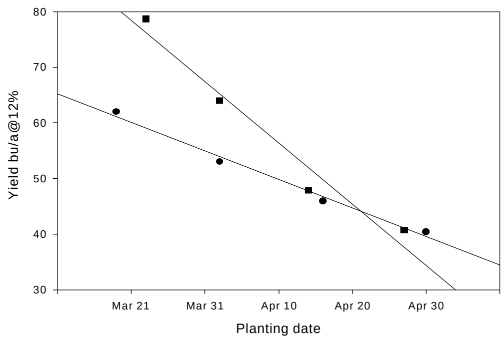


**Figure 1.** Yield versus planting date regression for Fruita Planting date experiment.

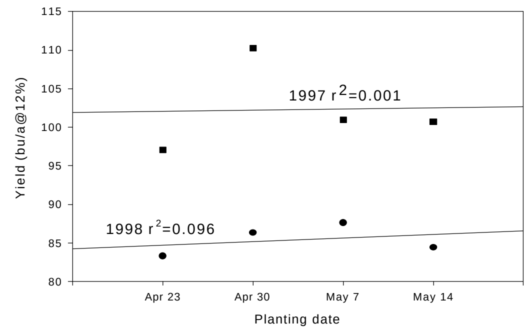


**Figure 2.** Yield versus yield regression for Yellow Jacket experiments.

than 1% of the data variation in either year. The difference between the two sites can be explained by summer temperatures during grain fill. July temperatures at the southwest Colorado site rarely exceed 90/, while at Fruita, temperatures above 100/are common.

There were no statistical differences in percent Russian wheat aphid symptomatic tillers in any of the experiment-years. There were more Russian wheat aphids per tiller in the earlier planting dates in the years that Russian wheat aphids were abundant (Fruita 1998, SW Colo 1997). The relationship between Russian wheat aphid numbers and planting date is displayed in Figure 3. The discrepancy between symptomatic tillers and Russian wheat aphid abundance can be explained by the position on the plants where the aphids are feeding. Early season aphid feeding is concentrated on newly emerging leaves, where streaking and rolling symptoms are created. Later season feeding is concentrated on wheat stems and heads where foliar symptoms are not created. These experiments have shown that scouting based on Russian wheat aphid foliar symptoms may not always detect economic infestations. To fully determine Russian wheat aphid abundance on spring wheat, heads must be dissected to determine the number of aphids feeding on the plant. The effect of Russian wheat aphid head feeding remains unknown, and will be the focus of continuing research.

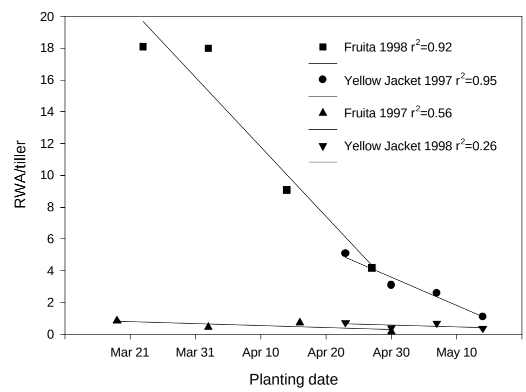


**Figure 3.** Regression of RWA/tiller versus planting date for four experiment location-years.


**<u>Acknowledgments:</u>** This research was done with the help of the support staff of the Fruita Research Center, Fred Judson and Lot Robinson, and the Southwest Colorado Research Center, Mark Stack, and Jerry Mahaffey. It was supported by the Colorado State University Russian Wheat Aphid research program, led by Dr. Frank Peairs.

**Evaluation of Advanced Russian Wheat Aphid Resistant Spring Barley Lines**
**Bob Hammon, Entomologist**

**Summary:** **Ninety advanced screening lines of spring barleys resistant to Russian Wheat Aphid (RWA) were evaluated in replicated and non-replicated trials at the Fruita and SW Colorado Research Centers, in cooperation with plant breeders at the University of Idaho and USDA-ARS, Stillwater, OK. One advanced barley line was identified that performed well at both sites, as well as other sites in the western US. Several other lines performed well enough to deserve further evaluation.**

**Background:** Russian wheat aphids have affected production of spring grain crops in western Colorado since their appearance in 1986. Profit margins on spring wheat and barley have been affected by RWA by direct damage and control costs. RWA resistant varieties, if adapted to local conditions, offer a means to produce spring grains without the damage and control costs that have plagued producers. The opportunity arose in 1998 to evaluate advanced screening lines of RWA resistant spring barleys developed in a cooperative effort between the University of Idaho and USDA-ARS in Stillwater OK under western Colorado conditions. The objective of the trials is to find a RWA resistant spring barley adapted to the unique conditions of western Colorado

**Method:** Two trials were planted at both the Fruita Research Center and the Southwest Colorado Research Center. They were identical in design at both research centers. One was a replicated trial, with 20 lines replicated four times. The other was a non-replicated trial, with 70 entries. All were planted in 12 ft x 5 ft plots at a seeding rate of 100 lb/a.

Plots were planted on March 23, 1998 at Fruita and on April 30, 1998 at the SW Colorado Research Center. Both sites had approximately 120 lb/a of total N applied. Harmony Extra (0.5 oz/a) and 2,4-D (4 oz/a) was used to control weeds at late tillering at both sites. The plots were furrow irrigated six times during the growing season at Fruita. The plots were sprinkler irrigated six times during the growing season, receiving a total of 20.3 inches of water at the SW Colo Research Center. A total of 2.42 inches of precipitation was recorded at Fruita, and 3.48 inches at SW Colorado.. Plots were harvested on August 10, 1998 at Fruita and Sep 14 at Sw Colorado. The plots at Fruita were injured by an application of Roundup to the lanes between plots in which wind drift caused some damage to most plots. Plot area was estimated, and yields were adjusted accordingly.

**Results:** RWA pressure was high at Fruita, and low at SW Colorado during the 1998 growing season. '95RWA26' was in the highest yielding statistical class at both sites, with a yield of 92 bu/a at the SW Colorado Research Center, and 150 bu/a at the Fruita Research Center. This line has also performed well in trials in Idaho, Wyoming and eastern Colorado. Six other lines performed well enough at both sites to be reevaluated in 1999. Twenty lines from the non-replicated trial performed well enough to be reevaluated in replicated trials in 1999.

**Acknowledgments:** Phil Bregitzer, Univ of Idaho, Moscow ID, organized the trials and did statistical analysis. Dolores Mornhinweg., USDA-ARS, Stillwater OK bred RWA resistance into the barley lines, which was incorporated into more adapted germplasm at the University of Idaho. Fred Judson and Lot Robinson assisted with the field operations at Fruita, and Mark Stack assisted at the SW Colorado Research Center.

## Influence of Plastic Mulch and Trickle Irrigation on Yield and Brix Levels of Kabocha Squash

**Rick Zimmerman, Entomologist**

**Summary:** **In general, drip irrigation resulted in the highest yields despite the color of mulch or whether planting method was direct seed or by transplant. The yields from the transplanted plots were significantly higher than the direct seeded plots (with the exception of the yield from those plots under black plastic). The plots in which the squash were transplanted into black plastic was not significantly higher than the yield found in the furrow irrigated plots with no mulch. This was due to squash bug , *Anasa tristis* (Coreidae) infestations which reduced the yields in the first two plots located in the outside row. Overall the yield per acre was significantly higher in the transplanted plots (mean=26445 lbs) than in the direct seeded plots (mean=15343 lbs) (F=31.83, P>0.0001). There was no significant differences in yield per acre between the two Kabocha varieties, Kurijiman and Ajehei (F=0.04, P>0.84).**

**Brix levels were not significantly different between any of the plots except for those squash which were direct seeded in the furrow irrigated plots (avg. Brix % = 11.29).**

**The squash yields resulting from the combination of drip irrigation and plastic mulch are similar to yields found under the same combination in Mexico. However, Colorado squash has much higher sugar levels. The brix level of Mexico grown Kabocha squash typically ranges from 9-11%, while Colorado brix levels range from 13 to 19%. Significantly higher yields per acre were found with squash transplants. This increase in yield may be in part due to lengthening of the growing season as a result of transplanting. The transplanted squash started flowering on June 23 (26 days after planting), while the direct seeded squash plots did not start flowering until July 15 (49 days after planting).**

**Background:** Kabocha squash, *Cucurbita moschata*, is an important cash crop for western Colorado. In 1998, over 350 acres of squash were planted in Delta and Montrose counties. Colorado grown Kabocha squash exported to Japan received a three to four cent premium per pound above Kabocha squash grown in other parts of the world. These premium prices are due to the high sugar content. Growers received 18 cents per pound for the 1998 crop. Research aimed at increasing yields and quality of fruit have not been conducted in Colorado.

**Method:** In 1998, a project was initiated at Rogers Mesa Research Center, to investigate the impact of drip irrigation and plastic mulches on yield and quality of Kabocha squash. This is the first year of a three year project. The growing season is approximately 150 days. A soil analysis of the plot showed the soil texture is clay with a pH of 7.8. Organic matter was 3.0%. Prior to planting the soil was disked and rototilled to a depth of 4-6 inches. Three different colored plastic mulches were evaluated: 1) clear, 2) black and 3) green. In addition rows were included with no mulch. Irrigation was by drip (T-Tape™ 24”-420TV) and furrow. The mulch and drip tape was laid with a Buckeye combination mulch-drip tape-bed shaper. The drip tape was placed 2-3 inches below the soil surface. In order to adequately filter the ditch water, the water was first filtered through 4 Amiad™ 120 mesh filters followed by 2 Spin-Klin™ 140 mesh filters. Fertilizers were injected via a Chem Feed™ C600P pump. A total of 14.8 gallons of Uran (32% nitrogen) and 21.7 gallons of 5-5-5 (5% nitrogen, 5% phosphate and 5% potash) was applied from June 29 to August 5. One half of plots were planted with 4 week old squash transplants. The second half of the plots were directly seeded. Seeds and transplants were planted on May 28. The plot was 200 feet wide x 160 feet long. Row orientation was north to south. Rows were spaced 8 feet apart. In row plant spacing was 2 ft. There were 20 plants per plot. The treatments are in Table 1. Harvest was conducted in the first week of September. Each squash was individually weighed and the Brix level (%sugar) was taken from three randomly selected squash from each plot.

**Table 1:** Plot design for 1998 Kabocha squash trial at Rogers Mesa Research Center, Hotchkiss.

| Row # | Irrigation Method | Plant stage | Mulch | Variety[a] | Variety |
|---|---|---|---|---|---|
| 1 | trickle | transplant | black | Kurijiman | Ajihei |
| 2 | trickle | transplant | clear | Kurijiman | Ajihei |
| 3 | trickle | transplant | green | Kurijiman | Ajihei |
| 4 | trickle | transplant | no mulch | Kurijiman | Ajihei |
| 5 | trickle | direct seeded | black | Kurijiman | Ajihei |
| 6 | trickle | direct seeded | clear | Kurijiman | Ajihei |
| 7 | trickle | direct seeded | green | Kurijiman | Ajihei |
| 8 | trickle | direct seeded | no mulch | Kurijiman | Ajihei |
| 9 | furrow | transplant | no mulch | Kurijiman | Ajihei |
| 10 | furrow | direct seeded | no mulch | Kurijiman | Ajihei |

[a] Each variety was replicated twice in each row (4 plots/row). Each plot was 40 feet long. Each row was 160 feet.

Irrigation was applied through the drip system on 20 days (total hours of irrigation for season 134.5, average time = 6.75 hours). Timing of irrigation was based on tensiometer readings and physically evaluating soil for soil moisture. Furrow irrigation was conducted on 12 days (total hours of irrigation for season 188.5, average irrigation time = 15.7 hours). A furrow was placed on either side of the squash row. Each drip line was able to put out 0.71 gals/ minute. Flow meters were not available this season for either the drip or furrow irrigation. Water usage in the drip irrigated plots was the equivalent of 516,912 gallons per acre. Water usage in the furrow irrigated plots was the equivalent of 4.1 million gallons per acre.

**Table 2:** 1998 yield and brix levels of Kabocha squash grown in research plots at Rogers Mesa Research Center, Hotchkiss.

| Stage Of Planting | Mulch Type | Type Of Irrigation | Market Weight[a] | Total Weight[d] | Avg. Fruit Weight[e] | % Brix[c] | Yield/ Acre (lbs) |
|---|---|---|---|---|---|---|---|
| Transplant | Clear | DRIP[f] | 145.7ab | 185.0ab | 3.11a | 13.68b | 26454a |
| | Green | DRIP[f] | 118.5ab | 169.2a | 3.36a | 14.44ab | 30710a |
| | Black | DRIP[f] | 82.6cd | 126.4c | 3.14a | 14.83ab | 15037bc |
| | No Mulch | DRIP[f] | 185.0a | 199.2a | 3.39a | 15.98ab | 33758a |
| | No Mulch | FURROW | 27.6e | 33.5ef | 3.14a | 14.54ab | 5108c |
| SEED | Clear | DRIP[f] | 81.4cd | 102.6cd | 3.47a | 15.92ab | 16867b |
| | Green | DRIP[f] | 48.4ed | 75.4ed | 3.49a | 16.37a | 10600bc |
| | Black | DRIP[f] | 120.9cb | 145.7cb | 3.54a | 15.31ab | 26623a |
| | No Mulch | DRIP[f] | 30.4e | 36.6ef | 3.03a | 15.74ab | 7282bc |
| | No Mulch | FURROW | 17.8e | 26.2f | 2.88a | 11.29c | 4654c |

[a]F=20.11, n= 40, P<.0001. [b]F=14.89, n=40, P<.0001. [c]F=8.48, n=110, P<0.0001. [d]F=26.49, n=40, P<0.0001. [e]F=2.20, n=40, P<0.05. [f]Subsurface drip irrigation. Treatments within the same column followed by the same letter are not significantly different.

Major pest problems were various weed species: common mallow (*Malva neglecta* Wallr.), lambs quarter (*Chenopodium berlandieri* Moq.), red root pigweed (*Amaranthus palmeri* S. Wats.) and bindweed (*Convolvulus arvensis* L.). The only insect pressure was from squash bugs. Yields in the furrow rows may have been depressed from weed competition, as well in the direct seeded, drip irrigated row with no mulch. The squash which were transplanted into the no-mulch, drip irrigated rows had yields similar to the transplanted squash in the plastic mulch. The transplanted squash were able to grow fast enough to shade out weed seedlings. Overall the plastic provided exceptional weed suppression and significantly decreased the amount of water needed for irrigation. Squash bug populations were treated with an insecticide. Identification and treatment of squash bugs was made difficult by their clumped distribution in the squash field. Scouting for early infestations is also difficult because the squash bug are secretive in nature, and tend to stay near the base of the squash plant.

## Apple Powdery Mildew Control, 1998 - Study 1 (Jonathan)

**Harold Larsen, Plant Pathologist**

**Summary:** **Four of seven control programs with sprays applied on 14 day intervals provided good control of apple powdery mildew infection on shoots and on fruit. Five spray programs with Nova alone, Procure alone, a Nova/ Sovran/ Sovran/ Nova/ Sovran rotation (with a lower rate of Sovran) , and a Nova/ Sovran/ Sovran/ Nova/ Sovran rotation (with a higher rate of Sovran) reduced shoot mildew infections 84%, 66%, 74%, and 64%, respectively, and fruit infections 57%, 33%, 65%, and 48%, respectively. A five spray program with Stylet oil provided good protection against shoot infections (71% reduction) but failed to reduce fruit infections. A Nova/ Sovran rotational program with the lower rate of Sovran is recommended because rotation of the different fungicide chemistries (sterol inhibitor and strobilurin, respectively) will reduce risk of developing resistance to these fungicides.**

**Background:** Apple powdery mildew infections to shoots reduce winter hardiness in buds (and thus return bloom) as well as general tree vigor. Infections to fruit early in fruit development cause fruit russet which reduces fruit appearance, storability, size, and salability. Continual use of single fungicide types over time increases likelihood of resistance development to that fungicide type. The goal is to identify new mildew control options that will allow rotation of chemistries and avoidance of resistance development while providing adequate levels of control for shoot and fruit infections.

**Method:** Treatments were applied by air blast sprayer at 400 gal/acre to Double Red Jonathan on seedling rootstock (planted 1965). Sprays were applied according to phenological development (tight cluster, bloom, petal-fall, and at 10-14 days thereafter until shoot growth stopped) except for the Qwel treatment applied at 7 day intervals. Standard insecticide/ miticide materials were used to control insect and mite pests. Shoots were examined for mildew infection; fruit infection data were collected after harvest with fruit classified as infected if any of the fruit surface showed mildew-induced russet. Means were separated by Duncan's Multiple Range Test ($p < 0.05$) after statistical analysis.

**Results:** Both sterol inhibitor fungicides, Nova and Procure, as well as the rotational sequence programs in which Nova rotated with the strobilurin fungicide Sovran provided good control of shoot and fruit infection (Table 1). In addition, the fruit russet for these four treatments was quite small (usually not noticeable) and thus below the level for fruit cullage. Stylet oil provided good control of shoot infection; it did not provide adequate protection against fruit infection and some of the fruit russet was large enough to result in cullage. The Macleaya extract Qwel provided no control of either shoot or fruit infection in this study.

Treatment costs per spray for Nova and Procure are around $19-22/acre; the Omni Supreme spray oil runs about $4.50 per gallon. Thus cost for a five spray program with Nova or Procure + Omni oil would be around $116 - 131/acre per season. Costs of the Sovran and Qwel were not available since they were experimental materials at the time and not available commercially. Cost of the Stylet oil is estimated to be around $6 - 10 per gallon, so cost of each spray would have been around $50 - 80/acre and for the season would have been around $250 - 400/acre. Return on apples in 1999 was very low at around $6/bushel; at 500 bu/acre, this would provide only around $3,000/acre return to the grower from which all other production costs would need to be paid. Thus the grower would need to look at both efficacy and control program cost. The five spray program with Nova or Procure still appears to be quite reasonable for the protection provided. If the new strobilurin Sovran is released with a comparable cost to them, then the rotational program would provide a cost effective control option. Sulfur sprays continue to be the lowest cost at approximately $15 / acre/ season, but risk of fruit russet and leaf burn are unacceptably high when temperatures exceed 85º F within 24 hours of application.

It is noted that 1998 crop development during prebloom to post bloom was slightly slower and later than anticipated earlier in the season. Cooler weather in late April to early May prolonged bloom and petal fall beyond normal times. Shoot infections were quite obvious in treatments 5 - 9 by mid-June, and treatments 5-9 also exhibited significant fruit russet (3-5%) at harvest. Fruit infections in treatments 1-4 did not result in cullable russet.

| Trt. No. | Materials | Rate (Product/acre) | % Shoots Infected (5/13/98) | % Shoots Infected (10/6/98) | % Fruit infection at Harvest |
|---|---|---|---|---|---|
| 1 | Nova 40W + Omni Oil | 5 oz. + 1 gal. | 15.3A | 8.5 A | 11.0 A B |
| 2 | Procure 50WS + Omni Oil | 10 oz. + 1 gal. | 21.0 A B | 18.7 B | 15.6 A B C D |
| 3 | Nova 40W/ Sovran 50WG/ Sovran/ Nova/ Sovran sequence + Omni Oil | Nova @ 5 oz./ Sovran @ 4.8 oz. + 1 gal. | 17.2 A | 11.0 A B | 9.0 A |
| 4 | Nova 40W/ Sovran 50WG/ Sovran/ Nova/ Sovran sequence + Omni Oil | Nova @ 5 oz. / Sovran @ 6.4 oz. + 1 gal | 37.7 C | 17.2 B | 13.4 B C D |
| 5 | Qwel 1.5% (7 da) | 4 gal. | 37.8 C | 45.0 C | 27.6 E |
| 6 | Qwel 1.5% (14 da) | 4 gal. | 33.5 B C | 49.7 C D | 23.4 C D E |
| 7 | JMS Stylet Oil | 8 gal. | 27.5 A B C | 15.7 A B | 20.7 B C D E |
| 8 | Water Check + Omni Oil | + 1 gal. | 28.2 A B C | 48.2 C D | 27.4 E |
| 9 | Non-sprayed Check | C | 38.8 C | 54.7 D | 25.7 D E |

**Acknowledgments:** The OMRC field staff provided assistance with preparation of spray equipment and harvest.

## Apple Powdery Mildew Control, 1998 - Study 2 (Gala)

**Harold Larsen, Plant Pathologist**

**Summary:** **A five-spray program of Nova + oil applied on 14 day intervals provided best control of apple powdery mildew infection on shoots (70%) and on fruit (58%). Programs with sodium bicarbonate + oil, stylet oil, and a rotational program with Nova + oil, Sovran + oil, Procure + oil, Qwel alone, and Stylet oil reduced shoot mildew infections 44%, 55%, and 52%, respectively, and fruit infections 44%, 52%, and 54%, respectively. A rotational program including different fungicide chemistries is recommended in order to reduce risk of developing resistance to available fungicides.**

**Background:** Apple powdery mildew infections to shoots reduce winter hardiness in buds (and thus return bloom) as well as general tree vigor. Infections to fruit early in fruit development cause fruit russet which reduces fruit appearance, storability, size, and salability. Continual use of single fungicide types over time increases likelihood of resistance development to that fungicide type. The goal is to identify new mildew control options that will allow rotation of chemistries and avoidance of resistance development while providing adequate levels of control for shoot and fruit infections.

**Method:** Treatments were applied by air blast at 100 gal/acre and 200 psi (to give a fine mist-like spray droplet size) to UltraRed Gala / EMLA 26 (planted 1995 at 16 X 20 ft). Most applications were made at night to minimize spray drift. Applications were made according to phenological development (tight cluster, bloom, petal-fall, and at 10-14 days thereafter until shoot growth stopped). Standard insecticide/ miticide materials were used to control insect and mite pests. Shoots were examined for mildew infection after the final spray application, and fruit infection data were collected after harvest; fruit were classified as infected if any mildew-induced russet was apparent on the fruit surface. Means were separated by Duncan's Multiple Range Test ($p < 0.05$) after statistical analysis.

**Results:** The sterol inhibitor fungicide Nova provided best control of shoot infection (70%; see table) and fruit infection (58%). Control of shoot infection by treatments 2-4 was not as good as Nova provided, but was better than the sprayed control. Treatments 2-4 did provide control of fruit infection that was as good as Nova, however; fruit russet for all four treatments was quite small (usually not noticeable) and thus generally below the level for fruit cullage.

Treatment costs per spray for Nova and Procure are around $19 and $22/acre, respectively; the Omni Supreme spray oil runs about $4.50 per gallon. Thus cost per spray with Nova + Omni oil would be around $23.50 or $116/acre per season for a 5 spray program. Costs of the Sovran and Qwel were not available since they were experimental materials at the time and not available commercially. Cost of the Stylet oil is estimated to be around $6 - 10 per gallon, so cost of each spray would have been around $50 - 80/acre and for the season would have been around $250 - 400/acre. Return on apples in 1999 was very low at around $6/bushel; at 500 bu/acre, this would provide only around $3,000/acre return to the grower from which all other production costs would need to be paid. Thus the grower would need to look at both efficacy and control program cost. The five spray program with Nova. If the new strobilurin Sovran is released with a comparable cost per acre, then a rotational program would provide a cost effective control option. Sulfur sprays continue to be the lowest cost at approximately $15 / acre/ season, but risk of fruit russet and leaf burn are unacceptably high when temperatures exceed 85º F within 24 hours of application.

Crop development during the prebloom to post bloom period was slightly slower and later than anticipated early in the season. Cooler weather in late April to early May prolonged bloom and petal fall beyond normal. Windy conditions during the spring and early summer made control of drift very difficult despite efforts to minimize this by spraying after dark; the high pressure (200 psi), small droplet sized, low volume sprays simply are more prone to drift even with only slight (below 2 - 3 mph) wind drift at night. In my judgment this reduced reliability of control results for the treatments below that which is usual.

| Trt. No. | Materials | Rate (Prod./acre) | % Shoot Infection | | % Fruit Infection at Harvest | |
|---|---|---|---|---|---|---|
| 1 | Nova 40W + Omni Oil | 1.25 oz + 1 qt. | 24.5 | A | 10.5 | A |
| 2 | NaHCO3 + Omni Oil | 1.5 lb. + 1 qt | 46.0 | B | 14.0 | A |
| 3 | Stylet Oil | 2 gal. | 36.5 | B | 12.0 | A |
| 4 | Spray Sequence: (14 da. intervals) | | 39.5 | B | 11.5 | A |
| | a. Nova 40W + Omni Oil | 1.25 oz. + 1 qt. | | | | |
| | b. Sovran 50WG + Omni Oil | 1.6 oz. + 1 qt. | | | | |
| | c. Procure 50WS + Omni Oil | 2.5 oz. + 1 qt. | | | | |
| | d. Qwel 1.5% | 1 gal. | | | | |
| | e. Stylet Oil | 2 gal. | | | | |
| 5 | Sprayed Check: | | 70.3 | C | 22.5 | B |
| | Water + Omni Oil | 1 qt. | | | | |
| 6 | Non-sprayed Check | --- | 81.8 | D | 25.0 | B |

**Acknowledgments:** The OMRC field staff provided assistance with preparation of spray equipment and harvest.

## Two-step Blossom Thinning for Apples and Peaches

**Matt Rogoyski, Horticulturist**

**<u>Summary:</u>** **There is a clear indication of the effectiveness of the two-step thinning method. Thinning of Glohaven peaches achieved 94%, Newhaven 58%, and SunPrince 57% of optimal crop load. Some phytotoxic symptoms were observed on peaches in form of fruit deformities; these were attributed to lack of uniformity of sodium bicarbonate distribution and/thinner on peach fruit. Apples responded to the two-step thinning method as well. Results of spur type Delicious thinning were consistent with the expectations; results of Golden Delicious thinning were variable.**

**<u>Background:</u>** During the 1998 growing season a new blossom thinning method has been developed and tested. This method overcomes a major problem of blossom thinners: either these thinners are not effective, or when their concentration is increased, they become phytotoxic to fruit and/or trees. Blossom thinning has a major impact on cropping consistency, fruit size and quality. There is no single practice that has such far reaching effect on profitability of apple and peach production. Only 10% of flowers are required to set full crop on apples and peaches. The timing of removal of thinning has impact not only on fruit quality but also, especially in case of apples, on return bloom in the subsequent year. The newly developed thinning method maximizes benefits of thinning.

The new method is based on the neutralizing properties of sodium bicarbonate, which is applied when one fifth of flowers are pollinated and fertilized. The second step of this method is application of high concentration of acidic thinner, Wilthin, to remove unprotected flowers. There is a clear indication of the effectiveness of the two-step thinning method. Thinning of peaches: Glohaven, Newhaven, and SunPrince achieved desired crop load. Apples responded to the two-step thinning method as well.

Blossom thinning of apples and peaches is highly recommended. Regardless how the flowers are thinned the goal should be the removal of at least half of flowers. More work is needed on the two-step method blossom thinning. In spite of the success, the two-step thinning method should be considered experimental at present. The new blossom thinning method is a two-step procedure. Application of a buffering/neutralizing agent - aqueous solution of sodium bicarbonate - is the first step. This solution is applied when approximately 20% flowers have been pollinated and fertilized. The second step is application of high concentration of acidic thinner several days later when more flowers open. The mode of action of this two-step method is based on the chemical properties of sodium bicarbonate. The coating of sodium bicarbonate protects treated flowers from phytotoxic properties of acidic thinner by neutralizing the thinner. The unprotected flowers, opened after application of sodium bicarbonate treatment, are removed by acidic thinners. Flowers opened prior to sodium bicarbonate treatment and flowers that were closed during acidic thinner application survive and some may also develop into fruit.

**<u>Method:</u>** During the 1998 bloom season sodium bicarbonate solution was applied after approximately 10% to 30% flowers were pollinated and fertilized. The acidic thinner was then applied when most of remaining flowers opened. The thinner used in these experiments was a commercial formulation of sulfcarbamide (Wilthin, Entek Corporation, Brea, California). This method was tested on three peach varieties: Glohaven, Newhaven, and Sunprince, and two apple varieties: Golden Delicious and spur type Delicious.

**<u>Results:</u>** Very interesting and potentially important observation has been made regarding the 1999 return bloom in Delicious plots treated with Wilthin. It is well known that blossom thinning is highly effective in inducing return bloom in pome fruits. The blossom thinner treated plots had more late blooming flowers, making the Wilthin treated trees more resistant to the frost damage. This observation will be a topic of research effort in future as this observation represent potential to considerably increase cropping reliability of fruit production in western Colorado.

Impact of the two-step thinning method is far-reaching: increase of cropping reliability, decrease in thinning costs, improvement of fruit quality and size, and a potential application to the organic fruit production. Colorado fruit growers will be able to apply blossom thinning with predictable results, without fear of over thinning. In areas of United States such as western Colorado where spring frost is sometimes a problem the late blooming flowers survive frost and become the crop. Traditional blossom thinning methods remove those flowers the two-step blossom thinning method is likely to preserve these commercially important, late blooming flowers.

Table 1 Fruit Crop Load rating expressed as a Beyrs index
(The rating of 100 indicates an optimum crop load)

| Peach Variety | Tree Number | Control | Bicarbonate | Wilthin | Bicarbonate/ Wilthin |
|---|---|---|---|---|---|
| Glohaven | 1 | 200 | 200 | 20 | 80 |
| | 2 | 200 | 200 | 20 | 120 |
| | 3 | 200 | 200 | 30 | 80 |
| | 4 | 200 | 200 | 40 | 100 |
| | 5 | 200 | 150 | 10 | 80 |
| | 6 | 200 | 180 | 30 | 100 |
| | 7 | 200 | 180 | 10 | 60 |
| | 8 | 200 | 160 | 30 | 120 |
| | 9 | 200 | 150 | 20 | 110 |
| | AVE | 200 | 180 | 23 | 94 |
| Newhaven | 1 | 200 | 200 | 10 | 60 |
| | 2 | 200 | 200 | 20 | 70 |
| | 3 | 200 | 200 | 20 | 50 |
| | 4 | 200 | 200 | 30 | 70 |
| | 5 | 200 | 200 | 20 | 50 |
| | 6 | 200 | 200 | 30 | 50 |
| | AVE | 200 | 200 | 21 | 58 |
| Sunprince | 1 | 200 | 150 | 10 | 40 |
| | 2 | 160 | 180 | 10 | 60 |
| | 3 | 160 | 140 | 50 | 60 |
| | 4 | 200 | 200 | 30 | 60 |
| | 5 | 180 | 80 | 30 | 60 |
| | 6 | 200 | 160 | 30 | 60 |
| | AVE | 183 | 152 | 26 | 57 |

Table 2 Percentage of Fruit in Clusters

| Peach Variety | Tree Number | Control | Bicarbonate | Wilthin | Bicarbonate/ Wilthin |
|---|---|---|---|---|---|
| Glohaven | 1 | 95 | 100 | 20 | 10 |
| | 2 | 100 | 95 | 30 | 40 |
| | 3 | 100 | 100 | 10 | 20 |
| | 4 | 95 | 95 | 50 | 30 |
| | 5 | 100 | 80 | 0 | 40 |
| | 6 | 100 | 95 | 30 | 60 |
| | 7 | 100 | 95 | 0 | 70 |
| | 8 | 200 | 80 | 20 | 70 |
| | 9 | 100 | 100 | 40 | 50 |
| | AVE | 110 | 93 | 22 | 43 |
| Newhaven | 1 | 100 | 100 | 0 | 30 |
| | 2 | 100 | 100 | 0 | 20 |
| | 3 | 100 | 100 | 0 | 10 |
| | 4 | 100 | 100 | 10 | 10 |
| | 5 | 100 | 90 | 0 | 30 |
| | 6 | 100 | 100 | 30 | 10 |
| | AVE | 100 | 98.33 | 7 | 18 |
| Sunprince | 1 | 100 | 100 | 0 | 30 |
| | 2 | 100 | 100 | 0 | 10 |
| | 3 | 100 | 60 | 70 | 10 |
| | 4 | 100 | 100 | 0 | 0 |
| | 5 | 100 | 30 | 0 | 20 |
| | 6 | 100 | 100 | 20 | 30 |
| | AVE | 100 | 82 | 15 | 17 |

## 1990 Apple Cultivar-Rootstock Trial (NC-140)

**Alvan G. Gaus, Research Scientist, Extension Specialist - Fruit**

**Summary**: **In 1998, the best combination of cultivar and rootstock for the greatest yield per tree was Smoothee Golden Delicious on Ottawa 3. This is also the combination that gave the greatest cumulative yield over the past 9 years. Based on 9 years worth of data, for Empire, use either M.26 or B.9; for Golden Delicious, use M.26 (M.9 EMLA and B.9 not tested); for Jonagold, M.26 EMLA or M.9 EMLA; for Rome, use M.26 EMLA or B.9. Mark has shown significant soil line trunk swelling and should not be planted in Colorado. The rootstock with the most rootsuckers was Ottawa 3, while M.26 EMLA, M.9 EMLA, and B.9 had the fewest. This suckering combined with virus susceptibility (as reported elsewhere) would lead to the recommendation not to plant Ottawa 3 rootstock.**

**Background:** The best choice of variety and 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 these cultivars and rootstocks would perform over a range of climates.

**Method:** This trial was done in Block 35 at the Rogers Mesa site. The initial trial was to include 4 varieties (Empire, Smoothee Golden Delicious, Nicobel Jonagold, and Rome) on 5 rootstocks (M.9 EMLA, M.26 EMLA, Ottawa 3, Mark and Budagovski 9). However, Golden Delicious on Bud.9 and M.9 EMLA were not available. It was planted in a randomized complete block design with 6 replications. Trees were supported and trained to a combination of slender spindle/central leader training system. Trees were watered by furrow irrigation. This same planting is replicated at 13 other sites across the U.S.

**Results:**

| Cultivar | Rootstock | TCSA 1998 ($in^2$) | Yield/ Tree 1998 (lb.) | Cumulative Yield/Tree (lb.) | Average Fruit Size (oz.) | Average Rootsuckers 1998 (#) |
|---|---|---|---|---|---|---|
| Empire | B.9 | 6.0 b | 55 ab | 91 ab | 6.6 a | 3.0 b |
| | M.9 EMLA | 6.8 b | 78 a | 118 a | 6.6 a | 3.7 b |
| | M.26 EMLA | 12.7 a | 81 a | 115 ab | 7.0 a | 0.0 b |
| | Mark | 3.4 c | 37 b | 79 b | 5.4 b | 7.4 b |
| | 0.3 | 8.2 b | 66 a | 109 ab | 6.6 a | 15.0 a |
| Gold Del. | M.26 EMLA | 14.0 a | 129 a | 243 ab | 8.1 a | 0.2 a |
| | Mark | 4.2 c | 56 a | 137 b | 5.1 b | 3.8 a |
| | O.3 | 9.4 b | 149 a | 309 a | 6.9 a | 4.0 a |
| Jonagold | B.9 | 7.4 bc | 78 ab | 147 ab | 9.7 a | 1.5 a |
| | M.9 EMLA | 9.5 b | 98 a | 165 a | 10.3 a | 0.5 a |
| | M.26 EMLA | 15.7 a | 88 ab | 155 ab | 10.8 a | 0.0 a |
| | Mark | 4.4 c | 36 c | 110 b | 8.2 b | 3.8 a |
| | O.3 | 9.7 b | 72 bc | 170 a | 10.0 a | 3.8 a |
| Rome | B.9 | 4.9 c | 54 b | 220 b | 11.1 bc | 0.5 b |
| | M.9 EMLA | 7.9 b | 86 ab | 277 a | 12.0 a | 0.4 b |
| | M.26 EMLA | 12.2 a | 113 a | 299 a | 11.7 ab | 0.0 b |
| | Mark | 5.3 c | 68 b | 199 b | 10.3 c | 1.5 ab |
| | O.3 | 8.8 b | 106 a | 290 a | 11.2 abc | 3.3 a |

Values within cultivar are significantly different if not followed by the same letter.

Bear in mind that this is a multi-year study. Using only one year's worth of data may lead to false conclusions. One thing that is clear is that Mark is one of the smallest trees in the study. This is mainly due to a runting out of the tree after soil-line swelling of the trunk began. Mark is known to start this soil-line swelling after a water stress event, and Colorado was no exception. Initial interpretation of yield data would indicate that one should choose a rootstock based on total yield. However, extrapolating the data out to yield per acre creates a different set of conclusions and recommendations. Using a semi-dwarf spacing of 605 trees per acre (12' x 6') and a dwarf spacing of 907 trees per acre (12' x 4'), the dwarf trees actually yield more per acre. Jonagold on Ottawa 3 yielded 170 lbs per tree cumulative yield that translates to 2449 bushels per acre. However, Jonagold on M.9 EMLA and Bud.9 yielded 165 and 147 cumulative bushels per tree, respectively. This translates to 3053 and 2720 bushels per acre, respectively. Taking this yield per land area into account, now the recommendations would be for M.9 EMLA and B.9; for Empire, Jonagold and Rome. Remember that Golden Delicious was not tested on the dwarf rootstocks.

**Acknowledgments:** Colorado Apple Administrative Committee funding that supported data collection and analysis. George Osborn, Bryan Braddy, Diane Cridler, and Juanita Ensley for data collection help.

# 1993 Cornell Geneva Rootstock Trial (NC-140)

**Alvan G. Gaus, Research Scientist, Extension Specialist - Fruit**

**Summary:** **In 1998, the greatest cumulative yield over the life of the planting occurred with CG.13, CG.30 and M.7 EMLA. The CG.202 rootstock had the least cumulative yield. All of the CG rootstocks in this trial had significantly smaller trees based on truck cross-sectional area than the standard semi-dwarf M.7 EMLA. Each rootstock had some suckers, but the numbers per tree were similar for all the rootstocks. Based on the data to date, the recommendation would be for trial plantings of either CG.13 or CG.30**.

**Background:** The best choice of rootstock could make the difference between an economically viable orchard and one that loses money for the orchardist, especially those orchards prone to fire blight. Fire blight in the rootstock has the potential to kill the whole tree. 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 some of the CG rootstocks that were breed for fire blight resistance would perform over a range of climates.

**Method:** This trial was done in Block 13 at the Rogers Mesa site. The trial consisted of 5 rootstock clones from the Cornell/Geneva apple rootstock-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. Trees were watered by micro sprinkler irrigation. Similar plantings are replicated at other sites across the U.S.

**Results:**

| Root-stock | Yield Per tree 1998 (lb) | TCSA 1998 ($in^2$) | Average Fruit Weight (oz) | Yield Eff. 1998 ($lb/in^2$) | Average Root-sucker (#/tree) | Cum. Yld. (lb) | Cum. Yld. Eff. ($lb/in^2$) |
|---|---|---|---|---|---|---|---|
| M.7 EMLA | 69 ab | 6.9 a | 7.4 a | 10.4 c | 8 a | 82 a | 12.4 b |
| CG.13 | 70 ab | 4.1 bc | 7.1 abc | 17.6 a | 9 a | 88 a | 22.1 a |
| CG.30 | 74 a | 4.2 bc | 7.2 ab | 18.3 a | 15 a | 88 a | 21.7 a |
| CG.202 | 38 c | 2.3 d | 6.4 c | 17.1 ab | 6 a | 49 b | 21.5 a |
| CG.210 | 59 abc | 4.7 b | 7.1 abc | 12.4 bc | 12 a | 80 ab | 16.7 ab |
| CG.222 | 46 bc | 2.8 cd | 6.5 bc | 16.2 ab | 17 a | 58 ab | 20.4 a |

Values are significantly different if not followed by the same letter.

Bear in mind that this is year 5 of a 10-year study. Using only one year's worth of data may lead to false conclusions. One thing that is clear is that all of the CG clones in this trial are smaller than M.7 EMLA. CG.202 appears to be the least productive tree and should not be considered for use in Colorado. All of these rootstocks produce suckers similar to M.7 EMLA.

**Acknowledgments:** Colorado Apple Administrative Committee funding that supported data collection and analysis. George Osborn, Bryan Braddy, Diane Cridler, and Juanita Ensley for data collection help.

## 1994 Apple Dwarf Rootstock Trial (NC-140)

**Alvan G. Gaus, Research Scientist, Extension Specialist - Fruit**

**Summary:** **This is the end of the 5th year of the planting. The trees are not growing vigorously in this replant site. Terminal growth is not excessive and leaf size is small. To date, M.9 RN 29 has produced the greatest cumulative yield (2 years ). M.26 EMLA has the largest trunk cross-sectional area; however, several rootstocks are very similar in size. These include V.1, Pajam 2, B.9, and M.9 RN29. It is too early in this planting to draw conclusions. No recommendations should be made at this time.**

**Background:** The best choice of 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.

**Method:** 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 micro sprinkler irrigation. Similar plantings are replicated at 21 other sites across the U.S.

**Results:**

| Rootstock Name | TCSA 1998 ($in^2$) | Rootsucker 1998 (#) | Yield/tree 1998 (lb) | Cumulative Yield ($lb^2$) | Average Fruit wt (oz) |
|---|---|---|---|---|---|
| M.9 EMLA | 1.7 cdef | 0.6 b | 10.8 abc | 14.2 abcd | 5.6 a |
| M.26 EMLA | 2.3 a | 0.8 b | 9.5 bcd | 13.6 bcd | 5.2 a |
| M.27 EMLA | 0.8 h | 1.7 ab | 4.6 cd | 6.1 cd | 5.0 bc |
| M.9 RN29 | 2.1 abc | 4.2 ab | 16.5 ab | 23.6 a | 5.6 a |
| PAJAM 1 | 1.7 cdef | 2.3 ab | 4.6 cd | 6.2 cd | 5.6 a |
| PAJAM 2 | 2.1 abc | 3.6 ab | 16.1 ab | 22.7 ab | 5.4 ab |
| B.9 | 2.0 abcd | 1.2 b | 11.2 abc | 15.7 abc | 5.3 ab |
| B.491 | 0.9 h | 3.1 ab | 7.3 cd | 9.1 cd | 4.6 abc |
| O.3 | 1.6 def | 3.4 ab | 10.2 abcd | 15.1 abcd | 4.6 abc |
| V.1 | 2.2 ab | 1.5 ab | 10.0 abcd | 11.1 cd | 5.4 ab |
| P.2 | 1.5 ef | 0.2 b | 9.1 cd | 13.7 abcd | 5.3 abc |
| P.16 | 1.1 gh | 5.6 a | 6.2 cd | 8.2 cd | 5.5 a |
| MARK | 1.9 bcde | 4.4 ab | 8.0 cd | 9.7 cd | 4.1 c |
| P.22 | 0.7 h | 1.7 ab | 3.3 d | 5.1 d | 4.2 bc |
| B.469 | 1.7 cdef | 1.6 ab | 6.6 cd | 11.8 cd | 4.6 abc |
| NAKBT 337 | 1.4 fg | 3.3 ab | 7.4 cd | 10.3 cd | 5.4 ab |

Values within column are significantly different if not followed by the same letter.

Making recommendations after only 5 years worth of data is not wise. The rootstock Mark was highly promoted after the preliminary 5-year report. Mark 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 are M.26 EMLA and the smallest trees are on M.27 EMLA and P.22. The most suckering is on P.16, but differences between rootstocks are small at this time. Greatest cumulative yield occurred on M.9 RN 29, Pajam 2, B.9 and O.3. The least yield occurred with P.22, but it was not significantly different than 12 other rootstocks.

**Acknowledgments:** Colorado Apple Administrative Committee funding that supported data collection and analysis. George Osborn, Bryan Braddy, Diane Cridler, and Juanita Ensley for data collection help.

# Yellow Peach Tree Syndrome

**Harold Larsen, Plant Pathologist**

**Summary:** **Applications of foliar micro nutrient sprays to highly chlorotic peach trees appeared to provide alleviation of leaf chlorosis in 1997, but failed to do so in 1998. Symptom alleviation in 1997 and return in 1998 is suggested to have been more likely the response to the unusually wet season in 1997 and return to more normal, dry conditions in 1998 rather than a response to foliar micro nutrient spray applications.**

**Background:** Peach trees with severely yellowed shoot growth produce smaller, less sweet fruit that has reduced marketability. Numbers of affected trees vary with the season and with the weather patterns B yellow tree numbers increase in hot, dry years and decrease in wet, cool years. The symptoms are consistent with iron and zinc deficiency and do respond to soil application of iron chelate in the sequestrene 138 form and sometimes to foliar or dormant zinc sprays. The goal was to see if foliar applications of micro nutrient sprays could alleviate symptoms and how long symptoms would take to return.

**Method:** Foliar sprays of different chelated mineral fertilizers were applied to drip in mid- and late July to 9-yr-old Newhaven peach trees with severe chlorosis symptoms. Treatments included: Ferriplus iron chelate and Rap-id-Gro fertilizers (each at 1 tablespoon /gal spray) and four Metalosate solutions (multi mineral, iron, manganese, and Zinc Plus, each at 3.2 fl. oz./gal spray). All six treatments had 3 ml of B-1956 spreader added per gal. spray. Trees were evaluated in late June 1998.

New treatments were set up in early July 1998 which included foliar sprays of RapidGro, Ferriplus iron chelate, and multi mineral Metalosate at the same rates as above and soil application of Nphuric acid diluted to 6.25% of stock solution and applied at 1 gal./tree). Trees were evaluated for response in late July and again in September.

**Results:** Initial responses to the sprays applied in 1997 were dramatic, and all trees exhibited almost no symptoms of chlorosis by September 1997. These trees leafed out nicely in spring of 1998 with no chlorosis, but symptoms began to appear by late May and early June. Severe chlorosis symptoms had returned by June 1998. Observations made in late July and in late September on trees used in the 1998 applications found no response to any treatments.

The lack of response to treatments in 1998 in contrast to the rapid response observed in 1997 is puzzling. It is worth noting that the 1997 was an extremely wet spring and summer season while 1998 was quite hot and dry. One explanation for the difference in response might well be that the wet 1997 season simply diluted soil salts and dropped soil pH levels to points that allowed the trees to access the iron, zinc, and manganese the needed. The return to hot, dry weather patterns the following year (1998) would have been reflected in greater irrigation and evapotranspiration demand for water by the trees; this could easily have resulted in return of salt and pH to damaging levels for the trees.

**Acknowledgments:** Nathan Orient helped with plot setup and spray applications in 1997 and again in 1998.

## Cytospora Canker Control Study

**Harold Larsen, Plant Pathologist**

**Summary:** **No alleviation of Cytospora canker incidence or severity was provided by three years of applications of sterol inhibitor (DMI) fungicides Nova and Procure for control of peach rusty spot (apple powdery mildew). No consistent reduction or alleviation was observed for two years application of Benlate nor for one year application of Elite.**

**Background:** Cytospora canker is a severe problem for peach producers in Colorado. It leads to removal of infected branches, limbs, scaffolds, entire trees, and eventually entire peach blocks. Growers have reported reduction in severity and incidence in peach blocks sprayed with the sterol inhibitor (DMI) fungicide Nova for control of peach rusty spot (apple powdery mildew on peach fruit) over the 5 years since that material was registered for use on that crop. Five-year studies were established at OMRC to verify whether such reduction in incidence and severity can be linked to use of fungicides used for peach rusty spot (mildew) control; 1998 represented the 3rd year in these studies for Nova and Procure, the 2nd year for the fungicide Benlate, and the first year for the DMI fungicide Elite.

**Method:** Studies were established in four peach blocks at OMRC (Red Globe, Red Haven, Brenda Sun, and the Nectarine/White Peach variety block). Two adjacent rows in each block were set up for comparison of Nova (at 3.75 oz./acre), Procure (at 12 oz./acre), and a water control. In one blocks (where enough rows allowed) a Benlate (at 1.5 lb gal/acre) was added, and an Elite (at 6 oz/acre) treatment was added in another block during 1998. Evaluations were made after leaf fall in early winter.

**Results:** No consistent differences were observed in canker incidence and severity during the first three years of the study. Although incidence and severity of canker was lower than that in the control in two blocks for trees sprayed with Nova, the reverse was true in a third block. Thus no conclusions could be drawn from the results.

**Acknowledgment:** The OMRC field staff assisted with all spray applications.

# 1994 Peach Rootstock Trial (NC-140)

**Alvan G. Gaus*, Research Scientist and Extension Specialist – Fruit**
**Harold Larsen. Extension Specialist – Fruit Pathology**

**Summary:** **This is the end of the 5th year of the planting. The trees are very similar in all growth aspects. It is too early in this planting to draw conclusions. No recommendations should be made at this time.**

**Background:** The best choice of 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 these relatively new peach rootstocks would perform over a range of climates.

**Method:** This trial was done in Block 8B at the Orchard Mesa site. The trial consisted of 17 peach rootstock clones and seedlings. The scion variety chosen was Redhaven. It was planted in a randomized complete block design with 10 replications. Trees were trained to an open-vase system. Trees were watered by furrow irrigation. Similar plantings are replicated at 17 other sites across the U.S.

**Results:**

| Rootstock | No. still alive | Yield 1998 (lb) | TCSA 1998 ($in^2$) | Average Fruit Wt (oz) | Average Rootsuckers (#/tree) |
|---|---|---|---|---|---|
| Lovell | 2 | 25.6 c | 11.9 b | 5.0 b | 0.4 |
| Bailey | 8 | 28.4 abc | 10.1 b | 5.6 ab | 0.0 |
| Tenn. Natural | 6 | 35.9 abc | 10.8 b | 5.5 ab | 0.0 |
| GF 305 | 6 | 32.0 abc | 10.9 b | 5.3 ab | 0.3 |
| Higama | 7 | 28.2 bc | 11.1 b | 5.6 ab | 0.2 |
| Montclar | 8 | 38.1 abc | 11.6 b | 5.8 ab | 0.1 |
| Rubira | 7 | 44.8 abc | 8.6 b | 6.1 a | 0.4 |
| Ishtara | 5 | 54.9 ab | 8.4 b | 6.1 a | 0.0 |
| Myran | 1 | 52.2 abc | 15.6 a | 6.0 ab | 0.0 |
| S 2729 | 7 | 38.4 abc | 12.1 ab | 5.9 ab | 0.0 |
| Chui Lum Tao | 4 | 30.2 abc | 8.8 b | 6.1 a | 0.0 |
| Tzim Pee Tao | 4 | 30.0 abc | 11.6 b | 5.9 ab | 0.0 |
| H 7338013 | 7 | 29.3 abc | 12.2 ab | 5.9 ab | 0.5 |
| H 7338019 | 4 | 56.0 a | 12.0 b | 5.9 ab | 0.0 |
| BY 520-8 | 6 | 42.5 abc | 12.6 ab | 5.5 ab | 0.3 |
| BY 520-9 | 8 | 47.8 abc | 12.8 ab | 6.2 a | 0.1 |
| Ta Tao 5 | 6 | 36.6 abc | 11.4 b | 5.4 ab | 0.0 |

Values within columns are significantly different if not followed by the same letter.

Making recommendations after only 5 years worth of data is not wise. After 5 years, the rootstocks seem to be very similar in yield, growth, and root sucker. Most of the apparent death (No. still alive) is due to lack of trees from the beginning of the experiment. The Lovell rootstock apparently had some problems at the supplying nursery and most died the first year.

**Acknowledgments:** Colorado Agricultural Experiment Station funds supported data collection and analysis. George Osborn and Bryan Braddy for data collection help.

## 1998 Sweet Cherry Rootstock Trial (NC-140)

**Alvan G. Gaus, Research Scientist, Extension Specialist – Fruit**

**Summary:** **This was the first year of this planting. It is too early in this planting to draw conclusions. No recommendations should be made at this time.**

**Background:** The best choice of sweet cherry 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 sweet cherry rootstocks varying in size from full-size to dwarf rootstocks would perform over a range of climates.

**Method:** This trial was done in Block 31 at the Rogers Mesa site. The trial consisted of 13 sweet cherry rootstock clones and seedlings. The scion variety chosen was Bing. It was planted in a randomized complete block design with 7 replications. Trees were trained to a central leader system. Trees were watered by furrow irrigation. Similar plantings are replicated at several other sites across the U.S.

**Results:**

| Rootstock | Average Trunk Diameter 1998 (in) |
|---|---|
| Edabriz | 0.6 f |
| G.6 | 1.1 ab |
| G.5 | 0.9 bcd |
| G.7 | 1.2 a |
| 195/20 | 0.9 bcd |
| 209/1 | 1.0 abc |
| Mazzard | 0.9 cde |
| Mahaleb | 0.9 cde |
| W.10 | 0.9 cde |
| W.13 | 0.8 def |
| W.53 | 0.7 ef |
| W.72 | 0.7 f |
| W.158 | 0.7 f |

Values within columns are significantly different if not followed by the same letter.

Initial tree size was quite variable. Some diameters were very small (1/4 inch), others were large (1 inch). One death occurred, but this was due to poor tree condition at planting with no buds on trunk.

**Acknowledgments:** Colorado Agricultural Experiment Station funds supported tree purchase, planting and data collection and analysis.

## Insect Monitoring

**Rick Zimmerman, Entomologist**

**<u>Summary:</u>** **Several exotic and established pests of tree fruit, sweet corn and ornamental crops are monitored on a regular basis in Delta, Mesa and Montrose counties. These include European corn borer in sweet corn, Japanese beetles on ornamental nursery stock and turf, and apple tufted bud moth, apple ermine moth, cherry bark tortrix, summer fruit tortrix and western cherry fruit fly in tree fruit. The only insect that has ben recovered in traps is the western cherry fruit fly, which is established only in certain areas around Grand Junction.**

**<u>Background:</u>** The European corn borer is one of the most destructive pests of corn in North America. 1998 was the sixth year that Colorado State University has supervised a monitoring program for the European corn borer in commercial sweet corn fields in Delta, Mesa and Montrose Counties. The larvae attack the corn stalk which leads to reduced yields and a mechanical weakening of the plant. Trap data is sent to the Arizona and California Departments of Agriculture which allows western Colorado growers participating in the trapping program to ship non-fumigated sweet corn to both states. Sweet corn grown in western Colorado is nationally recognized for its high quality. This quality in part is due to the fact that growers can quickly cool their sweet corn by avoiding the high temperatures required for fumigation with methyl bromide.

Other insect pests are not yet established in western Colorado, although Colorado fruit growing districts are within their geographical range of these insect pests. It is important to determine if local populations of these insects have become established. Japanese beetles are serious pests of ornamentals and turf. They have been found to enter the state via ball and burlap ornamental trees and a monitoring program is conducted in western Colorado.

**<u>Method:</u>** In 1998, approximately 2641 acres of sweet corn were monitored on a weekly basis for European corn borer, from June through the first part of September. This was done with over 321 delta style pheromone traps in Mesa, Delta and Montrose counties.

The following exotic insect pests are monitored in Delta County: Apple Tufted Bud Moth, Apple Ermine Moth, Cherry Bark Tortix and Summer Fruit Tortrix.. In addition, traps for Japanese beetles are monitored in Delta County.

In 1998, 42 traps were monitored for western cherry fruit fly on a weekly basis (June through September) in 9 different organic sweet cherry orchards located in Paonia and Hotchkiss.

**<u>Results:</u>** In six years of trapping, the program has not trapped a single European corn borer. None of the exotic tree fruit pests were detected. Western cherry fruit fly has established itself in certain areas around Grand Junction. Total trap catches for 1998 was 40 flies, which was up from the 22 trapped in 40 traps in 1997 Western cherry fruit fly has never been trapped on Rogers Mesa, which is west of Hotchkiss.

## Area Wide-Suppression of Codling Moth Through The Release Of The Parasitic Hymenopteran *Mastrus ridibundus*

**Rick Zimmerman, Entomologist**

**Summary:** **In June of 1999, approximately 4000 adult wasps were equally distributed in an organic apple orchard on Rogers Mesa (west of Hotchkiss) and on Powell Mesa (north of Paonia). As of this writing (October 1999) parasitization rates have yet to be established. Levels of parasitization will be known by December 1999.**

**Background:** Codling moth, *Cydia pomonella*, is the most damaging pest of apples in Western Colorado. Orchards can sustain upwards of 75- 100% infestation if control tactics are not employed. The apple industry is facing many issues that are impacting the methods by which apple pests are managed. A very important prospect looming in the near future is the loss of key organophosphate and carbamate insecticides due to the Food Quality Protection Act. If growers lose key insecticides, codling moth control will become a multi-tactic approach; relying on environmentally-friendly chemical (i.e. insect growth regulators, viruses), cultural, behavioral (pheromones) and biological control techniques. Many apple growers have already integrated mating disruption as a part of their control plan for codling moth

Mating disruption is a proven alternative control measure. Codling moth populations must be low in order for mating disruption to be successful. Major contributions to increased codling moth populations are backyard trees and abandoned orchards. As more people move onto traditional orchard ground, there will be an increase in the number of non-treated apple trees. These trees then serve as a source of codling moth infestations, which diminishes the effectiveness of mating disruption in nearby commercial orchards. Persuading people to treat or remove trees can be a fairly long process, costing growers time and money.

Biological control of codling moth with exotic parasites may prove to lower area-wide populations of codling moth. There are no parasites of the codling moth, which are native to the United States. Researchers have traveled to the republic of Kazakhstan in Central Asia to collect wasps found parasitizing codling moth. One species of wasp, *Mastrus ridibundus*, has the most potential to significantly impact codling moth populations. *M. ridibundus* is a small parasitic wasp that attacks the prepupal stage of the codling moth. *M. ridibundus* populations can expand quite rapidly, as 4-7 individual wasps can develop on a single host larvae. *M. ridibundus* searching behavior allows it to reach preferred codling moth overwintering sites such as cracks and crevices in the bark of the tree. In its native Kazakhstan, researchers have found upwards of 60% parasitization of overwintering codling moth larvae. *M. ridibundus* was first released on the west coast of the U.S. in 1995. In one particular orchard in California, releases were conducted in 1995 and 1996. In 1997 parasites were not released, yet a fall survey found over 40% parasitization of codling moth larvae The same levels of parasitization have been seen to occur in release sites in Washington state (pers. comm., Tom Unruh, USDA, Wapato, Wash.). In the fall of 1997, approximately 500 *M. ridibundus* individuals were released in an orchard just outside of Hotchkiss.

**Method:** Corrugated cardboard bands were placed in the trees prior to release and were collected in mid-December for evaluation. (Corrugated cardboard bands trap codling moth larvae as they move down the tree in search of sites to pupate).

**Results:** Several codling moth were found parasitized with *M. ridibundus* in late December of 1997. Bands were also left in the orchard to determine survivability of the wasp through the winter. Foraging birds decimated bands left on the trees through the winter of 1997-1998. Survivability through the Colorado winter has yet to be established.

There is a high probability that *M. ridibundus* will have a significant impact on regional codling moth populations in western Colorado. The following known factors will contribute to the success of *M. ridibundus* in Colorado: 1) the area of Kazakhstan where *M. ridibundus* was collected is very similar in climate and topography to western Colorado fruit growing areas, 2) successful parasitization of codling moth has been established in western Colorado and 3) observed biology and behavior of *M. ridibundus*.

## The Evaluation of Mechanical Pheromone Evaporators, "puffers", as a Method for Dispensing Pheromones for Disruption of Codling Moth

**Rick Zimmerman, Entomologist**

**Summary:** **The 1997 and 1998 trials show the puffers have considerable promise. Less than 1% of the apples were damaged through the first generation of codling moth. However, a control breakdown in an adjacent block of apples resulted 5% or more damage in the trees closest to this block. At the end of the growing season, the block was evaluated for codling moth damage. At total of 8115 apples were evaluated from 138 trees. Overall codling moth infested 7.49% (608) of the apples. An edge effect was once again observed: overall infestation rate was 3.61% in the western half of the block and 8.7% in the eastern half of the block.**

**Background:** Mating disruption for the control of codling moth is used successfully on more than 50% of the apple producing acres in western Colorado. Current technology requires the placement of individual ties in trees (250-400 per acre) to maintain the presence of pheromone throughout the orchard. An obstacle to the use of pheromone ties is the cost of labor for application. Over the last two years a mechanical device (called a puffer) which operates on a 24 hour timer to release bursts of codling moth pheromone from aerosol cans has been evaluated in blocks of apples.

**Methods:** In 1997, puffers were evaluated on a 10 acre block in both Cedaredge and Hotchkiss. In each block the puffers were place equidistantly around the perimeters to the equivalent of 4 puffers per acre. The puffers were place in the upper one-third of the tree canopies. Each puffer held one aerosol can containing 17.25 grams of codlemone (codling moth sex pheromone). Each puffer emitted a blast of pheromone every 25 minutes (57 times/day) (216 milligrams of pheromone per day per acre). Two important observations resulted from this first year of work: a) there is a significant reduction in placement time over Isomate-C pheromone ties, b) an edge effect was created- the eastern edges of both blocks resulted in high percentage of codling moth infested apples [4.6% at Hotchkiss and 15.5% at Cedaredge] while the western edge resulted in infestation rates of [ 1.2% at Hotchkiss and 2.5% at Cedaredge], and c) pheromone trap shutdown can be seen several thousand feet downwind from the puffers.

The puffers were again evaluated in 1998 at the Rogers Mesa Research Station. On May 19, 1998, 12 puffers were place on the perimeter of a 5 acre block of high density apples. The puffers were spaced every 60 feet (4 puffers ) on the east and west edge of the block (the wind moves in a east to west pattern in the am and a west to east pattern in the PM). Two puffers were placed on the south and north edge of the block . In addition the 3 puffers were equally spaced through the middle of the block (north- south orientation) in the center of the block to increase pheromone concentration within the orchard. The timers were set to release pheromone every 20 minutes for the entire growing season. Each puffer released 7.5 mg of codling moth pheromone per burst. This is the equivalent of 540 mg/puffer/day. In total there was approximately 168 grams of codlemone released per acre for the growing season (puffers were removed on September 1).

**Results:** Although a control was not used the overall infestation rate was considerably lower than an nearby non-treated group of Jonathons (100 feet from the puffer block, Jonathons had over 50% infested apples). Commercial acceptance in Colorado will probably not occur unless it shown to work on larger acreages. The puffers have many advantages: 1) reduction in labor costs for pheromone application, 2) timed releases [for example, the pheromone need only to be released during time the insect is active), 3) and 4) pheromones would be protected from UV light preventing degradation of the pheromone molecule. As of this writing, Paramount Farms of California is selling a computer controlled puffer. This has yet to be evaluated in Colorado.

## Control of Codling Moth, *Cydia pomonella*- Rogers Mesa Research Center

**Rick Zimmerman, Entomologist**

**Summary:** **The standard program of Guthion 50WP treatments every 21-days was significantly lower (8% infested fruit) than the control (no treatment) (50% infested fruit) , Guthion 50WP & Confirm 2F treatments (46% infested fruit) and 5 Confirm 2F treatments (51.6% infested fruit). Codling moth pressure was considered high with moth catches totaling 111 (May), 38 (June), 154 (July), 59 (August) and 4 (September). A total of 362 moths were trapped in 1998 compared with 606 moths in 1997. An orchard is considered to have high populations of codling moth if the trap catch exceeds 8-9 moths per generation.**

**Method:** This trial was conducted at the Rogers Mesa Research Center. The trial was conducted in a block (1.5 acre) of standard sized Jonathon apple trees (20 ft x 20 ft spacing). Each treatment consisted of 16 trees (4 x 4). The following treatments were applied:
Treatment A: Guthion 50WP (1lb/100 gal water) (196 [5/28] and 533 [6/23] degree days from biofix (50% a. i., azinphosmethyl, Bayer Corp.), followed by two applications of Confirm 2F (0.28 lb/ acre) (1193 [7/28] and 1503 [8/4] degree days from biofix). Treatment B: Four applications of Confirm 2F (0.28 lb/ acre) (applications made at 196 [5/28], 370 [6/11, 548 [6/24], [first generation], 1193 [7/21] and 1503 8/4] degree days [second generation]). Treatment C: Guthion 50WP (1lb/100 gal water) (50% a. i., azinphosmethyl) ( applications were made at 294 [6/3], 533 [6/23], 1270 [7/24] and 1795 [8/17] degree days). Treatment D: Control (water). Latron B-1956 (12 oz/acre) (Rohm & Haas Corp.) was added to all Confirm 2F treatments. Guthion 50WP applications were made approximately every 21 days after biofix (biofix= date of first consistent trap catch of codling moth). The apples were evaluated for codling moth infestation on August 7.

**Results:**

**Table 1:** Efficacy of Confirm 2F and Guthion 50WP (azinphosmethyl) on codling moth, *Cydia pomonella*, in standard Jonathon apples in western Colorado.

| TREATMENT | # trees[a] | total # | % CODLING |
|---|---|---|---|
| Guthion 50WP (1lb/100 gal water) (196 DD & 533 DD) + | 5 | 250 | 46a |
| Guthion 50WP (1lb/100 gal | 5 | 250 | 8b |

[a]5 trees were randomly selected from each treatment. 50 apples were randomly selected from each and evaluated for codling moth infestation. All treatments applied at 300 gallons/acre.
[b]Lower case letters in the same column, if different, denote significant differences ($P \leq 0.05$)

## Control of Codling Moth, *Cydia pomonella* – Orchard Mesa Research Center (Study 1)

**Rick Zimmerman, Entomologist**

**Summary:** **The Guthion 50WP + Imidan 70W treatments resulted in a significantly lower level of infestation (5.4%) than the control, Confirm 2F, and Guthion 50WP + Confirm 2F treatments. These results are similar to the trial conducted in 1997. There were no significant differences between the control, Confirm 2F treatments, and the combination of Guthion 50WP and Confirm 2F treatments. Codling moth pressure was high. A total of 179 moths were captured in a single pheromone trap during the growing season.**

**Method:** This trial was conducted at the Orchard Mesa Research Center. The trial was conducted in a block (1.0 acre) of semi-dwarf Granny Smith apple trees. Each treatment consisted of 20 trees (4 x 5). The following treatments were applied:

Treatment A: Guthion 50WP (1lb/100 gal water) (215 [5/15] and 645 [6/10] degree days from biofix (50% a. i., azinphosmethyl, Bayer Corp.), followed by three applications of Confirm 2F (0.28 lb/ acre) (1099 [7/2], 1488 [7/16] and 1971 [8/3] degree days from biofix)

Treatment B: Five applications of Confirm 2F (0.28 lb/ acre) (applications made at 215[5/15], 499 [6/1], 1099 [7/2], 1488 [7/16] and 1971 [8/3] degree days)

Treatment C: Guthion 50WP (1lb/100 gal water) (50% a. i., azinphosmethyl) ( applications made at 215 [5/15], 645 [6/10], 1089 [7/1] and 1616 [7/20], degree days) followed by three applications of Imidan 70W (70% a.i., phosmet, Gowan Co.) (applications at 2074 [8/7], 2432 [8/20] and 2636 [9/8] degree days.)

Treatment D: Control (water).

Latron B-1956 (12 oz/acre) (Rohm & Haas Corp.) was used in conjunction with the Confirm 2F. Guthion 50WP applications were made approximately every 20- 26 days, starting 215 degree days after biofix (biofix= date of first consistent trap catch of codling moth). All treatments were applied at the equivalent of 300 gallons of water per acre. The apples were evaluated for codling moth infestation on October 14.

## Results:

**Table 1:** Efficacy of Confirm 2F and Guthion 50WP (azinphosmethyl) on codling moth, *Cydia pomonella*, in semi-dwarf Granny Smith apples in western Colorado.

| TREATMENT | # trees[a] | total #[b] | % CODLING MOTH |
|---|---|---|---|
| Guthion 50WP (1lb/100 gal | 6 | 712 | 43.7b |
| Guthion 50WP (1lb/100 gal | 6 | 621 | 5.4c |

[a,b] trees were randomly selected from each treatment. All the apples from each selected tree were harvested and evaluated for codling moth infestation.
[c] Lower case letters in the same column, if different, denote significant differences ($P \leq 0.05$)

## Control of Codling Moth, *Cydia pomonella* – Orchard Mesa Research Center (Study 2)

**Rick Zimmerman, Entomologist**

**Summary:** **The level of infestation in the Confirm 2F treatment (60%) was significantly higher than the Guthion 50WP treatments (0%) and the pears treated with two Guthion 50WP treatments followed by three Confirm 2F treatments (36.6%). The infestation in the control trees (65.5%) was slightly higher than found in the trees treated with five applications of Confirm 2F. A total of 532 codling moths were trapped during the growing season in this block.**

**Method:** This trial was conducted at the Orchard Mesa Research Center, County) in western Colorado. The trial was conducted in a 2.5 acre block of standard Bartlett pear trees. The following treatments were applied:

Treatment A: Guthion 50WP (1lb/100 gal water) (215 [5/15] and 645 [6/10] degree days from biofix (50% a. i., azinphosmethyl, Bayer Corp.) followed by three applications of Confirm 2F (0.28 lb/ acre) (1099 [7/2], 1488 [7/16] and 1971 [8/3] degree days from biofix)

Treatment B: Five applications of Confirm 2F (0.28 lb/ acre) (applications made at 215[5/15], 499 [6/1], 1099 [7/2], 1488 [7/16] and 1971 [8/3] degree days)

Treatment C: Guthion 50WP (1lb/100 gal water) (50% a. i., azinphosmethyl) ( applications made at 215[5/15], 645 [6/10], 1089 [7/1] and 1650 [7/21], degree days) followed by a single application of Imidan 70W (70% a.i., phosmet, (Gowan Co.) at 2074 [8/7 degree days.

Treatment D: A control (water) was included.

Guthion 50WP applications were made approximately every 21 days, 250 degree days after biofix (biofix= date of first consistent trap catch of codling moth). All treatments were applied at the equivalent of 300 gallons of water per acre. The pears were evaluated for codling moth infestation August 19.

**Results:**

**Table 1:** Efficacy of Confirm 2F and Guthion (azinphosmethyl) on codling moth, *Cydia pomonella*, in standard Bartlett pears in western Colorado.

| TREATMENT | # trees[a] | total # | % CODLING MOTH |
|---|---|---|---|
| Guthion 50WP (1lb/100 gal | 7 | 350 | 36.6b |
| Guthion 50WP (1lb/100 gal | 7 | 301 | 0.0c |

[a] trees were randomly selected from each treatment.
[b]Lower case letters in the same column, if different, denote significant differences (P$\leq$0.05)

# Control of Woolly Apple Aphid, Eriosoma lanigerum (Hausman)

**Rick Zimmerman, Entomologist**

**Summary:** **A pre-count was not conducted, due to the destructive sampling needed to evaluate the efficacy of the treatments. There was 95-100 % mortality among the foliar treated colonies for the higher Aphistar and Lorsban 50WP treatments. An earlier application of two Aphistar rates (0.125 lb and 0. 25 lb a.i./ acre) and Lorsban 50WP (0.75lb/100 gal) was applied on September 24 (evaluated on September 29) without the addition of superior oil. This resulted in mortality only on the fringe of the aphid colonies for both Aphistar rates and the Lorsban 50WP rate. The first trial (without the addition of oil) demonstrates the importance of the oil in allowing the insecticide to penetrate the cottony mass covering the colony.**

**Method:** This trial was conducted at the Rogers Mesa Research Center. The trial was conducted within a block of semi-dwarf red delicious apple trees (14ft x 18ft spacing). The following treatments were applied: 1) RH-7988 50W (0.125 lb a.i./ acre + 1qt superior oil/acre)[FOLIAR APPLICATION], 2) RH-7988 50W (0. 25 lb a.i./ acre + 1qt superior oil/acre), [FOLIAR APPLICATION], 3) Lorsban 50WP (0.75 lb/100 gal ) [FOLIAR APPLICATION]. A control (water) was also included. Woolly apple aphids were not of sufficient population until late September. These treatments were applied to individual woolly apple aphid colonies on October 1. Application was made until run-off. All were applied at the equivalent of 300 gallons per acre.

The treatments were evaluated 5 days after treatment, October 6. Efficacy was determined by pruning woolly aphid colonies from the treated trees. The colonies were then brought into the laboratory and evaluated (number extant) with the aid of a dissecting scope.

**Results:**

**Table 1:** Foliar applications of RH-7988 50W and Lorsban 50W in apple trees for the control of woolly apple aphids, Eriosoma lanigerum (Huasman) in western Colorado.

| Colony | RH-7988 50W[ab] (0.125 lb ai/acre) | RH-7988 50W[ab] (0.25 lb ai/acre) | Lorsban 50WP[b] (0.75lb ai/acre) | Control |
|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 86 |
| 2 | 33/59 | 0 | 0 | 37 |
| 3 | 29/73 | 0 | 2 | 102 |
| 4 | No mortality | 0 | 19 | 51 |
| 5 | 0 | 0 | 0 | 67 |
| 6 | No mortality | 0 | 1 | 49 |
| 7 | No mortality | 0 | 0 | 115 |
| 8 | No mortality | 0 | 0 | 93 |

[a] Applied with the equivalent of 1qt superior oil per acre. Efficacy evaluated 5 days after treatment.
[b] Number of living woolly apple aphids per colony.

## Control of Rosy apple aphids, *Dysaphis plantaginea* Passerini

**Rick Zimmerman, Entomologist**

**Summary:** **There were no significant differences in mortality among all four treatments: Agrimek 0.15 EC (2.5 oz and 5.0 oz /100 gal water) and Pyramite (0.165 lb and 0.250 lb/ acre). All four treatments inflicted significant mortality among the rosy apple aphid populations. Rosy apple aphid feeding causes small, deformed fruit and leaf curling. If populations are not treated early, control becomes difficult because the curled leaves protect the aphids. Over the last five years I have observed increasing numbers of rosy apple aphids.**

**Method:** This trial was conducted in a commercial fruit orchard located on Rogers Mesa. The trial was conducted in a 20 acre block of standard Golden Delicious apple trees. The following treatments were applied: Agrimek 0.15EC (2.5 oz/ 100 gal water)(Lot # CDX-701), Agrimek 0.15EC (5.0 oz/ 100 gal water)(Lot # CDX-701), Pyramite (0.165lb/ acre) (BASF Corporation) and Pyramite (0.25 lb/ acre). A control (water) was also included. Terminals were randomly selected (n= 8 per treatment). A pre-count was conducted on July 2, followed immediately by application of the treatments. The treatments were evaluated 5 days after treatment. Efficacy was determined by counting the number of living rosy apple aphids on each respective terminal.

**Results:**

**Table 1:** Efficacy of two rates of Agrimek 0.15 EC (2.5 oz and 5.0 oz/ 100 gal water) and two rates of Pyramite (0.165 lb and 0.25 lb/ acre) against rosy apple aphids, *Dysaphis plantaginea*, on apples.

| TREATMENT | Terminals | PRE-COUNT [a] | POST-COUNT [a](5dat) |
|---|---|---|---|
| Agrimek 0.15 EC | 8 | 61.4a | 2.00b |
| Agrimek 0.15 EC | 8 | 77.8a | 0.00b |
| Pyramite | 8 | 61.8a | 0.00b |
| Pyramite | 8 | 93.0a | 0.00b |
| Control (water) | 8 | 69.3a | 73.4a |

* Lower case letters in same columns, if different denote significant differences.

[A] The counts represented in columns are the mean number rosy apple aphids.

# Control of White Apple Leafhopper, *Typhlocyba pomaria* McAtee

**Rick Zimmerman, Entomologist**

**Summary:** **All treatments resulted in significantly lower numbers of white leafhopper nymphs than were observed in the control. There was no significant differences between the different rates of Agrimek (2.5 oz and 5.0 oz /100 gal water). There were no significant differences in efficacy among the Agrimek 0.15 EC and the Provado 1.6F treatments. Agrimek 0.15 EC appears to be an excellent option for late season white apple leafhopper control. A caged trial or a larger area would be needed to determine adult leafhopper efficacy. Early season (June) may give season long control of leafhoppers. White apple leafhoppers can cause a reduction in fruit size when trees harbor very high populations. When white apple leafhoppers are at high populations, they are a nuisance as they get into the eyes, mouth and nose of pickers during harvest.**

**Method:** This trial was conducted at the Rogers Mesa Research Station (Colorado Agricultural Experiment Station). The trial was conducted in 2 acre block of semi-dwarf Red Chief red delicious apple trees. The following treatments were applied: Agrimek 0.15EC (2.5 oz/ 100 gal water)(Lot # CDX-701), Agrimek 0.15EC (5.0 oz/ 100 gal water)(Lot # CDX-701), Provado 1.6F (1 oz/100 gal water)(Bayer Corporation) and Provado 1.6F (2 oz/ 100 gal). A control (water) was also included. Terminals were randomly selected throughout the block (n=10). White apple leafhopper nymphs were counted on the terminals for each treatment. A pre-count was conducted on July 29, followed immediately by application of the treatments. The treatments were evaluated 5 days after treatment. Efficacy was determined by counting the number of living white apple leafhopper nymphs remaining on the respective terminals.

**Results:**

**Table 1:** Efficacy of two rates of Agrimek 0.15 EC (2.5 oz and 5.0 oz/ 100 gal water) and two rates of Provado 1.6F (1oz and 2 oz/ 100 gal water) against white apple leafhopper nymphs, *Typhlocyba pomaria* McAtee on apples.

| TREATMENT | Terminals | PRE-COUNT [a] | POST-COUNT [a](5dat) |
|---|---|---|---|
| Agrimek 0.15 EC | 10 | 14.6a* | 0.60b* |
| Agrimek 0.15 EC | 10 | 15.2a | 0.10b |
| Provado 1.6F | 10 | 21.9a | 0.00b |
| Provado 1.6F | 10 | 14.9a | 0.10b |
| Control (water) | 10 | 15.9a | 17.0a |

* Lower case letters in same columns, if different denote significant differences ($P \leq 0.05$).

[A] The counts represented in columns are the mean number white apple leafhopper nymphs.

## Control of European Red Mite, Panonychus ulmi (Koch)

**Rick Zimmerman, Entomologist**

**Summary:** **European red mite mortality was 100% at both rates of Pyramite. Three 2-spotted spider mites were found living in the lower Pyramite rate and six 2-spotted spider mites were found in the higher rate of Pyramite. Only one application was required to suppress both European red mite and two spotted spider mite populations for the remainder of the summer.**

**Method:** This trial was conducted at the Orchard Mesa Research Station located near Grand Junction (Mesa County) in western Colorado. The trial was conducted in two blocks of mature standard-sized red delicious and yellow delicious apple trees planted on a 20ft x 20ft spacing. The trees have experienced high European mite populations in the past. Summer conditions in the Grand Junction area are hot, dry and dusty. Conditions which are conducive to a buildup of large mite populations. Two rates of Pyramite were applied , 0.165 lb ai// acre and 0.25lb ai/acre. Both rates were applied at 300 gallons per acre. A pre-count was conducted on July 16. The treatments were applied on July 17, followed by a post-count on July 23. 50 leaves were randomly selected from each block for the pre- and post-count.

**Results:**

| TREATMENT | PRE-COUNT* | POST-COUNT* |
|---|---|---|
| Pyramite 0.165LB AI/ACRE[a] | 5.04 | 0.06 |
| Pyramite 0.25LB AI/ACRE | 5.98 | 0.12 |
| Control | 5.21 | 5.09 |

* Average number of leaves per mite (50 leaves per treatment)
[a] Applied at 300 gallons water per acre.

## Control of European Earwig, Forficula auricularia L.

**Rick Zimmerman, Entomologist**

**Summary:** **No earwig mortality was observed at any of the treatments, regardless of whether the Pyrellin E.C. was ingested or applied topically. This same lack of mortality was seen in field treatments at (2 pints/100 gal/acre).**

**Background:** In the past few years, European earwig, has become an important economic pest of peaches which are under "soft" or organic pest management. The damage occurs within days of harvest. The earwigs presumably chew large circular holes in the peach making the peach non-marketable. An effective control program is based on sound knowledge of the life history of the targeted insect, in this case, the European earwig. The female earwig lays approximately 20-50 eggs in the spring or fall in chambers 2-3 inches beneath the soil surface. Earwigs overwinter as both eggs and adults. An adult earwig can dig six foot underground to escape extremely cold temperatures. Earwigs are omnivores. In some cases, they can be important predators. In Colorado, earwigs may be contributing to lower early season pest pressure from peach twig borer and crown borer in organic peach orchards. Earwigs are weak fliers and will not crawl long distances. They are attracted to light. In the 1998 growing season growers were not successful in preventing earwigs from moving up into the peach tree with sticky bands wrapped around the trunk of the tree. The bands have been reported to work in other areas. The bands in this case may have not been wrapped tight enough around the trunk.

**Method:** A trial was also conducted with Pyrellin E.C. (0.6% pyrethrins, 0.5% rotenone) in the laboratory to determine if the Pyrellin E. C. was able to cause earwig mortality. Two test were conducted: 1) direct treatment of the earwigs with Pyrellin E.C. and 2) Pyrellin E.C. treated peach slices were fed to the earwigs. Concentrations ranged from 0.000025 to 0.5% plus a control.
NC-140

# Fall-Applied Glyphosate Timing Trial in Apples

**Alvan G. Gaus, Research Scientist, Extension Specialist – Fruit**

**Summary:** **Preliminary first year data indicate that glyphosate can be applied up to the first of December in the Rogers Mesa area and still provide control of weeds the following spring. One year's worth of data is not enough to base a recommendation on.**

**Background:** A fall application of glyphosate (Roundup) is quite common in the fruit growing regions. One question that is often asked is "How late can I apply Roundup and still have it work?" This test was done to determine how late glyphosate can be applied and still have positive results.

**Method:** This trial was done in Block 11A at the Rogers Mesa site. The trial consisted of 3% glyphosate applications on 5 dates at approximately 10-day intervals and an untreated control. Application dates were 21 October, 31 October, 10 November, 21 November, and 1 December. Treated area was approximately 50' long and 6 feet wide. A backpack-type sprayer with Tee-jet 8002 nozzles was used. Application was approximately 50 gallons of water per acre. Treatments were applied in a randomized complete block design with 4 replications. Percent weed cover was determined on 1 April 1998.

**Results:**

| Treatment | % Control of weeds on 1 April 1998 |
|---|---|
| 10/21 | 100 |
| 10/31 | 100 |
| 11/10 | 100 |
| 11/21 | 100 |
| 12/1 | 100 |
| Untreated | 0 |

This was only the first year of data, and more years under different weather conditions are needed to determine if these results can be repeated.

**Acknowledgments:** Colorado Agricultural Experiment Station funds supported this research. Thanks to George Osborn for application.

# 1998 Publications
# Western Colorado Research Center


Al-Harthy, A. 1998. The influence of Wilthin and sodium chloride on flowers of peach (*Prunus persica* L.). M.S. Thesis, Colorado State University. 51p. (M. Rogoyski / co-advisor)

Hammon, R.W., C.H. Pearson, and F.B. Peairs. 1998. Winter wheat planting date effect on Russian wheat aphid (Homoptera: Aphididae) and a plant virus complex. J. Kansas. Entomol. Soc. 69(4):302-309

Hammon, R.W. & F.B. Peairs. 1998 Natural history of *Diuraphis* (Homoptera: Aphididae) species occurring in western Colorado. *In:* S. Quisenberry and F.B. Peairs (eds.). Response Model for an Introduced Pest - The Russian Wheat Aphid (Homoptera: Aphididae). Thomas Say Publ. Entomol. pp:280-287.

Fithian, W.A, C.H. Pearson, W.M. Brown, Jr., R.L. Croissant. 1998. A morphological study of corn ear primordia to determine the timing of blunt ear syndrome symptom development. Agron. Abst. 90:109.

Johnson, Jerry J., John F. Shanahan, Merlin A. Dillon, Harold M. Golus, Calvin H. Pearson, Robert W. Hammon, Frank C. Schweissing, Abdel Berrada, Mark W. Stack, James P. Hain, and Cynthia L. Johnson. 1998. 1997 Colorado alfalfa variety performance trials. Colo. St. Univ. Agric. Exp. Sta. Tech. Rpt. TR 98-1.

Ogg, Barry, Mark A. Brick, and Calvin Pearson. 1998. Introgression of popping ability into dry beans adapted to Colorado. Ann. Rpt. Of the Bean Improvement Cooperative 41:35-36 Pearson, C.H., H.M. Golus and R.W. Hammon.. 1998 Fifty years of agronomic research in western Colorado. Colo. Agric. Exp. Sta. Tech. Rpt. 98-6. 18p.

Pearson, Calvin H., Karl E. White, and Aubrey L. Brinkworth. 1998. Surface residue and soil clods during furrow irrigation under simulated conditions. J. Sustain. Agric. 12:5-21.

Pearson, C.H.*, W.A. Fithian, and B.S. Curran. 1998. Blunt ear syndrome and applying anhydrous ammonia. Agron. Abst. 90:101.

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