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Arkansas Valley Research Center 2004-05 Reports

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Cover: Dr. Howard Schwartz (left) of the Department of Bioagricultural Sciences and Pest Management and graduate students Scott Fichtner (center) and David Gent harvest and grade onions for an onion pathology study.

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FIELD CROPS

VEGETABLE CROPS

THE EFFECTS OF PLANTING DATE ON THE PERFORMANCE OF SIX WINTER WHEAT VARIETIES IN THE ARKANSAS VALLEY[1]

Abdel Berrada[2], Jerry Johnson[3], and Scott Haley[3]
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ABSTRACT

A field trial was conducted in 2004-2005 to determine the effects of three planting dates (early Sept., late Sept., and mid-October) on the performance of six winter wheat varieties (‘Jagalene’, ‘NuHorizon’, ‘Platte’, ‘Prairie Red’, ‘Wesley’, and ‘Yuma’) in the Arkansas Valley. NuHorizon, Yuma, Platte, and Prairie Red performed best when planted on or before 27 Sept. Wesley produced 70 to 80 bu/acre with no significant differences among planting dates. Jagalene had the highest yield and the least incidence of lodging when planted on 18 Oct. NuHorizon performed the best in this one-year trial relative to yield, test weight, and the incidence of lodging and stripe rust. As expected, Platte and Prairie Red had the highest incidence of stripe rust, regardless of planting date. They also had the lowest grain yields and test weights.

OBJECTIVE

The objective of this trial was to assess the effects of planting date on irrigated winter wheat in the Arkansas Valley. This was part of a larger study to determine the latest insurable planting date of winter wheat for various environments in Colorado.

MATERIALS AND METHODS

The trial was conducted at the Arkansas Valley Research Center (AVRC) near Rocky Ford, CO during the 2004-05 season. It consisted of three planting dates and six winter wheat varieties arranged in a randomized complete block, split-plot design with three replications. Winter wheat varieties were: Jagalene, NuHorizon, Platte, Prairie Red, Wesley, and Yuma. They were planted on Sept. 2 (PD#1), Sept. 27 (PD#2), and Oct. 18 (PD#3), 2004. Planting dates were assigned to the main plots and varieties to the split plots. Individual plot size was 5 ft. (4 rows) by 24 ft.

The trial was furrow-irrigated twice in the fall of 2004 and five times in the spring of 2005 and was sprayed with Lorsban 4E at 16 oz/acre on April 14 and May 5, 2005 to control Russian wheat aphids. The soil had a high residual NO_3-N concentration (60 ppm in 0-2 ft.) and an adequate level of available P. The two middle rows of each plot were harvested on July 8, 2005 to determine wheat yield and test weight. The incidence of lodging, stripe rust, and wheat stem maggot was assessed in May and June.

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[1]Adapted from an article published in TR06-09.

RESULTS

Grain yield and test weight:

The effects of planting date, variety, and their interaction on wheat yield was significant at P ≤0.1 (Table 1). NuHorizon had the highest yield on average and at PD#1. Jagalene produced the highest yield at PD#3, while Platte and Prairie Red had the lowest yields on average.

Table 1. Wheat yield in 2005 as affected by variety and planting date.

Variety (VAR)	Planting Date (PD)			**Mean**
	2-Sep (PD#1)	27-Sep (PD#2)	18-Oct (PD#3)	
	bu/acre			
Jagalene	79.7	68.5	91.3	**79.8**
NuHorizon	96.9	95.0	78.1	**90.0**
Platte	65.6	58.3	51.3	**58.4**
Prairie Red	66.4	48.0	49.9	**54.7**
Wesley	75.6	70.5	79.3	**75.1**
Yuma	80.1	75.9	68.0	**74.7**
Mean	**77.4**	**69.4**	**69.6**	
Difference of least square means of VAR by PD = 10.1 bu/acre (P=0.1)				

*Adjusted to 13% moisture and 60 lb/bu.

Average test weights ranged from 50.2 to 60.6 lb/bu, with NuHorizon and Jagalene outperforming Wesley and Yuma at PD#1, PD#2 (NuHorizon), and PD#3 (Jagalene); and Platte and Prairie Red at all three planting dates (Table 2).

Table 2. Wheat test weight in 2005 as affected by variety and planting date.

Variety (VAR)	Planting Date (PD)			**Mean**
	2-Sep (PD#1)	27-Sep (PD#2)	18-Oct (PD#3)	
	lb/bu			
Jagalene	59.6	55.6	57.6	**57.6**
NuHorizon	60.6	58.0	54.7	**57.8**
Platte	55.1	51.5	49.7	**52.1**
Prairie Red	57.1	51.2	50.2	**52.8**
Wesley	57.7	53.6	54.1	**55.1**
Yuma	57.3	55.6	54.4	**55.8**
Mean	**57.9**	**54.2**	**53.4**	
Difference of least square means of VAR by PD = 1.7 lb/bu (P=0.1)				

Stripe rust and wheat stem maggot:

Platte and Prairie Red had a high infestation of stripe rust at all planting dates as did Yuma at PD#2 and PD#3 (Table 3). Jagalene and NuHorizon had the lowest incidence of stripe rust, particularly at PD#1 and PD#2.

Wheat stem maggots were noticeable (white heads) in Wesley at PD#1 and to a lesser extent in Platte and Jagalene, also at PD#1 (Table 4). Prairie Red did not have stem maggots at any planting date.

Table 3. Wheat stripe rust infestation in 2005 as affected by variety and planting date.

Variety (VAR)	Planting Date (PD)			**Mean**
	2-Sep (PD#1)	27-Sep (PD#2)	18-Oct (PD#3)	
	Rating (0-10)*			
Jagalene	0.8	0.9	2.4	**1.4**
NuHorizon	1.1	1.8	2.7	**1.9**
Platte	6.5	6.9	6.8	**6.7**
Prairie Red	7.2	7.2	7.5	**7.3**
Wesley	2.1	2.7	3.2	**2.7**
Yuma	4.5	6.3	7.5	**6.1**
Mean	**3.7**	**4.3**	**5.0**	
Difference of least square means of VAR by PD = 1.0 (P=0.1)				

*0: No infestation…10: 100% infestation

Table 4. Wheat stem maggot infestation in 2005 as affected by variety and planting date.

Variety (VAR)	Planting Date (PD)			**Mean**
	2-Sep (PD#1)	27-Sep (PD#2)	18-Oct (PD#3)	
	Rating (0-10)*			
Wesley	3.0	0.3	0.5	**1.3**
Platte	1.4	0.2	0.0	**0.5**
Jagalene	0.8	0.2	0.3	**0.4**
NuHorizon	0.2	0.4	0.4	**0.3**
Yuma	0.4	0.1	0.0	**0.2**
Prairie Red	0.0	0.0	0.0	**0.0**
Mean	**1.0**	**0.2**	**0.2**	
Difference of least square means of VAR by PD = 0.6 (P=0.1)				

*0: No infestation…10: 100% infestation

Lodging and plant height:

Lodging was severe (80%) in Jagalene at PD#2, substantial (32 to 48%) in Prairie Red (PD#1 and PD#2), Jagalene (PD#1), Wesley (PD#2), and Yuma (PD#2); moderate (12%) in Wesley (PD#1), and negligible or non existent at PD#3 (all varieties) and at all planting dates for NuHorizon and Platte (Table 5).

Jagalene, Prairie Red, and Yuma had the tallest plants, particularly at PD#1 and PD#2 (Yuma), while NuHorizon, Platte, and Wesley had the shortest plants, particularly at PD#3 (NuHorizon and Platte) and PD#1 (Table 6).

Table 5. Incidence of lodging in 2005 as affected by variety and planting date.

Variety (VAR)	Planting Date (PD)			**Mean**
	2-Sep (PD#1)	27-Sep (PD#2)	18-Oct (PD#3)	
	Rating (0-10)*			
Jagalene	3.5	8.0	0.0	**3.8**
Prairie Red	4.7	4.8	0.0	**3.2**
Yuma	2.3	3.2	0.0	**1.8**
Wesley	1.2	4.0	0.0	**1.7**
NuHorizon	0.0	0.3	0.0	**0.1**
Platte	0.0	0.0	0.0	**0.0**
Mean	**1.9**	**3.4**	**0.0**	
Difference of least square means of VAR by PD = 1.7 (P=0.1)				

*0: No infestation…10: 100% infestation

Table 6. Plant height in 2005 as affected by variety and planting date.

Variety (VAR)	Planting Date (PD)			**Mean**
	2-Sep (PD#1)	27-Sep (PD#2)	18-Oct (PD#3)	
	Inches			
Jagalene	40.7	40.5	38.8	**40.0**
Prairie Red	39.3	40.0	37.7	**39.0**
Yuma	38.0	40.7	38.3	**39.0**
Wesley	36.8	37.7	37.7	**37.4**
NuHorizon	35.2	37.7	35.3	**36.1**
Platte	36.0	37.5	34.0	**35.8**
Mean	**37.7**	**39.0**	**37.0**	
Difference of least square means of VAR by PD = 1.5 in. (P=0.1)				

CONCLUSION

NuHorizon, Yuma, Platte, and Prairie Red performed best when planted on or before 27 Sept. Wesley produced 70 to 80 bu/acre with no significant differences among planting dates. Jagalene had the highest yield and the least incidence of lodging when planted on 18 Oct. NuHorizon performed the best in this one-year trial relative to yield, test weight, and the incidence of lodging and stripe rust. As expected, Platte and Prairie Red had the highest incidence of stripe rust, regardless of planting date. They also had the lowest grain yields and test weights. Being one of the tallest varieties, Prairie Red also had a lot of lodging when planted on or before 27 Sept.

Wheat stripe rust was prevalent in the Arkansas Valley in 2005. It was exacerbated by above-average precipitation and by high residual soil nitrate-N at the test site. The high nitrate concentration and frequent irrigations caused excessive vegetative growth as well. Wheat stripe rust infestation was less severe in the winter wheat variety trial, which was planted late (28 Oct.), had less residual soil N and was irrigated fewer times (five vs. seven applications) than the planting date trial. In the variety trial Jagalene averaged 92.5 bu/acre, Wesley 88.7, NuHorizon 84.6, Yuma 82.1, Prairie Red 81.0, and Platte 77.7 bu/acre (p.15, TR06-09).

REFERENCE

Berrada, A., J.Johnson, and S. Haley. 2006. Irrigated winter wheat planting date study at Rocky Ford in 2005. p. 29-31 *In* J.J. Johnson (ed.) Making Better Decisions: 2005 Colorado Winter Wheat Variety Performance Trials. Technical Report TR06-09, May 2006. Colorado State University, Agricultural Experiment Station, Ft. Collins, CO. *The results of the winter wheat variety performance trial at Rocky Ford are shown on page 15 of TR06-09.*

THE EFFECTS OF DRIP IRRIGATION AND FERTILIZER RATE ON CORN YIELD AND SOIL SALINITY IN THE ARKANSAS RIVER VALLEY[1]

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[3]USDA-ARS, Ft. Collins, CO

ABSTRACT

A field experiment was conducted at the Arkansas Valley Research Center (AVRC) in 2005 to test the effects of irrigation type and scheduling and fertilizer rate on corn yield and soil salinity. Four N (0, 60, 120, and 180 lb N/acre) and four manure (0, 10, 20, and 30 t/acre) application rates were compared under *full* and *deficit* subsurface drip (SDI) and furrow (FrI) irrigation. The results show no significant difference in corn yield between SDI and FrI, even though nearly twice as much water was applied with FrI than with SDI. Deficit irrigation decreased corn yields since water was withheld during two critical growth stages, silking and milk. Corn did not respond to N fertilizer rates beyond 60 lb N/acre under deficit irrigation, while 30 tons of manure/acre depressed the yield due to stand loss. Under full irrigation, the highest yield was obtained with 180 lb N/acre which was more than the recommended rate of 120 lb N/acre. Manure increased soil salinity early in the season, which contributed to lower plant population compared to the non-manure treatments. Higher electrical conductivity values were observed after corn harvest at the 4- to 6-ft. soil depth under SDI than under FrI, probably due to the greater leaching potential of FrI.

INTRODUCTION

High NO_3-N concentrations were reported in the Arkansas River Valley of southeastern Colorado (Yergert et al., 1997). Research indicates that corn N fertilizer rate in the Arkansas Valley (Ark Valley) can be reduced substantially, particularly after vegetable crops, while maintaining optimum yield (Halvorson et al., 2002 and 2005). Leaching of NO_3-N below the root zone is exacerbated by inefficient irrigation. Over 90% of the cropland in the Arkansas Valley is furrow-irrigated. Over-application of manure can also lead to NO_3-N leaching and possibly salt build-up. Extensive monitoring in the Ark Valley shows increasing salt concentrations from West to East (Gates et al., 2006). Irrigation contributes approximately 14% of the total salt load in the Ark Valley (Miles, 1977). As water moves across the field or through the soil, it dissolves and transports salts and other pollutants.

Water quality issues coupled with recent droughts and diminishing water supplies have led to renewed interest in water conservation in the Ark Valley. Drip irrigation is gaining in importance but it is mostly used in intensive vegetable cropping systems. Research in Kansas and elsewhere has shown the feasibility of subsurface drip irrigation (SDI) for corn and other field crops (Lamm et al., 1995). A well designed and managed SDI system can save water by eliminating runoff losses and minimizing evaporation and deep percolation losses (Berrada,

[1]Adapted from Berrada et al. (2006).

2005). It also has the potential to minimize the leaching of salts and NO_3-N, but little is known about their movement under drip irrigation in the Ark Valley.

The main objective of this research was to assess the comparative effects of SDI and furrow irrigation on corn yield, N uptake, and soil salinity.

MATERIALS AND METHODS

This research was conducted at AVRC where the predominant soil type is Rocky Ford silty clay (fine-silty, mixed, calcareous, mesic Ustic Torriorthents). Composite soil samples were taken in each replication prior to fertilizer application. They averaged 1.5% O.M. and153 lb NO_3-N/acre at the 0- to 6-foot depth. Soil pH was 8.1. Corn hybrid Asgrow RX752RR/YG was planted on 27 April 2005 at 33,723 seeds/acre in 30-inch rows. The previous crop was soybean.

The factors tested and their levels were:

- Irrigation type: SDI vs FrI. The drip tapes used in SDI had an inside diameter of 0.875 inch and a flow rate of 0.45 gpm/100 ft. They were buried 8 inches below the soil surface, in the middle of 60-in.beds. Thus, each dripline delivered water to two corn rows. Water was pumped from the Rocky Ford Canal and filtered before it reached the drip tapes. Furrow irrigation consisted of dispensing water from the irrigation ditch, with siphon tubes, to every other furrow.
- Irrigation regime: Full vs. deficit irrigation. In the full irrigation regime, water was applied as often as possible to meet the crop demand. In the deficit irrigation regime, irrigation was skipped at the 10-leaf, silking, and milk growth stages. All the plots were furrow-irrigated on 5 May and on 16 May 2005 to ensure adequate corn germination and emergence. Precipitation dates and amounts are shown in Fig. 1.
- Nitrogen and manure fertilizer rates:
  - Nitrogen rate--0N: 46 lb P_2O_5/acre and no N added, 60N: 60 lb N/acre, 120N: 120 lb N/acre, 180N: 180 lb/acre. One hundred pounds of 0-46-0 per acre was added to treatments 60N, 120N, and 180N (same as 0N). A polycoated urea with a release time of 30 days was used as the N source. Nitrogen and P fertilizers were broadcast on 10 March 2005. The recommended rate was 120 lb N/acre based on a 250 bu/acre yield goal.
  - Manure rate--0NP: No N or P added, 10T: 10 tons manure/acre, 20T: 20 tons manure/acre, and 30T: 30 tons manure/acre. Feedlot beef manure was applied on 18 March 2005 with a manure spreader. It had 41% moisture, 1.78% total N, 1.43% Organic C, 0.35% NH_4-N, 0.001% NO_3-N, 0.4% P, C/N ratio of 13, and a pH of 7.6. The recommended manure rate was 10 tons/acre based on a 250 bu/acre yield goal. The whole plot area was disked shortly after manure application.

The experiment was designed as a split-split plot randomized complete block with four replications. Irrigation type was assigned to the main plots, irrigation regime to the split-plots, and fertilizer rate to the split-split plots. Individual plot size was 20 ft. by 60 ft.

Hot and dry conditions in July led to a substantial infestation of spider mite which was suppressed by a late application of Fanfare EC at 6.4 oz/acre plus Dimethoate at 14.5 oz/acre. Soil samples were taken in June and October 2005 in treatments 120N and 20T of the full irrigation regime (SDI and FrI) to determine the electrical conductivity (EC) of the soil solution

(Rhoades, 1996). An excellent correlation was found between EC of 1:1 (soil-to-water ratio by weight) and saturated-paste extracts (Fig. 2).

Data was analyzed using the PROC MIXED procedure (SAS 9.1 Software, 2002-2003). Grain yield was adjusted to 15.5% moisture and 56 lb/bu.

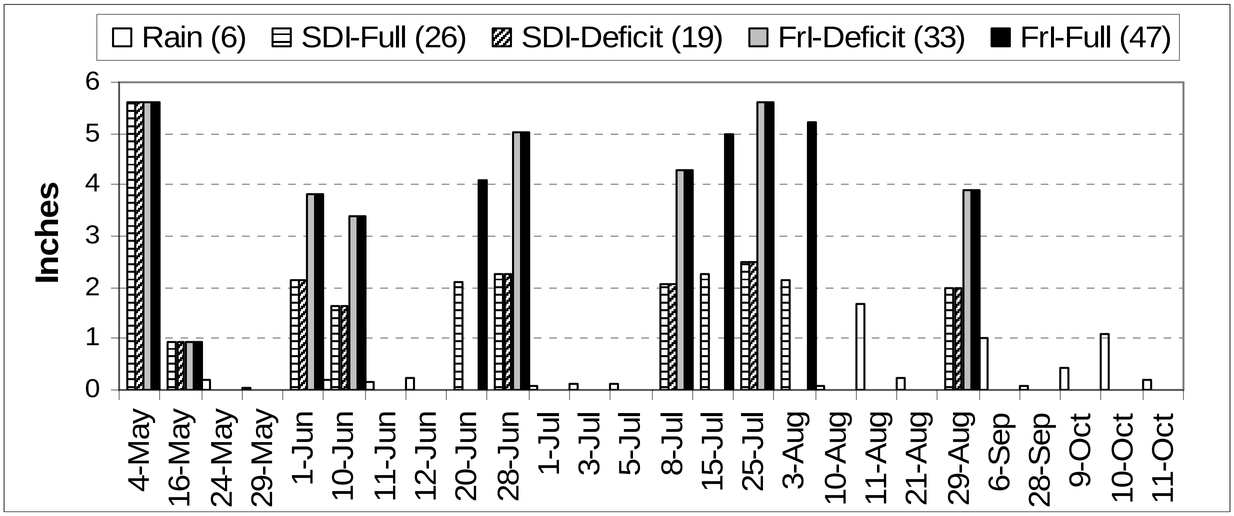

Figure 1. Precipitation amounts during the 2005 corn growing season. Numbers in parenthesis are precipitation totals in inches.

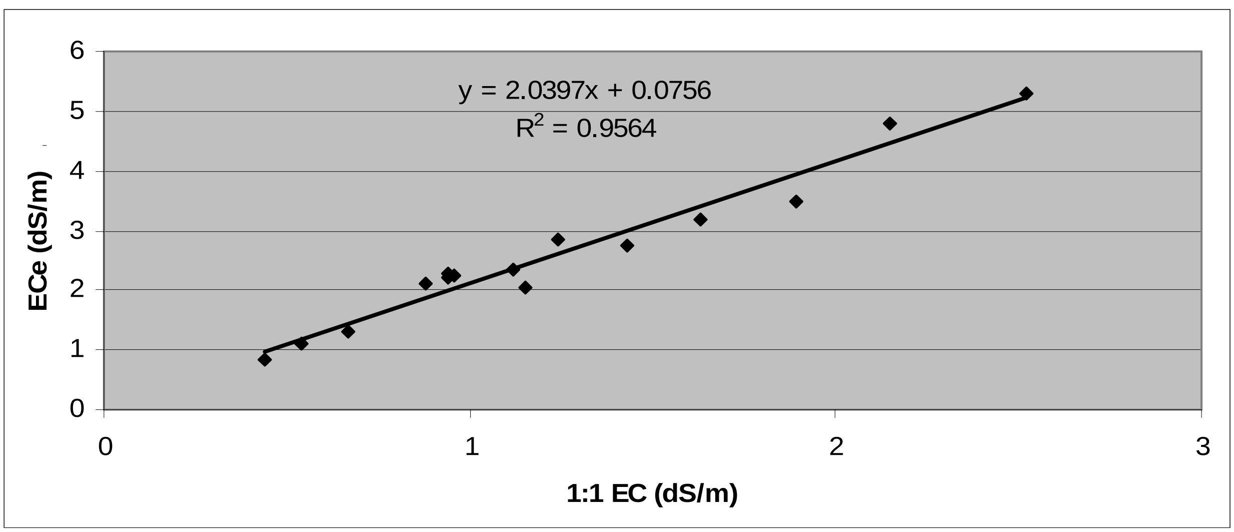

Figure 2. Electrical conductivity (ECe) of the saturated paste extract as a function of 1:1 EC.

RESULTS AND DISCUSSION

Corn yield averaged 197 bu/acre in 2005 across all treatments. There was no significant difference between SDI and FrI even though 76% more water, on average, was applied with FrI than with SDI. Full irrigation increased corn yield by 20 bu/acre compared to deficit irrigation

(P=0.001). Irrigation efficiency was 40 to 60% with FrI and around 90% with SDI, due to evaporation losses caused by subbing, which was the result of shallow drip-tape placement (8 in.) and long irrigation runs. Higher efficiencies are attainable with SDI (Camp, 1998).

Fertilizer rate (P < 0.0001), and fertilizer by irrigation type (P = 0.02) or irrigation regime (P=0.11) all had significant effects on corn yield. The highest yield of 233 bu/acre was obtained with 180 lb N/acre under full irrigation (Fig. 3). Treatments 0NP, 60N, 10T, 20T, and 30T produced similar yields with full irrigation while 0N, 0NP, and 30T had the lowest yields with deficit irrigation (Fig. 3).

Figure 4 illustrates the effect of fertilizer by irrigation type on corn yield. Yield ranking with SDI was as follows: 120N=180N≥60N=10T≥20T=0N=0NP>30T. With FrI, 120N=180N=20T while 0N and 0NP had the lowest yields. Nitrogen concentration in corn grain was significantly higher with 20T and 30T than with the other treatments (Table 1).

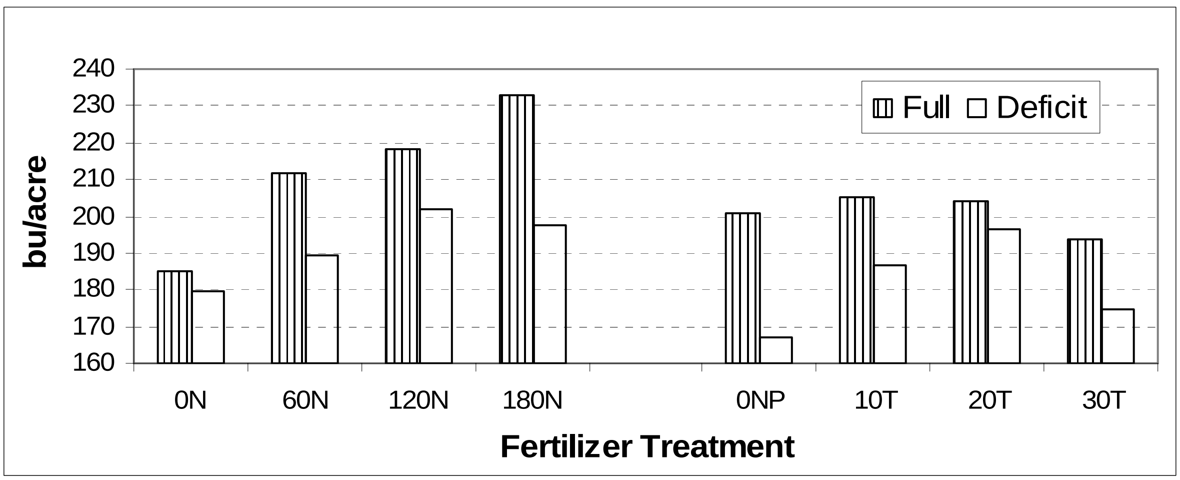

Figure 3. Corn yield in 2005 under full and deficit irrigation as affected by N or manure rate.

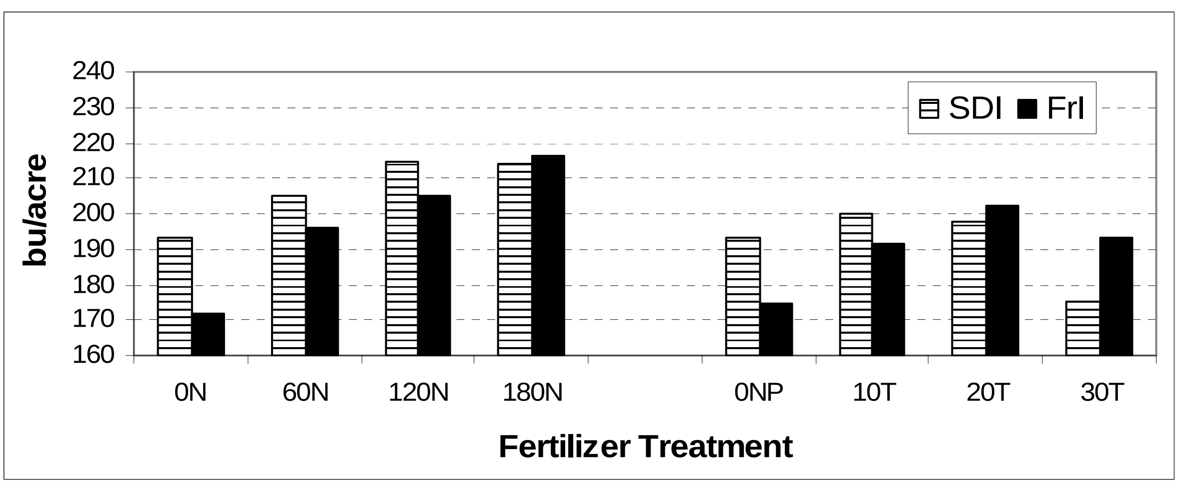

Figure 4. Corn yield in 2005 under SDI and FrI as affected by N or manure rate.

Table 1. Corn grain N content in 2005 as affected by N or manure rate.

Treatment	0N & 0NP	60N 120N &180N	10T	20T & 30T
lb N/bu	0.74c*	0.77b	0.78b	0.82a

*Values followed by a different letter are significantly different at P=0.05

Corn plant population at harvest was significantly lower with the high manure application rates (20T & 30T) than with the other treatments, regardless of the irrigation type (Fig. 5). This was caused by poor germination and emergence despite the fact that all the treatments were furrow-irrigated at the start of the season. Visual observations indicated that water in the high manure-rate treatments did not move as much laterally as it did in the other treatments, particularly with SDI (Fig. 6). Most of the manure was located near the soil surface since the field was not moldboard plowed after manure application; hence, more water may have been required to imbibe the seedbed due to high organic matter content, compared to the non-manure treatments.

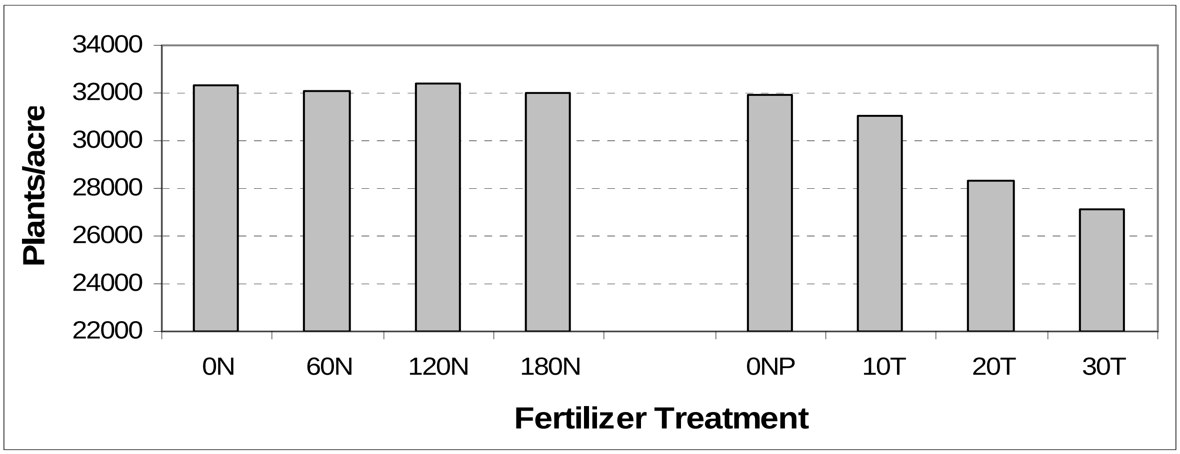

Figure 5. Plant population at corn harvest in 2005 as affected by N or manure rate.

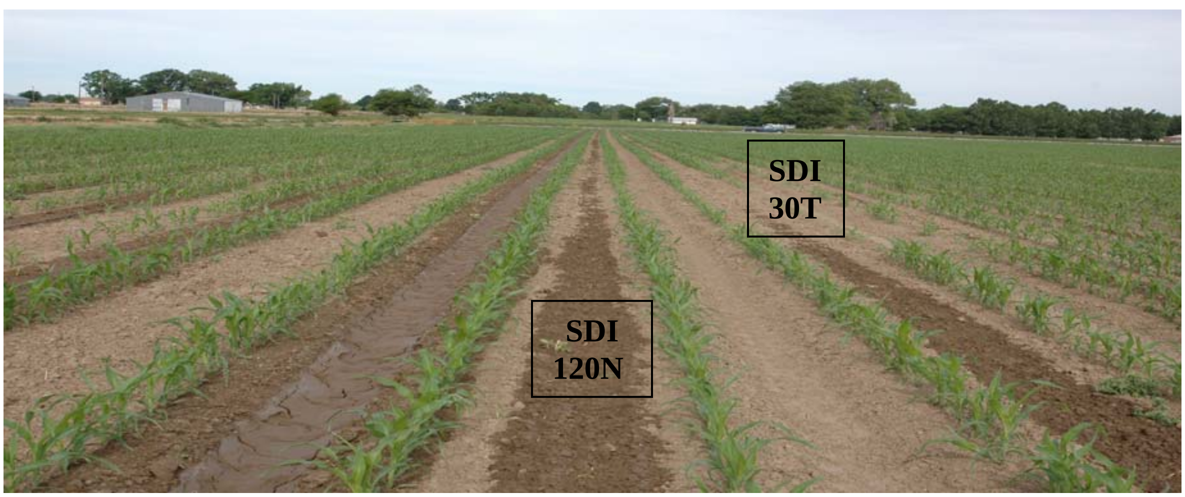

Figure 6. Early-season corn stand shortly after an irrigation event.

Another factor which may have adversely affected corn stand and productivity is salinity. ECe was substantially higher in 20T than in 120N early in the season, particularly under SDI (Fig. 7). ECe values were much lower after corn harvest, which would indicate a downward movement of salts in the soil profile, due to rain and irrigation (Table 2). Fertilizer treatment did not impact post-harvest ECe, while irrigation type by depth by position did. ECe generally increased with depth, with the exception of FrI in the bed center (Table 2). SDI had higher ECe in the furrow and corn row, while FrI had higher ECe in the middle of the bed, although the relative ranking varied with depth. On average, SDI had significantly higher ECe values at the 4- to 6-ft. depth compared to FrI, which raises the concern of salt accumulation under SDI.

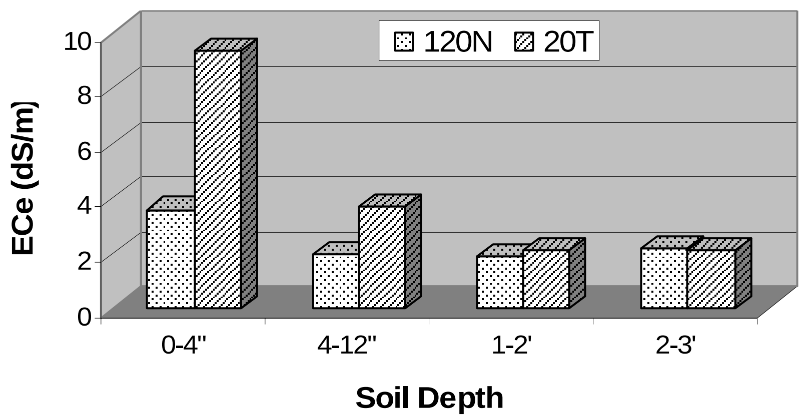

Figure 7. June 2005 ECe under SDI and FrI in 120N and 20T.

Table 2. Post-harvest ECe (dS/cm) under SDI and FrI as affected by soil depth and sampling location.

	SDI			FrI		
Soil Depth	Furrow	Row	Bed Center	Furrow	Row	Bed Center
0-6”	2.59	1.53	1.95	1.38	2.01	4.25
6-12”	2.01	1.49	1.28	1.61	1.28	2.62
1-2’	2.06	2.38	1.12	2.02	1.49	1.83
2-3’	2.46	2.94	1.28	2.03	1.91	1.52
3-4’	2.65	2.85	1.95	2.30	2.23	1.65
4-5’	3.32	3.63	3.26	2.76	2.85	2.09
5-6’	3.35	3.72	3.49	2.58	2.94	2.01

CONCLUSION

The 2005 results indicate that subsurface drip irrigation is a viable alternative to furrow irrigation for corn production in the Ark Valley. The water saved with drip irrigation can be used to irrigate more land or higher-value crops such as onions and cantaloupes. More and more acres of vegetable crops in the Ark Valley are being irrigated with SDI and are often grown in rotation with corn. Some of the challenges of drip irrigation in the Arkansas Valley are:

- Getting enough water to the seedbed to ensure adequate seed germination and plant establishment since natural precipitation is low and erratic. This would depend to a certain extent on SDI system capacity, drip tape placement depth and lateral spacing, and irrigation scheduling. The closer the tapes are to the soil surface and to each other, the more water will reach the crop seeds.
- Managing excess salts, particularly if well water is the irrigation water source since it generally contains higher salt concentration than surface water. Preliminary results of the corn experiment indicate salt accumulation at the 4- to 6-ft soil depth under SDI. If this trends continues, flushing of the salts with furrow irrigation may be necessary every so often (frequency to be determined) in drip-irrigated fields.

REFERENCES

Berrada, A. 2005. Alfalfa response to water deficit using subsurface drip irrigation. Agricultural Experiment Station Technical Bulletin TB05-01, Colorado State Univ., Ft. Collins, CO.

Berrada, A., A.D. Halvorson, M.E. Bartolo, and J. Valliant. 2006. The effect of manure and N rates on corn yield and salt and nitrate movement in the soil under furrow and drip irrigation in the Arkansas River Valley. p 264-269 *In* A.J. Schelegel (ed.) Great Plains Soil Fertility Conference Proceedings, vol. 11, March 7-8, 2006, Denver, CO.

Camp, C.R. 1998. Subsurface drip irrigation: A review. ASAE Trans. 41 (5): 1353-1367.

Gate, T.K., L.A. Garcia, and J.W. Labadie. 2006. Toward Optimal Water Management in Colorado's Lower Arkansas River Valley: Monitoring and Modeling to Enhance Agriculture and Environment. Colorado Water Resource Research Institute Completion Report No. 206. Colorado Agricultural Experiment Station Technical Report TR06-10, Colorado State University, Ft. Collins.

Halvorson, A.D., R.F. Follet, M.E. Bartolo, and F.C. Schweissing. 2002. Nitrogen use efficiency of furrow-irrigated onion and corn. Agron. J. 94: 442-449.

Halvorson, A.D., F.C. Schweissing , M.E. Bartolo, and C.A. Reule. 2005. Corn response to nitrogen fertilization in a soil with high residual nitrogen. Agron. J. 97:1037-1278.

Lamm, F.R., H.L. Manges, L.R. Stone, A.H. Khan, and D. H. Rogers. 1995. Water requirement of subsurface drip-irrigated corn in northwest Kansas. Transactions of the ASAE 38(2):441-448.

Miles, D. 1977. Salinity in the Arkansas River Valley of Colorado. Report complied for the Environmental Protection Agency, Region VIII.

Rhoades, J.D. 1996. Salinity: Electrical conductivity and total dissolved solids. P. 416-435 *In* Methods of Soil Analysis. Part 3. Chemical Methods. SSSA Book Series no. 5, Madison, WI.

Yegert, M., B. Austin, and R. Waskom. 1997. Ground water monitoring in the Arkansas Valley. Fact Sheet no.12. Colorado Department of Agriculture, Lakewood, CO.

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CROP VARIETY PERFORMANCE TRIALS[1]

2004 and 2005 Results

Abdel Berrada, Jerry Johnson, Kevin Larson, and Scott Haley

The variety trials were conducted at the Arkansas Valley Research Center near Rocky Ford, Colorado in collaboration with Colorado State University's crop testing team. The predominant soil type at the center is Rocky Ford silty clay (fine-silty, mixed, calcareous, mesic Ustic Torriorthents). Soil pH ranges from 7.5 to 8.0 and ECe from 1.0 to 3.0 dS/m. The elevation is 4180 ft. above sea level. Annual precipitation averaged 11.85 inches from 1918 through 2006 with a high of 22.4 in. (1941) and a low of 2.9 in. (2003). The average annual snowfall during the same period was 23.2 inches. The first fall frost typically occurs in early (32 °F) to mid-October (28 °F). The last spring frost occurs on April 18 (28 °F) and May 1 (32 °F) with a 50% probability. The average length of the growing season is 156 (32 °F) to 179 (28 °F) days (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?corock).

Above normal precipitation was recorded in the spring and summer of 2004 compared to 2005 and the 88-year average (Table 1).

Table 1. Monthly precipitation at the Arkansas Valley Research Center.

Month	1918-2006	2004	2005
	--------------------	inches	---------------------
January	0.31	0.35	0.45
February	0.28	0.38	0.24
March	0.72	0.10	1.55
April	1.23	3.91	0.75
May	1.81	0.07	0.49
June	1.44	2.64	1.05
July	1.97	3.49	0.45
August	1.61	4.90	2.17
September	0.92	0.64	1.38
October	0.78	0.32	2.04
November	0.48	0.84	0.04
December	0.30	0.06	0.25
Total	**11.85**	**17.7**	**10.86**

All the crops were furrow-irrigated based on water availability and other factors such as visual signs of water stress and soil dryness. Soil testing was done occasionally to determine fertilizer requirements. Field operations (cultivation, pest control, etc.) were done according to standard farming practices in the Ark Valley.

[1] Some of the results are published in: http://www.colostate.edu/Depts/SoilCrop/extension/CropVar/index.html

Alfalfa trials:

Alfalfa hay is the largest crop in Otero County and the second largest in southeastern Colorado after winter wheat (Colorado Agricultural Statistics, www.nass.usda.gov/co). It is typically irrigated once or twice before the first cutting, once between cuttings, and once after the fourth (last) cutting. Alfalfa hay yield potential in the Ark Valley is high (6 to 8 t/acre) due to productive soils, long growing season, and irrigation.

There were two trials in 2004 and one in 2005. The first one was planted on Sept. 1, 2000 and terminated in the fall of 2004. Alfalfa dry matter yield averaged 5.0, 7.3, 5.4, and 6.3 tons/acre in 2001, 2002, 2003, and 2004 respectively (Table 2). The second trial averaged the same yield of 6.9 t/a in 2004 (Table 3) and 2005 (Table 4), with no significant differences among entries in 2005. There was more variability in hay yield in 2005 than in 2004 due to soil compaction and uneven irrigation.

Corn hybrid trials:

The 2004 trial was planted on 3 May at 33,723 seeds/acre and harvested on 27 Oct. One hundred pounds/acre of 11-52-0 and 175 lb N/acre as Urea were broadcast in the fall of 2003 and plowed in. Corn was sprayed on 29 June with 2,4-D at 0.25 lb active ingredient (a.i.)/acre and Clarity at the same rate. It was furrow-irrigated on 7 May, 8 June, 13 July, 4 Aug., and 12 Sept. Total rain amount from planting to harvest was 11.8 inches, most of which fell from June through August.

The 2005 trial was planted on 28 Apr. at 33,723 seeds/acre and harvested on 18 Oct. Three hundred pounds/acre of Urea were broadcast on 13 Dec. 2004 and worked in. Corn was sprayed with Dual II Magnum at 1.5 lb/acre on 27 Apr. 2005 and with Clarity at 0.5 lb a.i./acre on 26 May. In addition, Fanfare 2EC at 6.4 oz/acre plus Dimethoate at 14.5 oz/acre were aerially sprayed on 10 Aug. to control spider mite.

Irrigation dates in 2005 were: 2 May, 4 June, 3 July, 21 July, 4 Aug., and 18 Aug. Rainfall amount from planting to harvest was 7.3 inches, most of which fell late in the season, i.e., from mid-August to mid-October.

Corn yield averaged 205 bu/acre in 2004 (Table 5) and 196 bu/acre in 2005 (Table 6). The highest yields were 244 and 220 bu/acre in 2004 and 2005, respectively. The lowest yield was around 155 bu/acre in both years. There was 3 to 5% lodging in 2004 and some bird damage in both years. A total of 31 hybrids were tested in 2004 and 20 in 2005. Only five hybrids with the same ID were tested in both years.

Forage sorghum trial:

Three forage sorghum and six sorghum sudan grass hybrids were tested in 2005. Forage yield ranged from 20 to 27 tons/acre and averaged 24 tons/acre (Table 7). The only hybrid that produced slightly (but not significantly) more forage than the check was CW 2.61.1. The check, NB 305F had the tallest plants at harvest and had the second highest (after Silex BMR501) number of days from planting to 50% bloom. CW 2.61.1, CW 2.62.6, and Canex BMR 208 had the lowest sugar concentration in the stem (Table 7).

Winter wheat trials:

The 2003-04 trial was planted on 1 Oct. 2003 and harvested on 3 July 2004. It was furrow-irrigated seven times (10/2/03, 11/3/03, 3/26/04, 4/27/04, 5/11/04, 5/25/04, and 6/11/04) and sprayed with Lorsban 4E at 16 oz/acre on 27 Apr. 2004 to control RWA. Lodging was exacerbated by the hail storm of 20 June 2004. Seed yield ranged from 77 to 106 bu/acre and averaged 90 bu/acre (Table 8).

The 2004-05 trial had 34 entries compared to 30 in the previous year. It was furrow-irrigated five times (10/29/04, 3/30/05, 4/20/05, 5/13/05, and 6/7/05) and sprayed with Lorsban 4E at 16 oz/acre on 5 May 2005. Grain yield averaged 88 bu/acre (Low: 78, High: 99).

Table 2. Forage yield of 24 irrigated alfalfa varieties and experimental lines at the Arkansas Valley Research Center in 2001-2004.

Entry/Variety	Company/Brand	1st Cut 25-May t/a	2nd Cut 12-Jul t/a	3rd Cut 18-Aug t/a	4th Cut 20-Oct t/a	2004 Total t/a	2003 Total t/a	2002 Total t/a	2001 Total t/a	4-yr Total t/a
Arapaho	Dairyland Seed	2.99	1.34	1.39	0.73	6.46	5.89	8.28	5.52	26.15
Arrowhead	Dairyland Seed	3.09	1.54	1.60	0.61	6.84	5.72	7.63	5.15	25.34
Ranger	USDA-Neb	2.82	1.60	1.58	0.78	6.78	5.84	7.63	4.83	25.08
54Q53	Pioneer Hi-Bred Int'l	2.83	1.79	1.41	0.89	6.91	5.80	7.13	4.91	24.75
4200	Seed Solutions	2.82	1.77	1.48	0.95	7.02	5.78	7.05	4.79	24.64
53V08	Pioneer Hi-Bred Int'l	2.43	1.64	1.45	0.74	6.27	5.99	7.29	5.02	24.57
ZX 9450A	ABI Alfalfa	2.64	1.45	1.46	0.89	6.44	5.27	7.49	5.20	24.40
Abilene+Z	America's Alfalfa	2.58	1.54	1.42	0.84	6.38	5.61	7.25	5.06	24.30
FG 3R139	Forage Genetics Int'l	3.05	1.81	1.35	0.86	7.07	5.66	6.84	4.67	24.24
FG 6M 71	Forage Genetics Int'l	2.79	1.51	1.41	0.83	6.54	5.01	7.48	5.10	24.13
ZG 9650A	ABI Alfalfa	2.72	1.26	1.30	0.67	5.95	5.65	7.36	5.07	24.03
Winter Crown	Dairyland Seed	2.68	1.33	1.41	0.76	6.19	5.50	7.19	5.06	23.94
Lahontan	USDA-NV	2.52	1.36	1.51	0.69	6.08	5.41	7.54	4.87	23.90
Emperor	America's Alfalfa	2.56	1.30	1.24	0.61	5.71	5.60	7.42	5.09	23.82
Geneva	Novartis	2.87	1.46	1.35	0.80	6.49	5.37	7.15	4.78	23.79
FG 5M84	Forage Genetics Int'l	2.73	1.67	1.29	0.70	6.40	5.39	7.00	4.90	23.69
MagnumV-Wet	Dairyland Seed	2.52	1.52	1.36	0.85	6.25	5.05	7.40	4.90	23.60
ZX 9853	ABI Alfalfa	2.66	1.40	1.36	0.79	6.21	5.21	7.22	4.71	23.35
Dagger+EV	AgriPro	2.26	1.28	1.32	0.68	5.54	5.28	7.43	5.03	23.28
Taget II Plus	Producers Hybrids	2.46	1.19	1.33	0.63	5.61	5.12	7.23	5.17	23.13
ZC 9941A	ABI Alfalfa	2.55	1.37	1.35	0.80	6.07	5.10	7.08	4.77	23.02
Baralfa421G	Barenburg USA	2.58	1.45	1.36	0.72	6.10	4.92	6.94	4.70	22.66
Samurai	America's Alfalfa	2.19	1.33	1.56	0.68	5.76	4.84	6.92	4.74	22.26
A 30-36	ABI Alfalfa	2.45	1.28	1.22	0.66	5.61	4.79	6.34	4.70	21.44
Average		**2.66**	**1.47**	**1.40**	**0.76**	**6.28**	**5.41**	**7.26**	**4.95**	**23.90**
$LSD_{(0.05)}$		NS*	0.36	NS*	NS	NS	1.07	0.76	0.33	2.11

*NS: Non significant differences at P=0.05. One hundred to 200 lb of 11-52-0 lb/acre was applied in the fall of each year.

Table 3. Forage yield of 32 irrigated alfalfa varieties and experimental lines at the Arkansas Valley Research Center in 2004 (First year results).

Entry/Variety	Company/Brand	1st Cut 25-May t/a	2nd Cut 20-Jul t/a	3rd Cut 18-Aug t/a	4th Cut 18-Oct t/a	2004 Total t/a
VL02[٢]	Great Plains Research	3.18	2.45	1.11	0.79	7.52
45098	Cal/West	2.61	2.76	0.97	1.05	7.39
Masterpiece	J.R. Simplot	2.91	2.47	1.07	0.93	7.37
WL 327	W-L Research	2.57	2.70	1.03	0.96	7.25
DS311 Hyb	Dairyland Seed	2.49	2.69	1.11	0.94	7.23
6530	Garst	2.55	2.89	1.03	0.76	7.23
HybriForce-420/Wet	Dairyland Seed	2.82	2.55	0.99	0.84	7.20
4M124	Croplan Genetics	2.78	2.45	1.04	0.86	7.13
6420	Garst	2.55	2.75	0.98	0.84	7.12
4M125	Syngenta Int'l AG	2.45	2.58	1.02	1.06	7.11
DS307 Hyb	Dairyland Seed	2.61	2.63	1.05	0.81	7.11
Arapaho	Dairyland Seed	2.68	2.46	1.04	0.87	7.05
Bullseye	Target Seed	2.91	2.38	1.03	0.72	7.04
Evermore	Allied Seed	2.66	2.39	1.00	0.93	6.98
Abundance	Sharp Bros. Seed	2.70	2.49	0.96	0.82	6.97
55H05	Pioneer Hi-Bred Int'l	2.54	2.31	1.11	1.00	6.96
Rebel	Target Seed	2.64	2.39	1.05	0.87	6.95
FSG 505	Allied Seed	2.52	2.50	0.97	0.95	6.95
05009	Cal/West	2.55	2.46	1.09	0.81	6.90
05073	Cal/West	2.51	2.45	1.02	0.90	6.88
Goliath	Allied Seed	2.67	2.50	0.89	0.78	6.85
Baralfa 53HR	Barenburg USA	2.56	2.51	0.89	0.83	6.79
Reward II	PGI Alfalfa	2.46	2.44	1.03	0.82	6.75
FSG 406	Allied Seed	2.44	2.38	1.04	0.87	6.73
15029	Cal/West	2.42	2.45	0.98	0.82	6.67
Lahontan	USDA/NV	2.42	2.54	0.90	0.80	6.66
Baralfa 42IQ	Barenbrug USA	2.52	2.58	0.89	0.65	6.63
Rugged	Target Seed	2.32	2.64	0.93	0.73	6.61
DS304 Hyb	Dairyland Seed	2.44	2.23	1.02	0.91	6.61
Expedition	Syngenta Int'l AG	2.33	2.49	0.95	0.84	6.60
WL 357 HQ	W-L Research	2.26	2.31	1.00	0.89	6.46
25035	Cal/West	2.06	2.39	0.94	0.74	6.13
Average		**2.57**	**2.51**	**1.00**	**0.86**	**6.93**
$LSD_{(0.05)}$		0.26	0.21	0.16	NS*	0.49

[٢]Certified seed of VLO2 was to be sold in the spring of 2005 as Cimarron VL400.
*NS: No significant differences at P=0.05. Three hundred lb/acre of 11-52-0 were broadcast on October 28, 2002. Alfalfa was planted on August 26, 2003 and was sprayed with Pursuit at 0.0625 lb a.i./acre on March 10, 2004.

Table 4. Forage yield of 32 irrigated alfalfa varieties and experimental lines at the Arkansas Valley Research Center in 2005.

Entry/Variety	Company/Brand	1st Cut 26-May	2nd Cut 8-Jul	3rd Cut 16-Aug	4th Cut[2] 28-Oct	2005 Total	2004 Total
		---------------------------- Tons/acre	------------------------------				
55H05	Pioneer Hi-Bred Int'l	2.67	2.11	1.89	1.43	8.41	6.96
4M124	Croplan Genetics	2.82	1.99	1.87	1.28	8.10	7.13
DS307 Hyb	Dairyland Seed	2.84	1.93	1.94	1.09	7.73	7.11
4M125	Syngenta Int'l AG	2.89	1.74	1.76	1.12	7.67	7.11
6420	Garst	2.21	1.65	1.70	1.42	7.53	7.12
15029	Cal/West	2.64	1.61	1.79	1.14	7.51	6.67
Evermore	Allied Seed	2.46	1.68	1.49	1.37	7.44	6.98
Abundance	Sharp Bros. Seed	2.72	1.70	1.66	1.11	7.18	6.97
Goliath	Allied Seed	2.52	1.77	1.78	1.19	7.16	6.85
FSG 505	Allied Seed	2.35	1.65	1.54	1.23	7.15	6.95
Lahontan	USDA/NV	2.33	1.61	1.72	1.05	7.10	6.66
Expedition	Syngenta Int'l AG	2.38	1.75	1.68	1.23	7.08	6.60
FSG 406	Allied Seed	2.56	1.80	1.76	1.00	7.06	6.73
25035	Cal/West	2.67	1.52	1.48	1.10	7.05	6.13
05009	Cal/West	2.79	1.73	1.76	0.96	7.04	6.90
45098	Cal/West	2.70	1.85	1.71	1.08	7.01	7.39
05073	Cal/West	2.52	1.66	1.97	1.05	6.93	6.88
VL02*	Great Plains Research	2.48	1.62	1.66	1.15	6.92	7.52
WL 357 HQ	W-L Research	2.67	1.79	1.69	0.97	6.88	6.46
HybriForce-420/Wet	Dairyland Seed	2.37	1.59	1.66	1.05	6.85	7.20
Baralfa 42IQ	Barenbrug USA	2.74	1.47	1.71	0.86	6.80	6.63
Rebel	Target Seed	2.60	1.46	1.62	0.98	6.68	6.95
WL 327	W-L Research	2.74	1.61	1.71	0.92	6.50	7.25
Baralfa 53HR	Barenburg USA	2.48	1.59	1.47	0.96	6.35	6.79
6530	Garst	2.52	1.26	1.73	0.94	6.32	7.23
Reward II	PGI Alfalfa	2.33	1.65	1.46	1.05	6.24	6.75
DS311 Hyb	Dairyland Seed	2.12	1.73	1.79	1.04	6.23	7.23
Arapaho	Dairyland Seed	2.37	1.41	1.77	0.95	6.11	7.05
Bullseye	Target Seed	2.13	1.61	1.74	0.84	6.08	7.04
Masterpiece	J.R. Simplot	2.67	1.52	1.60	0.94	6.01	7.37
Rugged	Target Seed	2.16	1.32	1.72	0.93	5.95	6.61
DS304 Hyb	Dairyland Seed	1.96	1.23	1.48	0.68	5.14	6.61
Average		**2.51**	**1.64**	**1.70**	**1.07**	**6.88**	**6.93**
$LSD_{(0.05)}$		NS*	NS	NS	NS	NS	0.49

*NS: Non significant differences at P=0.05. 150 lb/acre of 11-52-0 applied in the fall of 2004 & 2005.

Table 5. Irrigated Corn Variety Performance Trial at the Arkansas Valley Research Center in 2004[1].

Hybrid	Grain Yield	Grain Moisture	Test Weight	Plant Height	Density	Silking[2]
	bu/ac	%	lb/bu	in	plants/ac	date
Grand Valley SX1500 (YGCB/BT)	244	16.2	56.3	82	30129	197
Foundation Pilot HCS0112 (YGCB/RR)	233	15.9	59.1	83	31218	195
Foundation Pilot HCS0112 (RR)	228	15.7	59.4	81	31309	195
Triumph 1536 (CB/RR)	225	16.2	59.4	80	29494	195
DYNA-GRO 57P93	225	15.9	58.9	81	30220	195
HYTEST HT7729 (HT/LL)	222	15.2	57.4	84	31672	197
Grand Valley SX1395 (YGCB/BT)	220	15.9	59.1	77	29494	196
HYTEST HT7806 (BT/RR)	218	17.4	60.0	79	30674	198
HYTEST HT7710 (BT/LL)	213	16.2	58.8	84	30220	196
Foundation Pilot HCS0111 (RR)	213	15.4	61.3	82	29675	197
NK Brand N70-T9 (BT/LL/CL)	212	15.8	59.7	77	30946	195
Mycogen 2T801 (RR) (YGCB)	212	15.4	60.2	80	29766	195
Producers Hybrids 7373 (RR/BT)	210	15.9	58.8	82	28859	195
DEKALB DKC63-80 (RR2)	210	15.2	61.1	78	30129	197
Mycogen 2E705 (YGCB)	210	15.6	59.8	77	29857	195
Triumph 1416 (CB/BT)	210	15.4	59.3	80	31490	195
Producers Hybrids 7003 (RR/BT)	208	15.9	58.8	79	30220	195
Grand Valley GVX0125 (YGCB/BT)	207	16.4	58.4	90	29131	200
Foundation Pilot HCS0111 (RR/YGCB)	205	15.5	60.1	81	30038	197
NK Brand N72-J5	203	15.9	59.3	81	30401	196
NK Brand N67-T4 (BT/LL)	200	15.6	60.3	80	31309	194
Foundation Pilot HCS0113 (YGCB/RR)	197	15.8	59.5	79	29312	194
DEKALB DKC63-81 (RR2/YGCB)	195	16.1	61.1	77	28223	198
DYNA-GRO CXO 3512	189	14.4	59.4	71	30583	196
DEKALB DKC60-19 (RR2/YGCB)	189	15.7	60.5	73	31218	194
DYNA-GRO 57P69	189	15.5	59.4	79	30220	195
DEKALB DKC60-17 (RR2)	183	15.3	59.4	75	31490	194
DYNA-GRO CXO 3410	178	13.6	58.5	78	29948	196
Foundation Pilot HCS0113 (RR)	173	15.6	59.5	80	28133	195
DEKALB DKC53-34 (RR2/YGCB)	166	14.9	59.9	78	29857	193
DEKALB DKC53-33 (RR2)	154	14.6	59.3	78	29585	192
Average	**205**	**15.6**	**59.4**	**79**	**30155**	**196**
CV%	6					
$LSD_{(0.30)}$	11					

[1]Seeded on 5/3 and harvested on 10/27. [2]Julian date.

Table 6. Irrigated Corn Variety Performance Trial at the Arkansas Valley Research Center in 2005[1].

Hybrid	Grain Yield	Grain Moisture	Test Weight	Plant Height	Density	Silking[2]
	bu/ac	%	lb/bu	in	plants/ac	date
NK Brand N70-F1 (BT/LL)	220.4	17.7	56.7	81	33443	193
Dyna-Gro 57P93 (YGCB/RR2)	214.6	18.7	57.1	87	32600	192
NK Brand N70-T9 (BT/LL/CL)	212.8	20.0	56.5	83	33724	192
Mycogen 2T801 (RR/YGCB)	210.3	19.0	57.8	82	34145	193
Producers Hybrids 7361 (YGCB)	210.1	19.5	56.8	85	35832	195
Triumph 1416 (BT/YGCB)	209.2	17.0	57.1	83	32740	195
HYTEST HT7891 (BT/RR2)	206.8	19.9	55.5	92	35551	198
HYTEST HT7749 (BT/RR2)	203.6	23.5	56.8	92	32881	196
Triumph 1536 (YGCB/RR)	202.4	22.0	57.5	83	33021	195
Producers Hybrids 7373 (YGCB/RR)	199.3	19.2	57.3	86	29789	194
Grand Valley 13B53	196.0	17.9	59.5	88	31616	195
Grand Valley 14B95	193.5	17.5	56.6	88	29227	197
Mycogen 2T780 (LL/HXI)	191.2	20.5	56.7	90	34473	195
Grand Valley 25P00	180.7	19.9	56.0	84	34848	195
Grand Valley 23P95	180.6	20.1	57.9	84	25995	192
NK Brand N58-L8 (GT/RR)	180.4	14.8	58.0	82	30633	191
Grand Valley 14B69	172.9	18.7	59.5	91	31195	194
NK Brand N63-U9 (GT/RR)	172.6	15.9	56.4	81	32740	190
HYTEST HT7813 (HX/LL)	156.9	22.0	57.8	98	31335	199
Average	**195.5**	**19.2**	**57.2**	**86**	**32410**	**194**
$LSD_{(0.30)}$	16.6					

[1]Seeded on 4/28 and harvested on 10/18. [2]Julian date.

Table 7. Irrigated Forage Sorghum Performance Trial at the Arkansas Valley Research Center in 2005[1].

Hybrid	Brand	Forage type[2]	Days to 50% bloom	Plant height (in)	Stage at harvest[3]	Stem sugar (%)	Dry matter[4] (%)	Forage yield[5] Tons/A	Yield % of check
CW 2.61.1	CAL/WEST SEEDS	SS	69	90.0	ED	9.7	27.6	27.1	106
NB 305 F	**CHECK**	FS	84	104.8	EM	13.8	22.2	25.5	100
CW 2.62.6	CAL/WEST SEEDS	SS	69	95.9	LM	10.3	28.2	25.3	99
Grazex BMR 719	BUFFALO	SS	71	101.1	MM	14.1	26.2	24.2	95
CW 4.67.6	CAL/WEST SEEDS	SS	70	87.6	MM	13.3	26.8	23.1	91
CW 2.63.6	CAL/WEST SEEDS	SS	70	87.6	EM	13.6	26.2	22.9	90
Grazex BMR 718	BUFFALO	SS	74	103.1	EM	12.0	25.4	22.8	90
Canex BMR 208	BUFFALO	FS	73	100.6	MM	10.9	26.4	22.0	86
Silex BMR 501	BUFFALO	FS	99	96.6	PM	12.6	20.2	20.1	79
Average			**75**	**96.3**		**12.3**	**25.5**	**23.7**	
$LSD_{(0.05)}$				8.1			1.7	3.1*	
CV (%)				4.9			3.8	12.1	

[1]Planted on 6/8 and harvested on 9/20.
[2]Forage Type—FS: Forage sorghum, SS: Sorghum Sudan grass.
[3]Seed maturation—PM: Pre milk, EM: Early milk, MM: Mid milk, LM: Late milk, ED: Early dough, SD: Soft dough, HD: Hard dough, and MT: Mature.
[4]Forage yield adjusted to 70% moisture content.

Table 8. Irrigated winter wheat variety performance trial at the Arkansas Valley Research Center in 2004[1].

Entry	Yield bu/a	Moisture %	Test Weight lb/bu	Plant Height in	(7/03/04) Lodging[2] 0-9	50% Heading[3] date
Prairie Red	106.0	10.7	55.2	35	2	124
NuHills	102.1	11.0	55.5	34	0	126
CO991057	102.1	10.7	55.7	37	1	124
CO00016	100.9	10.7	54.9	37	4	124
Ok102	99.9	12.0	57.7	34	0	128
Ankor	97.3	10.9	53.9	36	2	126
Yuma	95.8	11.3	55.9	35	2	125
CO00698	95.1	11.4	56.9	39	4	127
CO00D007	95.0	10.9	55.1	38	2	124
CO99W183	94.0	11.1	56.7	35	2	126
CO970547-7	93.4	11.1	56.2	34	3	125
CO991132	92.9	10.4	54.3	36	1	124
NuFrontier	92.2	11.7	57.4	36	0	128
CO99W254	91.5	11.5	56.9	34	2	124
CO99W192	90.3	9.6	51.1	37	4	129
Nuplains	89.1	11.6	57.0	36	0	131
Dumas	88.2	11.6	58.0	34	0	126
CO00345	87.9	12.3	57.6	34	5	125
Overley	85.6	11.6	56.8	40	0	127
CO00347	85.4	12.2	56.9	35	4	126
CO980607	84.8	11.5	57.0	35	2	124
Wesley	83.3	10.4	54.2	34	1	128
CO99W329	82.8	11.5	56.3	34	1	123
CO00796	81.8	11.3	57.4	39	2	130
Jagalene	81.5	12.3	57.0	36	2	129
CO00739	80.0	11.1	55.4	37	3	129
Antelope	79.6	10.7	54.8	35	1	127
CO00554	78.4	12.3	56.3	36	2	126
NuHorizon	77.4	11.9	56.4	35	0	129
Platte	77.2	10.6	53.2	34	0	130
Average	**89.7**	**11.3**	**55.9**	**36**	**2**	
CV %	8.9					
$LSD_{(0.30)}$	6.8					
$LSD_{(0.05)}$	13.1					

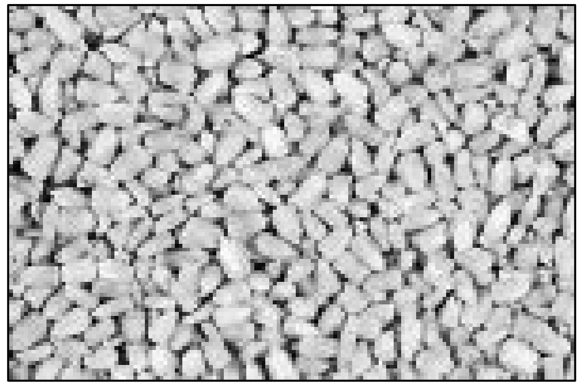
[1]Seeded on 10/1/03 and harvested on 7/3/04.
[2]Rating scale 0 = No lodging…9 = Completely lodged (down).
[3]Julian date to 50% heading.

Table 9. Irrigated winter wheat variety performance trial at the Arkansas Valley Research Center in 2005[1].

Entry	Yield bu/ac	Grain Moisture %	Test Weight lb/bu	Plant Height in	50% Heading[2] date
NuFrontier	99.1	9.4	58.9	37	137
NuHills	99.1	10.0	62.7	35	136
TAM 111	97.5	10.1	61.8	36	137
Hatcher	97.2	10.0	61.6	36	137
CO01385-A1	94.3	9.7	59.6	34	136
CO01385	92.5	9.2	56.6	34	137
Jagalene	92.5	10.2	61.7	35	139
CO991057-A4	92.4	9.4	59.4	36	138
CO991407-A3	92.0	10.0	61.5	36	135
Bond CL	92.0	9.2	58.6	37	135
CO01W189-A1	91.8	9.2	58.9	37	137
CO01W191	91.3	9.5	59.9	36	137
CO01212	91.1	10.1	61.7	39	135
CO01473	88.9	9.9	61.5	39	137
GM10006	88.9	10.0	61.8	37	137
Wesley	88.7	9.3	59.4	33	137
CO01434-A1	88.1	9.5	60.1	36	137
CO01W172	87.5	9.8	61.1	36	136
Dumas	87.3	9.6	58.7	33	136
CO00016	86.4	8.8	57.6	35	136
NuHorizon	84.6	10.2	61.8	31	138
CO01W171	84.3	9.2	58.3	34	138
CO01W189	84.2	9.3	58.0	35	137
CO01434	84.1	9.6	59.9	35	138
Antelope	83.9	9.6	60.2	35	137
CO01W173-A3	83.4	9.7	59.6	34	138
CO01W173	82.2	9.4	59.0	36	136
Yuma	82.1	9.7	60.8	35	137
Ankor	81.6	9.1	58.3	35	137
Prairie Red	81.0	9.2	59.0	35	136
Overley	80.2	10.0	61.6	37	136
W04-417	80.0	9.4	60.5	34	136
Ok102	78.4	9.6	60.3	33	137
Platte	77.7	9.6	60.3	31	138
Average	**87.8**	**9.6**	**60.0**	**35**	
CV %	5.2				
$LSD_{(0.30)}$	3.9				
$LSD_{(0.05)}$	7.4				

[1]Seeded on 10/28/04 and harvested on 7/8/05.
[2]Julian date to 50% heading.

Micronutrient Corn Trial



Michael Bartolo
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In the Arkansas Valley and other parts of Colorado, many crops, particularly lower value agronomic crops, are not fertilized with micronutrients due to the high elemental levels that often exist in soils and irrigation waters. Despite being at high levels in the soil, some micronutrients may not be readily available to a plant due to localized depletions around the root zone or limited mobility of the nutrient.

Corn used for grain or silage is an important crop in Colorado. Corn is used to support the state's large and economical vital livestock industry and is grown in many regions of the state. Most Colorado soils contain relatively high levels of micronutrients and agronomic crops like corn may not be fertilized with anything but the major nutrients. Nonetheless, some deficiencies may exist in certain soil types. Further, deficiencies may exist in irrigated soils that are prone to nutrient leaching. Because of this potential, this study was conducted to determine the effect of a soil-applied micronutrient fertilizer (Micro-Mix 15% Zn, Mezfer Crown Inc.) on the yield of a furrow-irrigated corn crop grown for grain.

Overall, there was a significant (p=0.1) increase in grain yield by the application of 80 lbs per acre of the micronutrient fertilizer compared to the unfertilized control. The 40 lb per acre rate also showed an increase (but nonsignificant) in yield.

METHODS

A micronutrient rate study was initiated under conventional till, furrow-irrigated corn on a calcareous Rocky Ford silty clay loam soil at Colorado State University's Arkansas Valley Research Center (AVRC) in 2005. The Center is located near Rocky Ford, Colorado. The plot area had previously been in soybeans during 2004. Three micronutrient fertilizer rates (0, 40, 80 lb product per acre) were established on April 27, 2005. The micronutrient source was Micro-Mix 15% Zn, Mezfer Crown Inc. (S= 8.00%, Cu=0.70%, Fe=7.00%, Mn=1.00%, and Zn=15.00%). The mironutrients were broadcast on top of 30 inch corn beds prior to planting. Immediately after broadcasting the fertilizer was incorporated with a rotary hoe. A randomized complete block design with 4 replications was used. Each plot was 4 beds wide (10 feet) and 36 feet long.

Corn (var. Gast 8467 RR) was planted on April 28, 2005 at a seeding rate of about 32,000 seeds per acre. A single line of corn was planted on top of the bed with a 30 inch row spacing (furrow to furrow). Conventional corn production practices were used throughout the course of the season. Irrigation was by gravity-flow furrows with water being applied to every other furrow (every 60 inches). The corn was harvested at full black layer maturity and 15%

grain moisture. Changes to estimated gross returns were based on a market price of $2.30 per bushel at harvest.

RESULTS

Fair corn yields were obtained in the micronutrient trial. Hot and dry conditions in July uniformly stressed the crop. Overall, there was a significant (p=0.1) increase in grain yield by the application of 80 lbs per acre of the micronutrient fertilizer compared to the unfertilized control. The 40 lb per acre rate also showed an increase, but nonsignificant, increase in yield (Figure1).

Figure 1: Yield of grain corn fertilized with three different rates of micronutrient fertilizer.

Treatment	*Total Grain Yield* *Bushels per acre*
Unfertilized Control	**189.7 a**
40 lbs per acre rate	**206.1 ab**
80 lbs per acre rate	**223.2 b**
lsd (0.1) =	**19.9**

Note:

Estimated gross returns can be based on an average price of $2.30 per bushel at harvest. Therefore, an increase in yield of 20 bushels per acre would increase gross returns $46.00 per acre.

Onion Variety Trial

Mike Bartolo
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Colorado State University

PRODUCTION INFORMATION

Plots - *Planted 20' long X 2 rows (3.3') wide. 16" X 24" - 2.5" spacing. Harvest 8 bed feet of row. Each plot was replicated four times in the trial.*

Planted *- March 10th , 2004*

Fertilizer *- 104 lbs. P_2O_5/A and 22 lbs N/A as 11-52-0 - preplant. ~ 100 lbs. N/A residual.*

Weed Control *- Prowl 3.3E + Roundup Ultra on March 26th*
-Goal 2 on May 6th
-Goal 2 + Dual II on May 20th (All ground applications)
-Select on July 9th
-Hand weeded 2 times

Insect Control *- None Applied (low thrips populations were detected)*

Disease Control *– Dithane + Copper (5 ground applications) July 14th and 28th, August 2nd, 9th, and 16th*

Irrigation *- 9 times (approximately 2" each irrigation); seasonal precipitation was 15.1"*

Harvest *- September 17th*

Grade *- November 15th - 18th*

Comments

The 2004 season was relatively cool and rainy compared to average. On June 20th a severe hail and wind storm damaged the plots. Despite the damage, the onions recovered nicely and had fairly good overall yields with little if any incidence of disease. Thrips populations were low throughout the season and as a result, the trial did not require any insecticide applications.

In general, the longer season Spanish varieties like Tequilla, Cannonball, and Ranchero performed extremely well. The white variety Cometa was notably outstanding with excellent yield and quality.

Please contact Mike Bartolo at the Arkansas Valley Research Center (719-254-6312) for additional information.

ONION VARIETY TRIAL

Arkansas Valley Research Center

Colorado State University, Rocky Ford, Colorado, 2004

Variety	*Source*	*Maturity (% tops down) 9-13*	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Pre-Pack 1¾"-2 ¼" %*	***Total Market. CWT/A***	*Culls %*	*Total Weight CWT/A*
Cometa (W)	Nunhems	35	0	88.2	10.4	0.1	**653.8**	1.1	661.1
Ranchero	Nunhems	60	4.4	83.5	9.4	0	**643.1**	2.5	661.1
Tequilla	D. Palmer	40	4.5	75.0	16.4	0.2	**632.1**	3.7	656.6
Colorado 6	Burrell	17	5.4	63.8	23.1	1.2	**571.7**	6.4	608.8
Cannonball	Seminis	50	0	73.2	23.5	0.3	**563.5**	2.8	580.7
BGS 196	Bejo	40	0	66.0	29.1	1.0	**559.8**	3.7	578.2
Harmony	Crookham	57	0	80.6	15.5	0	**554.5**	3.8	575.8
Torero	Nunhems	30	2.2	81.3	10.3	0.4	**550.0**	5.5	581.9
SX7004ON	Nunhems	37	0	76.3	22.8	0.1	**536.6**	0.7	540.2
OLYS97-24	Crookham	30	0	68.2	21.1	0.4	**534.9**	10.0	593.7
Tioga	Seminis	82	0	46.3	49.9	1.7	**521.9**	2.0	532.1
Pandero	Nunhems	37	1.8	69.3	23.3	1.8	**515.7**	3.5	535.3
Santa Fe	Seminis	45	0	64.8	31.6	1.2	**499.8**	2.2	509.6
Gladstone	Bejo	47	0	48.8	48.5	3.1	**495.3**	3.4	512.9
SR7009ON	Nunhems	25	1.1	77.3	18.8	1.0	**490.4**	1.5	598.2
Sweet Perfection	Crookham	25	0	68.7	23.1	1.1	**490.4**	6.9	525.9
Mesquite	D. Palmer	25	3.0	66.6	21.3	1.5	**473.7**	7.3	510.8
Vaquero	Nunhems	65	0	76.9	20.9	0	**472.4**	2.1	483.5
6876	Seminis	90	0	48.1	40.3	1.7	**471.6**	9.7	523.1

Variety	*Source*	*Maturity (% tops down) 9-13*	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Pre-Pack 1 ¾"-2 ¼" %*	***Total Market. CWT/A***	*Culls %*	*Total Weight CWT/A*
SR7008ON	Nunhems	25	1.6	70.8	21.8	0.9	**469.6**	4.6	491.6
Granero	Nunhems	60	0	76.6	21.4	0.3	**461.4**	1.5	467.9
Frosty (W)	D. Palmer	47	0	53.2	42.1	2.1	**450.8**	2.4	462.2
X-202	Waldow	32	1.5	70.2	17.1	0	**430.8**	11.0	489.2
Gunnison	Bejo	80	0	44.1	52.3	2.1	**416.1**	1.3	421.4
Salsa (R)	Nunhems	77	0	59.2	32.7	1.7	**405.1**	6.2	431.6
BGS194	Bejo	70	0	28.8	65.8	1.8	**402.2**	3.4	414.0
Blanco Duro (W)	Burrelll	37	0	62.2	31.8	1.0	**392.4**	4.7	413.6
Xph95345	Crookham	35	0	53.6	33.2	1.3	**370.3**	11.6	419.4
Delgado	Bejo	45	0	70.1	16.0	1.5	**360.1**	12.2	404.2
Daytona	Bejo	30	0	49.7	34.6	1.6	**351.2**	13.8	408.3
Tamera	Bejo	40	0	27.8	63.4	4.3	**326.7**	4.3	340.5
Redwing (R)	Bejo	12	0	43.0	45.4	0.8	**307.9**	10.6	344.6
Genesis	Crookham	85	0	10.8	77.2	4.6	**250.7**	7.2	270.3
OLYH02N2	Crookham	85	0	14.4	65.7	19.7	**233.1**	2.9	240.5
lsd (0.1) =							**79.4**		**76.3**

(W) = white-skinned, (R) = red-skinned, all other yellows

Onion Variety Trial

Mike Bartolo
Arkansas Valley Research Center
Colorado State University

PRODUCTION INFORMATION

Plots - *Planted 20' long X 2 rows on beds spaced 30" on centers. Rows were spaced 10" apart on top of the bed with an in-row spacing between plants of ~3". Harvested 8 bed feet (8' X 2 rows) for yield determination. Each plot was replicated four times in the trial.*

Planted *- March 10th , 2005*

Fertilizer *- 104 lbs. P_2O_5/A and 22 lbs N/A as 11-52-0 - preplant. ~ 100 lbs. N/A residual.*

Weed Control *- Prowl 3.3E + Roundup Ultra on March 29th*
-Goal 2 and Outlook on May 10th
-Goal 2 + Dual II on June 1st (all ground applications)
-Hand weeded 2 times

Insect Control *– Warrior + Lannate on June 23rd*

Disease Control *– Dithane + Top Cop on July 5th (ground application), Dithane and Copper July 22nd and August 3rd (aerial applications)*

Irrigation *- 11 times (approximately 2" each irrigation); seasonal precipitation was 6.46""*

Harvest *- September 8th*

Grade *– September 29th*

Comments

The 2005 season was relatively dry and particularly hot during the month of July. Overall, the there was an adequate supply of irrigation water and the onions grew extremely well. Thrips populations were fairly low throughout the season and only one insecticide application was applied. In addition, disease pressure was extremely low and overall bulb quality was excellent.

Please contact Mike Bartolo at the Arkansas Valley Research Center (719-254-6312) for additional information.

ONION VARIETY TRIAL

Arkansas Valley Research Center
Colorado State University, Rocky Ford, Colorado, 2005

Variety	*Source*	*Maturity (% tops down) 8-21*	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2¼"-3" %*	*Pre-Pack 1¾"-2¼" %*	***Total Market. Weight CWT/A***	*Culls %*	*Total Weight CWT/A*
SR7008 ON	Nunhems	47	5.2	85.5	8.0	1.1	**780.8**	0.1	781.9
Cometa (W)	Nunhems	50	1.0	80.4	15.0	2.6	**699.7**	0.9	706.7
Ranchero	Nunhems	67	7.1	72.7	19.0	1.1	**699.7**	0.0	699.7
Harmony	Crookham	62	4.4	72.7	19.1	3.4	**665.4**	0.4	667.5
Tequilla	D. Palmer	27	13.0	70.8	13.4	0.8	**663.7**	1.9	676.3
Sweet Perfection	Crookham	50	2.2	78.7	16.9	1.4	**661.5**	0.8	667.0
SX7004ON	Nunhems	55	0.0	73.0	25.6	1.4	**643.0**	0.0	643.0
15819	Seminis	55	0.0	64.5	33.1	2.1	**630.5**	0.3	632.2
Exacta	Seminis	90	2.2	65.9	27.8	3.3	**630.5**	0.7	634.9
Charismatic	Seminis	90	4.6	68.4	24.9	1.9	**621.8**	0.2	622.9
Colorado 6	Burrell	15	7.9	75.3	12.7	1.6	**618.5**	2.4	631.6
Vaquero	Nunhems	85	1.4	68.9	27.9	1.7	**593.5**	0.0	593.5
77106 (W)	Seminis	47	0.0	51.9	44.5	2.6	**584.8**	1.0	590.2
Pandero	Nunhems	40	2.4	71.9	23.4	2.0	**567.9**	0.3	569.5
Mesquite	D. Palmer	12	24.5	64.7	5.0	1.4	**562.5**	4.3	585.9
Granero	Nunhems	70	0.0	72.6	26.6	0.8	**556.5**	0.0	556.5
Sedona	Bejo	52	0.0	68.9	26.8	3.6	**531.4**	0.5	534.1
Calibra	Bejo	62	1.5	50.1	42.9	5.4	**518.4**	0.0	518.4
Salsa (R)	Nunhems	67	0.0	38.8	56.9	3.2	**509.6**	1.0	515.6

Variety	*Source*	*Maturity (% tops down) 8-21*	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Pre-Pack 1¾"-2 ¼" %*	***Total Market. Weight CWT/A***	*Culls %*	*Total Weight CWT/A*
Crockett	Bejo	27	0.0	58.8	36.4	4.4	**448.1**	0.4	449.7
Red Bull (R)	Bejo	32	0.0	35.8	58.2	3.0	**446.5**	2.9	459.6
Gunnison	Bejo	77	0.0	40.4	56.3	3.3	**444.8**	0.0	444.8
Blanco Duro (W)	Burrell	40	0.0	63.7	30.7	3.1	**430.7**	2.4	440.5
Citation	Seminis	90	0.0	47.0	48.4	3.6	**422.0**	0.8	425.8
Tamara	Bejo	40	0.0	35.4	58.2	6.3	**405.1**	0.0	405.1
Talon	Bejo	62	0.0	22.0	70.4	7.0	**393.1**	0.5	395.3
Genesis	Crookham	95	0.0	25.2	71.6	3.1	**373.0**	0.0	373.0
Nobility	Crookham	90	0.0	5.2	81.6	13.1	**340.3**	0.0	340.3
lsd (0.1) =							**74.3**		**72.2**

(W) = white-skinned, (R) = red-skinned, all other yellows

Onion Spacing Drip Irrigation Trial

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Rocky Ford, Colorado

This study was conducted to evaluate four different planting populations for onions grown with drip irrigation. Yield, market-class distribution, and water use were evaluated under an intensive production system.

Methods

This trial was conducted at the Arkansas Valley Research Center, on a Rocky Ford silty clay loam. Beds, 60 inches between centers, were listed and shaped on February 27th, with a one row bed shaper (Buckeye) and firmed and flattened with a Brillion Cultipacker. On each bed, two drip tape lines (T-Tape 506-drip) were injected on March 16th . Tapes were placed 10 inches from the center of the bed at a depth of 2-3 inches. After injecting the tape, the beds were refirmed with a flex-roller. On March 20th the plots were seeded with the variety X-202 (Waldow Seeds) using a Stanhay Vacuum Planter. Four seed rows spaced 10 inches apart were seeded on top of the bed (Figure 1). The plots were seeded at four populations: 103,508 , 122,632, 136,213, and 163,350 seeds per acre . These populations represent in-row spacings of 4.04, 3.41,3.07, and 2.56 inches, respectively.

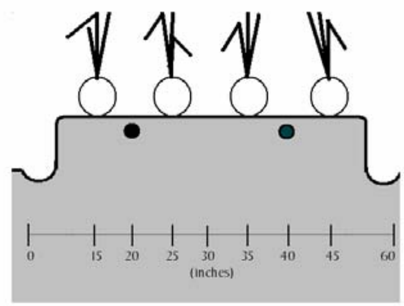

***Figure 1:** Planting and drip-line configuration in cross-section.*

On June 20th, a severe hailstorm almost completely defoliated the onions. They did, however, manage to recover. During the course of the season, normal pest control measures were taken. A total of 21 acre-inches of water was applied via the drip system. This amount includes a small amount used to flush the system of sediment and other particulates. The onions (and drip tape) were lifted and harvested on September 20th . Grading took place in late October.

Onion Spacing Trial

Arkansas Valley Research Center

Colorado State University, Rocky Ford, Colorado, 2004

In-row Spacing	*Seeds per acre*	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Jumbo Weight CWT/A*	*Medium 2 ¼"-3" %*	*Total Market. CWT/A*	***Culls %***
2.56	163,350	1.4	54.5	295.6	31.8	484.6	10.3
3.07	136,213	0.0	53.6	293.4	34.0	490.0	10.4
3.41	122,632	0.0	66.7	370.5	20.3	484.3	12.6
4.04	103,508	0.8	64.6	352.8	17.6	458.1	15.9
Lsd(0.1)				8.2		55.5	

2004 Onion – New and Biological Bactericide Study **September 16, 2004**

Dr. Howard F. Schwartz and David H. Gent, Dept. of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177

Objective: The objective of this study was to evaluate the effectiveness of new fungicides and bactericides in controlling the primary bacterial diseases in Colorado, including Xanthomonas Leaf Blight (*Xanthomonas campestris*), Sour Skin (*Burkholderia cepacia)*, Slippery Skin *(B. gladioli* pv. *alliicola*), Bacterial Soft Rot (*Erwinia carotovora* subsp. *carotovora*), and Pantoea leaf blight and center rot (*Pantoea ananatis*).

Experimental Design: Direct seeded onion plots were established at the Agricultural Research, Development, and Education Center (ARDEC) in Fort Collins and Irrigation Research Farm (IRF) near Yuma with the yellow onion variety 'Vantage'. All treatments were applied in 25 gallons of water per acre with a CO_2 backpack at 32 psi pressure, using Teejet 8002 flat-fan nozzles (2 per bed of 2 onion lines). Plots were one 30" wide row by 30 feet in length. The experiment was a randomized split-block design with 4 replicates. Weekly applications of ManKocide at 2 lb/A were applied to the sub-plot beginning two weeks prebulbing. Agriphage treatments were applied with 0.25% sucrose and 0.5% non-fat powdered skim milk at dusk or dawn. The field was furrow irrigated one to two times per week (ARDEC) or twice daily by sprinkler (IRF).

This study was replicated at the Arkansas Valley Research Center in Rocky Ford with the yellow variety 'X-202'. Plots at this site were 40" wide by 30 feet in length, separated by a single untreated spreader row. All treatments were applied in 25 gallons of water per acre at 32 psi with 8002 flat-fan nozzles (3 per bed of 2 onion lines). The experiment was a randomized split-block design with 4 replicates. Ten weekly applications of ManKocide at 2 lb/A were applied to the sub-plot beginning two weeks prebulbing. The field was furrow irrigated once weekly.

At all locations onions were grown according to standard production practices recommendations. All treatments were applied according to label recommendations.

Treatment protocols:

	Application Dates		
Main Plot Treatments	**Rocky Ford**	**ARDEC**	**Rate**
1. Untreated Control	(--)	(--)	(--)
2. Kocide 2000	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	1.5 lb/A
3. Actigard 50WG	6/28, 7/6, 7/12, 7/19	7/12, 7/18, 7/25, 7/29	0.75 oz/A
4. Blight Ban C9-1	6/28, 7/6	7/12, 7/18	10^{10}cfu/ml
5. Blight Ban C9-1/A506	6/28, 7/6	7/12, 7/18	10^{10}cfu/ml
6. Xaa Agriphage + 0.25% skim milk + 0.5% sucrose	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	1/100 dilution
7. Methyl Jasmonate	6/28, 7/6, 7/12, 7/19	7/12, 7/18, 7/25, 7/29	1 mM
Split Plot Treatments			
8. ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	(--)
9. Kocide 2000 + ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	1.5 lb/A
10. Actigard 50WG + ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	0.75 oz/A
11. Blight Ban C9-1 + ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	10^{10}cfu/ml
12. Blight Ban C9-1/A506 +ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	10^{10}cfu/ml
13. Xaa AgriPhage + ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	1/100 dilution
14. Methyl Jasmonate + ManKocide	6/28, 7/6, 7/12, 7/19, 7/26, 8/2, 8/9, 8/16, 8/23, 8/30	7/12, 7/18, 7/25, 7/29, 8/7, 8/15, 8/22, 8/29, 9/5	1 mM

Plot Inoculations: 10^8/ml bacterial cell suspension of X*anthomonas axonopodis* pv. *allii* strain RO177 amended with 0.25% v/v Silwet L-77: Rocky Ford 7/19/04; ARDEC 7/25/04 and 7/28/04; Yuma 8/21/2004 and 9/4/2004

Rocky Ford Disease Notes and Evaluations:

6/15/03 Xanthomonas leaf blight symptoms on volunteer onions
7/25/03 First disease evaluation
8/10/04 Second disease evaluation
8/16/04 Third disease evaluation
8/24/04 Fourth disease evaluation
9/09/04 Fifth disease evaluation

ARDEC Disease Notes and Evaluations:
8/05/04 Trace levels of Xanthomonas leaf blight first noted in plots
8/10/04 First disease evaluation
8/17/04 Second disease evaluation
8/29/04 Third disease evaluation
9/06/04 Fourth disease evaluation
9/16/04 Harvest (10' of one bed)

Yuma Disease Notes and Evaluations:
8/31/04 Trace levels of Xanthomonas leaf blight first noted in plots and first disease evaluation
9/4/04 Second disease evaluation
9/12/04 Third disease evaluation
10/13/04 Harvest and bulb rot evaluation from selected treatments (10' of one bed)

Results: Disease intensity ratings and relative area under the disease progress curve are presented for Rocky Ford, and ARDEC in Tables 1 and 2, respectively.

Main plot chemical treatments, subplot ManKocide treatments, and their interaction were significant in this study at Rocky Ford. Treatments that included Actigard with or without ManKocide significantly reduced disease severity and the relative area under the disease progress curve as compared to all other treatments. Actigard alone reduced the RAUDPC by 29 and 38% compared to Kocide 2000 and ManKocide, respectively. No other treatment significantly reduced the RAUDPC compared to ManKocide or Kocide 2000.

Main plot chemical treatments and subplot ManKocide treatments, but not their interaction, were significant in this study at ARDEC. Actigard with or without ManKocide also reduced the RAUDPC as compared to the untreated plots. Actigard alone provided disease suppression equivalent to weekly sprays of Kocide 2000 and superior to ManKocide. No other treatment significantly improved disease suppression compared to Kocide 2000 or ManKocide. Neither total nor marketable yield was significant in this trial, but Actigard treated plots had the highest total yield numerically.

At Yuma, little Xanthomonas leaf blight developed. Chemical treatment was nonsignificant for disease suppression or yield, but there was a general trend for less disease and higher yield of jumbo grade bulbs among ManKocide treated plots. Bulb rot incidence from slippery and sour skin was also measured at Yuma, and Actigard reduced the incidence of bulb rot 43% as compared to the untreated (28.5% to 12.2% incidence, P=0.0463). No other treatment was significantly less than the untreated.

Discussion: Under varying environmental conditions and production practices, Actigard (alone or tank-mixed with ManKocide) consistently provided disease suppression comparable or superior to weekly sprays of conventional copper and copper/EBDC bactericides. Actigard also appears to suppress bulb rot pathogens superior to ManKocide. Biological control of Xanthomonas leaf blight with BlightBan C9-1/A506 or Agriphage also appears promising. Agriphage tank-mixed directly with ManKocide appeared to improve disease control in this study, but the Agriphage manufacturer (OmniLytics, Inc., Salt Lake City, UT) recommends making applications at least 3 to 4 days following any copper application. Agriphage should be compatible with other biological control agents and Actigard.

Acknowledgements: Financial support from the Colorado State University Agricultural Experiment Station, Colorado Onion Association, and the USDA-Crops at Risk program is acknowledged and appreciated.

Table 1. Rocky Ford disease evaluations and relative area under the disease progress curve.

Main Plot Treatments	**Xanthomons leaf blight severity (%)**					
	7/25/04	**8/10/04**	**8/16/04**	**8/24/04**	**9/09/04**	**RAUDPC**
1. Untreated Control	29.25	34.75	43.75	50.63	56.25	0.48
2. Kocide 2000	18.50	22.00	27.88	31.25	31.25	0.29
3. Actigard 50WG	13.50	16.00	22.75	24.63	26.38	0.23
4. Blight Ban C9-1	20.25	29.38	34.38	37.50	40.63	0.36
5. Blight Ban C9-1/A506	18.75	18.25	23.25	28.13	31.25	0.26
6. Xaa Agriphage	22.00	28.00	37.50	34.38	43.75	0.37
7. Methyl Jasmonate	34.00	43.00	53.13	62.50	65.63	0.57
Split Plot Treatments						
8. ManKocide	20.25	26.00	32.25	34.38	40.63	0.34
9. Kocide 2000 + ManKocide	15.25	18.25	24.63	24.63	26.38	0.24
10. Actigard 50WG + ManKocide	12.25	13.00	21.50	21.50	25.00	0.21
11. Blight Ban C9-1 + ManKocide	16.00	25.38	29.50	31.25	37.50	0.31
12. Blight Ban C9-1/A506 + ManKocide	16.50	14.63	18.00	21.50	23.25	0.21
13. Xaa Agriphage + ManKocide	13.00	19.00	24.75	29.50	34.38	0.27
14. Methyl Jasmonate + ManKocide	32.00	41.00	46.88	59.38	65.63	0.54
C.V.%:	*21.96*	*27.53*	*21.25*	*23.25*	*24.17*	*20.41*
Treatment F Value:	*10.03*	*7.68*	*9.90*	*10.58*	*9.12*	*12.32*
Treatment P Value:	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
$LSD_{.05}$:	*6.31*	*9.81*	*9.56*	*11.67*	*13.53*	*0.09*

Table 2. ARDEC disease evaluations and relative area under the disease progress curve.

Main Plot Treatments	Xanthomons leaf blight severity (%)					
	8/10/04	8/17/04	8/29/04	9/06/04	9/16/04	RAUDPC
1. Untreated Control	22.00	33.00	34.38	37.50	37.50	0.29
2. Kocide 2000	21.00	23.00	24.50	25.00	25.00	0.21
3. Actigard 50WG	13.00	15.00	19.50	19.75	19.75	0.15
4. Blight Ban C9-1	26.00	29.88	34.38	40.63	40.63	0.30
5. Blight Ban C9-1/A506	22.00	24.75	24.75	25.00	25.00	0.22
6. Xaa Agriphage	21.00	23.50	26.13	29.50	31.25	0.23
7. Methyl Jasmonate	34.00	46.88	50.00	53.13	53.13	0.42
Split Plot Treatments						
8. ManKocide	18.00	27.88	27.63	31.25	31.25	0.24
9. Kocide 2000 + ManKocide	17.00	23.00	24.50	25.00	25.00	0.20
10. Actigard 50WG + ManKocide	13.00	13.50	18.00	19.75	21.50	0.15
11. Blight Ban C9-1 + ManKocide	21.00	25.88	26.38	28.13	31.25	0.23
12. Blight Ban C9-1/A506 + ManKocide	19.00	21.00	21.50	21.50	21.50	0.19
13. Xaa Agriphage + ManKocide	18.00	22.75	23.25	24.63	24.63	0.20
14. Methyl Jasmonate + ManKocide	30.00	43.75	50.00	50.00	50.00	0.40
C.V.%:	*22.29*	*21.98*	*17.00*	*19.30*	*18.73*	*15.93*
Treatment F Value:	*6.18*	*10.28*	*16.73*	*12.95*	*12.94*	*17.11*
Treatment P Value:	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
$LSD_{.05}$:	*6.72*	*8.39*	*7.04*	*8.50*	*8.37*	*0.06*

Table 3. Yuma disease evaluations, relative area under the disease progress curve, yield.

Main Plot Treatments	Xanthomons leaf blight severity (%)				Yield (cwt/A)		
	8/31/04	9/4/04	9/12/04	RAUDPC	Medium	Jumbo	Total
1. Untreated Control	5.3	6.0	10.5	0.06	7.7	7.6	16.8
2. Kocide 2000	3.4	3.0	5.6	0.03	8.3	8.0	17.9
3. Actigard 50WG	2.3	3.0	5.6	0.03	7.4	8.5	16.9
4. Blight Ban C9-1	3.4	4.1	9.8	0.04	7.5	9.8	18.2
5. Blight Ban C9-1/A506	2.6	3.4	8.6	0.04	7.0	8.0	16.0
6. Xaa Agriphage	3.0	4.9	9.4	0.04	7.9	7.7	17.3
7. Methyl Jasmonate	4.9	5.3	10.5	0.05	7.6	7.7	16.7
Split Plot Treatments							
8. ManKocide	2.3	3.4	4.1	0.03	6.1	10.7	17.8
9. Kocide 2000 + ManKocide	1.9	2.6	4.9	0.02	5.8	10.3	17.4
10. Actigard 50WG + ManKocide	1.5	2.1	4.1	0.02	6.2	8.6	16.2
11. Blight Ban C9-1 + ManKocide	2.3	2.3	3.4	0.02	5.7	11.2	18.6
12. Blight Ban C9-1/A506 + ManKocide	2.6	3.0	4.1	0.03	6.2	7.9	15.0
13. Xaa Agriphage + ManKocide	1.9	1.9	6.0	0.02	4.9	11.5	17.6
14. Methyl Jasmonate + ManKocide	2.6	3.4	8.3	0.04	6.9	9.3	17.7
C.V.%:	*58.65*	*47.06*	*35.5*	*34.65*	*21.59*	*28.61*	*11.11*
Treatment F Value:	*2.70*	*3.06*	*4.92*	*4.55*	*3.34*	*3.30*	*2.0*
Treatment P Value:	*0.0057*	*0.0022*	*<0.0001*	*<0.0001*	*0.0011*	*0.0012*	*0.0397*
$LSD_{.05}$:	*2.38*	*2.32*	*3.15*	*0.0165*	*2.09*	*3.69*	*2.72*

Table 4. Rocky Ford onion yield and grade.

Main Plot Treatments	Yield (lbs/plot)		
	Medium	Jumbo	Total
1. Untreated Control	15.4	8.8	25.9
2. Kocide 2000	12.9	8.0	22.9
3. Actigard 50WG	13.9	11.1	26.6
4. Blight Ban C9-1	15.5	7.8	25.5
5. Blight Ban C9-1/A506	13.8	7.6	23.4
6. Xaa Agriphage	15.8	7.3	24.8
7. Methyl Jasmonate	14.1	5.9	21.6
Split Plot Treatments			
8. ManKocide	14.8	9.5	26.6
9. Kocide 2000 + ManKocide	13.0	9.0	23.9
10. Actigard 50WG + ManKocide	13.6	10.8	26.1
11. Blight Ban C9-1 + ManKocide	15.4	5.9	24.6
12. Blight Ban C9-1/A506 + ManKocide	15.3	8.6	24.5
13. Xaa Agriphage + ManKocide	14.9	7.0	23.6
14. Methyl Jasmonate + ManKocide	16.6	4.5	22.9
C.V.%:	*19.62*	*38.76*	*12.67*
Treatment F Value:	*0.54*	*1.60*	*0.95*
Treatment P Value:	*0.9104*	*0.1143*	*0.5254*
$LSD_{.05}$:	*4.10*	*4.42*	*4.44*

Table 5. ARDEC onion yield and grade.

Main Plot Treatments	Yield (lbs/plot)	
	Medium	Total
1. Untreated Control	15.00	20.25
2. Kocide 2000	14.38	18.88
3. Actigard 50WG	16.75	24.50
4. Blight Ban C9-1	13.38	20.00
5. Blight Ban C9-1/A506	15.38	20.25
6. Xaa Agriphage	13.00	19.38
7. Methyl Jasmonate	8.88	14.50
Split Plot Treatments		
8. ManKocide	12.38	18.38
9. Kocide 2000 + ManKocide	12.38	21.13
10. Actigard 50WG + ManKocide	15.00	21.38
11. Blight Ban C9-1 + ManKocide	15.38	20.13
12. Blight Ban C9-1/A506 + ManKocide	17.13	21.13
13. Xaa Agriphage + ManKocide	13.00	18.50
14. Methyl Jasmonate + ManKocide	8.63	14.38
C.V.%:	*24.31%*	*18.64%*
Treatment F Value:	*2.03*	*2.09*
Treatment P Value:	*0.036*	*0.075*
$LSD_{.05}$:	*4.73*	*5.19*

2004 Onion – Bactericide Spray Timing Study November 1, 2004

Dr. Howard F. Schwartz and David H. Gent, Dept. of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177

Objective: The objective of this study was to evaluate spray timing and tank mixes of Kocide with varying rates of Maneb for Xanthomonas Leaf Blight (*Xanthomonas axonopodis* pv. *allii*) suppression.

Experimental Design: This study was conducted at the Arkansas Valley Research Center in Rocky Ford with the yellow variety 'X202'. Plots at this site were 40" wide by 60 feet in length, separated by a single untreated spreader row. All treatments were applied in 25 gallons per acre water at 32 psi with 8002 flat-fan nozzles (2 per bed of 2 onion lines). The experiment was a randomized split-block design with 4 replicates. The main plot received 1.5 lb/A Kocide 2000 and the subplots, each 15 feet in length, received 0.5, 1.0, or 2.0 lb/A Maneb 75 DF. Sprays programs were initiated on a weekly staggered schedule that began 4 weeks pre-bulbing to 2 weeks post-bulbing. The field was furrow irrigated and grown according to local recommendations.

Spray Protocol:

Table 1. Treatment application dates.

	Treatment Application Dates													
Timing	**5/31**	**6/7**	**6/14**	**6/21**	**6/28**	**7/6**	**7/12**	**7/19**	**7/26**	**8/2**	**8/9**	**8/16**	**8/23**	**8/30**
1.Maneb only*					x	x	x	x	x	x	x	x	x	x
2. 4 weeks pre-bulb	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3. 3 weeks pre-bulb		x	x	x	x	x	x	x	x	x	x	x	x	x
4. 2 weeks pre-bulb			x	x	x	x	x	x	x	x	x	x	x	x
5. 1 week pre-bulb				x	x	x	x	x	x	x	x	x	x	x
6. Bulbing					x	x	x	x	x	x	x	x	x	x
7. 1 week post-bulb						x	x	x	x	x	x	x	x	x
8. 2 week post-bulb							x	x	x	x	x	x	x	x

*Treatments 2 to 8 included Kocide 2000 at 1.5 lb/A

Results: A naturally-occurring late season epidemic of Xanthomonas leaf blight occurred and allowed for a comparison of treatments. On the last evaluation date, all treatments except the 2-weeks postbulb treatment reduced disease severity as compared to the untreated, but treatments applied at least 1 week prebulb initiation were the most effective (Table 1). No treatment significantly reduced the relative area under the disease progress curve or improved yield as compared to the untreated. We did observe a significant yield response from maneb treatment, ranging from 7.7 to 9.2% as compared to the no maneb treatments. No fungal diseases were observed in this experiment, so the basis for this yield response is unknown.

This study confirms previous work that sprays initiated earlier in the season provide better disease suppression, but sprays applied prior to 2-weeks before bulbing contribute little to Xanthomonas leaf blight control. Maneb or other EBDC fungicide tank-mixes will also provide fungal disease suppression and improve Kocide efficacy if copper resistant strains of bacteria are present, but do not appear necessary for Xanthomonas leaf blight suppression where copper-sensitive strains of the bacterium predominate.

ACKNOWLEDGEMENTS: We gratefully acknowledge the assistance of Mike Bartolo at Rocky Ford and financial support from the Colorado Onion Association and CSU Agricultural Experiment Station.

Table 1. Xanthomonas leaf blight severity and yield of onion at Rocky Ford, 2004.

Treatment[w]	Total sprays[y]	Final disease severity	RAUDPC	Yield (t/ha)y		
				Medium	Jumbo	Total
Untreated	10	13.0a	0.05a	10.4a	41.3a	52.3a
4-weeks prebulb	14	7.9d	0.04a	13.6a	37.3a	51.5a
3-weeks prebulb	13	7.6d	0.04a	11.4a	41.3a	52.8a
2-weeks prebulb	12	9.8cd	0.05a	11.7a	42.8a	53.9a
1 week prebulb	11	8.3d	0.04a	11.8a	40.9a	55.3a
Bulb intiation	10	10.8bc	0.05a	10.9a	44.2a	58.7a
1 week postbulb	9	10.5bc	0.05a	11.5a	42.3a	54.3a
2 weeks post bulb	8	12.3ab	0.06a	13.7a	39.1a	52.9a
Factor[z]						
Timing	--	0.0397	0.0761	0.6199	0.8102	0.4919
Maneb	--	0.9276	0.8685	0.6565	0.1052	0.0695
Timing*maneb	--	0.3425	0.3089	0.5476	0.3427	0.4906

2004 Onion-Bacteriophage Efficacy Study — October 19, 2004

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Objective: The objective of this study was to determine efficacy of bacteriophages (Agriphage, OmniLytics, Inc.) for control of onion Xanthomonas leaf blight caused by *Xanthomonas axonopodis* pv. *allii* compared to the industry standard bactericide, ManKocide, and in conjunction with Actigard 50WG (Syngenta, Inc.), a plant defense stimulating compound.

Experimental Design: Direct seeded onions were grown at the Agriculture Research Development Education Center (ARDEC) in Fort Collins, CO and at the Arkansas Valley Research Center (AVRC) in Rocky Ford, CO. At ARDEC, the susceptible yellow variety "Vantage" was used. Plots were 2.5' wide by 25' in length. All treatments were applied in 25 gallons of water per acre with a CO_2 backpack at 32 psi pressure, using Teejet 8002 flat-fan nozzles (2 per 15" boom). The experiment was set up in a randomized complete block design with 4 replications. The field was irrigated by furrow once to twice each week.

At AVRC, another susceptible variety of yellow onion, "X202," was directly planted. Plots were 3.3' wide by 25' in length. All treatments were applied in 25 gallons per acre water at 32 psi with Teejet 8002 flat-fan nozzles (2 per bed of 2 onion lines). This experiment was also set up in randomized complete block design with 4 replications. The field was furrow irrigated once each week.

Experimental Protocol:

Treatments*:	Product/Acre (unless otherwise stated):
1. Untreated Control	--
2. ManKocide	3 lb/A
3. *Xaa* Agriphage + Casecrete + PGCF + Sucrose	10^8pfu/ml + 0.5% + 0.5% + 0.25%
4. *Xaa* Agriphage + Casecrete + PGCF + Sucrose	10^8pfu/ml + 0.5% + 0.5% + 0.25%
ManKocide	3 lb/A
5. *Xaa* Agriphage +	10^8pfu/ml + 0.5% + 0.5% + 0.25%
Actigard 50WG(Sprays 1 and 2)	0.75 oz/A
6. Actigard 50WG(Sprays 1 and 2)	0.75 oz/A

*All Agriphage treatments were applied biweekly at dawn or dusk, with the exception of treatment 4, which was a biweekly rotation with ManKocide; ManKocide was applied weekly.

Treatment Application Dates:

ARDEC	AVRC
(1) 8 July	(1) 8 July
(2) 12 July	(2) 12 July
(3) 15 July	(3) 15 July
(4) 19 July	(4) 19 July
(5) 22 July	(5) 22 July
(6) 26 July	(6) 26 July
(7) 29 July	(7) 29 July
(8) 2 August	(8) 2 August
(9) 5 August	(9) 5 August
(10) 9 August	(10) 9 August
(11) 12 August	(11) 12 August
(12) 15 August	(12) 15 August
(13) 19 August	(13) 19 August
(14) 23 August	(14) 22 August
(15) 26 August	(15) 26 August
(16) 30 August	(16) 29 August

Plot Inoculations: 10^8cfu/ml *Xanthomonas axonopodis* pv. *allii* strain RO177

ARDEC	AVRC
(1) 22 July	(1) 19 July
(2) 10 August	

(17) 2 September
(18) 6 September
(19) 9 September

Disease Notes and Evaluations:

8/12/04	ARDEC, first disease evaluation
8/16/04	AVRC, first disease evaluation
8/20/04	ARDEC, second disease evaluation
8/22/04	AVRC, second disease evaluation
8/29/04	AVRC, third disease evaluation
8/30/04	ARDEC, third disease evaluation
9/6/04	ARDEC, fourth disease evaluation
9/16/04	ARDEC, fifth disease evaluation
9/30/04	AVRC, 8' length harvested and sorted to market class (jumbo, medium)
10/11/04	ARDEC, 10' length harvested and sorted to market class (jumbo, medium)

Results: Disease severity ratings, relative area under the disease progress curve and yield data are presented for ARDEC and AVRC in Tables 1 and 2, respectively. At ARDEC, all treatments suppressed leaf blight in third, fourth and fifth disease evaluations. The rAUDPC was reduced by all treatments compared to the untreated and were not different from ManKocide. The Agriphage with Actigard 50WG treatment reduced the rAUDPC more than all other treatments. Yield was not affected by any treatment.

At AVRC, Agriphage with ManKocide, Agriphage with Actigard 50WG and Actigard 50WG alone reduced disease severity in all evaluations but were never different from each other. Again, the rAUDPC was reduced by all treatments compared to the untreated. ManKocide and Agriphage alone were not different from each other. Agriphages with ManKocide, Agriphage with Actigard 50WG and Actigard 50WG alone lowered the rAUDPC more than other treatments but were not different from each other. Yield was not affected by any treatment.

Table 1. Xanthomonas leaf blight suppression and yield of onion variety "Vantage" at ARDEC, 2004

	Disease Severity						**Yield (cwt/A)**		
Treatment	**8/12**	**8/20**	**8/30**	**9/6**	**9/16**	**rAUDPC**	**Medium**	**Jumbo**	**Total**
1.Untreated control	14.1a	23.6ab	25.5a	37.2a	50.0a	0.21a	19.0a	9.6a	35.9a
2.ManKocide	11.0b	24.0a	22.3b	32.2b	41.0b	0.18b	17.8ab	7.0a	30.9a
3. *Xaa* Agriphage	13.9a	21.3ab	19.5c	29.8b	38.5bc	0.18b	13.3b	12.5a	30.8a
4. *Xaa* Agriphage + ManKocide	13.7a	22.3ab	20.5bc	30.7b	40.0bc	0.18b	14.8ab	13.9a	33.0a
5. *Xaa* Agriphage +Actigard 50WG	10.0b	18.2c	19.1c	30.0b	37.3c	0.16c	17.6ab	10.4a	33.3a
6. Actigard 50WG	14.2a	21.0bc	22.5b	30.3b	40.5b	0.18b	19.1a	10.4a	36.9a
CV%:	*47.68*	*30.67*	*27.43*	*22.34*	*16.58*	*13.88*	*19.08*	*44.66*	*12.54*
Treatment F:	*4.52*	*4.01*	*6.29*	*5.76*	*11.42*	*12.24*	*1.9*	*0.75*	*1.13*
Treatment P:	*<0.0001*	*0.0002*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.1344*	*0.6521*	*0.3987*
$LSD_{.05}$:	*2.69*	*2.94*	*2.61*	*3.12*	*3.01*	*0.01*	*4.86*	*7.15*	*6.32*

Table 2. Xanthomonas leaf blight suppression and yield of onion variety “X-202” at AVRC 2004.

	Disease Severity				Yield (cwt/A)		
Treatment	**8/16**	**8/22**	**8/29**	**rAUDPC**	**Medium**	**Jumbo**	**Total**
1. Untreated control	42.6a	41.4a	41.7a	0.28a	14.9a	9.13a	26.1b
2. ManKocide	32.9b	37.1ab	38.6ab	0.23b	16.9a	8.3a	26.9ab
3. *Xaa* Agriphage	33.5b	34.1bc	38.0ab	0.22b	16.6a	9.0a	27.1ab
4. *Xaa* Agriphage + ManKocide	25.7c	31.9bc	35.1bc	0.19c	16.8a	8.9a	30.4a
5. *Xaa* Agriphage + Actigard 50WG	25.8c	31.8c	33.0c	0.19c	15.6a	7.9a	26.8ab
6. Actigard 50WG	22.3c	32.4bc	34.9bc	0.18c	15.0a	10.8a	28.4ab
CV%:	*45.19*	*33.96*	*24.36*	*28.64*	*16.84*	*45.42*	*8.85*
Treatment F:	*9.36*	*3.35*	*3.14*	*10.79*	*0.67*	*0.30*	*1.94*
Treatment P:	*<0.0001*	*0.0012*	*0.0021*	*<0.0001*	*0.7123*	*0.9565*	*0.1270*
$LSD_{.05}$:	*6.06*	*5.20*	*3.96*	*0.0271*	*4.05*	*6.15*	*3.68*

Acknowledgements: We gratefully acknowledge the cooperation and assistance of Mike Bartolo at AVRC and Mike Matsuda at ARDEC; and financial assistance from the USDA Western Region IPM and Crops at Risk grants 2003-41530-01668 and 2003-34103-13676, as well as the Colorado Onion Association.

2004 Onion-Bacteriophage Interval Study **October 19, 2004**

Dr. Howard F. Schwartz, Jillian M. Lang and David H. Gent, Dept. Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177

Objective: The objective of this study was to determine the most efficient interval for applying bacteriophages (Agriphage, OmniLytics, Inc.) for control of onion Xanthomonas leaf blight caused by *Xanthomonas axonopodis* pv. *allii* compared to the industry standard copper bactericide, ManKocide.

Experimental Design: Direct seeded onions were grown at the Agriculture Research Development Education Center (ARDEC) in Fort Collins, CO and at the Arkansas Valley Research Center (AVRC) in Rocky Ford, CO. At ARDEC, the susceptible yellow variety "Vantage" was used. Plots were 2.1' wide by 25' in length. All treatments were applied in 25 gallons of water per acre with a CO_2 backpack at 32 psi pressure, using Teejet 8002 flat-fan nozzles (2 per 15" boom). The experiment was set up in a randomized complete block design with 4 replications. The field was irrigated by furrow once to twice each week.

At AVRC, another susceptible variety of yellow onion, "X202," was directly planted. Plots were 40" wide by 25' in length. All treatments were applied in 25 gallons per acre water at 32 psi with Teejet 8002 flat-fan nozzles (2 per bed of 2 onion lines). This experiment was also set up in randomized complete block design with 4 replications. The field was furrow irrigated once a week.

Experimental Protocol:

Treatments*:	Product/Acre (unless otherwise stated):
6. Untreated Control	--
7. ManKocide	3 lb/A
8. *Xaa* Agriphage + sucrose + powdered skim milk 7 day interval	10^8pfu/ml + 0.5% + 0.75%
9. *Xaa* Agriphage + sucrose + powdered skim milk 3 to 4 day interval	10^8pfu/ml + 0.5% + 0.75%
10. *Xaa* Agriphage + sucrose + powdered skim milk 14 day interval	10^8 pfu/ml + 0.5% + 0.75%

*All Agriphage treatments were applied at dawn or dusk, ManKocide was applied weekly.

Treatment Application Dates:

ARDEC	AVRC
(1) 8 July	(1) 8 July
(2) 12 July	(2) 12 July
(3) 15 July	(3) 15 July
(4) 19 July	(4) 19 July
(5) 22 July	(5) 22 July
(6) 26 July	(6) 26 July
(7) 29 July	(7) 29 July
(8) 2 August	(8) 2 August
(9) 5 August	(9) 5 August
(10) 9 August	(10) 9 August
(11) 12 August	(11) 12 August
(12) 15 August	(12) 15 August
(13) 19 August	(13) 19 August
(14) 23 August	(14) 22 August
(15) 26 August	(15) 26 August
(16) 30 August	(16) 29 August

Plot Inoculations: 10^8cfu/ml *Xanthomonas axonopodis* pv. *allii* strain RO177

ARDEC	AVRC
(1) 22 July	(1) 19 July
(2) 10 August	

Disease Notes and Evaluations:

8/12/04	ARDEC, first disease evaluation
8/16/04	AVRC, first disease evaluation
8/20/04	ARDEC, second disease evaluation
8/22/04	AVRC, second disease evaluation
8/29/04	AVRC, third disease evaluation
8/30/04	ARDEC, third disease evaluation
9/6/04	ARDEC, fourth disease evaluation

9/16/04 ARDEC, fifth disease evaluation
9/30/04 AVRC, 8' length harvested and sorted to market class (jumbo, medium)
10/11/04 ARDEC, 10' length harvested and sorted to market class (jumbo, medium)

Results: Disease severity ratings, relative area under the disease progress curve and yield data are presented for ARDEC and AVRC in Tables 1 and 2, respectively. At ARDEC, ManKocide and the 14-day interval Agriphage never reduced disease severity, except the latter on the fourth evaluation. The rAUDPC was reduced only by the 3 to 4 and 7-day Agriphage intervals compared to the untreated, while all other treatments were not different from each other. No treatment affected yield.

At AVRC, the 14-day Agriphage interval never reduced disease severity compared to the untreated. Again, the rAUDPC was reduced by all treatments except the 14-day Agriphage interval, but those treatments were not different from each other. Total yield was not affected by any treatment. Overall, the standard 3 to 4 day Agriphage interval was the most successful, while the 7-day interval is just as effective as ManKocide at reducing onion Xanthomonas leaf blight.

Table 1. Xanthomonas leaf blight suppression and yield of onion variety "Vantage" at ARDEC, 2004.

	Disease Severity						**Yield (cwt/A)**		
Treatment	**8/12**	**8/20**	**8/30**	**9/6**	**9/16**	**rAUDPC**	**Medium**	**Jumbo**	**Total**
1. Untreated control	14.6a	28.0a	24.2a	40.5a	40.5a	0.22a	19.0a	16.1a	35.3a
2. ManKocide	12.7ab	27.6a	25.2a	39.4ab	38.3a	0.21a	14.4a	13.1a	30.5a
3. *Xaa* Agriphage 7-day interval	11.9ab	25.5ab	25.2a	34.8cd	40.3a	0.20b	14.9a	16.4a	34.8a
4. *Xaa* Agriphage 3 to 4 day interval	11.4ab	22.9b	24.4a	33.9d	35.3b	0.19c	17.1a	13.0a	34a
5. *Xaa* Agriphage 14-day interval	14.0a	25.7ab	24.4a	37.2cd	38.5a	.021ab	12.1a	15.8a	30.5a
CV%:	*49.56*	*30.59*	*20.2*	*17.22*	*14.55*	*13.31*	*32.59*	*47.02*	*20.57*
Treatment F:	*1.37*	*1.74*	*0.66*	*5.29*	*4.7*	*4.52*	*1.01*	*.19*	*.41*
Treatment P:	*0.2195*	*0.1025*	*0.7035*	*<0.0001*	*<0.0001*	*<0.0001*	*0.4721*	*0.9823*	*0.8753*
$LSD_{.05}$:	*2.78*	*3.5*	*2.22*	*2.82*	*2.47*	*0.01*	*7.78*	*10.34*	*10.46*

Table 2. Xanthomonas leaf blight suppression and yield of onion variety "X-202" at AVRC, 2004.

	Disease Severity				**Yield (cwt/A)**		
Treatment	**8/16**	**8/22**	**8/29**	**rAUDPC**	**Medium**	**Jumbo**	**Total**
1. Untreated control	42.4a	40.6a	33.38a	0.27a	15.5ab	7.3bc	25.9a
2. ManKocide	37.9a	35.6c	27.7b	0.24bc	13.1b	12.3a	25.9a
3. *Xaa* Agriphage 7-day interval	39.5a	35.6c	30.2ab	0.24bc	17.4a	6.1c	26.0a
4. *Xaa* Agriphage 3 to 4 day interval	37.5a	36.2bc	30.8ab	0.23c	15.6ab	11.3ab	27.3a
5. *Xaa* Agriphage 14-day interval	42.3a	39.9ab	31.7ab	0.26ab	16.3ab	9.1abc	25.6a
CV%:	*33.09*	*22.08*	*31.41*	*22.75*	*16.09*	*32.49*	*9.89*
Treatment F:	*1.11*	*3.6*	*3.46*	*2.12*	*1.42*	*2.25*	*0.28*
Treatment P:	*0.0357*	*0.0011*	*0.0016*	*0.0437*	*0.2844*	*0.1034*	*0.9483*
$LSD_{.05}$:	*5.82*	*3.66*	*4.26*	*0.03*	*3.86*	*4.61*	*3.98*

Acknowledgements: We gratefully acknowledge the cooperation and assistance of Mike Bartolo at AVRC and Mike Matsuda at ARDEC; and financial assistance from the USDA Western Region IPM and Crops at Risk grants 2003-41530-01668 and 2003-34103-13676, as well as the Colorado Onion Association.

2004 Onion-Bacteriophage Titer Study **October 19, 2004**

Dr. Howard F. Schwartz, Jillian M. Lang and David H. Gent, Dept. Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523-1177

Objective: The objective of this study was to determine the most efficient titer of bacteriophages (Agriphage, OmniLytics, Inc.) required for control of onion Xanthomonas leaf blight caused by *Xanthomonas axonopodis* pv. *allii* compared to the industry standard copper bactericide, ManKocide.

Experimental Design: Direct seeded onions were grown at the Agriculture Research Development Education Center (ARDEC) in Fort Collins, CO and at the Arkansas Valley Research Center (AVRC) in Rocky Ford, CO. At ARDEC, the susceptible yellow variety "Vantage" was used. Plots were 2.5' wide by 25' in length. All treatments were applied in 25 gallons of water per acre with a CO_2 backpack at 32 psi pressure, using Teejet 8002 flat-fan nozzles (2 per 15" boom). The experiment was set up in a randomized complete block design with 4 replications. The field was irrigated by furrow once to twice each week.

At AVRC, another susceptible variety of yellow onion, "X202," was directly planted. Plots were 3.3" wide by 25' in length. All treatments were applied in 25 gallons per acre water at 32 psi with Teejet 8002 flat-fan nozzles (2 per bed of 2 onion lines). This experiment was also set up in randomized complete block design with 4 replications. The field was furrow irrigated once a week.

Experimental Protocol:

Treatments*:		Product/Acre (unless otherwise stated):
11.	Untreated Control	--
12.	ManKocide	3 lb/A
13.	*Xaa* Agriphage + sucrose + powdered skim milk	10^8pfu/ml + 0.5% + 0.75%
14.	*Xaa* Agriphage + sucrose + powdered skim milk	10^7pfu/ml + 0.5% + 0.75%
15.	*Xaa* Agriphage + sucrose + powdered skim milk	10^6 pfu/ml + 0.5% + 0.75%
16.	*Xaa* Agriphage + sucrose + powdered skim milk	10^5 pfu/ml + 0.5% + 0.75%

*All Agriphage treatments were applied biweekly at dawn or dusk, ManKocide was applied weekly.

Treatment Application Dates:

ARDEC:	AVRC:
(1) 8 July	(1) 8 July
(2) 12 July	(2) 12 July
(3) 15 July	(3) 15 July
(4) 19 July	(4) 19 July
(5) 22 July	(5) 22 July
(6) 26 July	(6) 26 July
(7) 29 July	(7) 29 July
(8) 2 August	(8) 2 August
(9) 5 August	(9) 5 August
(10) 9 August	(10) 9 August
(11) 12 August	(11) 12 August
(12) 15 August	(12) 15 August
(13) 19 August	(13) 19 August
(14) 23 August	(14) 22 August
(15) 26 August	(15) 26 August
(16) 30 August	(16) 29 August

Plot Inoculations: 10^8cfu/ml *Xanthomonas axonopodis* pv. *allii* strain RO177

ARDEC:	AVRC:
(1) 22 July	(1) 19 July
(2) 10 August	

Disease Notes and Evaluations:

8/12/04	ARDEC, first disease evaluation
8/16/04	AVRC, first disease evaluation
8/20/04	ARDEC, second disease evaluation
8/22/04	AVRC, second disease evaluation
8/29/04	AVRC, third disease evaluation
8/30/04	ARDEC, third disease evaluation
9/6/04	ARDEC, fourth disease evaluation

9/16/04 ARDEC, fifth disease evaluation
9/30/04 AVRC, 8' length harvested and sorted to market class (jumbo, medium)
10/11/04 ARDEC, 10' length harvested and sorted to market class (jumbo, medium)

Results: Disease severity ratings, relative area under the disease progress curve and yield data are presented for ARDEC and AVRC in Tables 1 and 2, respectively. At ARDEC, all treatments suppressed leaf blight in the fourth and fifth disease evaluation. ManKocide was worse than 10^8pfu/ml Agriphage and was not different than the lower titer Agriphage treatments. The rAUDPC was reduced by all Agriphage treatments compared to the untreated, but not by ManKocide. However the varied titers did not affect the rAUDPC differently from each other.

At AVRC, 10^8pfu/ml Agriphage reduced leaf blight compared to the untreated in all evaluations. Varied Agriphage titer treatments were not different from each other in any evaluation. ManKocide was never different from any Agriphage treatment in any evaluation. The rAUDPC was not reduced by any treatment and treatments were not different from each other. Yield was not affected by any treatment.

Table 1. Xanthomonas leaf blight suppression and yield of onion variety "Vantage" at ARDEC, 2004.

	Disease Severity						Yield (cwt/A)		
Treatment	**8/12**	**8/20**	**8/30**	**9/6**	**9/16**	**rAUDPC**	**Medium**	**Jumbo**	**Total**
1. Untreated control	14a	24.1a	26.8a	38.8a	49.5a	0.22a	20.0a	10.0a	33.5a
2. ManKocide	18.1a	25.1a	23.4bc	33.4bc	40.0b	0.21ab	15.63a	14.1a	33.0a
3. *Xaa* Agriphage 10^8pfu/ml	16.5ab	23.8a	21.7c	30.7c	36.1c	0.19c	15.13a	11.3a	29.1a
4. *Xaa* Agriphage 10^7pfu/ml	15.1ab	22.3ab	23.4bc	31.8bc	37.2bc	0.19c	13.8a	10.9a	29.8a
5. *Xaa* Agriphage 10^6pfu/ml	18.1a	19.7b	25.0ab	34.1b	38.5bc	0.20bc	18.9a	10.4a	33.6a
6. *Xaa* Agriphage 10^5pfu/ml	17.4a	19.0b	23.0ab	32.3bc	39.3bc	0.19c	18.0a	12.7a	35.5a
CV%:	*43.24*	*39.48*	*19.95*	*20.44*	*18.34*	*14.35*	*26.94*	*41.74*	*15.61*
Treatment F:	*1.9*	*3.63*	*4.31*	*4.69*	*12.81*	*5.39*	*0.87*	*0.51*	*1.13*
Treatment P:	*0.0604*	*0.0005*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.5631*	*0.8302*	*0.4004*
$LSD_{.05}$:	*3.15*	*3.89*	*2.10*	*3.02*	*3.24*	*0.01*	*6.86*	*7.26*	*7.63*

Table 2. Xanthomonas leaf blight suppression and yield of onion variety "X-202" at AVRC, 2004.

	Disease Severity				Yield (cwt/A)		
Treatment	**8/16**	**8/22**	**8/29**	**rAUDPC**	**Medium**	**Jumbo**	**Total**
1. Untreated control	43.6a	44.0a	39.7a	0.26a	15.5a	10.63ab	26.9ab
2. ManKocide	37.1b	39.3ab	36.3ab	0.25a	14.9ab	11.63a	27.6a
3. *Xaa* Agriphage 10^8pfu/ml	36.4b	36.6b	34.4b	0.24a	17.1a	6.13c	24.4b
4. *Xaa* Agriphage 10^7pfu/ml	40.1ab	38.2b	37.0ab	0.26a	10.4b	11.63a	25.8ab
5. *Xaa* Agriphage 10^6pfu/ml	41.0ab	39.2ab	36.1ab	0.26a	17.9a	7.5bc	25.9ab
6. *Xaa* Agriphage 10^5pfu/ml	40.3ab	37.1b	35.8ab	0.25a	16.1a	7.0bc	24.8ab
CV%:	*34.0*	*28.76*	*27.29*	*25.19*	*20.92*	*27.92*	*7.63*
Treatment F:	*1.64*	*1.53*	*1.41*	*1.58*	*2.20*	*3.12*	*1.11*
Treatment P:	*0.1153*	*0.1469*	*0.1913*	*0.1320*	*0.0892*	*0.0276*	*0.4107*
$LSD_{.05}$:	*5.95*	*4.95*	*4.39*	*0.03*	*4.83*	*3.82*	*2.98*

Acknowledgements: We gratefully acknowledge the cooperation and assistance of Mike Bartolo at AVRC and Mike Matsuda at ARDEC; and financial assistance from the USDA Western Region IPM and Crops at Risk grants 2003-41530-01668 and 2003-34103-13676, as well as the Colorado Onion Association.

Inoculum Sources and Survival of *Xanthomonas axonopodis* pv. *allii* in Colorado

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ABSTRACT

Gent, D. H., Lang, J. M., Bartolo, M. E., and Schwartz, H. F. 2005. Inoculum sources and survival of *Xanthomonas axonopodis* pv. *allii* in Colorado. Plant Dis. 90:xx

Xanthomomas leaf blight, caused by the bacterium *Xanthomonas axonopodis* pv. *allii*, is an emerging disease of onion in the western U. S. and worldwide, but few management strategies have been developed because little is known about disease epidemiology and pathogen survival. Therefore, we sought to identify and quantify primary inoculum sources of the pathogen in Colorado. Growth chamber and field studies evaluated survival and dissemination of *X. axonopodis* pv. *allii* in association with weed, alternate host, and volunteer onion plants, irrigation water, and crop debris. Epiphytic *X. axonopodis* pv. *allii* was recovered from the foliage of nine asymptomatic weed species and *Medicago sativa*, but the bacterium was not recovered from plants in locations where an epidemic of Xanthomonas leaf blight did not occur the prior year. The bacterium also was isolated from volunteer onion with characteristic Xanthomonas leaf blight symptoms. A rifampicin mutant of *X. axonopodis* pv. *allii* strain O177 was recovered consistently from the irrigation tail water of onion fields inoculated with the bacterium; populations as large as 3.02 x 10^4 CFU/ml were recovered. *X. axonopodis* pv. *allii* was recovered from infested onion leaves nine months after they were placed on the soil surface or buried to a depth of 25 cm, but culturable populations of the pathogen decreased 10^4 to 10^6 more in buried leaves. Cultural practices that avoid or eliminate *X. axonopodis* pv. *allii* inoculum sources should reduce Xanthomonas leaf blight losses to onion.

Additional keywords: *Allium cepa*, integrated pest management, onion bacterial blight, *Xanthomonas campestris* pv. *allii*

ONION RESPONSE TO NITROGEN FERTILIZATION UNDER DRIP AND FURROW IRRIGATION

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ABSTRACT

Onion is a high cash value crop with a very shallow root system that is frequently fertilized with high N rates (>200 lb N/a) to maximize yield. In 2005, we applied six N rates (0, 40, 80, 120, 160, and 200 lb N/a) to existing N plots previously cropped to corn (2000-2003) and chile pepper (2004). The N source was a polycoated urea with a 90 to 120 day release period which was applied prior to planting. The N main plots were split in 2005 to allow irrigation by furrow (normal method) and by a drip system. At the end of the season, a total of 27 inches of irrigation water had been applied with the drip system and 96 inches with the furrow system. Total marketable fresh onion yield increased with increasing N rate in both systems, with less response of onion to N with the drip system compared to the furrow irrigation system. Significantly higher onion yields were obtained with the drip system. The percentage of the onion crop that was of colossal size (>4 inch diameter) increased from 5% to 14% with increasing N rate, jumbo size (3-4 inch diameter) which made up 80% of the yield was not affected by N rate, and medium size (2-3 inch diameter) decreased from 14% to 5% with increasing N rate. Adjusted gross economic returns were greater with drip irrigation than with furrow irrigation. This work demonstrates that economic returns can be maintained by using the more efficient drip irrigation system for onion production rather than the inefficient furrow irrigation system. With the drip system, onion yields were maximized with a lower rate of N fertilizer and 72% less irrigation water than with the furrow irrigation system.

INTRODUCTION

High NO_3-N levels have been reported in groundwater in the Arkansas River Valley in Colorado (Austin, 1997; Ceplecha et al., 2004), which is a major producer of melons, onions, and other vegetable crops grown in rotation with alfalfa, corn, sorghum, winter wheat, and soybeans. High rates of N fertilizer (>200 lb N/a) are usually applied to onion to increase overall yield and bulb size, generally without regard to soil testing (Bartolo et al., 1997). Halvorson et al. (2002) reported nitrogen fertilizer use efficiency (NFUE) by onion to be only 15%. Onion has a shallow rooting depth (<2 ft) and requires frequent irrigation to maintain market quality. High N fertilization rates to shallow-rooted crops, shallow water tables, and excess water application to control soil salinity all contribute to a high NO_3-N leaching potential in this area (Halvorson et al., 2001, 2002a, 2002b). Irrigation, crop, and N management practices need to be developed to reduce NO_3-N leaching potential and improve N use efficiency (NUE). Halvorson et al. (2005) established a N fertility study in 2000 to evaluate the use of continuous corn to reduce the residual soil NO_3-N levels in the Arkansas River Valley in Colorado. They found that residual soil NO_3-N levels were reduced significantly by corn with conservative N fertilizer application. These same N plots were planted to chile pepper in 2004 and to onion in 2005 to determine the effects of N fertilization on vegetable crop yields and residual soil NO_3-N.

The objective of the research reported here was to determine N fertilizer needs of onion under drip and furrow irrigation in Arkansas River Valley to optimize yield and quality following corn and chile pepper, and evaluate the influence of N fertilizer rate and irrigation system on residual soil NO_3-N and potential for groundwater contamination.

METHODS AND MATERIALS

A N source and rate study was initiated under conventional till, furrow-irrigated corn on a calcareous Rocky Ford silty clay loam soil at the Arkansas Valley Research Center (AVRC) in 2000 (Halvorson et al., 2005). The plot area had previously been in continuous corn for 4 years and chile pepper in 2004. Six N rates (0, 40, 80, 120, 160, and 200 lb N/a or N1, N2, N3, N4, N5, N6, respectively) were established on February 22, 2005. The N source was a controlled-release polycoated urea (Duration Type III produced by Agrium[3c]; cost $950/ton or $1.10/lb N) with a 90 to 120 day release period. The N fertilizer was broadcast and incorporated with a harrow on February 28, 2005. Two irrigation systems were used, furrow irrigation (normal practice) and drip irrigation. A split-plot, randomized complete block design with N rate as main plots and irrigation system as subplots with 4 replications was used.

Onion (var. Ranchero) was planted on March 8, 2005 at a seeding rate of about 129,466 seeds per acre. At harvest, the plant population was 106,649 plants/a when averaged over all plots. Two rows of onion were planted on a 10 inch bed with a 30 inch row spacing (furrow to furrow). The onions were harvested on August 29th for fresh weight yield and graded for quality (size). Marketable onion sizes were colossal (<4" diameter), jumbo (3 to 4" diameter), and medium (2 to 3" diameter). Onion yields are expressed as bags (one bag = 50 lbs) of fresh onion weight per acre. Estimated gross return per acre was calculated based on a harvest price of $10/bag of colossal, $8/bag of jumbo, and $6/bag of medium size onions. Water cost was estimated at $11 per acre-ft. The drip irrigation system was estimated to cost $750 per acre. Herbicides were applied for weed control, with the plots being relatively weed free during the study period. Soil NO_3-N levels in the 0-6 ft profile were measured before fertilization and after harvest. The spring soil NO_3-N levels were 40, 43, 50, 50, 62, and 81 lb N/a in the 0- to 2-ft soil depth, and 71, 71, 78, 66, 99, and 111 lb N/a in the 0- to 6-ft soil depth for the N1, N2, N3, N4, N5, and N6 treatments. Soil sample collected after harvest had not been analyzed for NO_3-N when this article was prepared.

The onions under drip irrigation were irrigated 20 times during the growing season with a total water application of 27 inches (2.22 acre feet). The drip tape was located about 2-3 inches below the soil surface on the bed between the two onion rows. Onions under furrow irrigation received a total of 96 inches (8.03 acre feet) of irrigation water in 13 irrigations. Under furrow irrigation, water was applied to every furrow (30 inch spacing) to obtain uniform wetting of both onion rows on the bed. The runoff water from the furrow irrigated plots was estimated using a flume placed in the furrow at the lower end of the field. Approximately 32.4 inches (2.7 acre feet) of water ran off the end of the field in the furrow irrigated system. No water was lost off the end of the field with the drip system. Water samples collected for NO_3-N analysis have not been analyzed. Assuming similar NO_3-N levels

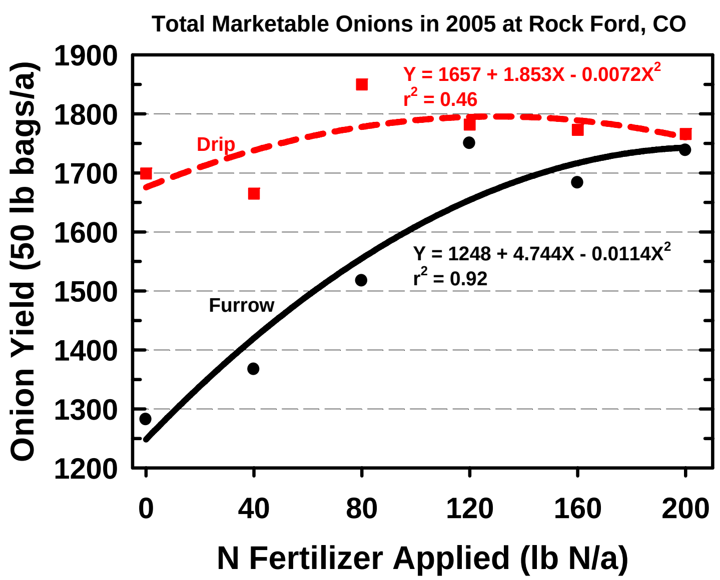

Figure 1. Onion yield as a function of N fertilizer rate and irrigation system.

[c] Trade names and company names are included for the benefit of the reader and do not imply any endorsement or preferential treatment of the product by the authors or the USDA, Agricultural Research Service.

in the irrigation water as in previous years (2.6 ppm), about 16 lb NO_3-N/a was added to the soil with the drip system and 37 lb NO_3-N/a with the furrow irrigation system.

Precipitation during the growing season was 1.55" in March, 0.75" in April, 0.49" in May, 1.05" in June, 0.45" in July, and 2.17" in August. Total precipitation for the growing season was 6.46 inches.

RESULTS

Excellent onion yields were obtained in 2005 at Rocky Ford, CO. Onion yields increased with increasing N rate for both irrigation systems (Fig. 1), with the drip system having a significantly greater yield (1756 bags/a) than the furrow irrigation system (1556 bags/a). The N rate x irrigation system interaction shown in Fig. 1 was significant at P = 0.159. Marketable onion yields were near maximum with the application of 80 to 120 lb N/a with the drip system, whereas, the 200 lb N/a rate was needed in the furrow system to attain equal yields to those in the drip system. Differences in yield between the two irrigation systems were greatest at the lower N rates, with the difference diminishing as N rate increased.

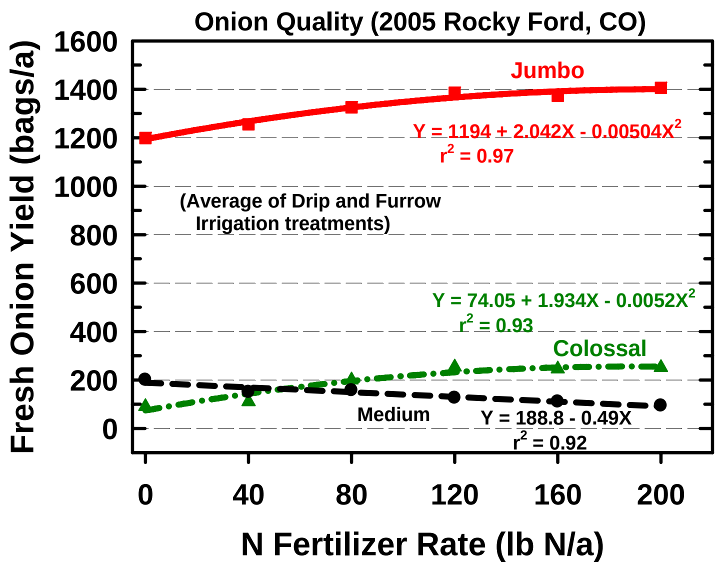

Figure 3. Onion market class distribution as a function of N fertilizer rate in 2005 at Rocky Ford, CO.

Onion quality, as indicated by size of onion, increased with increasing N rate for the colossal onion (P = 0.117) and the jumbo onion (P = 0.0223) but decreased in size for the medium onion (P = 0.018) with increasing N rate (Fig. 2) when averaged over both irrigation systems (N rate x irrigation system interactions were not significant, P > 0.5). The drip system had more colossal and jumbo size onions than the furrow system, but fewer medium size onions than the furrow system. Colossal size onions averaged 223 bags/a with the drip system and 161 bags/a with the furrow irrigation system (P = 0.191). The percentage of colossal size onions increased from 5% for the check plot (no N added) to a maximum of 14% of the marketable onions at the 120 and 160 lb N/a rates (P = 0.077). Jumbo size onion averaged 1403 bags/a with the drip system and 1245 bags/a with the furrow system (P = 0.0058). Increasing N rate did not change the percentage of jumbo size onion as a percentage of the total marketable onion yield, averaging 80 % over all N rates and irrigation systems. Medium size onions averaged 130 bags/a with the drip system and 150 bags/a with the furrow system (P = 0.317). Increasing N rate decreased the percentage of medium sized onions from 14 % at the lowest N level to 5% at the highest N level. This demonstrates the need to have

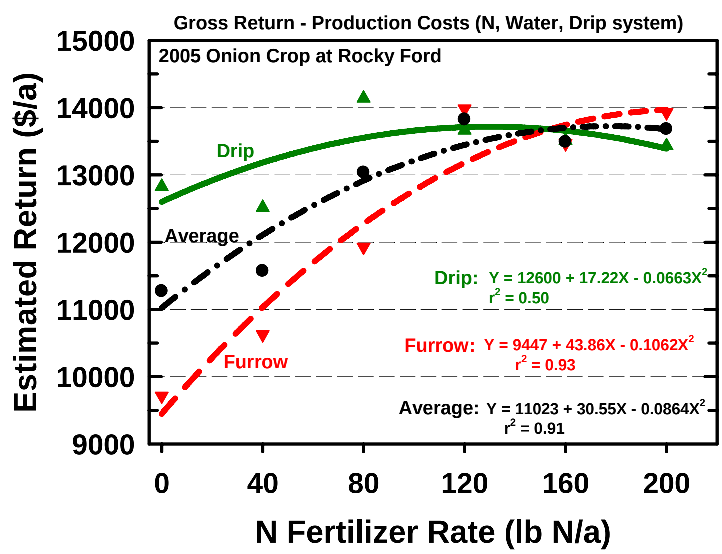

Figure 2. Adjusted gross return as a function of N rate and irrigation system and average of irrigation systems in 2005.

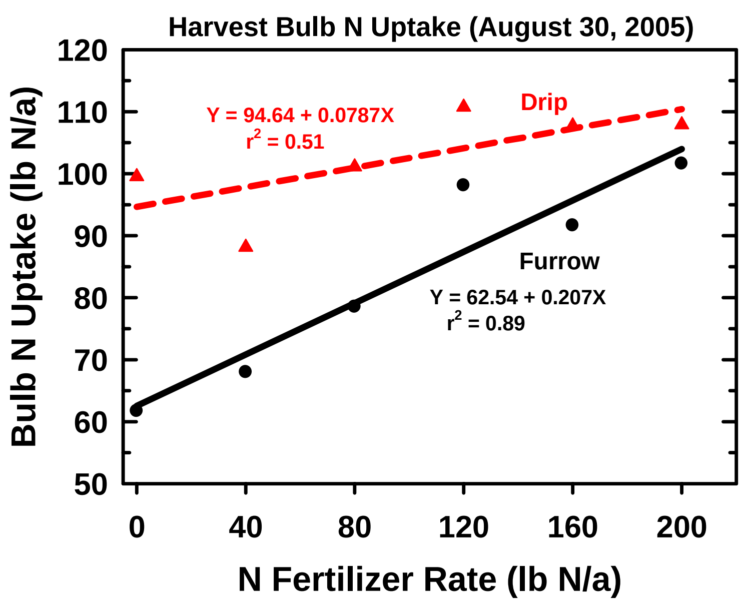

Figure 4. Nitrogen uptake at harvest in the onion bulbs as a function of N rate and irrigation system.

adequate N available to maximize bulb size.

An adjusted gross dollar return per acre (gross return *minus* N, water, and drip system costs) was calculated for each treatment. Adjusted gross returns were increased with increasing N rate in both irrigation systems (Fig. 3) and tended to be greater with the drip system than with the furrow system at lower N rates (N rate x irrigation system interaction significant at P = 0.21) similar to marketable onion yield shown in Fig. 1. The average adjusted gross return is also shown in Fig. 3.

Nitrogen uptake by the onion tops did not vary with N rate or irrigation system at harvest on August 30, 2005. At harvest the tops contained 28 lb N/a. Nitrogen uptake by the bulbs increased linearly with increasing N rate, with a significant N rate x irrigation system interaction (P = 0.03). Nitrogen uptake was greater with the drip system at the lower N rates than with the furrow system. Estimating NFUE [(N uptake for a given N rate – N uptake with no N applied)*100) based on bulb N uptake and N removal from the field showed that the furrow system had a higher NFUE than the drip system. NFUE averaged -28, 2, 9, 5, and 4 % for the 40, 80, 120, 160, and 200 lb N/a treatments, respectively, with the drip system. The low NFUE with the drip system resulted because of the minimal yield responds to N fertilizer and a high N uptake (Fig. 4) for the zero-N rate. The N uptake for the zero-N rate was higher than that for the 40 lb N/a rate, thus the negative number. NFUE with the furrow system was 16, 21, 30, 19, and 20 % for the 40, 80, 120, 160, and 200 lb N/a treatments, respectively, which was higher than that with the drip system. The reason the furrow system had a higher NFUE was due to the fact that N uptake was significantly less in zero N rate plot (check) than with the drip system, thus, making the furrow system look more efficient. The 20% NFUE at the 200 lb N rate with the furrow system was slightly higher than the 15% reported by Halvorson et al. (2002a). The 9 % NFUE at the 120 lb N rate with the drip system is lower than the 15% reported by Halvorson et al. (2002a). Soil samples were collected after onion harvest, but have not yet been analyzed. Residual soil N is expected to be significantly greater in the drip system.

This work in 2005 demonstrates that economic returns can be maintained by using the more efficient drip irrigation system for onion production rather than the inefficient furrow irrigation system. With the drip system, onion yields were maximized with a lower rate of N fertilizer and 72% less irrigation water than with the furrow irrigation system. Soil erosion was also less with the drip system than with the furrow irrigation system.

ACKNOWLEDGMENT

The authors wish to thank Patti Norris, Brad Floyd, Catherine Cannon, and Kevin Tanabe for their field assistance and analytical support in processing the soil and plant samples and collecting the data reported herein.

REFERENCES

Austin, B. 1997. Ground water monitoring activities - Arkansas River Valley alluvial aquifer 1994-1995. Report to the Commissioner of Agriculture, Colorado Dept. of Agric. 20p. Colorado Dept. of Public Health and Environment. Denver, CO.

Bartolo, M.E., F.C. Schweissing, J.C. Valliant, D.B. Bosley, and R.M. Waskom. 1997. Nutrient Management of onions: A Colorado Perspective. *In* Proc. Western Nutrient Management Conference, Salt Lake City, Utah, March 6-7, 1997, 2:114-118.

Ceplecha, Z.L., R.M. Waskom, T.A. Bauder, J.L. Sharkoff, and R. Khosla. 2004. Vulnerability assessments of Colorado groundwater to nitrate contamination. Water, Air, and Soil Pollution 159: 373-394.

Halvorson, A.D., R.F. Follett, M.E. Bartolo, and F.C. Schweissing. 2002a. Nitrogen fertilizer use efficiency of furrow-irrigated onion and corn. Agron. J. 94:442-449.

Halvorson, A., C. Reule, F. Schweissing, and M. Bartolo. 2001. Nitrogen management projects on corn and onion at AVRC. p. 11-14. *In* 2000 Research Reports, Arkansas Valley Research Center, Colorado State Univ. Agric. Exp. Sta. Technical Report TR01-9.

Halvorson, A.D., Schweissing, F., Bartolo, M., Reule, C.A. 2005. Corn response to nitrogen fertilization in a soil with high residual nitrogen. Agron. J. 97:1222-1229.

Halvorson, A.D., F. Schweissing, and C. Reule. 2002b. Nitrogen fertilization of irrigated corn in a high residual soil N environment in the Arkansas River Valley. *In* Proc. of 2002 Great Plains Soil Fertility Conference. Kansas State University, Manhattan and Potash and Phosphate Institute, Brookings, SD. 9:138-142.

Onion Micronutrient Trial

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In the Arkansas Valley and other parts of Colorado, many crops are not fertilized with micronutrients due to the high elemental levels that often exist in soils and irrigation waters. Despite being at high levels in the soil, some micronutrients may not be readily available to a plant due to localized depletions around the root zone or limited mobility of the nutrient. Crops with limited root zones may be prone to these types of deficiencies.

Onions are one of the most widely grown and economically important vegetable crops grown in Colorado. In addition, onions are one of the most inefficient crops when it comes to nutrient uptake. This characteristic is attributed to the onion's shallow root system. Therefore, this study was conducted to determine the effect of a soil-applied micronutrient fertilizer (Micro-Mix 15% Zn, Mezfer Crown Inc.) on the yield and market class distribution of a Sweet Spanish type onion.

Overall, there was a slight but not significant (p=0.1) increase in marketable yield and the colossal (largest and most profitable) market class of onion by the application of 80 lbs per acre of the micronutrient fertilizer compared to the 40 lb rate and the unfertilized control. Composite soil samples taken from the top foot of soil did not reveal an appreciable increase of Zinc in the soil. Nonetheless, localized increases in the root zone may have occurred but were not discerned with the composite soil sampling procedure.

METHODS

A micronutrient rate study was initiated under conventional till, furrow-irrigated onion on a calcareous Rocky Ford silty clay loam soil at Colorado State University's Arkansas Valley Research Center (AVRC) in 2005. The Center is located near Rocky Ford, Colorado. The plot area had previously been in soybeans during 2004. Three micronutrient fertilizer rates (0, 40, 80 lb product per acre) were established on March 10, 2005. The micronutrient source was Micro-Mix 15% Zn, Mezfer Crown Inc. (S= 8.00%, Cu=0.70%, Fe=7.00%, Mn=1.00%, and Zn=15.00%). The mironutrients were banded at the aforementioned rates below the seed row just prior to planting. A randomized complete block design with 4 replications was used.

Onion (var. Ranchero) was planted on March 10, 2005 at a seeding rate of about 129,466 seeds per acre. Two rows of onion were planted on a 10 inch bed with a 30 inch row spacing (furrow to furrow). Conventional onion production practices were used throughout the course of the season. The onions were harvested on September 8th for fresh weight yield and graded for quality and size. Marketable onion sizes were colossal (<4" diameter), jumbo (3 to

4" diameter), and medium (2 to 3" diameter). Onion yields are expressed as bags (one bag = 50 lbs) of fresh onion weight per acre. Estimated gross return per acre was calculated based on a harvest price of $10/bag of colossal, $8/bag of jumbo, and $6/bag of medium size onions. Soil nutrient levels in the top 12 inches profile were measured after harvest.

RESULTS

Good onion yields and quality were obtained in the micronutrient trial. Overall, there was a slight but not significant (p=0.1) increase in marketable yield and the colossal (largest and most profitable) market class of onion by the application of 80 lbs per acre of the micronutrient fertilizer compared to the 40 lb rate and the unfertilized control (Figure 1). Composite soil samples taken from the top foot of soil did not reveal an appreciable increase in levels of Zinc in the soil (Figure 2). Nonetheless, localized increases in the root zone may have occurred but not discerned with the composite soil sampling procedure.

Figure 1: Yield and market class distribution of onion fertilized with three different rates of micronutrient fertilizer.

Treatment	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Culls %*	*Total Marketable Weight 50 lb bags per acre*
Unfertilized Control	7.9	77.0	0.58	**1331.8**
40 lbs per acre rate	6.7	74.9	0.25	**1304.6**
80 lbs per acre rate	11.8	74.5	0.00	**1476.6**
lsd (0.1) =				**248.8**

Figure 2: Residual Zinc level remaining in the soil (top 12 inches) in a composite sample.

Treatment	*Residual Zinc levels after harvest (ppm)*
Unfertilized Control	5.5
80 lbs per acre rate	5.0

Note:
Estimated gross returns can be based on an average price of $8.00 per bag at harvest. Therefore, an increase in yield of 100 bags per acre would increase gross returns $800 per acre.

2004 Demonstration

Transplant Onion using Agri-Blend, HYDROGEL/Zeolite Blend

Location: Hanagan Farms near Swink in Otero County

Investigator: Jim Valliant, Irrigation Specialist and Research Scientist
Colorado State University

Introduction:

One of the problems with transplanted onions planted on beds using drip irrigation is getting water to the roots of the young sprouts and maintaining moisture around the roots as they begin to grow. Because, in most installations, the drip-lines are buried 8 or more inches below the surface, the pull of gravity may reduce the amount of water reaching these young sprouts.

Agri-Blend, a mixture of HYDROGEL, a water-absorbing polyacrylamide, and Zeolite, a clay capable of transporting water, have been tested on several crops and have been shown to help move and maintain moisture around seeds and sprouts. For maximum effect, Agri-Blend is applied just behind the chisel opener in the slot where the onion sprout will be placed.

Previous demonstrations using Agri-Blend have shown an increase in yield and quality of different crops such as tomatoes, peppers and transplanted onions when compared to the untreated areas of these crops. In 1997, yields were increased from 755 bags (50 lbs) on the untreated areas to 855 bags per acre on the areas treated with Agri-Blend on transplanted onions at the Frank Milenski Farm.

Materials and Methods

'Vaquero" variety onions were planted March 27 with three rows per 60-inch bed. The rows were spaced 7-inches apart with the center row directly above the drip line. The sprouts were placed about 4-inches apart in chisel slots. The Agri-Blend was applied at the rate of 15 pounds per acre using two methods, just behind the chisel opener (Treatment 2.) and broadcast on top of the bed (Treatment 3.) as compared to an untreated area (Treatment 1.).

The drip lines were 8 to 10 inches below the surface and the crop was irrigated as soon as possible after transplant. A total of approximately 15 inches of well water was applied during the growing season. Water from the well in fairly high in salts at around 1800 parts per million (ppm) Total Dissolved Solids (TDS) as compared to river water at approximately 800 ppm TDS.

The crop was fertilized with 150 pounds per acre of 10-34-0 and 150 pounds per acre of 20-0-0-5. A solution of the fertilizer was sprayed on the bed and then re-bedded to get the fertilizer in the top of the bed. A solution of 28-0-0 was applied through the drip system as needed, usually after a hail or other type of plant stress.

Four replications each 5-feet long on each of the three rows were harvested from each bed on July 29 and air-dried. The onions were then graded, separated and weighed on August 6 to determine quality and yield.

Results and Discussion

The onion transplants grown where Agri-Blend was applied in the chisel-slot (Treatment 2) produced higher yields, better quality and greater returns than the broadcast Agri-Blend (Treatment 3) and the untreated check (Treatment 1) The chisel-slot applied Agri-Blend produced a total of 368 bags per acre (50-pound bags) with a gross return of $2,968 per acre as compared to 289.1 bags and $2,150 on the untreated check and 271.1 bags and $2,052 on the broadcast Agri-Blend area, shown in Table 1.

The higher yields and returns from Treatment 2 are due mainly to a greater number of Jumbos and Mediums. Treatment 2 produced 325.7 bags as compared to 226.6 for Treatment 1 and 221.4 for Treatment 3.

Part of the lack of response from the broadcast application, Treatment 3, was that the Agri-Blend was applied on top of the ground behind the furrow opener and did not get enough product down in the area of sprout roots. The Agri-Blend was broadcast on top of the bed at planting, not incorporated in the soil before planting as is normally recommended for broadcast applications.

Even though above average rainfall was received in 2004, most of these rains were received too late to be beneficial to the young transplants and the results of these demonstration trials would indicate that the moisture held close to the sprouts by the Agri-Blend aided in early growth. This early growth appears to be the reason for the higher yields, better quality and greater returns on the transplant onions treated with chisel-slot applied Agri-Blend.

Table 1. Yield, Quality and Gross Return of Transplanted Onions, Hanagan Farms, Swink, CO, 2004

Treatment	Jumb Bags/A	Value Per Bag	Return Per Acre	Med Bags/A	Value Per Bag	Return Per Acre	Pre-pack Bags/A	Value Per Bag	Return Per Acre	Total Bags Per Acre	Total Return Per Acre
1. Check	11.3	$10	$113	215.3	$8	$1,722	63.0	$5	$315	289.6	$2,150
2. Furrow-Slice	75.0	$10	$750	250.7	$8	$2,006	42.3	$5	$212	368.0	$2,968
3. Broadcast	15.7	$10	$157	205.7	$8	$1,646	49.7	$5	$249	271.1	$2,052

Onion Polymer Trial

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Colorado State University

Effect of Polymer Treatment on Furrow-Irrigated Onions (var. Ranchero).

Variety	Colossals ≥ 4" %	Jumbos 3"-4" %	Medium 2 ¼"-3" %	Cull %	**Total Market. Weight CWT/A**
Polymer Treated	10.8	71.9	16.4	0.0	585.3
Control	5.8	78.0	15.8	0.0	622.9
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Effect of Polymer Treatment on Drip-Irrigated Onions (var. Ranchero).

Variety	Colossals ≥ 4" %	Jumbos 3"-4" %	Medium 2 ¼"-3" %	Cull %	**Total Market. Weight CWT/A**
Polymer Treated	19.2	60.3	19.3	0.0	726.3
Control	10.7	78.0	10.6	0.0	724.7
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Plots – *Each plot was two beds wide (5 feet) and 25' long. Each bed had two rows spaced 10" apart on top of the bed with an in-row spacing between plants of ~3". Eight bed feet (8' X 1 row) was used for yield determination. Each plot was replicated four times in the trial. For the drip trial, a single drip line was placed down the center.*

Polymer Application *– "Agriblend" – hydrogel polymer banded in the seed row prior to planting (March 7th) at a rate of 20 lbs/acre..*

Planted *- March 8th, 2005 (var. Ranchero – Nunhems Seeds)*

Harvest and Grade *– September, 2005*

Proctor Furrow-Irrigated Onion Polymer Demo

Jim Valliant
Cooperative Extension
Colorado State University

Effect of Polymer Treatment on Furrow-Irrigated, Transplanted White Onions (Variety-Cometa).

Variety	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Prepacks < 2 ¼" %*	***Total Market. Weight CWT/A***
Polymer Treated	0.0	37.4	60.0	2.6	428.5
Control	0.0	45.1	53.7	2.2	459.9
lsd= 0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Effect of Polymer Treatment on Furrow-Irrigated, Transplanted Yellow Onions (Variety-Ranchero).

Variety	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Prepacks < 2 ¼" %*	***Total Market. Weight CWT/A***
Polymer Treated	19.2	60.3	19.3	0.0	726.3
Control	10.7	78.0	10.6	0.0	724.7
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Effect of Polymer Treatment on Furrow-Irrigated Purple Onions (Variety-Red Wing).

Variety	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Prepacks < 2 ¼" %*	***Total Market. Weight CWT/A***
Polymer Treated	19.2	60.3	19.3	0.0	726.3
Control	10.7	78.0	10.6	0.0	724.7
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Plots – *Each plot was two beds wide (5 feet) and 25' long. Each bed had two rows spaced 10" apart on top of the bed with an in-row spacing between plants of ~3". Eight bed feet (8' X 1 row) was used for yield determination. Each plot was replicated four times in the trial. For the drip trial, a single drip line was placed down the center.*

Polymer Application *– "Agriblend" – hydrogel polymer banded in the seed row prior to planting (March 7th) at a rate of 20 lbs/acre..*

Planted *- March 8th, 2005 (var. Ranchero – Nunhems Seeds)*

Harvest and Grade *– September, 2005*

Proctor Drip-Irrigated Onion Polymer Demo

Jim Valliant
Cooperative Extension
Colorado State University

Effect of Polymer Treatment on Drip-Irrigated Seeded White Onions (Variety-Cometa).

Variety	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Prepacks < 2 ¼" %*	***Total Market. Weight CWT/A***
Polymer Treated	0.0	44.4	47.8	7.8	311.8
Control	0.0	44.9	46.4	8.7	277.1
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Effect of Polymer Treatment on Drip-Irrigated Seeded Yellow Onions (Variety-Vaquero).

Variety	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Prepacks < 2 ¼" %*	***Total Market. Weight CWT/A***
Polymer Treated	19.2	60.3	19.3	0.0	360.0
Control	10.7	78.0	10.6	0.0	319.6
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Zones – *Each zone of the drip irrigation system was 5.7 acres with 60 inch beds. Six rows of onions were planted on each bed. Each row was spaced 3 inches apart. The drip lines were placed in the center of the beds approximately 8 inches below the surface. Eight feet of bed was harvested (8' X 6 rows of onions) at nine locations in each zone for yield determination.*

Polymer Application *– "Agriblend" – (hydrogel + zeolite) polymer was banded at the rate of 10 lbs/acre at planting on March 1 and 2. The AgriBlend was applied in front of the covering wheel so that it was in the furrow with the seed.*

Planted *- March 1, 2005 – Cometa Variety, March 2, 2005 – Vaquero Variety*

Harvest and Grade *– August 29 and 30, 2005*

Hanagan Drip-Irrigated Onion Polymer Demo

Jim Valliant
Cooperative Extension
Colorado State University

Effect of Polymer Treatment on Drip-Irrigated, Transplanted Yellow Onions (Variety-Vaquero).

Variety	*Colossals ≥ 4" %*	*Jumbos 3"-4" %*	*Medium 2 ¼"-3" %*	*Prepacks < 2 ¼" %*	***Total Market. Weight CWT/A***
Polymer Treated	0.0	60.5	37.0	2.5	618.4
Control	0.0	60.4	37.6	2.0	585.0
lsd=0.1	*ns*	*ns*	*ns*	*ns*	*ns*

Zones – *Each zone of the drip irrigation system was 8.0 acres with 60 inch beds. Three rows of onions were planted on each bed. Each row was spaced 7 inches apart. The drip lines were placed in the center of the beds about 15 inches below the surface. Eight feet of bed was harvested (8' X 3 rows of onions) at 12 locations in each treatment for yield determination. Approximately 30.0 inches was applied through the drip-irrigation system.*

Polymer Application *– "Agriblend" – (hydrogel + zeolite) polymer was banded at the rate of 10 lbs/acre in the transplant furrow just prior to transplanting the seedling onions. The AgriBlend was applied immediately behind the transplant furrow opening chisel.*

Transplanted *– April 10, 2005*

Harvest and Grade *– July 26, 2005*

Mira Sol Variety Development

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'Mosco' , a roasting-type chile pepper (*Capsicum annuum* L.), was developed by the Colorado Agricultural Experiment Station and will be released to seed producers and growers. Mosco was released based on its superior horticultural traits compared to existing land races of the Mira Sol pepper (a.k.a 'New Mexico Chile Improved' and Pueblo Chile). It is adapted to irrigated production in the Arkansas Valley of Colorado and other pepper producing regions.

'Mosco' originated from a land race of what is referred to in Southern Colorado as the Mira Sol chile pepper. Mira Sol is Spanish for "looking at the sun" and describes the major distinguishing characteristic of this pepper, an upright growth habit for the fruit. The grower of the original land race stock was Mr. Harry Mosco (dec.) who farmed east of Pueblo, Colorado in an area known as the St. Charles Mesa. 'Mosco' was derived from a single plant selection made in 1994. In 1995-98, a single plant was selected out of a bulk planting and the seed from that single plant was sown the following year. In 1999-2004, the seed from selected uniform plants was bulked for testing at Colorado State University's Arkansas Valley Research in Rocky Ford, Colorado.

'Mosco' has thick fruit walls and good yield potential. 'Mosco' is more pungent than a typical Anaheim-type pepper, having an estimated pungency of 5,000-6,000 Scoville units. Fruit are 12-16 cm in length, 2-3 cm at the shoulder and tapered to a point at the end. Fruit grow in an upright position but may bend downward as the pods reach full maturity and weight. Growth habit is lower and more branching than the typical Anaheim and Mira Sol pepper. 'Mosco' is superior to the existing land races of the Mira Sol chile pepper in total yield, fruit size and fruit uniformity. Fruit wall thickness is also greater in this line resulting in better roasting characteristics. Pungency is equal to or slightly greater than existing lines of the Mira Sol. Fruits are slightly harder to detach from the plant in 'Mosco' than the typical Mira Sol pepper. As a result, harvest is somewhat more difficult.

In 2004, a yield comparison was made between 'Mosco"and a commercially available source of New Mexico Chile Improved (Burrell Seeds). Comparisons were made under conventional (direct-seeded, furrow-irrigated) conditions and intensive (transplant, black mulch, drip irrigation) production conditions. In both trials, plots were replicated four times in a randomized complete block design. In the conventional trial, peppers were direct-seeded into beds on 30" centers. Seeding occurred in late April 2004 and harvest data was collected in late September. In the intensive trial, six week-old transplant were set through holes in black plastic much in early May. Mulched beds were spaced on 60" centers. Two rows of peppers were spaced 18" apart on top of the bed. The distance between the plants within the row was 12". Harvest of the intensively-grown plots occurred in early to mid September.

Yield and pod characteristic of Mira Sol Type peppers grown with conventional production methods (direct-seeding, furrow irrigation) in 2004.

Variety	*Average Pod Length (in)*	*Average Pod Weight (oz)*	*Plant Height (in)*	*Yield per Acre (lbs)*
NM Chile Improved	4.27	1.16	15.75	16,596
Mosco	5.24	1.95	17.00	25,495
Lsd 0.1	0.39	0.15	1.12	7,520

Yield and pod characteristic of Mira Sol Type peppers grown with intensive production methods (plastic mulch, drip irrigation) in 2004.

Variety	*Average Pod Length (in)*	*Average Pod Weight (oz)*	*Yield per Acre (lbs)*
NM Chile Improved	3.99	0.91	13,372
Mosco	5.12	1.66	18,295
Lsd 0.1	0.26	0.21	5,302

Chile Pepper Response To Nitrogen Fertilization In Colorado Arkansas Valley

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SUMMARY

This 2005 N study evaluated the effects of N fertilization (6 N rates) on chile pepper yield following 4 years of continuous corn production. A controlled release N fertilizer (Polyon®[3]) was used. Fresh chile pepper yields increased with increasing N rate up to about 90 to 120 lb N/a then leveled off. Estimated gross economic returns reflected the fresh chile pepper yield. Total plant biomass production increased with increasing N rate. Plant size (stems + leaves) had maximized by the September 1 sampling date while pepper yield continued to increase until final harvest. Total N uptake increased from 101 lb N/a with no N fertilizer applied to 180 lb N/a with 120 lb/a of fertilizer N applied, resulting in an estimated N fertilizer use efficiency of about 66%. Residual soil NO_3-N levels were relatively low in the spring before planting chile pepper, but did increase slightly with increasing N rate applied to the previous corn crops. Residual soil NO_3-N levels were even lower after chile pepper harvest. This may indicate that chile pepper was effective in utilizing soil residual N from the root zone or that the residual N was moved out of the root zone by the frequent irrigations.

PROBLEM

High nitrate-N (NO_3-N) levels have been reported in groundwater in the Arkansas River Valley in Colorado, which is a major producer of melons, onions, and other vegetable crops grown in rotation with alfalfa, corn, sorghum, winter wheat, and soybeans. Relatively high rates of N fertilizer are used to optimize crop yields and quality, generally without regard to soil testing. Vegetable crops generally have shallow rooting depths (< 3ft) and require frequent irrigation to maintain market quality. High residual soil NO_3-N levels, high N fertilization rates to shallow-rooted crops, shallow water tables, and excess water application to control soil salinity all contribute to a high NO_3-N leaching potential.

Little information is available on the response of chile pepper to N fertilization in the Arkansas River Valley in Colorado. Generally, residual soil N is very high in fields used for production of vegetable crops as a result of past N fertilization history and management. We completed a 4-year continuous corn production study in 2003 with varying N rates (Halvorson et

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[3]Trade names and company names are included for the benefit of the reader and do not imply any endorsement or preferential treatment of the product by the authors or the USDA, Agricultural Research Service.

al., 2005). Residual soil N levels had been reduced to relatively low levels in the plot area. This provided an opportunity to evaluate the response of chile pepper to N fertilization without having extremely high levels (> 200 lb/a) of residual soil N in the profile. Our plan is to follow chile pepper with onion and then corn in the rotation. Our goal is to see if corn can effectively utilize the residual N left over from fertilization of the chile and onion crops. Nitrogen management research is needed to develop improved NUE and N management practices for furrow irrigated crops in this area. Improved N management practices for crops in the Arkansas River Valley should optimize crop yields while minimizing N fertilizer impacts on ground water quality.

Objective of this research was to determine N fertilizer needs for optimizing furrow-irrigated chile pepper yields in the Arkansas River Valley, and evaluate the influence of N fertilizer application rate on residual soil NO_3-N and potential for groundwater contamination.

Study Details. A N rate study was conducted under conventional till, furrow irrigated chile pepper on a calcareous Rocky Ford silty clay loam soil at the Arkansas Valley Research Center (AVRC) in 2004 on plots previously cropped to continuous corn for four years (Halvorson et al., 2005). Six N rates (0, 30, 60, 90,120, and 150 lb N/a or N1, N2, N3, N4, N5, N6, respectively) were applied on April 5, 2004. The N source was Polyon® (a controlled-release urea fertilizer), which provided about a 30 day release period from time of N application. . The N fertilizer was broadcast and incorporated with a harrow before chile pepper planting. A randomized complete block design with 4 replications was used.

Chile pepper (Sonora) was planted on April 28, 2004 at a seeding rate of about 29,684 seeds per acre. Herbicides were applied for weed control, with the plots being essentially weed free during the study period. Soil NO_3-N levels in the 0-6 ft profile were monitored in the spring before N fertilizer was applied and in the fall after chile pepper harvest. The plots were hand thinned on June 17 to about 24,000 plants/a. Hail on June 20 with high winds caused severe damage to the plants and resulted in stand loss. An average harvest stand of 19,212 plants/a was present after the hail storm. The peppers were sampled bi-weekly starting on June 7 until final harvest for total biomass determination. Peppers, when present, on each plant were separated from the stems and leaves at each biomass harvest. On September 20th, two rows 20 feet long were hand harvested for marketable peppers. On October 5th the same harvest area was hand harvested a second time to obtain a final yield. Fresh weight of the peppers were recorded.

The plots were irrigated nine times in 2004, with about 3 inches of water applied each time. In 2004, N level in the water was not monitored, but was assumed to be similar to previous years. Assuming a 50% irrigation efficiency, less than 7 lbs of N may have entered the soil with the irrigation water.

RESULTS

In April 2004, the soil NO_3-N in the profile was concentrated in the 0-3 ft soil depth, with low levels of NO_3-N at deeper depths (Table 1), except for the highest N treatment (N6) which received the highest rate of N during the corn years. The total amount of residual NO_3-N in the 6-ft profile increased with increasing N rate. Residual soil NO_3-N levels after chile pepper harvest for each N rate in 2004 are also reported in Table 1. Residual soil NO_3-N levels were very low following chile pepper harvest which was not expected. This may indicate that some some residual soil and fertilizer N was lost from the root zone due to leaching with the frequent irrigations.

Table 1. Soil NO_3-N levels with soil depth for each N rate treatment before planting and after harvest of the chile peppers.

Soil Depth	2004 Fertilizer N Rate (lb N/a)						2004 Fertilizer N Rate (lb N/a)					
	0	30	60	90	120	150	0	30	60	90	120	150
	N1	N2	N3	N4	N5	N6	N1	N2	N3	N4	N5	N6
	4 April 2004						13 October 2004					
Ft	Soil NO_3-N, lb N/a											
0-2	25	35	40	46	59	77	5	6	12	7	15	7
0-3	28	38	46	54	63	100	6	6	14	9	20	8
0-6	33	43	54	62	82	163	8	10	31	17	26	29

Fresh chile pepper yields were increased significantly ($\alpha = 0.05$) by N fertilization (Figure 1). This was an excellent yield considering the damage to the plants during the June 20th hail storm. The fresh weight yield assumes a bushel weight of 23 lb. Fresh pepper yield started leveling off above the 90 lb N/a fertilizer N rate. This would indicate that 120 to 150 lb N/a was adequate to optimize chile pepper yield.

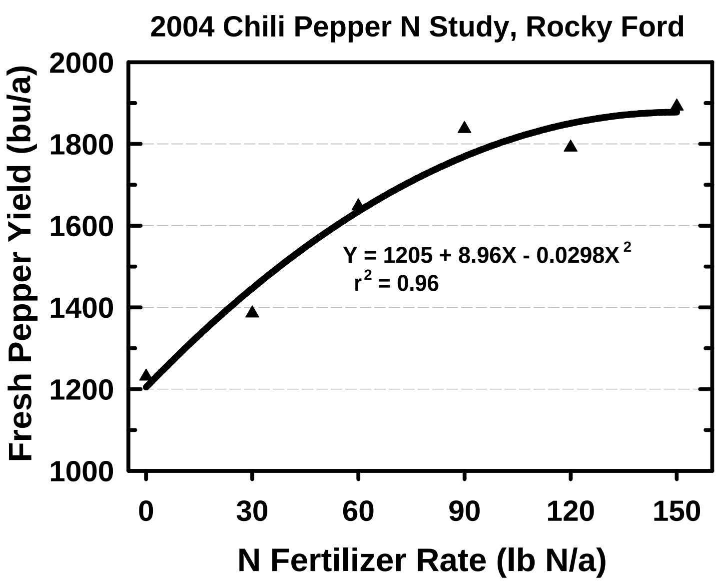
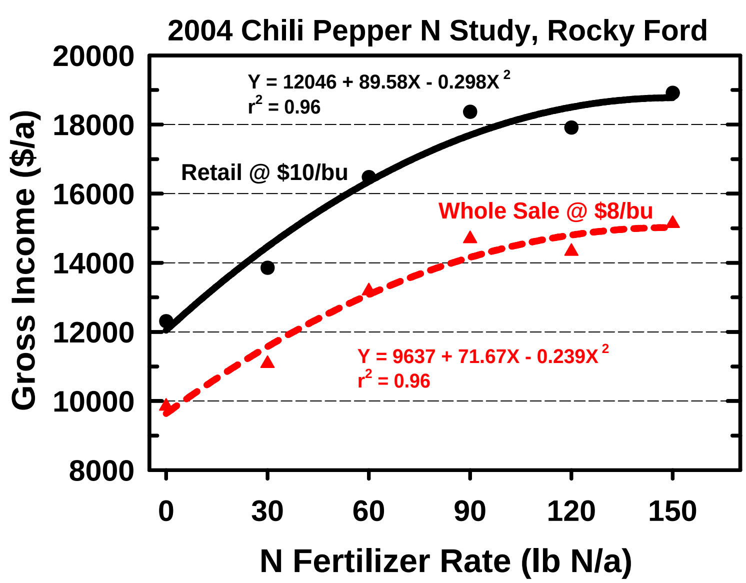


Figure1. Fresh chile pepper (Sonora) yield in 2004 with increasing N fertilizer rate.

Figure 2. Estimated gross economic return from chile pepper as a function of N fertilizer rate in 2004.



The gross economic return for each N fertilization rate is shown in Figure 2, assuming a retail value of $10/bu and a whole sale value of $8/bu. The gross returns were near $19,000/a based on a retail price and $15,000/a based on a whole sale price for the peppers.

Average biomass yield and pepper yield averaged over N rates are shown in Figure 3. Biomass accumulation was very slow until early July, when the plants started to grow more rapidly. Total biomass yields increased with increasing N rate. Biomass (stems plus leaves) accumulation was near maximum at the September 1 sampling date, while the weight of the

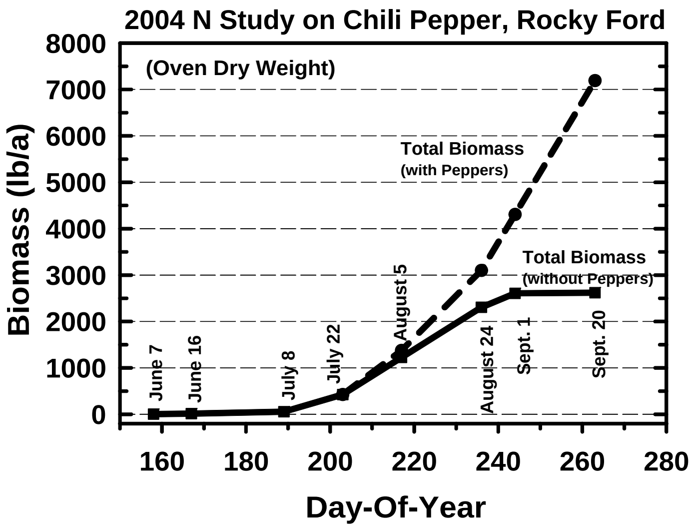


Figure 3. Chile pepper biomass accumulation with time in 2004.

peppers continued to increase at a rapid rate until harvest. Biomass accumulation was similar for each N rate, but tended to be greater with increasing N rate (data not shown).

Based on the chile pepper N uptake data, total N uptake (stems+leaves+peppers) increased with increasing N rate with a total N uptake level of 101, 113, 138, 137, 180, and 174 lb N/a for the N1, N2, N3, N4, N5, and N6 treatments, respectively. A N fertilizer use efficiency of about 66% was estimated for the N5 treatment.

Based on the low soil NO_3-N levels following chile pepper harvest (Table 1) and assuming an effective rooting depth of 3 ft, some of the fertilizer N may have been leached beyond the root zone in this study.

This N study will be continued on the same plots in 2005 with onion as the crop. Nitrogen fertilizer (controlled release type) will be applied at slightly higher rates than used in 2004. Nitrogen fertilization effects on residual soil NO_3-N levels will continue to be monitored.

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ACKNOWLEDGMENT

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Bell Pepper Quality Trial

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Bell peppers are often subject to environmental conditions that can severely reduce fruit quality. In Colorado, a high incidence of solar radiation and high temperatures contribute to significant amounts of fruit damage. Sunburn or sunscald is manifested as dark and dry patches on the fruit surface. These patches alone will render the fruit unmarketable. In addition, tissue affected by sunburn are prone to secondary disease infection.

This study was conducted to determine the effect of a spun-bound polyester row cover on the incidence of sunscald on three bell pepper cultivars. Fruit quality was assessed at both the green and colored-mature stages of development.

Overall, the use of a spun-bound row cover significantly improved the quality of bell pepper fruit by reducing the incidence of sunscald. Marketable yield was improved by row covers at both the green and colored stage of development.

Methods

This study was conducted at the Arkansas Valley Research Center in Rocky Ford. Beds, 45 inches wide and 60 inches between centers, were shaped in early April. Drip lines were placed 1-2 inches from the center of the bed at a depth of 3 inches. The beds were covered with black embossed plastic mulch (Mechanical Transplanter) in late April using a one-bed mulch layer.

Three bell pepper varieties, described below, were used in this study.

Variety	First Stage Color	Mature Color
King Arthur	Green	Red
Purple Beauty	Purple	Red
8610	Green	Yellow

Six-week-old transplants were set through holes in the plastic mulch in a double row. Rows were spaced 18 inches apart and distance between plants was 12 inches. Each plot was one bed wide (5 feet) and 10 feet long and was replicated four times. The experiment was designed as a split plot with varieties as the main plot and covering as the sub-plot.

On July 14th, spun-bound polyester fabric (Kimberly-Clark .5 oz/ft^2) was placed over the "covered" treatments. The fabric was 60" wide and was held in place by wire hoops placed every 3 feet. The fabric reduced light transmission by 14-18% as measured by a hand held photometer (LiCor Li-189).

The plots were harvested on August 9th (green stage) and August 22nd for the mature colored stage. One row (of the two rows) in the plot was designated exclusively for each harvest stage. At each harvest, fruit were weighed and counted and separated into marketable and cull classes. The row covers were removed on September 20 and a final harvest was made on October 10 to collect any remaining fruit. This later harvest was significantly smaller and data is presented separately.

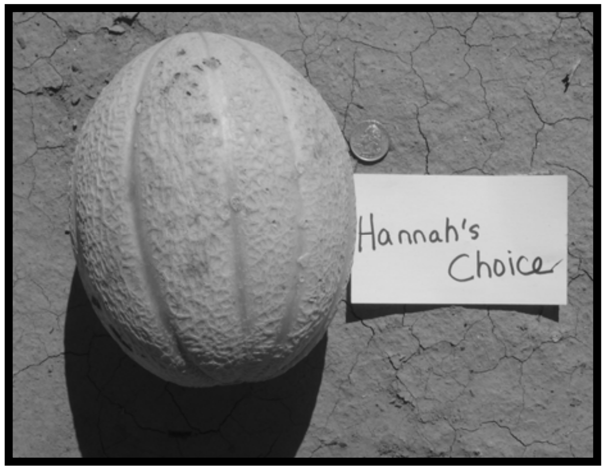
Marketable yield and fruit quality of bell peppers covered or not covered with a spun-bound polyester row cover. Fruit were harvested on August 9th at the green (or purple) stage of development.

Variety	Covering Treatment	% Culls (by weight)	Average Market. Fruit Weight (oz)	Marketable Yield (lbs/acre)
King Arthur	Uncovered	21.7	5.1	22,694
King Arthur	Covered	8.9	6.0	31,581
Purple Beauty	Uncovered	47.9	3.9	12,327
Purple Beauty	Covered	28.4	4.0	20,647
8610	Uncovered	43.0	5.2	18,992
8610	Covered	26.0	5.6	22,172

Marketable yield and fruit quality of bell peppers covered or not covered with a spun-bound polyester row cover. Fruit were harvested on August 22nd at the colored-mature stage of development.

Variety	Covering Treatment	% Culls (by weight)	Average Market. Fruit Weight (oz)	Marketable Yield (lbs/acre)
King Arthur	Uncovered	38.1	6.0	20,691
King Arthur	Covered	32.4	7.0	21,083
Purple Beauty	Uncovered	53.7	4.9	12,806
Purple Beauty	Covered	43.4	4.9	18,206
8610	Uncovered	63.6	6.4	7,884
8610	Covered	58.7	6.9	12,980

Early Cantaloupe Production Trial



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Cantaloupe are one of the most popular produce items grown in the Arkansas Valley. The price for cantaloupe grown for road-side stands and other direct markets is consistently greater early in the season. Therefore, growers may benefit by expanding the traditional marketing period.

As seen in previous studies, early hybrid varieties used in conjunction with plasticulture techniques can help expand the production period and improve yields for early market melons. This study was an expansion of those trials to determine how early cantaloupes can be produced in the Arkansas Valley using additional combinations of plastic mulches, row covers and hybrid varieties.

The 2005 season was relatively good for growing melons. A small hail storm in May slightly injured some of the more advanced melons. Nonetheless, yields and quality were still fairly good.

Overall, a combination of clear plastic mulch, clear plastic row covers and a transplanted early variety provided the earliest harvest with the first fruit being picked on June 29th .

Methods

This study was conducted at the AVRC in Rocky Ford. Beds, 45 inches wide and 60 inches between centers, were shaped in early April. Drip lines were placed 1-2 inches from the center of the bed at a depth of 3 inches The test area was then sprayed with a combination of Prefar (Gowan Chemical) and Alanap (Uniroyal Chemical) for weed control. The beds were covered with clear embossed plastic mulch (Mechanical Transplanter) on April 18th using a one-bed mulch layer.

Six melon varieties, "Earligold" , "Rocket", "Nitro", "Valley Gold", "Hannah's Choice" and "Athena", were used in this trial. Four-week-old transplants were set through holes in the plastic mulch in a single row down the center of the bed at an in-row spacing of 18 inches. Each plot was one bed wide (5 feet) and 18 feet long and was replicated three times.

All six varieties were subjected to the following production methods:

1. All 6 varieties transplanted April 19th into clear mulch and covered with a perforated row cover.

2. All 6 varieties transplanted April 26th into clear mulch and covered with a perforated row cover.

3. All 6 varieties transplanted into clear plastic mulch on May 5th without any row cover.

Plastic row covers were suspended by wire hoops spaced 3-4 feet apart. The plastic row covers were made of clear perforated polyethylene (Mechanical Transplanter. Large holes were cut into the tops of the plastic row covers for ventilation in early May and the plastic row covers were completely removed off the transplanted and seeded treatments in late May to early June depending on the treatment. Generally, row covers were removed from a treatment when the first fruiting flowers were discovered.

Beside the application of herbicides, weeds were controlled via cultivation and hand weeding. No other pest control measures were used. The crop was irrigated as needed via drip lines.

Cantaloupe were harvested at full slip every 1-2 days. Marketable melons were weighed and counted at each harvest. Melons were considered marketable if they weighed over 2 lbs. and were free of any physical defects.

Temperature (°F)in April and May 2005 during establishment period of early cantaloupe.

Date-April	High	Low	Date-May	High	Low
19	93	35	1	63	33
20	80	33	2	53	33
21	75	30	3	64	32
22	73	35	4	76	26
23	72	35	5	80	34
24	69	35	6	86	47
25	63	35	7	78	49
26	69	35	8	79	37
27	73	29	9	83	40
28	68	33	10	90	49
29	45	28	11	85	42
30	65	30	12	77	30

Yield and earliness of six cantaloupe varieties grown with different plasticulture combinations.

Variety and Transplanting Date	***Row Cover***	***First Harvest***	***Ave. Fruit Size (lbs)***	***Market Fruit/acre***	***Market. Yield (lbs/ac)***
Earligold Transplanted April 19	*perforated*	*July 5*	*2.88*	*8,712*	*24,974*
Rocket Transplanted April 19	*perforated*	*July 5*	*2.62*	*9,034*	*23,570*
Nitro Transplanted April 19	*perforated*	*June 29*	*3.79*	*11,616*	*44,076*
Valley Gold Transplanted April 19	*perforated*	*July 5*	*2.76*	*12,745*	*35,009*
Hannah's Choice Transplanted April 19	*perforated*	*June 29*	*2.86*	*12,745*	*36,687*
Athena Transplanted April 19	*perforated*	*June 30*	*3.38*	*10,970*	*36,929*
Earligold Transplanted April 26	*perforated*	*July 5*	*2.56*	*8,550*	*22,038*
Rocket Transplanted April 26	*perforated*	*July 5*	*2.39*	*8,066*	*19,182*
Nitro Transplanted April 26	*perforated*	*July 5*	*3.18*	*7,777*	*24,926*
Valley Gold Transplanted April 26	*perforated*	*July 5*	*2.38*	*11,293*	*27,104*
Hannah's Choice Transplanted April 26	*perforated*	*July 1*	*2.59*	*10,002*	*26,087*
Athena Transplanted April 26	*perforated*	*July 5*	*2.97*	*11,132*	*33,234*
Earligold Transplanted May 5	*None*	*July 4*	*2.74*	*10,809*	*29,798*
Rocket Transplanted May 5	*None*	*July 13*	*2.70*	*10,002*	*26,991*
Nitro Transplanted May 5	*None*	*July 4*	*3.94*	*11,132*	*43,914*
Valley Gold Transplanted May 5	*None*	*July 11*	*2.53*	*11,454*	*28,862*
Hannah's Choice Transplanted May 5	*None*	*July 4*	*3.02*	*13,068*	*39,284*
Athena Transplanted May 5	*None*	*July 11*	*3.75*	*5,969*	*22,376*

Tomato Virus Control Trial

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Colorado State University

In the Arkansas Valley and other parts of Colorado, tomatoes often face pest pressures that can severely reduce fruit yield and quality. In recent years, extremely high incidences of viral diseases have severely reduced tomato stands. Some growers have reported over 50% stand losses. Several viral diseases have been known to infect tomatoes in the state and one of the most common is Curly Top with the curly top virus (CTV) as the causal agent. The CTV is vectored by the beet leafhopper which has numerous hosts in addition to tomato. In other parts of the country, conventional insecticide applications have not been effective in controlling the beet leaf hopper and subsequently the spread of the CTV.

This study was conducted to determine the effect of alternative measures for the control of CTV. The percentage of plants showing disease infection were recorded at several stages of plant development.

Overall, several alternative methods reduced the incidence of viral infection. A systemic insecticide (Admire), a plant defense activator (Actigard), and a reflective silverized mulch (Repelgro) all reduced disease infection compared to an untreated control.

Methods

This study was conducted at the Arkansas Valley Research Center in Rocky Ford. Beds, 45 inches wide and 60 inches between centers, were shaped in early April. Drip lines were already in place as part of a permanent sub-surface drip system. The lines were located in the center of the bed at a depth of 8 inches. The beds were covered with black embossed plastic mulch (Mechanical Transplanter) or a silverized-reflective mulch (ReflecTec) on May 4th using a one-bed mulch layer.

Six-week-old transplants were set through holes in the plastic mulch in a single row down the center of the bed on May 13th . The distance between plants was 18 inches. Each plot was three beds wide (15 feet) and 27 feet long and was replicated three times. There was a total of 54 plants in each plot.

The experiment was designed as a randomized complete block with the following four treatments:

1. Untreated control tomatoes grown in black plastic mulch.
2. Tomatoes grown in “Repelgro” silverized reflective mulch (Reflec Tec).
3. Tomatoes treated with Admire (Bayer Corp.) insecticide. Insecticide was drenched around the base of the transplant on May 20th at a rate of 24 fluid ounces per acre. Each plant received 100 ml of drench solution.
4. Tomatoes treated two times with Actigard 50WG (Syngenta Crop Protection). At each application, each treated plant was thoroughly wetted with a 38 ml solution containing 0.5 oz/acre Actigard. Applications were made on May 24th and June 20th .

Disease symptoms were evaluated on June 28th, July 19th, and August 22nd . Plant infection was categorized as having slight infection (some leaf curling but still somewhat healthy plant) or obvious infection (severe leaf curling, plant yellowing, and stunting). It should be noted that the symptoms of “slight infection” are similar to those caused by other environmental stresses. Disease was confirmed by laboratory assay.

Percent tomato plants exhibiting signs of infection with Curly Top Virus at the June 28th observation date.

Treatment	% Plants Showing Slight Infection	% Plants Showing Obvious Infection
Control	0	5.5
Silver Mulch	0	1.8
Admire	0	2.4
Actigard	0	3.0

Percent tomato plants exhibiting signs of infection with Curly Top Virus at the July 19th observation date.

Treatment	% Plants Showing Slight Infection	% Plants Showing Obvious Infection
Control	1.8	11.7
Silver Mulch	0	3.0
Admire	1.2	2.4
Actigard	0.6	3.0

Percent tomato plants exhibiting signs of infection with Curly Top Virus at the August 22nd observation date.

Treatment	% Plants Showing Slight Infection	% Plants Showing Obvious Infection
Control	0	19.7
Silver Mulch	0	5.5
Admire	0	5.5
Actigard	0	3.0