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PLANT PATHOLOGY RESEARCH AND DEMONSTRATION PROGRESS REPORTS

Compiled by G.D. Franc and W.L. Stump
University of Wyoming
Department of Plant Sciences

University of Wyoming

2007
Plant Pathology
Research and Demonstration
Progress Reports

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Additional copies are available by telephone (307-766-2397), or by e-mail: FrancG@UWYO.edu. This report will also be published during the spring of 2008 as MP101-08 and will be available online from the University of Wyoming Plant Sciences website at: www.uwyo.edu/ces/plantsci.htm.

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Research Project	**Field tests of corn (maize) selections for disease response following inoculation with the Goss' wilt bacterium, 2007**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc, J.T. Cecil, J. Nachtman and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences Dept-3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	The field plot was located at the Sustainable Agricultural Research & Extension Center (SAREC) near Lingle, WY at an elevation of 4165 ft MSL. The soil type was a Haverson series silty-clay, pH = 7.9. Ground was prepared by discing twice and then by using a seed-bed packer. Furrow irrigation was provided as needed during the season.
Plot Design	The plot design was a randomized complete block design with two replications. Blind tests of corn selections were made and their response following inoculation with the Goss' wilt pathogen were recorded. Two seed companies provide selections for testing; Mycogen entered 100 corn selections and Garst entered 13 corn selections. Individual plot dimensions for the Mycogen selections were 17.5 ft long by one row wide (30 inch centers) and Garst plot dimensions for each selection were 17.5 ft long by two rows wide (30 inch centers).
Plot Management	**Planting Date:** 10 May, 2007. **Variety:** Tests in 2007 screened 113 corn selections. **Fertilizer:** 180 lb N + 35 lb P_2O_5 + 20 lb S **Herbicide:** Post applications of Option (1.5 oz product) and Clarity (6 oz product) on 4 June.
Disease Inoculation and Development	Inoculum was recovered from infected plant tissue collected during visits to fields located in southeastern Wyoming. Bacterial strains were prepared and purified in the laboratory by aseptic sub-culturing. Purified bacterial strains were increased in shake-culture to produce sufficient inoculum for field plots. Immediately after increase in shake-culture, liquid cultures were placed on ice in a cold room and then held on ice while being transported to the field for inoculation. Mycogen selections were inoculated on 11 July and Garst selections were inoculated on 12 July. Corn plants were inoculated using a "corn clapper" that simultaneously injured foliar tissue while it introduced inoculum into the wound. Uninoculated check plants were included for each selection to facilitate rating disease development following inoculation.

Disease Evaluations	Foliar lesions developed following inoculation, and lesion development from wound sites was evident. Foliar lesions progressed and killed large portions of the canopy for some selections. Inoculated plants for the same selections were compared to non-inoculated plants of the same selection. Plots were visually rated for disease incidence and severity on 16 August and 13 September. A rating scale of 1 (all inoculated plants dead) to 9 (all inoculated plants healthy) was used for comparison of the relative disease reaction among corn selections.
Statistical Analysis	Data from selections were provided to the appropriate seed company for statistical analysis.
Harvest	No yields were measured, and plots were subsequently destroyed by tillage and incorporation of crop residue into soil.

Results and Discussion

Goss's bacterial wilt and blight of corn is caused by the bacterium *Clavibacter michiganense* subsp. *nebraskensis* (Vidaver & Mandel) Davis *et al*, and is a disease of susceptible dent, food-grade, sweet and popcorn hybrids. Other hosts may include grass weeds such as green foxtail, barnyardgrass and shattercane. Goss' wilt was first discovered in Nebraska in 1969 and has since been identified in the corn growing areas of Wyoming, Kansas, Colorado, S. Dakota, Iowa, Illinois and Wisconsin.

Management of Goss' wilt involves the use of resistant cultivars and residue destruction to reduce overwintering. The incidences of this disease appears to be increasing in southeastern Wyoming, possibly due to increased popularity of continuous corn production and conservation tillage operations that preserve residue on the soil surface. Un response to this increased threat, seed companies are developing resistant varieties adapted to the region.

This pathogen can cause two major types of symptoms in corn, leaf blight (more common) and a vascular wilt. Leaf blight is characterized with grey to light yellow lesions with wavy margins that follow leaf veins sometimes preceded by water soaking. Small dark green to black water soaked spots develop within lesions. These leaf "freckles" are diagnostic of the disease, and were present on most naturally infected corn foliage initially utilized as an inoculum source. Bacterial exudate on disease tissue appears shiny and is another sign of the disease. Foliar lesions may progress and kill large portions of the canopy giving the plant a scorched appearance which may be confused with the effects of drought stress or hot drying winds. Inoculation of corn selections in this study resulted in leaf blight symptoms, as vascular wilt (discoloration of the vascular system and a water-soaked rot in the lower stalk) was not observed and/or was not rated.

On 8 June, nighttime temperatures were 27°F and caused severe frost injury to the corn plants. Also on this date, the plots were cultivated and ditched in preparation for furrow

irrigation. Due to extensive frost injury, plants were permitted to recover and were subsequently inoculated after a 1 month delay.

Ratings revealed a wide range in disease reaction following inoculation. On 13 September, individual plot ratings revealed a range of reactions from 2 (almost dead) to 8 (slight necrosis and leaf scorching) in the ca. 2 months following inoculation with the Goss' wilt bacterium. The range of results are not due to escapes, as each plant was inoculated. Results suggest that some of the selections tested in this study possess considerable resistance or tolerance to disease development following inoculation with the Goss' wilt bacterium.

Research Project	**Insect Management in Spring Wheat, 2007**
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Field Plot Details	The field plot was located at the Sustainable Agricultural Research & Extension Center (SAREC) near Lingle, WY at an elevation of 4165 ft MSL. The soil type was a Mitchell silt loam soil at pH = 7.9. Overhead sprinkler irrigation was provided as needed.
Plot Design	The plot design was a randomized complete block design with four replications. Each plot was 10 ft wide by 20 ft long with a 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center 6.7 ft (width) by 20 ft length of plot area. The center 5 ft by 20 ft was harvested to provide grain yield and grain quality information.
Plot Management	Planting Date: 17 April, 2007. Variety: Oslo (spring wheat) Fertilizer: 100 lb N + 30 lb P_2O_5 + 20 lb S on 6 March, with application amounts based on prior soil tests. Herbicide: Bronate Advanced (1.2 pt product) on 12 May.
Treatment Applications	The insecticide treatments were applied on 3 and 10 July, 2007 at the times corresponding to growth stages “wheat berries in milk stage” and “wheat berries in dough stage,” respectively. Insecticide treatments were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).
Insect Development	All insect population development resulted from natural infestations. The buffer rows were not treated with insecticide to improve the potential for insect pest development. The majority of thrips present were presumptive barley thrips but no further characterization was conducted. Subsequent data collection, analysis and presentation included all thrips encountered on the tiller and this population was referred to collectively as “thrips.” Stink bugs were also not identified as to species and were collectively referred to as “stink bug.”

Insect Treatment Evaluations

The initial thrip population was determined immediately prior to the first treatment application on 3 July. For this determination, 10 tillers were selected at random from within each plot boundary by cutting tillers ca. 1-2 inches below the flag leaf. Thrips were enumerated by dissecting the head and unrolling the flag leaf from the stem while viewing under a dissecting microscope; the average number of thrips per tiller was calculated. This procedure was repeated on 5 July by randomly selecting tillers from the treated (6.7 ft by 20 ft) area of each plot. On each subsequent evaluation date (10, 12 and 17 July), five tillers were selected from each plot and only heads were rated for thrip infestation.

Stink bug populations were determined with a sweep net (5 sweeps along the length of the plot) on 3, 5, 10, 12 and 17 July.

Statistical Analysis

ANOVA with four replications was performed for statistical analysis. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$). Insect count data were transformed (Log_{10}) to correct for non-homogeneity prior to analysis. Data prior to transformation are summarized in Table 1.

Harvest

Plots were harvested on 14 August with a combine designed for harvesting small plots. The center 5 ft by 20 ft length (100 ft^2) of each plot was harvested for grain yield determination. Grain moisture-content and grain test-weight also were determined and analyzed. A special thanks goes to Jerry Nachtman for grain harvest.

Results and Discussion

Plots were periodically monitored during the growing season to detect the initial appearance of stink bugs and thrips. On 3 July thrip populations were found to be increasing although stink bug populations remained barely detectable. The insecticide treatments were applied on 3 and 10 July, 2007.

Effects of foliar insecticide treatments on thrip populations are summarized in Table 1. The thrip population sizes measured on 5 July were not significantly affected by treatment applied 3 July (P=0.05). However, a data trend indicates a reduced number of thrips per tiller following insecticide application. On 10 July (immediately prior to 10 July insecticide application) the Warrior and SpinTor treatments had significantly fewer thrips per tiller compared to the nontreated check ($P \leq 0.05$). There were no significant treatment effects detected on 12 July (P=0.05) and no thrips were detected on 17 July (data not shown). By mid-July, the spring wheat was starting to mature and thrip populations declined. No phytotoxicity was observed in the plots at any time.

Effects of foliar insecticide treatments on stink bug populations are summarized in Table 2. Treatments had no significant effect on stink bug populations at any evaluation time

(*P*=0.05). Data are not meaningful because the stink bug population was too low to properly measure treatment effects under the conditions that this test was conducted.

Effects of foliar insecticide treatments on spring wheat yield and quality are shown in Table 3. No significant treatment effects were detected for wheat grain yield, grain moisture or seed test weight (*P*=0.05).

Table 1. Effects of foliar insecticide treatments on spring wheat thrip populations (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment (product/A)[1]	Thrip[2] numbers per tiller			
	Initial 3 July[3]	5 July[3]	10 July[4]	12 July[4]
1. Nontreated check.	3.4 a[5]	3.3 a	0.5 a	0.1 a
2. Warrior with Zeon Tech. 1CS (3.84 fl oz).	2.4 a	0.7 a	0.1 b	0.3 a
3. Lannate LV 2.4SL (1.5 pt).	4.1 a	2.1 a	0.5 a	0.2 a
4. SpinTor 2SC (10 fl oz).	2.9 a	2.2 a	0.1 b	0.1 a

[1] Plots were planted 17 April, 2007 with cv. Oslo (spring wheat). Treatments were foliar applied in 43 gpa carrier at 30 psi to spring wheat on 3 July (milk stage) and 10 July (dough stage).

[2] Thrips present were presumptive barley thrips.. No thrips were detected on the 17 July evaluations.

[3] A total of ten tillers was randomly selected from each plot during evaluations.

[4] A total of five tillers was randomly selected from each plot during evaluation.

[5] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. Effects of foliar insecticide treatments on spring wheat stink bug populations (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment (product/A)[1]	Average number of stink bugs per plot[2]				
	Initial 3 July	5 July	10 July	12 July	17 July
1. Nontreated check.	0.0 a[3]	0.0 a	0.3 a	0.5 a	0.0 a
2. Warrior with Zeon Tech. 1CS (3.84 fl oz). .	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
3. Lannate LV 2.4SL (1.5 pt).	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
4. SpinTor 2SC (10 fl oz).	0.0 a	0.0 a	0.3 a	0.0 a	0.0 a

[1] Plots were planted 17 April, 2007 with cv. Oslo (spring wheat). Treatments were foliar applied in 43 gpa carrier at 30 psi to spring wheat on 3 July (milk stage) and 10 July (dough stage).

[2] Data indicate the number of stink bugs per 5 sweeps per plot. Stink bugs were not identified as to species.

[3] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 3. Effects of foliar insecticide treatments on spring wheat yield and quality (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment (product/A)[1]	Spring wheat yield and quality		
	bu/A	% moisture	lb/bu
1. Nontreated check.	51.9 a[2]	9.8 a	54.9 a
2. Warrior with Zeon Tech. 1CS (3.84 fl oz).	55.1 a	9.7 a	54.4 a
3. Lannate LV 2.4SL (1.5 pt).	55.5 a	9.7 a	55.0 a
4. SpinTor 2SC (10 fl oz).	50.9 a	9.8 a	54.8 a

[1] Plots were planted 17 April, 2007 with cv. Oslo (spring wheat). Treatments were foliar applied in 43 gpa carrier at 30 psi to spring wheat on 3 July (milk stage) and 10 July (dough stage).

[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Research Project	**Management of Foliar and Head Diseases in Barley with Foliar Fungicides, 2007**
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Field Plot Details	The field plot was located at the Sustainable Agricultural Research & Extension Center (SAREC) near Lingle, WY at an elevation of 4165 ft MSL. The soil type was a Mitchell silt loam at pH = 7.9. Overhead sprinkler irrigation was provided as needed.
Plot Design	The plot design was a randomized complete block design with four replications. Each plots was 10 ft wide by 20 ft long with a 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center 6.7 ft (width) by 20 ft length of plot area.
Plot Management	**Planting Date:** 17 April, 2007. **Variety:** Burton (barley) **Fertilizer:** 100 lb N + 30 lb P_2O_5 + 20 lb S on 6 March, with application rates based on prior soil tests. **Herbicide:** Bronate Advanced (1.2 pt product) on 12 May.
Treatment Applications	The fungicide treatments were applied on 21 June. The barley growth stage at the time of application was early head emergence. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).
Disease Development	Plots were inoculated with stripe rust (presumptive *Puccinia striiformis*) spores on 26 June. The stripe rust inoculum was naturally occurring and was collected from a neighboring irrigated winter wheat field. Urediospores were harvested from wheat by placing infected and symptomatic (signs) leaves in a container with one liter of water plus several drops of Tween 20 and shaking vigorously. Foliar application of spores (3.75×10^3 spores/ml) was made directly over the center of each plot in a total volume of 1.06 gal/1000 row-ft via a single-nozzle (8002 flat fan) equipped boom in a swath approximately 2.5 ft wide.

Disease Evaluations	Initial rust disease severity was determined on 21 June, prior to inoculation and treatment applications. Twenty tillers were selected at random from each of the four replicate blocks (80 tillers total). Tillers were observed for any signs and symptoms of disease. On 12 July following application, 10 tillers were selected from the center of each plot and evaluated for foliar disease. After harvest, a subsample of 25 individual barley kernels was weighed and evaluated for fungal growth (presumptive black point or kernel blight). Phytotoxicity ratings due to treatment were made on 28 June and 12 July.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).
Harvest	Plots were harvested on 14 August with a combine designed for small plots. The center 5 ft by 20 ft (100 ft^2) of each plot was harvested for evaluation. Grain moisture-content and kernel test weight was determined. A subsample of barley grain was collected for barley kernel disease evaluations.

Results and Discussion

Stripe rust failed to develop in the field plot following inoculation. No disease was detected on the 12 July or later evaluations (Table 1, P=0.05). There was no phytotoxicity observed in the plots on 28 June and 12 July (data not shown).

Treatments had no significant effect on grain yield and grain quality (Table 2, P=0.05). However, data for treatments containing either Punch or YT699 revealed a trend for reduced incidence and severity of barley kernel fungal infestation compared to the nontreated check or Lem17 alone treatments. Note that the severity ratings are the average surface area affected by fungal growth for only those kernels with fungal growth already present (i.e., having a severity rating of 1-4). For example, treatment 1 had 16 percent of the kernels with fungal growth evident, and an average 3 percent of the surface area affected (for that 16 percent). Therefore, severity rating averages do not include data for unaffected kernels (84 percent of the kernels evaluated for treatment 1). Although fungal infestation incidence appeared reduced, treatments that included Punch or YT699 also had a trend of reduced kernel weight (Table 2), perhaps indicating a potential effect on barley grain development.

Table 1. Effects of foliar fungicide treatments on cv. Burton barley foliar disease and harvested grain quality (G.D.Franc and W.L. Stump, Univ. of WY; 2007).

Treatment (oz a.i./A)[1]	Stripe Rust disease incidence		Barley kernel disease and kernel quality ratings[4]		
	Initial 21 June[2]	12 July[3]	Incidence %	Severity % kernel surface area affected	Grain wt grams per 25 kernels
1. Nontreated check.	0 a[5]	0 a	16.0 a	3.0 a	1.04 a
2. Lem 17 1.67SC (2.0).	0 a	0 a	18.0 a	2.5 a	1.17 a
3. Lem 17 1.67SC (3.5).	0 a	0 a	16.0 a	1.6 a	1.01 a
4. Lem 17 1.67SC (2.0) + YT699 2.08SC (1.04).	0 a	0 a	8.0 a	1.2 a	0.95 a
5. Lem 17 1.67SC (2.0) + Punch 3.3EC (1.24).	0 a	0 a	10.0 a	2.0 a	0.90 a
6. Punch 3.3EC (1.65).	0 a	0 a	9.0 a	2.0 a	0.90 a
7. Punch 3.3EC (1.24) + YT699 2.08SC (1.04).	0 a	0 a	8.0 a	2.5 a	0.95 a

[1] Treatments were applied to foliage on 21 June and plants were inoculated with stripe rust inoculum (3.75 x 10^3 spores per ml) on 26 June. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).

[2] Twenty tillers were randomly selected from each replicate block during evaluations.

[3] Ten tillers were randomly selected from each plot during evaluations.

[4] A 25-kernel subsample was visually evaluated for fungal growth (presumptive black point or kernel blight). The severity rating scale was: 0= no fungal growth, 1= <3%, 2= 3-6%, 3= 6-12%, and 4= 12-25% of the kernel surface area affected by fungal growth. Data were converted to percentage using the appropriate Horsfall-Barratt conversion scale. Note: severity ratings are the average surface area affected by fungal growth for only those kernels with fungal growth present (i.e., rating of 1-4).

[5] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. Effects of foliar fungicide treatments on cv. Burton barley yield and quality (G.D.Franc and W.L. Stump, Univ. of WY; 2007).

Treatment (oz a.i./A)[1]	Barley yield and quality at harvest		
	bu/A	% moisture	lbs/bu
1. Nontreated check.	78.2 a[2]	7.9 a	45.4 a
2. Lem 17 1.67SC (2.0).	74.3 a	7.9 a	44.3 a
3. Lem 17 1.67SC (3.5).	70.2 a	7.9 a	44.7 a
4. Lem 17 1.67SC (2.0) + YT699 2.08SC (1.04).	66.4 a	7.7 a	44.2 a
5. Lem 17 1.67SC (2.0) + Punch 3.3EC (1.24).	65.5 a	7.6 a	43.8 a
6. Punch 3.3EC (1.65).	65.4 a	7.6 a	43.0 a
7. Punch 3.3EC (1.24) + YT699 2.08SC (1.04).	65.1 a	7.6 a	43.7 a

[1] Treatments were applied to foliage on 21 June and plants were inoculated with stripe rust inoculum (3.75×10^3 spores per ml) on 26 June. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches). Plots were harvested on 14 August.

[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Research Project	**Insect Management in Dry Beans, 2007**
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Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	
Field Plot Details	The field plot was located at the Sustainable Agricultural Research & Extension Center (SAREC) near Lingle, WY at an elevation of 4165 ft MSL. The soil type was a Mitchell silt loam soil at pH = 7.9. Overhead sprinkler irrigation was provided as needed.
Plot Design	The plot design was a randomized complete block design with four replications. Each plot was 4 rows wide (30 inch row-centers) by 20 ft long with a 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows by 20 ft length of plot area.
Plot Management	**Planting Date:** 30 May, 2007. **Variety:** cv. Othelo **Fertilizer:** 30 lb N + 35 lb P_2O_5 + 20 lb S on 9 May, with application amounts based on prior soil tests. **Herbicide:** Eptam 3 pt product + Sonolan 2 pt product on 21 May.
Treatment Applications	The insecticide treatments were applied on 31 July and 7 August in response to increased Mexican bean beetle populations. Insecticides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).
Insect Development	All insect population development relied on natural infestation(s). The buffer rows were left untreated to improve the potential for greater insect pest pressure. Leaf hoppers were not identified as to species, however the majority appeared to be potato and sugar beet leafhoppers.
Insect Treatment Evaluations	Mexican bean beetle populations were determined on 31 July, prior to treatment applications. Additional counts were done on 3 and 10 August for both Mexican bean beetle and leafhopper. Counts were made via two methods; using a beater-board placed between two rows, approximately 10 plants (5 from each row) were agitated over the top of a 2 ft square (beater) board and the dislodged insects were counted. Since many Mexican bean beetle larvae proved tenacious and remained on the plants after agitation, these same 10 plants were

visually examined and the larvae that remained on the plant were counted. Both counts were summed for analysis and data presentation. Later in the season, visible necrosis due to Mexican bean beetle feeding was visually estimated on 21 and 28 August using the Horsfall-Barratt scale (0-11).

Statistical Analysis

ANOVA with four replications was conducted for statistical analysis. Mean separations were done using Fisher's protected LSD at $P \leq 0.05$, except for foliar feeding injury on 28 August which used $P \leq 0.06$. When needed, insect count data were transformed (Log_{10}) to correct for non-homogeneity prior to analysis. Data prior to transformations are presented in Table 1.

Harvest

Plots were harvested on 10 September with a plot combine designed for small plots. The middle 10 ft of the two center treated rows for each plot was harvested (20 row-feet total). Seed test-weight also was determined as a measure of seed quality.

Results and Discussion

Plots were monitored over the growing season for the presence of various Lepidopterous insects, Mexican bean beetle and leaf hoppers. Lepidopterous insects were not detected. However, Mexican bean beetle populations became elevated with corresponding feeding injury visible on plants in the field by mid-August.

Effects of foliar insecticide treatments on Mexican bean beetle and leaf hopper populations are summarized in Table 1. On 3 August (3 days after application), there were no significant treatment effects detected on Mexican bean beetle larvae populations (P=0.05). On 10 August (3 days after the second application) all treatments except Intrepid, reduced larvae numbers compared to the nontreated check ($P \leq 0.05$). There were no significant treatment effects on Mexican bean beetle adults + pupae or leaf hopper populations (P=0.05). No phytotoxicity due to treatment was observed in the plots at any time.

Crop necrosis evaluations resulting from insect feeding are shown in Table 2. Steward and SpinTor applications reduced crop necrosis compared to the nontreated check on the 21 August evaluation ($P \leq 0.05$). By 28 August, only the SpinTor treatment had reduced necrosis compared to the nontreated check ($P \leq 0.05$). Intrepid had no significant effect on feeding injury ($P \leq 0.05$).

Effects of foliar insecticide treatments on bean seed yield and quality are also shown in Table 2. There were no significant treatment effects on both yield or quality (P=0.05). However, data indicate a consistent trend of increased seed yield for all insecticide treatments.

Table 1. Effects of foliar insecticide treatments on insect populations (G.D. Franc, W.L. Stump and J.T. Cecil, Univ. of WY; 2007).

Treatment (product/A)[1]	Mexican bean beetle[2]				Leaf hopper[2]	
	larvae			adults + pupae		
	Initial 31 Jul	3 Aug	10 Aug	10 Aug	3 Aug	10 Aug
1. Nontreated check.	3.3 a[3]	13.3 a	21.8 a	3.3 a	0.8 a	1.0 a
2. Steward 1.25EC (6.7 fl oz).	1.3 a	8.3 a	2.3 c	3.3 a	0.3 a	1.3 a
3. Steward 1.25EC (11.3 fl oz).	5.0 a	9.8 a	1.5 c	3.3 a	1.0 a	0.0 a
4. SpinTor 2SC (6.0 fl oz).	6.0 a	2.5 a	5.0 bc	2.3 a	1.8 a	0.0 a
5. Intrepid 2F (10 fl oz).	2.8 a	10.3 a	19.3 ab	0.0 a	0.5 a	0.8 a

[1] Plots were planted 30 May, 2007. Treatments were foliar applied in 43 gpa carrier at 30 psi on 31 July and 7 August.

[2] Ten plants from each plot were shaken over a counting board and insects counted, and then visually inspected for adhering insects: data represent the sum of both methods.

[3] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. Effects of foliar insecticide treatments on crop injury and seed yield and quality (G.D. Franc, W.L. Stump and J.T. Cecil, Univ. of WY; 2007).

Treatment (product/A)[1]	% crop necrosis (due to feeding injury)		Bean seed yield and quality	
	21 Aug	28 Aug	cwt/A	200 seed wt (oz)
1. Nontreated check.	76.5 a[2]	90.0 ab[3]	17.0 a[2]	2.3 a[2]
2. Steward 1.25EC (6.7 fl oz).	40.5 b	76.5 bc	18.6 a	2.3 a
3. Steward 1.25EC (11.3 fl oz).	46.0 b	73.5 bc	20.9 a	2.3 a
4. SpinTor 2SC (6.0 fl oz).	37.0 b	65.0 c	18.6 a	2.4 a
5. Intrepid 2F (10 fl oz).	73.5 a	94.0 a	17.9 a	2.2 a

[1] Plots were planted 30 May, 2007. Treatments were foliar applied in 43 gpa carrier at 30 psi on 31 July and 7 August.

[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

[3] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.06$).

Research Project	**Management of Potato Early Blight with Foliar Fungicide Programs in 2007**
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Field Plot Location	Field plots were placed at the Sustainable Agricultural Research & Extension Center (SAREC) located near Lingle, WY. The elevation of SAREC is placed at 4,165 ft MSL, and the soil type at the plot location was a Mitchell clay loam soil at pH = 7.9. Overhead sprinkler irrigation was applied as needed.
Plot Design	RCBD with 4 replications; plots were 4 rows (36-in row centers) by 20 ft long, with a 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date**: 10 May, 2007. **Variety**: FL1867 **Fertilizer**: 175 lb N + 80 lb P_2O_5 + 35lb S on 9 May, based on prior soil tests. **Herbicide**: Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A). Herbicides were then water (irrigation) incorporated.
Disease Development	On 12 and 19 July, *Alternaria solani* spores and associated hyphae harvested from culture plates were applied (1.15×10^4 and 4.6×10^3 spores per ml, respectively) to foliage of the two center rows in each plot and the 5 ft in-row buffer rows of each plot. These applications (inoculations) were made in a total volume of 1.06 gal/1000 row-ft via a single-nozzle (8002 flat fan) equipped boom. Early blight lesions were first detected in the plots on 12 July, indicating the first inoculation coincided with natural disease onset. Severe early blight resulted in nontreated plots and plots with weaker fungicide programs by the end of the growing season. White mold and late blight were not observed at any time during the growing season.
Treatment Applications	Foliar treatments for early blight disease management consisted of spray programs initiated on 12 July and all application dates were as indicated in the following Tables. When foliar fungicide applications coincided with inoculations, fungicide applications were made at least several hours prior to inoculation and had dried on the foliage. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).

Disease and other Treatment Ratings	Early blight disease severity was measured by calculating the average number of lesions per leaflet. Six leaves were randomly selected from each treatment plot; two leaves each from the top, middle, and bottom third of the canopy. The number of early blight lesions was counted on up to seven leaflets from each of the six leaves. Leaves were collected on 17, 24, 31 July, and 7, 14 August. Data for 17 July is not included in Table 1 due to low disease severity at the start of the epidemic and the 14 August data collection also was not included because disease progression had resulted in extensive canopy decline and defoliation in many plots, resulting in missing data points. Disease severity data from 17 July to 7 August were used to calculate an area under the disease progress curve (AUDPC) rating for each treatment program. The AUDPC is a measure of season-long disease severity for each treatment. Additionally, plots were visually rated using the Horsfall-Barratt scale (0-11) to estimate the percentage of foliar necrosis (combined effects of disease and senescence) on 10, 14, 21 and 28 August; an area under the necrosis progress curve (AUNPC) was also calculated using these data. Data are summarized in Table 1. Data for 28 August are not shown in Table 1, since most values indicated 100 percent defoliation by this date.
Harvest	Two rows by 10 ft were harvested with a one-row mechanical digger. Harvest was done on 6 September, and tubers were sorted and weighed to determine yield and grade on 14 September. All yield data are summarized in Table 2.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$). Linear contrasts were made on some treatment comparisons ($P \leq 0.05$).

Results and Discussion

Early blight lesions were first detected in the plots on 12 July, indicating that the first inoculation attempt coincided with natural early blight disease onset. Early blight disease development was greatly accelerated following inoculation, with disease development and defoliation first becoming evident in the non-treated inoculated rows dispersed through the field plot area and, by early August, early blight disease pressure was severe in the general field plot area. The appearance of natural disease onset on 12 July and canopy decline from disease pressure was observed ca 2 wk earlier than for prior studies done at SAREC. This may indicate a build-up of overwintering inoculum at SAREC that may be beneficial for future studies. Inoculations were also made ca. 1 wk earlier than in prior years. No foliar or tuber phytotoxicity was observed for any of the fungicide programs during 2007.

Disease severity data are summarized in Table 1. Foliar lesion counts tend to underestimate disease severity as early blight progresses and becomes increasingly severe in the plant canopy, because leaflets lower most affected by early blight are those first lost by the plant during defoliation. Therefore, leaflets remaining on the plant and subsequently collected for disease ratings tend to be those less heavily infected. The AUNPC rating indirectly measures

season-long disease development and late season foliar necrosis ratings in Table 1 become increasing important for rating fungicide program effects late in the growing season. If the growing season is sufficiently long, plots with the least foliar damage continue to bulk tubers while defoliated plots lag increasingly behind. If the growing season is not long enough, yields do not adequately represent foliar disease suppression.

- Most fungicide programs significantly reduced early blight compared to the nontreated check (P= 0.05). The exceptions were the "organic" treatment compounds "Organic B" and "Organic A" which had no significant disease suppression (P= 0.05). Additionally, Echo applications that were delayed 1-3 weeks after the 12 July disease onset had AUDPC and AUNPC values similar, or worse, than that of the nontreated check (P= 0.05).

- LEM 17 (treatments 2 - 6) provided early blight suppression similar to that provided by chlorothalonil alone (Bravo Weather Stik, treatment 14; Echo, treatment 16; P= 0.05). However, LEM 17 was applied on a 14-day application interval as opposed to the 7-day application interval for the other fungicide programs to which LEM 17 is being compared. There was no consistent rate effect evident for the LEM 17 treatments, and both formulations (EC vs SC) appear similar in efficacy.

- There was no significant difference on average between the LEM 17 EC and SC formulations on early blight severity (AUDPC) and foliar necrosis (AUNPC) values (Linear contrast, P= 0.05).

- The Revus Opti/ Bravo Weather Stik program (treatment 8) provided disease suppression equivalent to that provided by Bravo Weather Stik (treatment 14; P= 0.05). Revus Opti is a mixture of Bravo Weather Stik and mandipropamid (10:1 mix), the latter which has activity against late blight.

- Programs with Revus Top in combination with Bravo Weather Stik (treatments 9 and 10) provided the greatest disease suppression, but did not differ significantly from Bravo Weather Stik applied alone (P= 0.05). Revus Top is a mixture of difenoconazole and mandipropamid (1:1 mix) providing activity for both early blight and late blight suppression.

- A13703 is a mixture of azoxystrobin (18%) and difenoconazole (11%) and this fungicide program in combination with Bravo Weather Stik (treatment 12) provided disease suppression equivalent to that provided by the Revus Top fungicide programs (P= 0.05).

- Echo applied season-long (first application made at the time of disease onset = 0 week delay; treatment 16) at a lower use rate (1.5 pt product), provided disease suppression similar to that provided by season-long applications of Bravo Weather Stik (2.125 pt; P= 0.05). If Echo applications were delayed 1 wk (treatment 17), 2 wk (treatment 18), or 3 wk (treatment 19), season-long disease suppression was greatly compromised compared to when Echo was applied at the time of disease onset (0 week delay; $P \leq 0.05$). Timing studies indicate the importance of applying fungicide

for disease suppression at the time of disease onset, or shortly before. This effect is not unique to Echo.

- Effects of treatments on yield and quality are shown in Table 2. Tuber yield and tuber quality were not significantly affected by treatment (P=0.05).

For additional comparisons, fungicide treatment 13 in this report is identical to the fungicide program established in a nearby demonstration plot (see: **Establishment of a Demonstration Plot at SAREC for Management of Potato Early Blight with Foliar Fungicide, 2007**).

Table 1. Effects of foliar fungicide programs on potato foliar disease (G.D. Franc and W.L. Stump, U of WY; 2007).

Treatment and rate (amount./A)	Fungicide application dates [1]	Early blight lesions per leaflet				Foliar necrosis (%) [3]			
		24 Jul	31 Jul	7 Aug	AUDPC[2]	10 Aug	14 Aug	21 Aug	AUNPC[3]
1. Nontreated check.	NA	0.11 cd[4]	0.70 bcd	8.90 bc	36.92 b	35.0 a	90.0 abc	97.0 abc	183.5 ab
2. LEM17 1.67EC (2.0 oz a.i.).	A, C, E	0.00 d	0.28 ef	3.53 efg	14.85 cd	12.0 cde	69.0 c-g	95.5 a-d	158.3 b-f
3. LEM17 1.67EC (3.5 oz a.i.).	A, C, E	0.03 d	0.16 f	2.53 fgh	10.35 cde	8.5 de	59.5 e-h	90.0 b-e	145.9 c-h
4. LEM17 1.67EC (5.0 oz a.i.).	A, C, E	0.01 d	0.15 f	4.84 ef	18.40 c	8.5 de	56.0 e-h	95.5 a-d	151.5 c-f
5. LEM17 1.67SC (3.5 oz a.i.).	A, C, E	0.00 d	0.25 ef	5.52 de	21.19 c	15.0 bcd	80.5 a-e	98.0 ab	171.1 a-d
6. LEM17 1.67SC (5.0 oz a.i.).	A, C, E	0.03 d	0.15 f	2.66 e-h	10.83 cde	7.5 de	46.0 fgh	95.5 a-d	147.0 c-g
7. Organic B (150 ml product/gal mix).	A-F	0.09 cd	0.81 bc	10.00 bc	41.52 b	28.0 abc	91.5 ab	99.5 a	190.3 a
8. Revus Opti 3.67SC (2.5 pt product) + induce (0.125% v:v).	A, B, D, E	0.02 d	0.30 def	2.29 fgh	10.35 cde	12.0 cde	65.0 d-h	99.0 a	167.4 a-e
8. Bravo Weather Stik 6F (1.5 pt product). . . .	C, F								
9. Revus Top 4.17SC (5.5 fl oz product) + induce (0.125% v:v).	A, B, D, E	0.03 d	0.08 f	0.30 h	1.87 e	12.0 cde	50.0 e-h	90.0 b-e	142.3 c-h
9. Bravo Weather Stik 6F (1.5 pt product). . . .	C, F								
10. Revus Top 4.17SC (7.0 fl oz product) + induce (0.125% v:v).	A, B, D, E	0.01 d	0.07 f	0.53 h	2.70 e	8.5 de	50.0 e-h	86.0 cde	137.0 e-h
10. Bravo Weather Stik 6F (1.5 pt product). . .	C, F								
11. Quadris Opti 5.5SC (1.6 pt product).	A, C	0.01 d	0.21 ef	0.83 gh	4.88 de	7.5 de	37.0 gh	83.0 de	128.5 fgh
11. Revus Top 4.17SC (7.0 fl oz product) + induce (0.125% v:v).	B, D								
11. Bravo Weather Stik 6F (1.5 pt product). . .	E, F								

Table 1 continued

Treatment and rate (amount./A)	Fungicide application dates [1]	Early blight lesions per leaflet				Foliar necrosis (%) [3]			
		24 Jul	31 Jul	7 Aug	AUDPC[2]	10 Aug	14 Aug	21 Aug	AUNPC[3]
12. A13703 (0.525 pt product) + induce (0.125% v:v).	A, B, D, E	0.01 d	0.01f	0.65 gh	2.44 e	5.0 e	31.0 h	69.0 e	114.9 h
12. Bravo Weather Stik 6F (1.5 pt product). . . .	C, F								
13. Quadris Opti 5.5SC (1.6 pt product).	A, D	0.03 d	0.06 f	1.06 gh	4.40 de	5.0 e	37.0 gh	73.5 e	118.9 gh
13. Bravo Weather Stik 6F (1.5 pt product). . . .	B, E								
13. Revus Top 4.17SC (7.0 fl oz product) + induce (0.125% v:v).	C, F								
14. Bravo Weather Stik 6F (2.125 pt product).	A-F	0.01 d	0.22 ef	2.07 fgh	9.10 cde	8.5 de	59.5 e-h	88.0 b-e	141.5 d-h
15. Organic B (300 ml product/gal mix).	A-F	0.31 ab	0.71 bcd	10. 10 bc	42.50 b	31.0 ab	91.5 ab	99.5 a	192.0 a
16. Echo 6F (1.5 pt product): **0 week delay**. . . .	A-F	0.01 d	0.04 f	2.66 e-h	9.68 cde	7.5 de	56.0 e-h	95.5 a-d	148.9 c-g
17. Echo 6F (1.5 pt product): **1 week delay**. . . .	B-F	0.41 a	0.61 cde	8.04 cd	35.52 b	23.5 abc	73.5 b-f	98.0 ab	173.6 abc
18. Echo 6F (1.5 pt product): **2 week delay**. . . .	C-F	0.34 ab	0.59 cde	11. 31 ab	46.20 b	37.0 a	93.0 a	99.5 a	194.3 a
19. Echo 6F (1.5 pt product): **3 week delay**. . . .	D-F	0.22 bc	1.43 a	14.00 a	60.62 a	40.5 a	88.0 a-d	99.0 a	191.0 a
20. Organic A (0.5% v:v).	A-F	0.14 cd	1.08 ab	8.00 cd	36.67 b	37.0 a	93.0 a	98.0 ab	189.0 ab

[1] Plots were planted 10 May, 2007 with variety FL1867, inoculated (early blight: 12, 19 July), and harvested 6 September, 2007. Fungicide applications were: A=12 July, B=19 July, C=25 July, D=2 August, E=9 August, F=16 August and NA= not applicable.

[2] AUDPC= area under the disease progress curve for data collected from 17 July through 7 August. The AUDPC is an estimate of season-long disease severity.

[3] Foliar necrosis was estimated using the Horsfall-Barratt scale (0-11) and converted to percentage using the appropriate conversion table. Necrosis resulted from the combined effects of early blight disease and senescence. AUNPC= area under the necrosis progress curve for data collected from 10 through 28 August.

[4] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. The effects of foliar fungicide programs on potato yield and quality (G.D. Franc and W.L. Stump, U of WY; 2007).

Treatment and rate (a.i./A)	Fungicide application dates [1]	Yield (cwt)						
		US#1			US#2	Grade B	Cull	Total
		>10 oz	<10 oz	total				
1. Nontreated check.	NA	1.8 a	130.2 a	132.0 a	9.8 a	12.4 a	18.4 a	173.2 a
2. LEM17 1.67EC (2.0 oz a.i.).	A, C, E	3.7 a	150.3 a	154.0 a	8.9 a	19.8 a	8.8 a	191.5 a
3. LEM17 1.67EC (3.5 oz a.i.).	A, C, E	2.6 a	115.8 a	118.4 a	13.6 a	16.2 a	17.1 a	165.3 a
4. LEM17 1.67EC (5.0 oz a.i.).	A, C, E	1.1 a	134.9 a	136.0 a	17.1 a	15.4 a	9.9 a	178.3 a
5. LEM17 1.67SC (3.5 oz a.i.).	A, C, E	3.8 a	135.6 a	139.4 a	12.3 a	15.4 a	9.8 a	176.9 a
6. LEM17 1.67SC (5.0 oz a.i.).	A, C, E	1.3 a	135.9 a	137.2 a	13.4 a	15.1 a	11.8 a	177.5 a
7. Organic B (150 ml product/gal mix).	A-F	4.5 a	125.1 a	129.6 a	10.6 a	17.2 a	7.4 a	164.8 a
8. Revus Opti 3.67SC (2.5 pt product) + induce (0.125% v:v).	A, B, D, E	2.6 a	104.0 a	106.6 a	8.9 a	13.1 a	9.7 a	138.3 a
8. Bravo Weather Stik 6F (1.5 pt product).	C, F							
9. Revus Top 4.17SC (5.5 fl oz product) + induce (0.125% v:v).	A, B, D, E	1.4 a	125.6 a	127.0 a	11.4 a	12.2 a	9.2 a	159.7 a
9. Bravo Weather Stik 6F (1.5 pt product).	C, F							
10. Revus Top 4.17SC (7.0 fl oz product) + induce (0.125% v:v).	A, B, D, E	0.0 a	111.3 a	111.3 a	12.4 a	9.6 a	10.9 a	144.2 a
10. Bravo Weather Stik 6F (1.5 pt product).	C, F							
11. Quadris Opti 5.5SC (1.6 pt product).	A, C	1.7 a	149.2 a	150.9 a	15.8 a	15.6 a	14.2 a	196.6 a
11. Revus Top 4.17SC (7.0 fl oz product) + induce (0.125% v:v).	B, D							
11. Bravo Weather Stik 6F (1.5 pt product).	E, F							

Table 2 continued

Treatment and rate (a.i./A)	Fungicide application dates [1]	Yield (cwt)						
		US#1			US#2	Grade B	Cull	Total
		>10 oz	< 10 oz	total				
12. A13703 (0.525 pt product) + induce (0.125% v:v). .	A, B, D, E	7.5 a	133.8 a	141.3 a	6.2 a	15.2 a	12.8 a	175.5 a
12. Bravo Weather Stik 6F (1.5 pt product).	C, F							
13. Quadris Opti 5.5SC (1.6 pt product).	A, D	5.1 a	126.3 a	131.4 a	13.4 a	12.3 a	14.2 a	171.3 a
13. Bravo Weather Stik 6F (1.5 pt product).	B, E							
13. Revus Top 4.17SC (7.0 fl oz product) + induce (0.125% v:v).	C, F							
14. Bravo Weather Stik 6F (2.125 pt product).	A-F	0.0 a	134.9 a	134.9 a	15.9 a	14.5 a	13.1 a	178.3 a
15. Organic B (300 ml product/gal mix).	A-F	4.1 a	148.6 a	152.7 a	10.2 a	20.7 a	5.8 a	189.4 a
16. Echo 6F (1.5 pt product): **0 week delay**.	A-F	5.2 a	132.3 a	137.5 a	10.2 a	13.6 a	12.1 a	173.3 a
17. Echo 6F (1.5 pt product): **1 week delay**.	B-F	0.0 a	123.2 a	123.2 a	1.5 a	15.4 a	11.1 a	151.2 a
18. Echo 6F (1.5 pt product): **2 week delay**.	C-F	0.0 a	127.4 a	127.4 a	16.4 a	16.2 a	12.1 a	172.1 a
19. Echo 6F (1.5 pt product): **3 week delay**.	D-F	1.3 a	142.1 a	143.4 a	9.8 a	16.2 a	3.4 a	172.7 a
20. Organic A (0.5% v:v).	A-F	0.0 a	121.6 a	121.6 a	9.7 a	14.7 a	10.4 a	156.5 a

[1] Plots were planted 10 May, 2007 with variety FL1867, inoculated (early blight: 12, 19 July), and harvested 6 September, 2007. Fungicide applications were: A=12 July, B=19 July, C=25 July, D=2 August, E=9 August, F=16 August and NA= not applicable.

[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Research Project	**Establishment of a Demonstration Plot at SAREC for Management of Potato Early Blight with Foliar Fungicide, 2007**
Research Team	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	
Field Plot Location	This field plot was placed at the Sustainable Agricultural Research & Extension Center (SAREC) located near Lingle, WY. The elevation of SAREC is placed at 4,165 ft MSL, and the soil type at the plot location was a Mitchell clay loam soil at pH = 7.9. Overhead sprinkler irrigation was applied as needed.
Plot Design	This was a plot established for demonstration, meeting requirements for ready access and observation from multiple vantage points. Plots were arranged so that they could be easily observed during a field day. The field plot was placed within a bulk potato planting and the dimensions of the field plot was 28 rows wide (36-in row centers) and 40 ft long. Three nontreated check plots were established in rows 1-4, rows 13-16 and rows 25-28. Therefore, each nontreated check plot was four rows wide and 40 ft long. Two fungicide treated plots were established in rows 5-12 and rows 17-24. Therefore, fungicide treated plots were eight rows wide and 40 ft long. In the nontreated check plots, all inoculations were made to, and all data were collected from, the center two rows of each plot. In the fungicide treated plots all inoculations and fungicide applications were made to, and all data were collected from, rows 6-7, 9-10, 18-19, and rows 21-22. Data were collected from two sub-samples in each nontreated check plot for a total of 6 replications. In the fungicide treated plots, four sub-samples were collected per plot for a total of 8 replications.
Plot Management	**Planting Date**: 10 May, 2007. **Variety**: FL1867 **Fertilizer**: 175 lb N + 80 lb P_2O_5 + 35lb S on 9 May, based on prior soil tests. **Herbicide**: Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A). Herbicides were then water (irrigation) incorporated.

Disease Development	On 12 and 19 July, *Alternaria solani* spores and associated hyphae harvested from culture plates were applied (1.15×10^4 and 4.6×10^3 spores per ml, respectively) to foliage of the two center rows in each plot and the 5 ft in-row buffer rows of each plot. These applications (inoculations) were made in a total volume of 1.06 gal/1000 row-ft via a single-nozzle (8002 flat fan) equipped boom. Early blight lesions were first detected in the plots on 12 July, indicating the first inoculation coincided with natural disease onset. Severe early blight resulted in nontreated plots by the end of the growing season. White mold and late blight were not observed at any time during the growing season.
Treatment Applications	Treatments for foliar disease management consisted of a spray program initiated on 12 July and all application dates were as indicated in the following Tables. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A @ 30 psi boom pressure (four #8004 flat fan nozzles spaced @ 20 inches).
Disease and other Treatment Ratings	Early blight disease severity was measured by calculating the average number of lesions per leaflet for leaves collected on 17, 24, 31 July, and 7 August. Six leaves were randomly selected from each treatment plot; two leaves each from the top, middle, and bottom third of the canopy. The number of early blight lesions was counted on up to seven leaflets from each of the six leaves. Disease severity data from 17 July to 7 August were used to calculate an area under the disease progress curve (AUDPC) rating for each treatment program. The AUDPC is a measure of season-long disease severity for each treatment. Additionally, plots were visually rated using the Horsfall-Barratt scale (0-11) to estimate the percentage of foliar necrosis (combined effects of disease and senescence) on 10, 14, 21 and 28 August. Subsample data were not collected when visually rating plots for foliar senescence. An area under the necrosis progress curve (AUNPC) value was calculated for foliar necrosis using the 10 - 28 August data. A portion of the data are summarized in Table 1.
Harvest	Two rows by 10 ft for each sub-sample were harvested in the nontreated checks (two sub-samples per nontreated check plot) and two rows by 10 ft for were harvested for each sub-sample in the fungicide treatment plots (four sub-samples per fungicide treated plot) with a one-row mechanical digger. Harvest was done on 6 September, and tubers were sorted and weighed to determine yield and grade on 14 September. All yield data are summarized in Table 2.
Statistical Analysis	ANOVA with unequal replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

Early blight lesions were first detected in the field plot area on 12 July, indicating that the first inoculation attempt coincided with natural early blight disease onset. Early blight disease development was greatly accelerated following inoculation, with disease development and defoliation first becoming evident in the non-treated inoculated rows dispersed through the field plot area and, by early August, early blight disease pressure was severe in the general field plot area. The appearance of natural disease onset on 12 July and canopy decline from disease pressure was observed ca 2 wk earlier than for prior studies done at SAREC. This may indicate a build-up of overwintering inoculum at SAREC that may be beneficial for future studies. Inoculations were also made ca. 1 wk earlier than in prior years. No foliar or tuber phytotoxicity was observed for any of the fungicide programs during 2007.

A field day to demonstrate treatment effects was held for growers and fieldmen on 10 August at SAREC. Field plots were viewed, and a program on new fungicide product development was held. Additional information was presented on fungicide resistance management, as it relates to plant disease control and fungicide timing.

Disease severity data are summarized in Table 1. By 31 July, the fungicide program treatment had significantly less disease compared to the nontreated check, and by 7 August the nontreated check had almost four times the amount of disease as the fungicide treated plots ($P \leq 0.05$). The season-long AUDPC also indicates a level of disease severity almost four times greater in the nontreated check plot compared to the fungicide treatment. Disease pressure was severe by mid-August and during a 4-day period (10-14 August) even the fungicide treated plots progressed from 32 percent of the foliage necrotic to 94 % of the foliage necrotic.

Yield and tuber quality results are shown in Table 2. There were no significant differences between the nontreated check and the fungicide program (P=0.05). However there was a trend in the data for increased yields due to fungicide treatment.

For additional comparisons, the fungicide treatment in this demonstration plot is identical to treatment 13 in the report **Management of Potato Early Blight with Foliar Fungicide Programs in 2007.**

Table 1. Effects of a foliar fungicide program on potato foliar disease (G.D. Franc and W.L. Stump, U of WY; 2007).

Treatment and rate (amount./A)	Fungicide application dates [1]	Early blight lesions per leaflet				Foliar necrosis (%) [3]			
		24 Jul	31 Jul	7 Aug	AUDPC[2]	10 Aug	14 Aug	21 Aug	AUNPC[3]
1. Nontreated check.	NA	0.66 a[4]	2. 04 a	13.66 a	67.0 a	72.0 a	100.0 a	100.0 a	222.7 a
2. Quadris Opti 5.5SC (1.6 pt product).	A, D	0.03 a	0.43 b	4.01 b	17.5 b	31.0 b	94.0 b	98.0 b	189.5 b
2. Bravo Weather Stik 6F (1.5 pt product).	B, E								
2. Revus Top 4.17SC (0.438 pt product) + induce (0.125% v:v).	C, F								

[1] Plots were planted 10 May, 2007 with variety FL1867, inoculated with early blight spores and hyphae on 12 and 19 July, and harvested 6 September. Fungicide applications were: A=12 July, B=19 July, C=25 July, D=2 August, E=9 August, F=16 August and NA= not-applicable.

[2] AUDPC= area under the disease progress curve for early blight lesion count data collected from 19 July through 9 August. The AUDPC is an estimate of season-long disease severity.

[3] Foliar necrosis was estimated using the Horsfall-Barratt scale (0-11) and converted to percentage using the appropriate conversion table. AUNPC= area under the disease progress curve for necrosis data collected from 10 through 28 August.

[4] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. The effects of a foliar fungicide program on potato yield and quality (G.D. Franc and W.L. Stump, U of WY; 2007).

Treatment and rate (a.i./A)	Fungicide application dates [1]	Yield (cwt)						
		US#1			US#2	Grade B	Cull	T otal
		>10 oz	<10 oz	total				
1. Nontreated check.	NA	0.9 a [2]	108.9 a	109.8 a	9.9 a	14.8 a	6.2 a	140.7 a
2. Quadris Opti 5.5SC (1.6 pt product).	A, D	0.8 a	126.1 a	126.9a	11.6 a	16.2 a	11.0 a	165.7 a
2. Bravo Weather Stik 6F (1.5 pt product).	B, E							
2. Revus Top 4.17SC (0.438 pt product) + induce (0.125% v:v).	C, F							

[1] Plots were planted 10 May, 2007 with variety FL1867, inoculated with early blight spores and hyphae on 12 and 19 July, and harvested 6 September. Fungicide applications were: A=12 July, B=19 July, C=25 July, D=2 August, E=9 August, F=16 August and NA= not-applicable.

[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Research Project	**Cercospora Leaf Spot Management in Sugar Beet with Foliar Fungicide Programs, 2007**
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Field Plot Details	Field plots were placed at the Sustainable Agricultural Research & Extension Center (SAREC) located near Lingle, WY. The elevation of SAREC is placed at 4,165 ft MSL, and the soil type at the plot location was a Mitchell clay loam soil at pH = 7.9. Overhead sprinkler irrigation was applied as needed.
Plot Design	Randomized complete block design with four replications; plots were four rows (30-in row centers) by 20 ft with a 5 ft in-row buffer. Inoculations and fungicide treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date:** 1 May, 2007 **Variety:** Monohikari **Fertilizer:** 140 lb N + 80 lb P_2O_5 + 20 lb S **Herbicide:** Post-emergence applications (all rates in product/A) of Betamix (24 oz) + Upbeet (0.5 oz) on 17 May; followed by Betamix (24 oz) + Upbeet (0.5 oz) on 24 May; followed by Betamix (24 oz) + Select (8 fl oz) and Nortron (3 oz) on 30 May.
Disease Development	Field plots were exposed to powdery mildew and Cercospora leaf spot to increase disease pressure. On 31 July, greenhouse-grown sugar beet plants infected with powdery mildew (showing symptoms and signs) were transplanted into buffer rows of roughly alternating treatment plots (36 plants total). On 3 and 10 August, foliar applications of *Cercospora beticola* spores (7.1×10^3 and 3.4×10^3 spores-hyphae per ml, respectively) were made to the two middle rows, and the 5-ft in-row buffer of each plot. Applications were made in a total volume of 1.06 gal/1000 ft of row via a single-nozzle (8002 flat fan). The first inoculation made on 3 August corresponded to natural disease development that was observed on the edge of the field plot area.
Treatment Applications	Foliar fungicide applications indicated as A, B and C in the Tables, were made on 2, 16, and 30 August, respectively. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).

Disease Ratings Cercospora leaf spot severity was determined on 31 July, 9, 14, 21, 28 August, and 5, 11 September. The lesions on five randomly selected leaves per plot were counted and an average was calculated for each plot. The data from 31 July and 9 August are not shown in the table due to low disease severity on those dates. Disease severity data from 31 July through 11 September were used to calculate an area under the disease progress curve (AUDPC) rating for each treatment program. The AUDPC is a measure of season-long disease severity for each treatment. Powdery mildew did not appear until late in the season (13 September) in the field plot area.

Harvest One row of the two treated rows was harvested (20 ft) on 27 September and the total beet root yield was determined. The percentage of total sucrose was determined by Western Sugar's tare laboratory.

Statistical Analysis ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$). Lesion count data was transferred (Square root) to correct for non-homogeneity prior to analysis. Data prior to transformations are presented in Table 1.

Results and Discussion

Cercospora leaf spot (CLS) development was light to moderate in 2007. Powdery mildew was not observed in the plots until late in the season, and subsequent disease severity was too low for generating meaningful results.

CLS disease severity data are summarized in Table 1. Most fungicide treatments had significant effects on lesion counts by 21 August compared to the nontreated check ($P \leq 0.05$). Most fungicide programs reduced the AUDPC compared to the non-treated check ($P \leq 0.05$). The organic compounds, Organic A and Organic B, provided no disease suppression when compared to the nontreated check ($P=0.05$). The lower rate of organic B (treatment 19) appeared to significantly increase disease compared to the nontreated check ($P \leq 0.05$). As disease pressure increased during the season, the greater rates of Caramba (metconazole: treatments 14 and 15) significantly suppressed CLS disease development compared to the nontreated check ($P=0.05$), although the intended use of Caramba in this study was suppression of powdery mildew. This treatment effect for Caramba is not evident until the end of August and is not readily apparent in the season-long AUDPC.

The AUDPC values for BAS55601 (pyraclostrobin + metconazole)), Headline (pyraclostrobin) and A8122 (difenoconazole + propiconazole) show strong season-long CLS suppression, indicating the likely need for diligent fungicide resistance management programs for these compounds. Tank mixes or alternating effective fungicide partners in fungicide resistance management programs should prolong the useful life of these chemistries.

Treatment effects on root yield, sugar content and sugar quality are summarized in Table 2. Fungicide treatments did not significantly effect root yield, sugar or sugar quality (sugar lost to molasses, SLM value: P=0.05).

The treatment 4 fungicide program (A8122 4.17EC and Quadris 2.08SC) was also utilized in a nearby study. Results for this treatment are also summarized in the report Establishment of a Demonstration Plot for Cercospora Leaf Spot Management in Sugar Beet, 2007.

Table 1. Effects of foliar fungicide programs on Cercospora leaf spot development in cv. Monohikari sugar beet (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (product/A)	Application dates[1]	Number of Cercospora lesions per leaf (five leaves were rated per plot)					AUDPC[2]
		14 Aug	21 Aug	28 Aug	5 Sep	11 Sep	
1. Nontreated check	NA	0.1 a	4.3 abc	25.8 b	45.1 a	78.0 ab	758.5 bc
2. A8122 4.17EC (7.0 fl oz)	A-C	0.0 a	0.6 cd	1.1 ef	0.0 e	0.0 f	12.3 d
3. A8122 4.17EC (7.0 fl oz)	A, C	0.2 a	0.2 d	0.1 f	2.5 cde	0.6 f	22.2 d
3. Eminent 125SL (13 fl oz)	B						
4. A8122 4.17EC (7.0 fl oz)	A, C	0.6 a	0.2 d	12.4 c-f	1.0 de	3.2 def	114.4 cd
4. Quadris 2.08SC (11.5 fl oz)	B						
5. Eminent 125SL (13 fl oz)	A, C	0.0 a	0.0 d	0.4 ef	0.3 de	1.8 def	11.0 d
5. Headline 2.08EC (9 fl oz)	B						
6. Eminent 125SL (13 fl oz)	A, C	0.1 a	1.7 bcd	12.6 b-e	5.3 b-e	3.1 def	154.2 cd
6. Super Tin 80WP (3.75 oz)	B						
7. Organic “A” (0.5% v:v)	A-C	0.8 a	8.6 ab	13.9 b-f	66.7 a	77.3 abc	870.7 ab
8. SA-140201 (12.8 fl oz)	A, C	0.1 a	3.1 bcd	15.1 b-f	10.3 b-e	12.8 def	245.8 bcd
8. Super Tin 80WP (3.75 oz)	B						
9. Gem 4.17SC (3.5 fl oz)	A	0.1 a	0.0 d	0.7 ef	0.7 de	2.9 def	19.5 d
9. Eminent 125SL (13 fl oz)	B						
9. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz)	C						
10. Eminent 125SL (13 fl oz)	A	1.4 a	0.3 d	0.9 ef	2.1 cde	8.3 def	56.9 d
10. Gem 4.17SC (3.5 fl oz)	B						
10. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz)	C						
11. Gem 4.17SC (3.5 fl oz)	A	1.5 a	0.1 d	8.1 c-f	0.8 de	5.6 def	94. 1 cd
11. Proline 4SC (5 fl oz) + Induce (0.125% v:v)	B						
11. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz)	C						

Treatment and rate (product/A)	Application dates[1]	Number of Cercospora lesions per leaf (five leaves were rated per plot)					AUDPC[2]
		14 Aug	21 Aug	28 Aug	5 Sep	11 Sep	
12. Proline 4SC (5 fl oz) + Induce (0.125% v:v).	A	2.1 a	0.4 cd	1.3 ef	3.5 b-e	4.6 def	63.8 d
12. Gem 4.17SC (3.5 fl oz).	B						
12. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz). . .	C						
13. Caramba 0.75SL (4.6 fl oz).	A-C	0.9 a	1.4 bcd	27.0 bc	14.5 a-d	23.8 bcd	390.1 bcd
14. Caramba 0.75SL (9.2 fl oz).	A-C	1.6 a	1.0 bcd	7.3 b-f	7.2 b-e	38.2 cde	236.2 bcd
15. Caramba 0.75SL (13.8 fl oz).	A-C	1.1 a	1.1 bcd	1.8 ef	8.2 b-e	12.1 def	120.7 cd
16. BAS 55601F 1.75EC (6.8 fl oz).	A-C	0.0 a	0.0 d	0.4 ef	1.0 de	0.6 f	11.6 d
17. Headline 2.08EC (6 fl oz).	A-C	0.2 a	0.3 d	0.2 f	0.4 de	1.3 ef	10.8 d
18. Super Tin 80WP (3.75 oz).	A-C	0.2 a	1.3 bcd	2.2 def	25.3 ab	7.0 def	228.6 bcd
19. Organic “B” (150 ml product/gal mix).	A-C	3.6 a	11.5 a	84.4 a	49.5 a	145.0 a	1534.1a
20. Organic “B” (300 ml product/gal mix).	A-C	0.6 a	8.5 a	21.4 bcd	31.3 abc	78.2 abc	677.4 bcd

[1] Field plots were planted on 1 May, 2007. Fungicide application dates were: A= 2 August, B= 16 August, and C= 30 August. NA= not-applicable. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).

[2] Cercospora leaf spot area under the disease progress curve (AUDPC) was calculated for data collected from 31 July through 11 September. Border rows of field plots received greenhouse-grown sugar beet transplants possessing foliar powdery mildew on 31 July. Foliar inoculations with *Cercospora beticola* spores were done on 3 and 10 August.

[3] Treatment means followed by different letters differ significantly (Fisher’s protected LSD, $P \leq 0.05$).

Table 2. Effects of foliar fungicide programs on cv. Monohikari sugar beet root yield and sucrose quality (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (product/A)	Application dates[1]	Sugar beet root yield and quality		
		Root yield (tons/A)	% total sucrose	% sugar lost to molasses
1. Nontreated check	NA	16.0 a[2]	15.3 a	1.4 a
2. A8122 4.17EC (7.0 fl oz)	A-C	14.5 a	15.9 a	1.4 a
3. A8122 4.17EC (7.0 fl oz)	A, C	13.7 a	15.3 a	1.5 a
3. Eminent 125SL (13 fl oz)	B			
4. A8122 4.17EC (7.0 fl oz)	A, C	13.0 a	15.1 a	1.6 a
4. Quadris 2.08SC (11.5 fl oz)	B			
5. Eminent 125SL (13 fl oz)	A, C	15.7 a	14.8 a	1.6 a
5. Headline 2.08EC (9 fl oz)	B			
6. Eminent 125SL (13 fl oz)	A, C	17.2 a	15.3 a	1.4 a
6. Super Tin 80WP (3.75 oz)	B			
7. Organic “A” (0.5% v:v)	A-C	16.8 a	14.9 a	1.5 a
8. SA-140201 (12.8 fl oz)	A, C	15.7 a	14.7 a	1.6 a
8. Super Tin 80WP (3.75 oz)	B			
9. Gem 4.17SC (3.5 fl oz)	A	17.5 a	15.1 a	1.6 a
9. Eminent 125SL (13 fl oz)	B			
9. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz)	C			
10. Eminent 125SL (13 fl oz)	A	14.8 a	14.9 a	1.5 a
10. Gem 4.17SC (3.5 fl oz)	B			
10. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz)	C			

Treatment and rate (product/A)	Application dates[1]	Sugar beet root yield and quality		
		Root yield (tons/A)	% total sucrose	% sugar lost to molasses
11. Gem 4.17SC (3.5 fl oz).	A	15.8 a	15.4 a	1.4 a
11. Proline 4SC (5 fl oz) + Induce (0.125% v:v).	B			
11. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz).	C			
12. Proline 4SC (5 fl oz) + Induce (0.125% v:v).	A	11.0 a	14.3 a	1.4 a
12. Gem 4.17SC (3.5 fl oz).	B			
12. Super Tin 80WP (3.75 oz) + Topsin M 70WP (6.1 oz).	C			
13. Caramba 0.75SL (4.6 fl oz)..	A-C	16.9 a	13.6 a	1.6 a
14. Caramba 0.75SL (9.2 fl oz)..	A-C	13.5 a	15.6 a	1.4 a
15. Caramba 0.75SL (13.8 fl oz)..	A-C	15.8 a	13.3 a	1.6 a
16. BAS 55601F 1.75EC (6.8 fl oz).	A-C	12.4 a	15.4 a	1.4 a
17. Headline 2.08EC (6 fl oz).	A-C	15.9 a	15.9 a	1.4 a
18. Super Tin 80WP (3.75 oz).	A-C	19.6 a	14.7 a	1.6 a
19. Organic “B” (150 ml product/gal mix)..	A-C	14.2 a	15.1 a	1.5 a
20. Organic “B” (300 ml product/gal mix)..	A-C	13.7 a	14.7 a	1.6 a

[1] Field plots were planted on 1 May, 2007. Fungicide application dates were: A= 2 August, B= 16 August, and C= 30 August. NA= not-applicable. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).

[2] Treatment means followed by different letters differ significantly (Fisher’s protected LSD, $P \leq 0.05$).

Research Project

Establishment of a Demonstration Plot for Cercospora Leaf Spot Management in Sugar Beet, 2007

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Field Plot Details

Field plots were placed at the Sustainable Agricultural Research & Extension Center (SAREC) located near Lingle, WY. The elevation of SAREC is placed at 4,165 ft MSL and the soil type at the plot location was a Mitchell clay loam soil at pH = 7.9. Overhead sprinkler irrigation was applied as needed during the season.

Plot Design

The demonstration plot was established within a field of sugar beet. Treatment plots were arranged so that they could be readily observed by producers and fieldmen from multiple vantage points during a field day program. The plot dimension was 28 rows wide (30-in row centers) by 40 ft long. There were three nontreated check plots that bordered the two fungicide treated plots. Nontreated plots were four rows by 40 ft long and were located at rows 1-4, 13-16, and 25-28. This resulted in the fungicide-treated plot being surrounded by the nontreated check. Disease data were collected from two sub-samples for each nontreated check plot for a total of six replications. Two fungicide-treated plots eight rows wide by 40 ft long were situated between the nontreated checks at rows 5-12 and 17-24, inclusive. Four sub-samples were collected from each fungicide treated plot for a total of eight replications. In the nontreated check plots inoculations and data collections involved rows 2-3, 14-15, and 26-27. In the fungicide-treated plots all inoculations, fungicide applications and data collections involved rows 6-7, 9-10, 18-19, and 21-22.

Plot Management

Planting Date: 1 May, 2007
Variety: Monohikari
Fertilizer: 140 lb N + 80 lb P_2O_5 + 20 lb S
Herbicide: Post-emergence applications (all rates in product/A) of Betamix (24 oz) + Upbeet (0.5 oz) on 17 May; followed by Betamix (24 oz) + Upbeet (0.5 oz) on 24 May; followed by Betamix (24 oz) + Select (8 fl oz) and Nortron (3 oz) on 30 May.

Disease Development

Field plots were inoculated with *Cercospora beticola* to increase disease pressure. On 3 and 10 August, foliar applications of *Cercospora beticola* spores (7.1×10^3 and 3.4×10^3 spores per ml respectively) were made to rows 2-3, 6-7, 9-10, 14-15, 18-19, 21-22, 26-27 in a total volume of 1.06 gal/1000 ft of row via a single-nozzle (8002 flat fan). The first inoculation made on 3 August corresponded with natural disease development and the first appearance of Cercospora leaf spot lesions on plants near the edge of the field plot area.

Treatment Applications

Foliar fungicide applications indicated as A, B and C in the Tables were made on 2, 16, and 30 August, respectively. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).

Disease Ratings

Cercospora leaf spot severity was determined on 31 July, 9, 14, 21, 28 August, and 5, 11 September. The lesions present on five randomly selected leaves per replication (two replications per plot) were counted and an average was calculated. The data from 31 July and 9 August are not shown in the table due to low disease pressure. Disease severity data from 31 July through 11 September were used to calculate an area under the disease progress curve (AUDPC) rating for each treatment. The AUDPC is a measure of season-long disease severity for each treatment.

Harvest

One row (one of the inoculated rows in each check plot) by 40 ft was harvested in the checks (3 rows total) and two of the inoculated rows in each treatment plot by 40 ft (4 rows total). Harvest was done with a one-row mechanical digger on 27 September. All yield data are summarized in Table 2. The percentage of total sucrose was determined by Western Sugar's tare laboratory.

Statistical Analysis

ANOVA with unequal replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$). Lesion count data were transformed (square-root) to correct for non-homogeneity prior to analysis. Data prior to transformations are presented in Table 1.

Results and Discussion

Cercospora leaf spot (CLS) development was moderate in 2007. Powdery mildew was not observed in the plots until late in the growing season.

Disease severity data are summarized in Table 1. The fungicide program significantly suppressed CLS development by 28 August compared to the nontreated check ($P \leq 0.05$). The

comparison of season-long disease suppression (AUDPC values) indicated that the fungicide program reduced CLS by 98.1 percent compared to the nontreated check ($P \leq 0.05$).

Treatment effects on root yield, sugar content and sugar quality are summarized in Table 2. Fungicide treatments did not significantly effect root yield, sugar or the sugar lost to molasses value (P=0.05). The small number of replications and plot variability contributed to the lack of significance.

The fungicide program in this report was also included as “treatment 4" in a large replicated field study; see the report Cercospora Leaf Spot Management in Sugar Beet with Foliar Fungicide Programs, 2007.

Table 1. Effects of a foliar fungicide program on Cercospora leaf spot development (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (product/A)	Application dates[1]	Number of Cercospora lesions per leaf					AUDPC[2]
		14 Aug	21 Aug	28 Aug	5 Sep	11 Sep	
1. Nontreated check.	NA	13.1 a	74.1 a	110.5 a	221.8 a	216.9 a	3672.1 a
2. A8122 4.17EC (7.0 fl oz).	A, C	1.2 a	0.3 a	1.0 b	5.2 b	1.4 b	71.0 b
2. Quadris 2.08SC (11.5 fl oz). . .	B						

[1] Field plots were planted on 1 May, 2007. Fungicide application dates were: A= 2 August, B= 16 August, and C= 30 August. NA= not-applicable. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).

[2] Cercospora leaf spot area under the disease progress curve was calculated for data collected from 31 July through 11 September. Foliar inoculations with *Cercospora beticola* spores and hyphae were done on 3 and 10 August. The time of natural CLS disease onset was approximately 3 August.

[3] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. Effects of a foliar fungicide program on sugar beet root yield and sucrose quality (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (product/A)	Application dates[1]	Sugar beet root yield and quality		
		Root yield (tons/A)	% total sucrose	% sugar lost to molasses
1. Nontreated check.	NA	18.3 a[2]	14.1 a	1.7 a
2. A8122 4.17EC (7.0 fl oz).	A, C	20.8 a	14.5 a	1.5 a
2. Quadris 2.08SC (11.5 fl oz).	B			

[1] Field plots were planted on 1 May, 2007. Fungicide application dates were: A= 2 August, B= 16 August, and C= 30 August. NA= not-applicable. Fungicides were applied with the aid of a portable (CO_2) sprayer in a total volume of 43 gal/A at 30 psi boom pressure (four #8004 flat fan nozzles spaced at 20 inches).

[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Research Project	**Rhizoctonia Root and Crown Rot Management with Banded Fungicide Applications to Sugar Beet Crowns, 2007**
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Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	
Field Plot Details	Field plots were at the Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY. The elevation of the site was 4165 MSL. The soil was a Mitchell clay loam at pH = 7.9. Overhead irrigation was applied as needed.
Plot Design	The statistical design was a randomized complete block design with four replications; plots were four rows (30-in row centers) by 20 ft with a 5 ft in-row buffer. Inoculations and fungicide treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date:** 1 May, 2007 **Variety:** Monohikari **Fertilizer:** 140 lb N + 80 lb P_2O_5 + 20 lb S **Herbicide:** Post-emergence applications (all rates in product/A) of Betamix (24 oz) + Upbeet (0.5 oz) on 17 May; followed by Betamix (24 oz) + Upbeet (0.5 oz) on 24 May; followed by Betamix (24 oz) + Select (8 fl oz) and Nortron (3 oz) on 30 May.
Disease Development	Immediately following fungicide applications on 26 June, inoculum (0.25 tsp = 0.8 g) was applied to the crown of each plant in the two center rows of each plot. Plants were in the 12- to 16-leaf stage when inoculated. Shortly after inoculation, plots were cultivated to move soil onto the crown and then irrigated (0.5 inch) to create conditions that favored infection. Inoculum used in 2007 was prepared from *Rhizoctonia solani* AG2-2 cultured on grain that was subsequently pulverized.
Treatment Applications	Fungicides were applied in a 7-inch band to the plant crowns on 26 June (immediately prior to inoculation). For the half-rate split application treatments, the second half-rate application was made on 10 July. Fungicide was applied with the aid of a portable (CO_2) sprayer in a total volume of 1.06 gal/1000 row ft at 45 psi boom pressure. The boom was equipped with a single #8002 flat fan nozzle.

Disease Ratings Initial beet stands (two rows by 20 row-ft) were determined on 18 June. Rhizoctonia root and crown rot (RRCR) incidence ratings were expressed as a percentage of the initial plant stand to standardize disease ratings. RRCR incidence was rated on 10, 19, 31 July, and 9 August. Infected beets were those that had rapidly wilting leaves, darkened petioles and/or decayed crowns evident with necrotic leaves present. An area under the disease progress curve (AUDPC) was calculated for disease incidence data from 18 June (time zero) through 9 August. Additionally, plots were visually rated for the percentage of total canopy necrosis present on 10, 19, 31 July, 9, 21 August, and 11 September, and an AUNPC (area under the necrosis progress curve) was calculated for this data collection period. At harvest, a final harvested beet root count was determined. Harvested beet roots were those that were still firm. Rhizoctonia disease incidence, disease severity and root yield were determined for harvested beet roots. Disease severity was determined by visually estimating the surface area (Horsfall-Barratt scale)of each beet root affected by decay and an average computed for all harvested beets per plot ("all" column in Table 3) and also was calculated for only those roots that were diseased ("diseased" column in Table 3). Disease incidence is the percentage of the harvested roots with any visible decay present.

Harvest The middle five feet of each of the two treated rows was harvested on 28 September (10 total row feet) and the total beet root yield was determined. The percentage of total sucrose and sugar lost to molasses was determined by Western Sugar's laboratory.

Statistical Analysis An ANOVA with four replications was utilized. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

Rhizoctonia root and crown rot (RRCR) developed rapidly following the 26 June inoculation. Symptoms were easily observed within 2 weeks, first appearing as rapidly wilting leaves with petioles becoming darkened near the crown. All plants in the nontreated inoculated check were dead from RRCR by 31 July. Results for the nontreated non-inoculated check (treatment 1) revealed that naturally occurring disease pressure was low in the field plot area with only 2.9 percent of the plants becoming symptomatic by 9 August and a season-long AUDPC of 33.9. Therefore, most disease development in the plots resulted from the 26 June inoculation. Rapid and severe RRCR development following inoculation provided for a rigorous test of fungicide efficacy in 2007.

All fungicide treatments, except YT669 on 9 August, significantly reduced RRCR incidence, disease severity and AUDPC over the season compared to the nontreated inoculated check (Table 1; $P \leq 0.05$). The YT669 treatment significantly suppressed disease early in the

epidemic with the treatment weakening by 9 August with 87.4 percent of the plants becoming symptomatic (P=0.05).

All fungicide treatments except Maxim and YT669 resulted in statistically equivalent AUDPC values when compared to the standard Quadris full rate and half-rate split applications (Table 1: P=0.05). A similar pattern was observed when RRCR disease severity was indirectly estimated via canopy necrosis ratings; all fungicide treatments except YT669 resulted in statistically equivalent AUNPC values compared to the Quadris treatments (Table 2: P=0.05). The Quadris treatments (treatments 3 and 4) were included as standard programs to which other fungicides can be compared.

Half-rate split applications of Quadris, Proline or Lem17 generally improved their respective AUDPC values compared to a single application made at their full rate. The co-application of Proline + Induce improved the AUDPC compared to application of Proline alone, although the difference was not significant (P=0.05).

All treatments, except YT669, resulted in beet root yields equivalent to or greater than the nontreated non-inoculated check (Table 3, $P \leq 0.05$). However, visual assessment of beet roots at harvest revealed that considerable disease was present (Table 3). Treatments with Quadris, Lem17, or Maxim also resulted in the percentage of total sucrose equivalent to that of the nontreated non-inoculated check (P=0.05). The incidence and severity of decay on harvested roots will reduce the percentage of total sucrose compared to roots with less decay, and this interaction may explain some of the differences observed among treatments in Table 3.

Table 1. Effects of banded fungicide applications on Rhizoctonia root and crown rot (RRCR) incidence and season-long disease severity (G.D. Franc and W.L. Stump, University of WY; 2007).

Treatment and rate (oz ai/1000 ft)[1]	Application dates[2]	Beet stand (2 rows by 20 ft) 18 Jun	RRCR incidence as a percentage of initial stand				AUDPC[3]
			10 Jul	19 Jul	31 Jul	9 Aug	
1. Nontreated non-inoculated check.	NA	62.3 a[4]	0.4 b	0.4 d	0.9 f	2.9 g	33.9 e
2. Nontreated inoculated check.	NA	62.3 a	76.7 a	97.5 a	100.0 a	100.0 a	3713.4 a
3. Quadris 2.08SC (0.15).	A	73.0 a	0.0 b	2.8 d	9.8 c-f	20.4 def	224.1 de
4. Quadris 2.08SC (0.075).	A, B	69.3 a	0.0 b	3.0 d	5.1 ef	9.1 fg	125.7 de
5. Proline 2.08EC (0.16).	A	72.3 a	1.1 b	3.7 d	16.5 cd	37.4 b	397.3 cd
6. Proline 2.08EC (0.16) + Induce (0.125% v:v).	A	61.0 a	2.0 b	5.7 cd	10.3 c-f	27.1 bcd	321.4 cde
7. Proline 2.08EC (0.08).	A, B	57.8 a	0.4 b	6.5 cd	16.0 cd	28.8 bcd	372.8 cd
8. Lem17 1.67 SC (0.34)..	A	67.3 a	0.7 b	7.3 cd	13.1 cde	34.2 bc	379.6 cd
9. Lem17 1.67 SC (0.17)..	A, B	71.3 a	0.4 b	2.5 d	8.5 def	21.8 c-f	219.6 de
10. Maxim 4EC (0.73).	A	60.3 a	7.4 b	14.0 c	18.8 c	26.0 b-e	576.7 c
11. Moncut 70WP (0.73).	A	58.0 a	0.7 b	1.9 d	5.5 ef	13.3 efg	147.9 de
12. YT669 2.08SC (0.15).	A	55.3 a	7.9 b	39.9 b	81.2 b	87.4 a	1787.2 b

1 All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in the two center rows of each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (12-16 leaf stage) immediately following fungicide application.

2 Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable.

3 The AUDPC (area under the disease progress curve) is for data collected from 18 June through 9 August. The AUDPC is an indication of season-long disease severity.

4 Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 2. Effects of banded fungicide applications on Rhizoctonia root and crown rot (RRCR) severity measured as foliar necrosis (G.D. Franc and W.L. Stump, University of WY; 2007).

Treatment and rate (oz ai/1000 ft)[1]	Application dates[2]	RRCR severity as a percentage of total canopy necrosis						AUNPC[3]
		10 Jul	19 Jul	31 Jul	9 Aug	21 Aug	11 Sep	
1. Nontreated non-inoculated check.	NA	0. 2 bc[4]	0.2 e	0.2 d	1.2 g	1.2 f	0.0 g	21.4 f
2. Nontreated inoculated check.	NA	25.0 a	93.5 a	99.0 a	100.0 a	100.0 a	100.0 a	681.2 a
3. Quadris 2.08SC (0.15).	A	0.0 c	1.0 cde	2.5 cd	5.0 d-g	40.5 cd	37.0 e	167.8 cd
4. Quadris 2.08SC (0.075).	A, B	0.0 c	0.8 de	1.5 cd	2.5 fg	6.5 ef	17.0 f	95.4 e
5. Proline 2.08EC (0.16).	A	0.8 bc	1.5 cde	4.0 c	15.0 c	59.5 c	59.5 cd	225.6 c
6. Proline 2.08EC (0.16) + Induce (0.125% v:v). . .	A	0.8 bc	1.5 cde	1.8 cd	8.5 cde	46.0 c	59.5 cd	198.8 cd
7. Proline 2.08EC (0.08).	A, B	0.2 bc	2.0 cd	5.0 c	10.5 cde	42.0 cd	50.0 cde	202.0 cd
8. Lem17 1.67 SC (0.34).	A	0.5 bc	2.5 cd	2.5 cd	11.5 cd	48.0 c	69.0 c	214.6 c
9. Lem17 1.67 SC (0.17).	A, B	0.2 bc	1.2 cde	2.5 cd	7.5 c-f	33.0 cd	56.0 cde	180.6 cd
10. Maxim 4EC (0.73).	A	1.5 b	3.0 c	4.0 c	6.0 c-f	38.5 cd	40.5 de	194.4 cd
11. Moncut 70WP (0.73).	A	0.2 bc	0.8 de	1.5 cd	4.0 efg	18.5 de	50.0 cde	147.1 de
12. YT669 2.08SC (0.15).	A	1.0 bc	8.0 b	59.5 b	73.5 b	93.0 b	96.0 b	410.7 b

[1] All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in the two center rows of each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (12-16 leaf stage) immediately following fungicide application.

[2] Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable.

[3] The AUNPC (area under the necrosis progress curve) is for data collected from 18 June through 11 September. The AUNPC is an indication of season-long disease severity and its subsequent effect on canopy development.

[4] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 3. Effects of banded fungicide applications for Rhizoctonia root and crown rot (RRCR) management on sugar beet root yield, root quality and root disease present on harvested roots (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (oz ai/1000 ft) [1]	Application dates [2]	Beet root yield and quality				Disease incidence and disease severity at harvest		
		Beet no. per 20 row ft	Beet yield (tons/A)	% total sucrose	% sugar lost to molasses [3]	Symptomatic beets (%)	Surface area of root decayed (%) [4] "diseased"	"all"
1. Nontreated non-inoculated check.	NA	15.5 a-d[5]	12.1 b	13.9 a	1.7	1.6 f	0.5 c	0.0 e
2. Nontreated inoculated check.	NA	0.0 e	0.0 c	0.0 e	NA	100.0 a	100.0 a	100.0 a
3. Quadris 2.08SC (0.15).	A	18.3 ab	10.7 b	12.1 abc	1.6	46.6 cde	65.0 b	11.5 de
4. Quadris 2.08SC (0.075).	A, B	20.8 a	15.7 a	11.8 abc	1.7	33.2 de	83.0 b	8.5 de
5. Proline 2.08EC (0.16).	A	16.3 abc	11.8 b	6.8 d	1.9	85.4 ab	94.5 ab	86.0 ab
6. Proline 2.08EC (0.16) + Induce (0.125% v:v). . . .	A	14.0 bcd	10.3 b	9.4 cd	1.7	68.5 bc	88.5 ab	48.0 bcd
7. Proline 2.08EC (0.08).	A, B	14.5 bcd	12.1 b	10.5 bc	1.7	66.5 bc	91.5 ab	52.0 bcd
8. Lem17 1.67 SC (0.34).	A	10.0 d	8.9 b	11.4 abc	1.6	55.5 cd	89.5 ab	35.0 bcd
9. Lem17 1.67 SC (0.17).	A, B	13.3 bcd	11.1 b	11.4 abc	1.7	62.5 bc	76.5 b	29.5 cd
10. Maxim 4EC (0.73).	A	12.3 cd	10.4 b	13.0 ab	1.7	26.1 ef	65.0 b	7.5 de
11. Moncut 70WP (0.73).	A	12.5 bcd	12.2 b	10.6 bc	1.7	60.5 bcd	75.0 b	28.0 cd
12. YT669 2.08SC (0.15).	A	0.8 e	1.2 c	2.5 e	0.5	87.5 ab	90.0 ab	75.0 bc

1 All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in the two center rows of each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (12-16 leaf stage) immediately following fungicide application.

2 Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable.

3 Severe disease resulted in some treatments that had no or few beets to rate: no statistical analysis was run on these data. NA= non-applicable. Plots were harvested 28 September, 2007.

4 The average surface area of beet root decayed was calculated for only those beet roots that had disease present ("diseased" column) and was calculated as an average for all roots harvested ("all" column).

5 Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Research Project	**Interaction of Glyphosate and Fungicide for Rhizoctonia Root and Crown Rot Management in Roundup Ready Sugar Beets, 2007**
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Field Plot Details	Field plots were at the Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY. The elevation of the site was 4165 MSL, and the soil was a Mitchell clay loam, pH = 7.9. Overhead irrigation was applied as needed.
Plot Design	The statistical design was a split block design with four replications; plots were one row (30-in row centers) by 7 ft with a 1 ft in-row buffer. Fungicide treatments were the main plots and roundup applications (+/-) were the subplots. Hand-weeding of plots was done to compensate for the lack of weed control in plots not receiving Roundup. Therefore, results for disease development in the plots were not influenced by the presence, or absence, of weeds.
Plot Management	**Planting Date:** 1 May, 2007 **Variety:** Roundup Ready **Fertilizer:** 140 lb N + 80 lb P_2O_5 + 20 lb S **Weed control:** Plots were hand weeded as needed.
Disease Development	Plants received fungicide applications on 26 June. Immediately following fungicide application, *Rhizoctonia solani* AG2-2 inoculum (0.25 tsp = 0.8 g) was applied to the crown of each plant in each one-row plot. Plants were in the 10- to 12-leaf stage when inoculated. Shortly after inoculation, plots were cultivated to move soil onto the crown and then irrigated (0.5 acre-inch) to create conditions that favored infection of the sugar beet crown. Inoculum used in 2007 was prepared from *Rhizoctonia solani* AG2-2 cultured on whole grain that was subsequently pulverized.
Treatment Applications	Applications of Roundup Original Max formulation (3.75 lb ai/gal; use rate 1.375 pt product) plus ammonium sulfate (17 lb AMS per 100 gal spray volume) were made on 21 June directly over each row in a 7-inch band. Hand-weeding of plots was done to compensate for the lack of weed control in plots not receiving Roundup. Fungicide for Rhizoctonia suppression was applied in a 7-inch band over each

row on 26 June (immediately prior to inoculation), and for the half-rate split application treatments, the second half-rate application was made on 10 July. Herbicide and fungicide applications were accomplished with the aid of a portable (CO_2) sprayer in a total volume of 1.06 gal/1000 row ft at 45 psi boom pressure. The boom was equipped with a single #8002 flat fan nozzle.

Disease Ratings

Initial beet stands (one row by 7 row-ft) were determined on 18 June. Rhizoctonia root and crown rot (RRCR) incidence ratings were expressed as a percentage of the initial plant stand to standardize disease ratings. RRCR incidence was rated on 10, 17, 31 July, and 9, 21 August. Infected beets were those that had rapidly wilting leaves, darkened petioles and/or decayed crowns evident with necrotic leaves present. An area under the disease progress curve (AUDPC) was calculated for disease incidence data from 18 June (time zero) through 21 August. Additionally, plots were visually rated for the percentage of total canopy necrosis present on 10, 17, 31 July, and 9, 21 August and 11 September, and an area under the necrosis progress curve (AUNPC), an indirect estimate of disease severity, also was calculated for this data collection period. At harvest, a final harvested beet root count was determined. Harvested beet roots were those that were still firm. Rhizoctonia disease severity, incidence and root yield were determined on the harvested beet roots. Disease severity was determined by visually estimating the surface area of each beet root affected by decay and an average computed for only the diseased roots**.** Disease incidence was the percentage of the harvested roots with any visible decay present.

Harvest

All beets per plot were hand dug on 28 September (7 total row feet) and the total beet root yield was determined. The percentage of total sucrose and sugar lost to molasses was determined by Western Sugar's laboratory.

Statistical Analysis

A split plot ANOVA with four replications was utilized. Mean separations for main effects were done using Fisher's protected LSD ($P \leq 0.05$), and the interaction means were compared with a least square means procedure ($P \leq 0.05$).

Results and Discussion

Rhizoctonia root and crown rot (RRCR) developed rapidly following the 26 June inoculation. Symptoms appeared within 2 weeks, first appearing as rapidly wilting leaves with petioles becoming darkened near the crown. All plants in the nontreated inoculated check (+/- Roundup) became diseased and totally necrotic by 31 July. Beet stands on 18 June (Table 1)

ranged from 6.5 to 11.5 plants per plot. Although all plot stands were statistically equivalent ($P \leq 0.05$), the range indicates considerable variability occurred among plots in this study.

Effects of fungicide and Roundup interactions for RRCR incidence are shown in Table 1. On 10 July, application of Roundup to the nontreated inoculated check significantly increased RRCR incidence ($P \leq 0.05$). This early-season effect was not detected later in the season because all plants eventually became infected ($P=0.05$). When Quadris (single application full rate) was applied to suppress RRCR, data trends indicate greater disease suppression when Roundup was applied, although differences were not significant ($P \geq 0.05$). No significance occurred for the Quadris (half-rate split application) and AUDPC values were similar ($P=0.05$).

Main effects (Fungicide treatments, averaged over +/- Roundup) on RRCR incidence are shown in Table 2. Both Quadris treatment timings significantly reduced disease compared to the nontreated inoculated check ($P \leq 0.05$). The Quadris split half rate timing had less disease incidence than the Quadris full rate single application, although differences were not always significant ($P \leq 0.05$).

Effects of fungicide and Roundup interactions on RRCR canopy necrosis (AUNPC) are shown in Table 3. There were no significant effects of Roundup application on RRCR disease severity within each of the main treatments (P=0.05). Main effects for RRCR on canopy necrosis are shown in Table 4. Both Quadris treatments significantly reduced canopy necrosis compared to the nontreated inoculated check; the split application provided greater disease suppression compared to the full-rate single Quadris application ($P \leq 0.05$).

Roundup application appeared to have little effect on beet root yield and quality within each treatment (Table 5, $P=0.05$). However, Roundup application resulted in fewer symptomatic beets present at harvest for the full rate Quadris treatments ($P \leq 0.05$). Main treatment effects (Table 6) revealed that Quadris treatments and the nontreated non-inoculated check resulted in statistically similar beet numbers and total root yields at harvest (P=0.05). However, greater numbers of diseased beets were present in the Quadris treatments compared to the nontreated non-inoculated check ($P \leq 0.05$).

Because Roundup treatment effects were inconsistent, possibly due to small plot size and plot variability, firm conclusions cannot be made pertaining to the effect of Roundup application and subsequent susceptibility of Roundup Ready sugar beet to Rhizoctonia infection. Additionally, it should be noted that Roundup was only applied once, unlike the multiple applications that may occur in commercial situations. Because of the potential wide spread adoption of Roundup ready beets and the perennial threat of Rhizoctonia root and crown rot in the High Plains, this potential interaction warrants more study.

Table 1. Interaction of fungicide and Roundup application on Rhizoctonia root and crown rot (RRCR) incidence in Roundup Ready sugar beets (G.D. Franc and W.L. Stump, University of WY; 2007).

Treatment and rate (oz ai/1000 ft); application date[1]	Roundup application[2]	Beet stand (7 ft of row) 18 Jun	RRCR incidence as a percentage of initial stand					AUDPC[3]
			10 Jul	17 Jul	31 Jul	9 Aug	21 Aug	
1. Nontreated non-inoculated check; NA.	+	10.5 a[4]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
2. Nontreated non-inoculated check; NA.	-	6.5 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
3. Nontreated inoculated check; NA.	+	7.8 a	71.8 a	97.5 a	100.0 a	100.0 a	100.0 a	4917.1 a
4. Nontreated inoculated check; NA.	-	7.0 a	54.3 b	91.7 a	100.0 a	100.0 a	100.0 a	4549.6 a
5. Quadris 2.08SC (0.15); A.	+	10.5 a	0.0 a	3.1 a	11.3 a	22.6 a	36.5 a	619.2 b
6. Quadris 2.08SC (0.15); A.	-	9.5 a	3.1 a	14.4 a	32.6 a	51.0 a	66.3 a	1504.6 a
7. Quadris 2.08SC (0.075); A, B.	+	11.5 a	0.0 a	1.6 a	8.3 a	35.3 a	38.4 a	713.6 a
8. Quadris 2.08SC (0.075); A, B.	-	8.8 a	0.0 a	3.6 a	18.7 a	21.0 a	32.7 a	669.7 a

1 All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (10-12 leaf stage) immediately following fungicide application. Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable.

2 Roundup applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure (Roundup Original, 3.75lb/gal formulation, 1.375 pt product) with AMS (17 lb AMS per 100 gal spray) on 21 June.

3 Area under the disease progress curve for data collected from 18 June through 21 August.

4 Mean comparisons are only between subplots (Roundup +/-) within a common treatment. Treatment means followed by different letters differ significantly (LSmeans, $P \leq 0.05$).

Table 2. Main treatment effects for fungicide applied for Rhizoctonia root and crown rot (RRCR) suppression in Roundup Ready sugar beets (G.D. Franc and W.L. Stump, University of WY; 2007).

Treatment and rate (oz ai/1000 ft); application date[1]	Beet stand (7 ft of row) 18 Jun	RRCR incidence as a percentage of initial stand					AUDPC[2]
		10 Jul	17 Jul	31 Jul	9 Aug	21 Aug	
1. Nontreated non-inoculated check; NA.	8.5 a[3]	0.0 b	0.0 c	0.0 c	0.0 c	0.0 d	0.0 c
2. Nontreated inoculated check; NA.	7.4 a	63.0 a	94.6 a	100.0 a	100.0 a	100.0 a	4733.4 a
3. Quadris 2.08SC (0.15); A.	10.0 a	1.6 b	8.8 b	22.0 b	36.8 b	51.4 b	1061.9 b
4. Quadris 2.08SC (0.075); A, B.	10.1 a	0.0 b	2.6 bc	13.5 b	28.2 b	35.6 c	691.7 b

[1] All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (10-12 leaf stage) immediately following fungicide application. Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable. Roundup applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure (Roundup Original, 3.75lb/gal formulation, 1.375 pt product) with AMS (17 lb AMS per 100 gal spray) on 21 June.

[2] Area under the disease progress curve for data collected from 18 June through 21 August.

[3] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 3. Interaction of fungicide and Roundup application on Rhizoctonia root and crown rot (RRCR) severity measured as canopy necrosis in Roundup Ready sugar beets (G.D. Franc and W.L. Stump, University of WY; 2007).

Treatment and rate (oz ai/1000 ft); application date[1]	Roundup application[2]	RRCR severity as a percentage of total canopy necrosis						AUNPC[3]
		10 Jul	17 Jul	31 Jul	9 Aug	21 Aug	11 Sep	
1. Nontreated non-inoculated check; NA.	+	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
2. Nontreated non-inoculated check; NA.	-	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
3. Nontreated inoculated check; NA.	+	12.0 a	80.5 a	100.0 a	100.0 a	100.0 a	100.0 a	658.6 a
4. Nontreated inoculated check; NA.	-	21.0 a	83.0 a	100.0 a	99.0 a	99.8 a	100.0 a	662.8 a
5. Quadris 2.08SC (0.15); A.	+	0.0 a	0.5 a	1.5 a	6.0 a	15.0 a	17.0 a	122.6 a
6. Quadris 2.08SC (0.15); A.	-	0.5 a	1.5 a	5.0 a	8.5 a	21.0 a	40.5 a	172.3 a
7. Quadris 2.08SC (0.075); A, B.	+	0.0 a	0.5 a	1.0 a	6.0 a	10.5 a	15.0 a	108.9 a
8. Quadris 2.08SC (0.075); A, B.	-	0.0 a	0.5 a	2.0 a	4.0 a	7.5 a	6.0 a	88.0 a

[1] All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (10-12 leaf stage) immediately following fungicide application. Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable.

[2] Roundup applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure (Roundup Original, 3.75lb/gal formulation, 1.375 pt product) with AMS (17 lb AMS per 100 gal spray) on 21 June.

[3] Area under the necrosis progress curve for data collected from 18 June through 11 September.

[4] Mean comparisons are only between subplots (Roundup +/-) within a common treatment. Treatment means followed by different letters differ significantly (LSmeans, $P \leq 0.05$).

Table 4. Main treatment effects for fungicide applied for Rhizoctonia root and crown rot (RRCR) suppression in Roundup Ready sugar beets (G.D. Franc and W.L. Stump, University of WY; 2007).

Treatment and rate (oz ai/1000 ft); application date[1]	RRCR severity as a percentage of total canopy necrosis						AUNPC[3]
	10 Jul	17 Jul	31 Jul	9 Aug	21 Aug	11 Sep	
1. Nontreated non-inoculated check; NA.	0.0 b	0.0 b	0.0 b	0.0 c	0.0 c	0.0 d	0.0 d
2. Nontreated inoculated check; NA.	16.0 a	81.5 a	100.0 a	99.6 a	99.9 a	100.0 a	660.7 a
3. Quadris 2.08SC (0.15); A.	0.3 b	1.0 b	3.0 b	7.5 b	17.0 b	28.0 b	147.4 b
4. Quadris 2.08SC (0.075); A, B.	0.0 b	0.5 b	1.5 b	5.0 c	8.5 b	9.0 c	98.4 c

[1] All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (10-12 leaf stage) immediately following fungicide application. Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable. Roundup applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure (Roundup Original, 3.75lb/gal formulation, 1.375 pt product) with AMS (17 lb AMS per 100 gal spray) on 21 June.

[2] Area under the necrosis progress curve for data collected from 18 June through 11 September.

[3] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Table 5. Interaction of fungicide applied for RRCR management with Roundup application; effects on sugar beet root yield and quality in Roundup Ready sugar beets (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (oz ai/1000 ft)[1]	Roundup application[2]	Beet root yield and quality				Disease incidence and disease severity at harvest	
		Beet no. per 7 row ft	Beet yield (lbs/7 ft)	% total sucrose	% sugar lost to molasses[3]	Symptomatic beets (%)	Surface area of root decayed (%) (for diseased roots only)
1. Nontreated non-inoculated check; NA.	+	12.0 a[4]	18.6 a	12.0 a	2.1	0.0 a	0.0 a
2. Nontreated non-inoculated check; NA.	-	8.3 a	18.0 a	12.8 a	2.1	1.8 a	0.5 a
3. Nontreated inoculated check; NA.	+	0.0 a	0.0 a	0.0 a	NA	100.0 a	100.0 a
4. Nontreated inoculated check; NA.	-	0.0 a	0.0 a	0.0 a	NA	100.0 a	100.0 a
5. Quadris 2.08SC (0.15); A.	+	8.0 a	18.9 a	10.5 a	2.1	29.1 b	91.0 a
6. Quadris 2.08SC (0.15); A.	-	7.0 a	11.0 a	8.4 a	2.2	74.7a	95.5 a
7. Quadris 2.08SC (0.075); A, B.	+	9.0 a	16.6 a	11.1 a	2.2	48.0 a	73.5 a
8. Quadris 2.08SC (0.075); A, B.	-	8.0 a	17.5 a	11.6 a	2.3	28.0 a	69.0 a

1 All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (10-12 leaf stage) immediately following fungicide application. Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable.

2 Roundup applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure (Roundup Original, 3.75lb/gal formulation, 1.375 pt product) with AMS (17 lb AMS per 100 gal spray) on 21 June.

3 Severe RRCR disease resulted in some treatments that had no or few beets to rate; statistics were not run on these data. NA= non-applicable. Plots were harvested 28 September, 2007.

4 Mean comparisons are only between subplots (Roundup +/-) within a common treatment. Treatment means followed by different letters differ significantly (LSmeans, $P \leq 0.05$).

Table 6. Main effects of fungicide application made for Rhizoctonia root and crown rot (RRCR) management on sugar beet root yield and quality in Roundup Ready sugar beets (G.D. Franc and W.L. Stump, Univ. of WY; 2007).

Treatment and rate (oz ai/1000 ft)[1]	Beet root yield and quality				Disease incidence and disease severity at harvest	
	Beet no. per 7 row ft	Beet yield (lbs/7 ft)	% total sucrose	% sugar lost to molasses[2]	Symptomatic beets (%)	Surface area of root decayed (%) (for diseased roots only)
1. Nontreated non-inoculated check; NA.	10.1 a[3]	18.3 a	12.4 a	2.1	0.9 c	0.2 c
2. Nontreated inoculated check; NA.	0.0 b	0.0 b	0.0 c	NA	100.0 a	100.0 a
3. Quadris 2.08SC (0.15); A.	7.5 a	14.9 a	9.4 b	2.2	51.9 b	92.0 ab
4. Quadris 2.08SC (0.075); A, B.	8.5 a	17.0 a	11.3 a	2.2	38.0 b	72.0 b

1 All applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure. Plants in each treatment plot were inoculated with *Rhizoctonia solani* AG2-2 on 26 June, 2007 (10-12 leaf stage) immediately following fungicide application. Fungicide application dates were A= 26 June, B= 10 July, and NA= not-applicable. Roundup applications were made in a 7-inch banded spray in 1.06 gal carrier/1000 row ft at 45 psi boom pressure (Roundup Original, 3.75lb/gal formulation, 1.375 pt product) with AMS (17 lb AMS per 100 gal spray) on 21 June.

2 Because severe disease resulted in some treatments that had no or few beets to rate, no statistics were run on these data. NA= non-applicable. Plots were harvested 28 September, 2007.

3 Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

University of Wyoming Research and Extension Plant Pathology
Field Crops Disease Survey

2007 Cercospora Survey Results: Fungicide Sensitivity Characteristics of *Cercospora beticola* Isolates Recovered from Infected Sugar beet in the High Plains of Colorado, Montana, Nebraska, and Wyoming

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Abstract

The 2007 Cercospora leaf spot survey tested the fungicide reaction of 239 *Cercospora beticola* isolates recovered from 52 fields: 8 fields from CO, 10 fields from MT, 30 from NE, and 4 fields from WY. All isolates were tested for sensitivity to benzimidazole (Benlate®, Topsin®), triphenyltin hydroxide (Super Tin®, Agritin®), tetraconazole (Eminent®), propiconazole (Tilt®), azoxystrobin (Quadris®), trifloxystrobin (Gem®) and pyraclostrobin (Headline®). Only benzimidazole had appreciable insensitivity observed; 52 percent of the fields surveyed had detectable levels of benzimidazole insensitivity. Historical trends for High Plains surveys initiated in 1998 revealed that fields with benzimidazole insensitivity increased from 26 percent in 1998 to 80 percent in 2003, followed by a three year decline to 45 percent in 2005. Results consistently reveal that benzimidazole insensitivity is still widespread in High Plains sugar beet fields. Therefore, reliance on benzimidazole or thiophanate-methyl for Cercospora leaf spot suppression is not advised. Isolate reaction to diethofencarb in 2004-2007 revealed that all isolates insensitive to benzimidazole were sensitive to diethofencarb (negative cross resistance), indicating the likely presence of a single (and previously described) mutation conferring benzimidazole resistance.
Results for 2007 did not have the intermediate reaction to benzimidazole as in 2006, with only 2 isolates with a intermediate reaction (between 20-39% inhibition). Addtionally, a small number of isolates are showing insensitivity to azoxystrobin and trifloxystrobin in several states. In summary, the 2007 survey revealed that, with the exception of benzimidazole, our fungicide chemistries remain effective for Cercospora leaf spot suppression and that fungicide resistance management must be practiced by growers to maintain long-term efficacy of our fungicide chemistries.

Materials and Methods

Cercospora leaf spot samples were collected from commercial sugar beet fields during the late growing season by the Western Sugar cooperative personnel and one sample collection was made in Wyoming by UW personnel. The 2007 survey consisted of leaf samples collected from 54 fields throughout the High Plains growing region: 8 fields from Colorado, 10 fields from Montana, 32 fields from Nebraska, and 4 fields from Wyoming. Leaf samples were air-dried and stored for approximately two months prior to recovery attempts. Up to three

recovery attempts were made for each sample so that each field was represented by at least one fungal isolate, with up to 12 isolates was tested from a field. Cercospora isolates (239 isolates) were successfully recovered from 52 of the 54 fields; 8 fields from CO, 10 fields from MT, 30 from NE, and 4 fields from WY.

Fungicide sensitivity tests:

The media for testing the strobilurin fungicides azoxystrobin (Quadris®), trifloxystrobin (Gem®) and pyraclostrobin (Headline®) was made by amending glycerol medium and all other fungicides were added to potato dextrose agar (PDA). Diethofencarb, a fungicide with activity against certain benzimidazole-resistant fungi, also was tested. Media was autoclaved and cooled to approximately 55°C. Stock suspensions of 500 ppm triphenyltin hydroxide (Super Tin®, Agritin®), tetraconazole (Eminent®), propiconazole (Tilt®), azoxystrobin (Quadris®), trifloxystrobin (Gem®) and pyraclostrobin (Headline®) were prepared in sterile distilled water. Benzimidazole (used technical grade) and diethofencarb were both added to 5 ml of acetone prior to adding to the media. Stock suspensions were added to achieve concentrations in the media listed below; 13.5 mL of cool amended medium was dispensed into each Petri dish with the aid of an automatic dispensing unit. The poured plates were allowed to dry in the hood for at least 24 hr prior to use. The concentrations of amended media prepared were benzimidazole 5 ppm, triphenyltin hydroxide 1 ppm, tetraconazole 1 ppm, propiconazole 1 ppm, azoxystrobin 1 ppm, trifloxystrobin 1 ppm, pyraclostrobin 1 ppm, and diethofencarb 5 ppm.

Each isolate recovered from infected leaves was cultured onto a SBLEA (sugar beet leaf extract) source plate, incubated for 12 to 14 days at 23°C with a 12 hr photoperiod and the colony was allowed to desiccate prior to use for plate inoculations. Conidial suspensions from each isolate were prepared by scraping a small section of colony mycelium and adding it to small centrifuge tube containing 1 mL of sterile distilled water and then agitating with a vortex for 10 seconds. The conidial suspension was collected with an Eppendorf Repeater Plus® pipettor fitted with a sterile 0.1 mL pipette tip. For each isolate, non-amended and amended PDA and glycerol plates were inoculated with three evenly spaced 1.0 ì L aliquots of the conidia suspension. Therefore, for each isolate tested there were eight amended plates plus glycerol and PDA non-amended control plates. All ten plates for a given isolate were sleeved together for incubation, two isolate series per sleeve. Known *Cercospora beticola* strains sensitive and insensitive to benzimidazole were included as controls. Inoculated plates were incubated at 23°C with a 12 hr photoperiod.

Colony diameters for each inoculation site were measured after 7 days growth with the aid of a digital caliper and the mean value for the three inoculation sites was computed for each isolate on each medium. The percentage of inhibition of radial growth for each test isolate grown on fungicide-amended media was compared to its growth on non-amended media. Because the diameter of the initial inoculum drop was approximately 3 mm (± 0.1 mm, 95% CI), 3 mm was subtracted from the mean colony diameter for each isolate before calculating growth inhibition. The percent inhibition for each isolate was then calculated with the following equation, [(non-amended control – amended)/non-amended control X 100]. Although isolates that had colony growth greater than 3 mm after 7 days had measurable

"insensitivity" to the fungicide present in the amended medium, only isolates that exhibited 20% or less inhibition (80% or more growth) were considered insensitive.

Results and Discussion

A total of 239 isolates were recovered in 2007 from 52 sugar beet fields with symptoms of Cercospora leaf spot. For two of the fields we failed to recover *C. beticola* due to lack of sufficient lesions or the presence of other organisms. Each isolate represented a single separate foliar lesion. All isolates were tested for growth on the ten different media plates. Known benzimidazole sensitive and insensitive *C. beticola* isolates from prior surveys were tested and reacted consistently on the test media. Fifteen isolates were pulled from the strobilurin part of the survey due to no growth on the glycerol check plates. Therefore there were 224 isolates results summarized for azoxystrobin, trifloxystrobin and pyraclostrobin fungicides.

The *C. beticola* isolates that were inhibited 20 percent or less in the presence of fungicide were considered insensitive. In other words, these isolates grew at least 80 percent of their colony size in the presence of fungicide compared to their growth in the absence of fungicide. Isolate insensitivity data are summarized in Table 1. Insensitivity to triphenyltin hydroxide, tetraconazole, propiconazole, or pyraclostrobin was not detected. A total of 81 isolates (34%) were found to be insensitive to benzimidazole at 5 ppm. Montana had the greatest percentage of insensitive isolates (39%) followed by Nebraska (35%), Wyoming (33%), and Colorado (28%). A small number of isolates were found to be insensitive to azoxystrobin and trifloxystrobin.

The number of fields in which at least one benzimidazole insensitive isolate was detected are shown in Table 2. Overall, 52% of the fields tested in the High Plains region had detectable benzimidazole insensitivity in 2007. For Colorado 38% of the fields (3/8) were benzimidazole resistant; 2 of these 8 fields had mixed populations of sensitive and insensitive isolates. In Nebraska, 53% (16/30) of the fields had benzimidazole resistance; 10 of these 30 fields had mixed populations. Montana had 60% (6/10) of the fields with an insensitive isolate detected; 4 of these 10 fields had mixed populations. Wyoming had 4 fields tested with 2 of the 4 fields being insensitive and of mixed populations. The small sample size must be considered when evaluating data trends.

The range of insensitivity of *C. beticola* isolates in the presence of 1 ppm azoxystrobin, trifloxystrobin and pyraclostrobin fungicides are shown in Table 3. For the first time, a small number of isolates were found to be insensitive to azoxystrobin and trifloxystrobin. These isolates will be tested further. In general, isolates had greater inhibition of growth in the presence with pyraclostrobin compared to azoxystrobin and trifloxystrobin, similar to field trials that revealed pyraclostrobin suppressed Cercospora leaf spot more effectively than did azoxystrobin. Additionally, compared to past surveys, percent inhibition levels have been slowly decreasing for azoxystrobin and trifloxystrobin indicating a possible shift in the *C. beticola* populations to decreased susceptibility these fungicides.

Isolate inhibition in the presence of 1 ppm tetraconazole and propiconazole fungicides are summarized in Table 4. Although there were no insensitive isolates found for either tetraconazole or propiconazole, there was a trend of decreasing inhibition compared to previous survey years.

Isolate inhibition in the presence of triphenyltin hydroxide at 1 ppm are summarized in Table 5. The majority of the isolates were inhibited 90-100% at 1 ppm.

Isolate inhibition in the presence of benzimidazole at 5 ppm are summarized in Table 6. Results from the survey in 2006 revealed the presence of a number of "intermediate reaction" isolates that had exhibited inhibition levels between 21 and 74 percent. For the 2007 survey results this was not the case, with only 2 isolates that had 20-39% inhibition levels. One difference in methods this year compared to past years, was the use of technical grade benzimidazole rather than formulated benzimidazole (Benlate). Results for diethofencarb revealed that all isolates insensitive to benzimidazole were sensitive to diethofencarb, and isolates sensitive to benzimidazole were not affected by diethofencarb (negative cross resistance; data not shown).

Trends in survey results over the years for benzimidazole at 5 ppm are shown in Table 7. Based on total fields from the High Plains region, benzimidazole insensitivity increased from 26 percent in 1998 to a high of 80% in 2003, followed by a three year decline to 45% in 2005, 62% in 2006, and 52% in 2007. Results reveal the consistent trend that benzimidazole insensitivity is still widespread in High Plains sugar beet fields. Although the field fungicide-use data is incomplete, no fields sampled in 2007 indicated the use of benzimidazole for the 2007 field season. Additionally, 63 % of the fields considered to be insensitive to benzimidazole also had at least one sensitive isolate recovered from the same field (up from 46% in 2006 and 32% in 2005). This increase of mixed populations indicates a possible shift in *Cercospora beticola* populations.

Tests with diethofencarb reveal that all isolates insensitive or with an intermediate insensitive reaction to benzimidazole were sensitive to diethofencarb (negative cross resistance), suggesting diethofencarb plus benzimidazole use as a potential tank mix to suppress the spectrum of isolates present in the field. This approach had limited success in other production regions because tank mixes resulted in isolates insensitive to both diethofencarb and benzimidazole. More importantly, the consistent correlation of benzimidazole insensitivity to diethofencarb sensitivity suggests the presence of a single mutation that conferred benzimidazole insensitivity to all isolates recovered during 2004-2007 surveys. In summary, the 2007 survey reveals that our fungicide chemistries, except for benzimidazoles, remain effective and that fungicide resistance management must be practiced by growers to preserve the useful life of our fungicide chemistries.

Table 1. The number of insensitive *Cercospora beticola* isolates (20% or less growth inhibition in the presence of the indicated fungicide) recovered in 2007 from symptomatic leaves collected from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

Fungicide (ppm)*	Number of insensitive isolates (20% or less inhibition)**				
	CO	MT	NE	WY	Total
Azoxystrobin (1)	4	1 (20.07%)	1	0	6
Pyraclostrobin (1)	0	0	0	0	0
Trifloxystrobin (1)	4	0	2	0	6
Total isolates tested	48	41	126	9	224
Tetraconazole (1)	0	0	0	0	0
Propiconazole (1)	0	0	0	0	0
Triphenyltin (1)	0	0	0	0	0
Benzimidazole (5)	14	17	47	3	81
Total isolates tested	51	44	135	9	239

* Azoxystrobin, trifloxystrobin and pyraclostrobin utilized a glycerol based medium, while all other fungicides were tested utilizing potato dextrose agar.

** Percent inhibition: Mean colony diameter was first computed for both the amended and non-amended control for each isolate (three replications) and 3mm was subtracted from each value to account for the initial inoculum deposition area. The percent inhibition for each isolate was calculated with the formula [(non-amended control-amended control)/non-amended control] X 100.

Table 2. The number of fields with at least one benzimidazole insensitive *Cercospora beticola* isolate (20% or less inhibition) present. Isolates were recovered in 2007 from symptomatic leaves collected from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

Fungicide (ppm)*	Number of fields with at least one insensitive isolate (20% or less inhibition)**				
	CO	MT	NE	WY	Total
Benzimidazole (5)	3	6	16	2	27
Total fields tested	8	10	30	4	52

* Azoxystrobin, trifloxystrobin and pyraclostrobin utilized a glycerol based medium, while all other fungicides were tested utilizing potato dextrose agar.

** Percent inhibition: Mean colony diameter was first computed for both the amended and non-amended control for each isolate (three replications) and 3mm was subtracted from each value to account for the initial inoculum deposition area. The percent inhibition for each isolate was calculated with the formula [(non-amended control-amended control)/non-amended control] X 100.

Table 3. Sensitivity distribution of *Cercospora beticola* isolates to azoxystrobin (Quadris), trifloxystrobin (Gem) and pyraclostrobin (Headline) fungicides. Isolates were recovered from symptomatic leaves collected in 2007 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

% inhibition*	Number of isolates within a category														
	Azoxystrobin 1 ppm					Trifloxystrobin 1 ppm					Pyraclostrobin 1 ppm				
	CO**	MT	NE	WY	Total	CO	MT	NE	WY	Total	CO	MT	NE	WY	Total
0-9	2	0	1	0	3	3	0	2	0	5	0	0	0	0	0
10-19	2	0	0	0	2	1	0	0	0	1	0	0	0	0	0
20-29	3	2	3	0	8	2	0	2	0	4	0	0	0	0	0
30-39	6	3	8	0	17	2	5	4	0	11	0	0	0	0	0
40-49	4	7	10	1	22	3	5	10	1	19	0	0	0	0	0
50-59	5	8	19	0	32	6	4	19	0	29	0	0	0	0	0
60-69	7	9	23	3	42	8	6	13	3	30	3	0	1	0	4
70-79	8	3	16	3	30	5	5	15	1	26	5	3	5	0	13
80-89	5	1	9	0	15	4	4	12	2	22	6	5	15	0	26
90-99	1	2	1	0	4	3	1	5	0	9	7	5	12	0	24
100	5	6	36	2	49	11	11	44	2	68	27	28	93	9	157
Total tested	48	41	126	9	224	48	41	126	9	224	48	41	126	9	224

* Percent inhibition: Mean colony diameter was first computed for both the amended and non-amended control for each isolate and 3mm was subtracted from each value to account for the initial inoculum deposition area. The percent inhibition for each isolate was calculated with the formula [(non-amended control-amended control)/non-amended control] X 100.

** State codes: CO= Colorado, MT= Montana, NE= Nebraska, WY= Wyoming.

Table 4. Sensitivity distribution of *Cercospora beticola* isolates to tetraconazole (Eminent) and propiconazole (Tilt) fungicides. Isolates were recovered from symptomatic leaves collected in 2007 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

% inhibition*	Number of isolates within a category									
	Tetraconazole 1 ppm					Propiconazole 1 ppm				
	CO**	MT	NE	WY	Total	C O	MT	NE	WY	Total
0-9	0	0	0	0	0	0	0	0	0	0
10-19	0	0	0	0	0	0	0	0	0	0
20-29	0	1	0	0	1	0	0	0	0	0
30-39	0	0	0	0	0	0	0	1	0	1
40-49	0	0	1	0	1	0	0	0	0	0
50-59	0	0	0	0	0	10	4	18	0	32
60-69	0	0	0	0	0	17	9	40	1	67
70-79	2	0	0	0	3	19	14	37	4	74
80-89	19	8	32	2	61	4	10	29	4	47
90-99	27	27	77	7	138	0	6	10	0	16
100	3	8	24	0	35	1	1	0	0	2
Total tested	51	44	135	9	239	51	44	135	9	239

* Percent inhibition: Mean colony diameter was first computed for both the amended and non-amended control for each isolate and 3mm was subtracted from each value to account for the initial inoculum deposition area. The percent inhibition for each isolate was calculated with the formula [(non-amended control-amended control)/non-amended control] X 100.

** State codes: CO= Colorado, MT= Montana, NE= Nebraska, WY= Wyoming.

Table 5. Sensitivity distribution of *Cercospora beticola* isolates to triphenyltin hydroxide (Super Tin, Agritin) fungicide. Isolates were recovered from symptomatic leaves collected in 2007 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

% inhibition*	Number of isolates within a category				
	Triphenytin hydroxide (1 PPM)				
	CO**	MT	NE	WY	Total
0-9	0	0	0	0	0
10-19	0	0	0	0	0
20-29	0	0	0	0	0
30-39	0	0	0	0	0
40-49	0	0	0	0	0
50-59	0	0	0	0	0
60-69	0	0	1	0	1
70-79	0	0	0	0	0
80-89	0	0	0	0	0
90-99	15	4	19	2	40
100	36	40	115	7	198
Total tested	51	44	135	9	239

* Percent inhibition: Mean colony diameter was first computed for both the amended and non-amended control for each isolate and 3mm was subtracted from each value to account for the initial inoculum deposition area. The percent inhibition for each isolate was calculated with the formula [(non-amended control-amended control)/non-amended control] X 100.

** State codes: CO= Colorado, MT= Montana, NE= Nebraska, WY= Wyoming.

Table 6. Sensitivity distribution of *Cercospora beticola* isolates to benzimidazole (Topsin) fungicide. Isolates were recovered from symptomatic leaves collected in 2007 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

% inhibition*	Number of isolates within a category				
	Benzimidazole (5 PPM)				
	CO**	MT	NE	WY	Total
0-9	14	13	45	3	75
10-19	0	4	2	0	6
20-29	0	0	1	0	1
30-39	0	0	1	0	1
40-49	0	0	0	0	0
50-59	0	0	0	0	0
60-69	0	0	0	0	0
70-79	0	0	0	0	0
80-89	0	0	0	0	0
90-99	0	0	0	0	0
100	37	27	86	6	156
Total tested	51	44	135	9	239

* Percent inhibition: Mean colony diameter was first computed for both the amended and non-amended control for each isolate and 3mm was subtracted from each value to account for the initial inoculum deposition area. The percent inhibition for each isolate was calculated with the formula [(non-amended control-amended control)/non-amended control] X 100.

** State codes: CO= Colorado, MT= Montana, NE= Nebraska, WY= Wyoming.

Table 7. Survey trends (1998-2007) for the number of fields / number of fields tested with at least one isolate exhibiting insensitivity (20 percent or less inhibition) to benzimidazole (5 ppm).

State	Survey year									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Colorado	19/36	14/29	9/23	18/29	3/5	17/21	9/12	5/10	8/11	3/8
	53%	48%	39%	62%	60%	81%	75%	50%	73%	38%
Montana	0/19	1/5	3/5	6/11	0/1	3/5	2/6	1/10	1/2	6/10
	0%	20%	60%	55%	0%	60%	33%	10%	50%	60%
Nebraska	4/33	8/39	8/32	7/29	21/27	13/16	16/20	19/35	14/25	16/30
	12%	21%	25%	24%	78%	81%	80%	54%	56%	53%
Wyoming	NT*	0/1	0/1	NT	1/1	3/3	0/2	0/1	1/1	2/4
		0%	0%		100%	100%	0%	0%	100%	50%
Total	23/88	23/74	20/61	31/69	25/34	36/45	27/40	25/56	24/39	27/52
	26%	31%	33%	45%	74%	80%	68%	45%	62%	52%

* NT=Not tested

Products tested in 2007 field research studies

Product	Class*	Manufacturer	Composition
A1370	F	Syngenta Crop Protection, Inc. P.O. Box 18300 Greensboro, NC 27419	18.18% azoxystrobin + 11.36% difenoconazole
Asana XL 0.66 EC	I	Dupont Agricultural Products Wilmington, DE 19880-0402	8.4% Esfenvalerate
BAS 556 01 F	F	BASF Corp. 26 Davis Dr. Research Triangle Park, NC 27709	12.1 % pyraclostrobin + 7.45% metconazole
Beyond	B		Information not provided
Bravo Weather Stik 6F	F	Syngenta Crop Protection, Inc. P.O. Box 18300 Greensboro, NC 27419	54% Chlorothalonil
Caramba 90SL	F	BASF	9% metconozole
Echo 720	F	Sipcam Agro USA, Inc. 70 Mansell Ct., Suite 230 Roswell, GA 30076	54% Chlorothalonil
Eminent 125SL	F	Sipcam Agro USA, Inc.	11.6% Tetraconazole
Gem 4.17SC	F	Bayer CropScience 2 T.W. Alexander Dr Reaserch Triangle PK, NC 27709	38.5% Trifloxystrobin
Global Biobased Asian	B	Global Biobased Asian 2137 Cape Heather Circle Cape Coral, FL 33991	Information not provided
Headline 2.08EC	F	BASF Corp.	22.9% Pyraclostrobin
Induce	S	Helena Chemical Co. 225 Schilling Blvd., Suite 300 Collierville, TN 38017	Nonionic surfactant mixture
Intrepid 2F	I	Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268	23.17% methoxyfenozide
Lannate LV 2.4SC	I	Dupont Agricultural Products Wilmington, DE 19880-0402	29% Methomyl
LEM17 SC200 GL	F	Dupont Agricultural Products Wilmington, DE 19880-0402	Information not provided
LEM17 1.67EC	F	Dupont	Information not provided
LEM17 1.67SC	F	Dupont	Information not provided
Maxim 4FS	F	Syngenta Crop Protection, Inc.	40.3% Fludioxonil
Moncut 70DF	F	Gowan Co. PO Box 5569 Yuma, AZ 85366-5569	70% Flutolanil

Proline 4EC	F	Bayer Corp.	41% Prothioconazole
Punch 3.3EC	F	Dupont	37.8% Flusilazole
Quadris 2.08SC	F	Syngenta Crop Protection, Inc.	22.9% Azoxystrobin
Quadris Opti 5.5SC	F	Syngenta Crop Protection, Inc.	4.6% azoxystrobin + 46% chlorothalonil
Revis Opti 3.67SC	F	Syngenta Crop Protection, Inc.	33.3% chlorothalonil + 3.33% mandipropamid
Revis Top 4.17SC	F	Syngenta Crop Protection, Inc.	25% difenoconazole + 25% mandipropamid
Roundup Original	H	Monsanto Co. St Louis, MI 63167	41% glyphosate
SA-140201	F	Sipcam	Information not provided
Steward EC	I	Dupont	15.84% indoxacarb
Spintor/Success 2SC	I	Dow	22.8% spinosad
Super Tin 80WP	F	Dupont	80% Triphenyltin hydroxide
Taspa (A8122 500EC)	F	Syngenta Crop Protection, Inc.	22.8% difenoconazole + 22.8% propiconazole
Topsin M 70WP	F	Cerexagri, Inc. 900 First Ave. King of Prussia, PA 19406	70% Thiophanate-methyl
Vydate C-LV	I	Dupont	42% Oxamyl
Warrior with Zeon Technology	I	Syngenta Crop Protection, Inc.	11.4% Lambda-cyhalothri
X77	S	Loveland Industries, Inc. P.O. Box 1289 Greeley, CO 80632-1289	Nonionic surfactant
YT669 2.08SC	F	Dupont	25% picoxystrobin

* B= Biological, F= fungicide, I= insecticide, H= herbicide, S= surfactant