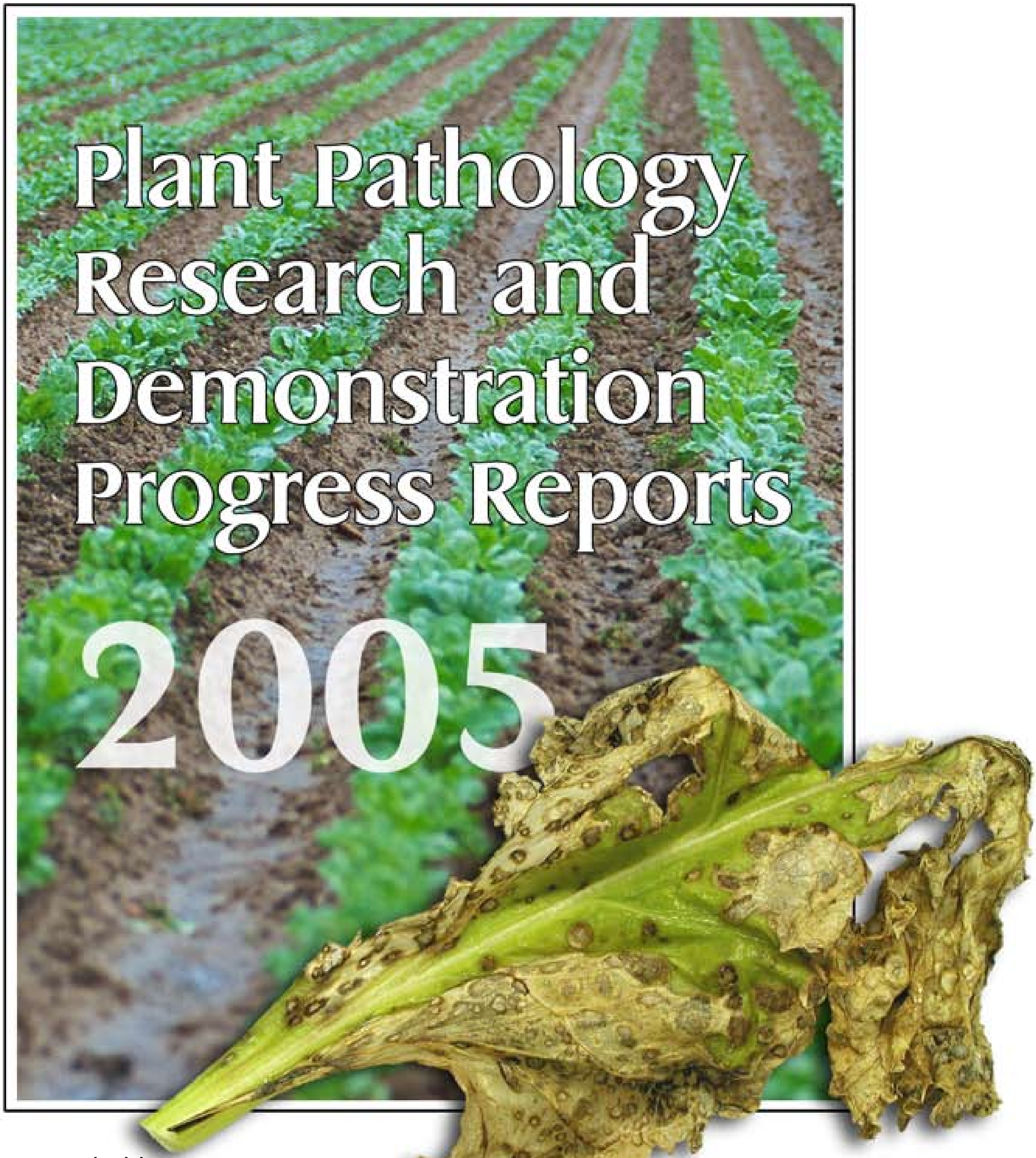
Plant Pathology Research and Demonstration Progress Reports 2005



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MP 101-06
March 2006
UNIVERSITY OF WYOMING

2005 Plant pathology Research and Demonstration Progress Reports

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Additional copies are available by telephone (307-766-2397), or by e-mail to: FrancG@UWYO.edu. This report will also be published during the spring of 2006 as MP101-06 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	**Management of Dry Bean Rust and Bacterial Bean Blight Diseases in Southeastern Wyoming, Lingle, WY, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc, W.L. Stump, and Jack T. Cecil University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Research plots were at the Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY 4165 MSL: Mitchell clay loam soil, pH = 7.9-8.3; overhead irrigation.
Plot Design	Randomized complete block design with four replications; plots were four rows (30-in row centers) X 20 ft with 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date:** 26 May, 2005 **Variety:** Bill Z **Fertilizer:** 30 lb N + 35 lb P_2O_5 + 20 lb S **Herbicide:** Eptam 7EC (4 pt product) + Sonalan 3EC (3 pt product) preplant incorporated. **Insecticide:** An aerial application of Asana (8 oz product/A) was made on 3 August for Mexican bean beetle suppression.
Disease Development	On 26 August, the middle two rows of each plot were inoculated with the causal agents of halo blight and common bacterial blight to induce disease development. Inoculum was prepared from approximately 25 Petri plate cultures of each *Xanthomonas campestris* pv. *phaseoli* (common bacterial bean blight) and *Pseudomonas syringae* pv. *phaseolicola* (halo blight). Bacteria were removed by washing Petri plate cultures with distilled water to create a very turbid (concentrated) bacterial suspension. The bacterial suspension was brought up to a final volume of 4 liters with distilled water which was then sprayed over the bean canopy with a portable (CO_2) sprayer at 45 psi boom pressure (a single #8002 flat fan nozzle). Inoculations were repeated in the same manner on 29 August, except that 10 Petri plate cultures of each bacterium were harvested and the total spray volume was 2 liters. On 29 August, symptomatic pods infected with the common bacterial bean pathogen also were scattered throughout the plot area at an approximate concentration of two infected pods per plot. It was hoped that infected pods would provide a more stable long-term source of the bacterium in the research plot area for sustained disease development. Bean rust development relied on natural inoculation sources.
Treatment Applications	Fungicide treatments consisted of spray programs initiated on 18 August and continued on a weekly basis for a total of 3 applications. Application dates and treatment rates are indicated in the Table. Fungicides for all treatments 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 and other Treatment	Bean rust disease severity was assessed by selecting 10 terminal leaflets at random from each plot and counting the number of pustules on the underside of the leaflet surface. The average number of pustules per leaflet was calculated for

Evaluations	presentation in the Table. Bean rust data were collected on 11, 18, 26, and 31 August, and, on these dates, plots were inspected for common bacterial bean blight and halo blight symptoms.
Harvest	On 20 September, the center five feet by two rows for each plot was harvested by hand and then threshed with a small plot combine for determination of total plot yield. As a measure of seed quality, a 200-seed test weight was determined.
Statistical Analysis	ANOVA with four replications. Non-transformed data, log and square root transformations were analyzed for the bean rust data. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

Bacterial bean blight disease (halo blight or common bacterial bean blight) was not observed in the plots on any of the evaluation dates, before or after inoculation. Environmental conditions during the growing season did not favor disease development from either inoculation method. Phytotoxicity was not observed in the plots for any of the fungicide treatment programs.

Bean rust development was light and sporadic throughout most of the region. Bean rust was first observed in the research plots on 26 August. All rust evaluation data are presented in Table 1. Distribution of the rust was not uniform in the plot area with most of the disease occurring in the second block of the experiment. Because of this variability, significant treatment effects were not detected for all disease evaluation dates, even though large numerical differences occurred among treatments (P=0.05). The data did reveal an obvious trend of reduced rust severity for all fungicide programs when compared to the nontreated check. These data represents an unusual distribution of rust, and the variability among the nontreated treatment replications is unexplained.

Treatment effects on bean yield and quality are also shown in Table 1. Total yield and seed quality was not affected by treatment (P=0.05). However the data did reflect a trend that fungicide treatments had a greater overall yield compared to the nontreated check.

Table 1. Effects of foliar fungicide programs on bean rust management, seed yield, and seed quality (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	No. of rust pustules per leaflet		AUDPC[2]	Seed yield and quality	
		26 Aug	31 Aug		cwt/a	oz/200 seed
1. Nontreated check...	NA	18.1 a[3]	22.1 a	173.1 a	27.0 a	2.6 a
2. Manex 4F (1.4 qt)..	A-C	0.3 a	1.2 a	4.7 a	31.2 a	2.5 a
3. Manex 4F (1.2 qt) + Kocide 2000 53.8DF (1 lb)	A-C	1.1 a	0.8 a	8.9 a	27.3 a	2.5 a
4. Headline SBR (comprised of following mixture) 4. Headline 2.08EC (4.7 fl oz) + Folicur 3.6EC (3.1 fl oz)...	A-C	0.4 a	1.7 a	6.8 a	29.6 a	2.6 a

1 The planting date was 26 May, 2005 with variety Bill Z, and harvest was on 20 September. Fungicide application dates were: A= 18 Aug, B= 24 Aug, C= 31 Aug, and NA= not-applicable.

2 Area under the disease progress curve for data collected from 18 through 31 August.

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

Research Project	**Management of Potato Foliar Diseases with Foliar Fungicide Programs at Lingle WY, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY; 4165 MSL: Mitchell clay loam soil, ph=7.9; overhead irrigation.
Plot Design	Randomized complete block design with four replications; plots were four rows (36-in row centers) X 20 ft 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, 2005 **Variety:** FL1867 **Fertilizer:** 140 lb N + 50 lb P_2O_5 **Herbicide:** Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A) on 18 May. Herbicides were water (irrigation) incorporated on 19 May. **Insecticide:** Aerial application of Asana (8 fl oz product/A) was made on 3 August for potato pysllid suppression.
Disease Development	On 27 July and 3 August foliar applications of *Alternaria solani* spores and hyphae (6.6 x 10^3 spores per ml measured for the 3 August inoculation) harvested from culture plates were made to the 5 ft in-row buffers of each plot in a total volume of 1.06 gal/1000 ft via a single-nozzle (8002 flat fan) equipped boom. The first inoculation date corresponded to when the 300 P-day threshold was reached based on the WISDOM disease forecasting model. Early blight lesions were first detected in the general plot area on 8 August, and their presence was verified by recovery of *Alternaria solani* in culture. Late blight was not detected during the growing season.
Treatment Applications	Treatments for foliar disease consisted of spray programs initiated on 20 July (prior to inoculation) and all application dates are indicated in the Tables. Treatments 7-11 and 15-17 were made at a 14-day application interval, while treatments 2-6 and 12-14 were made at 7-day application intervals. The DACOM system is a disease forecasting service based in the Netherlands that is being tested in North America in 2005. Treatment 19 followed the DACOM forecast schedule for fungicide application timings and treatment 18 was the "grower standard" schedule included for comparison. Results for the DACOM treatments will be presented in a separate report. Fungicides for all treatments 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 and other Treatment Evaluations	Early blight disease severity was measured by counting lesions on foliage and then calculating the average number of lesions per leaflet for leaves collected on 20, 27 July; 3, 10, 17, 24, 31 August; and 7, 15 September. Six leaves were randomly selected from each treatment plot (two leaves each

	from the top, middle, and bottom third of the canopy) and the number of early blight lesions present on up to seven leaflets from each leaf were counted. Disease severity data from 3 August to 15 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. 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 15 September. A portion of the data is summarized in the Tables.
Harvest	Two rows by 10 ft were dug with a two-row mechanical digger on 22 September. Tubers were sorted and weighed to determine yield and grade on 26 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 to compare 7-day and 14-day spray programs ($P \leq 0.05$).

Results and Discussion

This was the first year of potato cultivation at SAREC, located near Lingle, Wyoming. Early blight disease development was moderate following inoculation. Lesions became more numerous in inoculated buffer rows and the first lesions were detected in the general plot area by 8 August. It is not known to what extent natural inoculum contributed to disease development. Despite having conditions favorable for late blight development in the region, late blight was not detected in the research plots nor was late blight found in any nearby fields. Phytotoxicity was not observed for any of the fungicide treatment programs. Potato psyllids were present in the plot area and caused some visible crop injury (psyllid yellows).

Disease severity data (the average number of early blight lesions per leaflet) collected on 17 August was the first data set that revealed significant differences among treatments (Table 1, $P \leq 0.05$). Ratings done prior to this date failed to reveal significant differences ($P \leq 0.05$). Data from leaves collected on 31 August revealed all fungicide treatments except treatment 11 significantly reduced disease severity compared to the nontreated check (Table 1, $P \leq 0.05$). All fungicide programs significantly reduced the season-long AUDPC value compared to the nontreated check ($P \leq 0.05$). In general, fungicide programs made at 14-day application intervals were less effective as a group compared to the group of fungicide programs made at 7-day application intervals (linear contrast, $P \leq 0.05$). However, treatments 9, 16, and 17 were made at 14-day application intervals and were statistically equivalent to the most effective programs made at 7-day application intervals ($P \leq 0.05$). Therefore, considerable overlap in disease suppression efficacy resulted between the two groups. Chlorothalonil treatment formulations of Echo Zn and Bravo Weather Stik provided equivalent disease suppression (P=0.05). Weak trends in the data from 2005 and prior years reveal that chlorothalonil formulations containing zinc (e.g., Echo Zn) are more suppressive on early blight than are chlorothalonil formulations that lack zinc. Both Manzate Pro-Stick and Dithane DF (Rainshield) NT are commercial formulations of mancozeb, and both provided similar levels of disease suppression (P=0.05).

Fungicide treatment effects on potato yield and quality are shown in Table 2. Both total yield and tuber quality were not affected by treatment (*P*=0.05). Lack of treatment effect is at least partially due to the late onset of early blight during in 2005. The proportion of total yield in each tuber quality category also was analyzed and found to be not significant (*P*=0.05).

Table 1. The effects of foliar fungicide programs on potato early blight disease severity in Wyoming (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	Early blight lesions per leaflet					AUDPC[2]	% necrosis
		17 Aug	24 Aug	31 Aug	7 Sep	15 Sep		15 Sep
1. Nontreated check	NA	0.06 bc[3]	1.78 a	6.19 a	12.67 a	13.70 a	206.0 a	50.0 a
2. DPX-JE874-426 5SC (2.4 fl oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.15 bc	0.80 a	1.15 d	1.68 d-g	4.76 bcd	46.5 efg	8.5 d
2. Manzate Pro-Stick 75DF (1.5 lb)........	C, F, H							
3. DPX-JE874-425 0.82SC (15 fl oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.00 c	0.36 a	0.67 d	1.33 efg	2.16 d	25.9 g	7.3 d
3. Manzate Pro-Stick 75DF (1.5 lb)........	C, F, H							
4. DPX-JE874-425 0.82SC (7.5 fl oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.01 c	0.07 a	0.91 d	1.97 d-g	4.23 cd	38.7 fg	10.3 cd
4. Manzate Pro-Stick 75DF (1.5 lb)........	C, F, H							
5. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)...	B, D, G, I	0.01 c	0.08 a	1.14 d	0.67 g	3.26 cd	26.7 g	8.5 d
5. Manzate Pro-Stick 75DF (1.5 lb)........	C, F, H							
6. Manzate Pro-Stick 75DF (2 lb)........	B, C, D, F-I	0.02 c	1.30 a	1.57 bcd	2.66 c-g	5.17 bcd	60.9 d-g	8.5 d
7. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)...	B	0.01 c	0.28 a	3.07 bc	3.98 bcd	6.05 bc	77.5 cde	17.0 bc
7. Manzate Pro-Stick 75DF (2 lb)........	D, G, I							
8. Manzate Pro-Stick 75DF (1.5 lb)........	B, D, I	0.23 ab	2.63 a	2.02 bcd	3.67 b-e	5.09 bcd	82.0 b-e	10.3 cd
8. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)...	G							
9. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)...	B, G	0.18 abc	0.35 a	1.41 bcd	3.34 c-f	4.54 bcd	57.0 d-g	8.5 d
9. Manzate Pro-Stick 75DF (2 lb)........	D, I							
10. Manzate Pro-Stick 75DF (1.5 lb)........	B, G, I	0.10 bc	2.96 a	1.83 bcd	4.61 bc	5.52 bc	90.9 bcd	10.3 cd
10. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb).	D							
11. Manzate Pro-Stick 75DF (1.5 lb)........	B, D, I	0.35 a	1.09 a	5.22 a	5.70 b	7.43 b	119.6 b	17.0 bc
11. Manzate Pro-Stick 75DF (1.5 lb) + Super Tin 80WP (2.5 oz)........	G							
12. Dithane DF (Rainshield) NT (2 lb)........	B, C, D, F-I	0.01 c	0.30 a	2.20 bcd	2.74 c-g	4.92 bcd	58.2 d-g	12.0 cd
13. Echo Zn 4.17F (2.125 pt)........	B, C, D, F-I	0.04 bc	0.17 a	1.26 cd	1.24 fg	2.25 d	28.7 g	7.3 d
14. Bravo Weather Stik (1.5 pt)........	B, C, D, F-I	0.12 bc	0.08 a	0.76 d	1.51 efg	3.50 cd	32.2 g	10.3 cd

Treatment and rate (product/A)	Application dates[1]	Early blight lesions per leaflet					AUDPC[2]	% necrosis 15 Sep
		17 Aug	24 Aug	31 Aug	7 Sep	15 Sep		
15. Headline 2.08EC (6 fl oz)..	B, G	0.11 bc[3]	0.36 a	2.16 bcd	4.42 bc	5.58 bc	73.8 c-f	12.0 cd
15. Bravo Weather Stik (1.5 pt)..	D, I							
16. Endura 70WP (2.5 oz)	B, G	0.01 c	0.11 a	1.31 cd	2.84 c-g	3.25 cd	44.3 efg	10.3 cd
16. Bravo Weather Stik (1.5 pt)..	D, I							
17. Headline 2.08EC (6 fl oz)..	B, I	0.07 bc	0.17 a	1.06 d	1.18 fg	3.87 cd	33.4 g	7.3 d
17. Endura 70WP (2.5 oz)	D							
17. Bravo Weather Stik (1.5 pt)..	G							
DACOM grower standard schedule								
18. Amistar 80WP (2 oz)...	E	0.12 bc	0.46 a	2.31 bcd	3.86 bcd	7.45 b	79.0 cde	12.0 cd
18. Bravo Weather Stik (1.5 pt)..	H, I							
DACOM forecast schedule								
19. Tanos 50WG (8 oz) + Bravo Weather Stik (1.5 pt).........	A	0.02 c	0.58 a	3.19 b	4.94 bc	11.28 a	109.8 bc	23.5 b
19. Tanos 50WG (8 oz)	C							
19. Amistar 80WP (2 oz)...	F							

[1] The planting date was 10 May, 2005 with variety FL1867, and harvest was on 22 September. Fungicide application dates were: A= 5 Jul, B= 20 Jul, C= 28 Jul, D= 4 Aug, E= 8 Aug, F= 11 Aug, G= 18 Aug, H= 24 Aug, and I= 1 September. NA= not-applicable.

[2] Area under the disease progress curve for data collected from 3 Aug through 15 September.

[3] 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 in Wyoming (G.D. Franc and W.L. Stump, Univ. of WY; 2005)

Treatment and rate (product/A)	Application dates[1]	Potato yield (cwt/A)						
		US#1			US#2	Grade B	Cull	Total
		(>10 oz)	(<10 oz)	total				
1. Nontreated check	NA	58.1 a[2]	222.2 a	280.2 a	6.2 a	23.2 a	5.4 a	315.1 a
2. DPX-JE874-426 5SC (2.4 fl oz) + Manzate Pro-Stick 75DF (1.5 lb) 2. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	36.3 a	237.9 a	274.2 a	1.7 a	20.5 a	4.3 a	300.7 a
3. DPX-JE874-425 0.82SC (15 fl oz) + Manzate Pro-Stick 75DF (1.5 lb) 3. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	34.4 a	223.2 a	257.6 a	1.5 a	22.8 a	8.5 a	290.5 a
4. DPX-JE874-425 0.82SC (7.5 fl oz) + Manzate Pro-Stick 75DF (1.5 lb) 4. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	43.7 a	230.0 a	273.7 a	0.5 a	19.6 a	4.4 a	298.3 a
5. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb) 5. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	46.1 a	233.6 a	279.7 a	1.0 a	19.0 a	6.9 a	306.6 a
6. Manzate Pro-Stick 75DF (2 lb)	B, C, D, F-I	31.4 a	222.9 a	254.3 a	1.9 a	24.7 a	1.9 a	282.8 a
7. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb) 7. Manzate Pro-Stick 75DF (2 lb)	B D, G, I	33.0 a	237.4 a	270.4 a	4.6 a	26.0 a	6.3 a	309.6 a
8. Manzate Pro-Stick 75DF (1.5 lb) 8. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, I G	33.2 a	189.8 a	223.1 a	0.0 a	21.4 a	1.9 a	246.4 a
9. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb) 9. Manzate Pro-Stick 75DF (2 lb)	B, G D, I	36.8 a	236.0 a	272.8 a	1.7 a	19.3 a	6.3 a	300.1 a
10. Manzate Pro-Stick 75DF (1.5 lb) 10. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, G, I D	48.8 a	243.8 a	292.6 a	7.9 a	19.0 a	1.9 a	321.3 a
11. Manzate Pro-Stick 75DF (1.5 lb) 11. Manzate Pro-Stick 75DF (1.5 lb) + Super Tin 80WP (2.5 oz)	B, D, I G	35.0 a	246.1 a	281.1 a	3.0 a	22.8 a	9.6 a	316.5 a

Treatment and rate (product/A)	Application dates[1]	Potato yield (cwt/A)						
		US#1			US#2	Grade B	Culls	Total
		(>10 oz)	(<10 oz)	total				
12. Dithane DF (Rainshield) NT (2 lb)	B, C, D, F-I	31.8 a[2]	240.5 a	272.3 a			4.0 a	297.9 a
13. Echo Zn 4.17F (2.125 pt)	B, C, D, F-I	38.2 a	225.4 a	263.6 a	3.3 a	20.1 a	9.5 a	296.5 a
14. Bravo Weather Stik (1.5 pt)	B, C, D, F-I	45.4 a	226.1 a	271.5 a	2.3 a	19.6 a	3.2 a	296.6 a
15. Headline 2.08EC (6 fl oz) .... 15. Bravo Weather Stik (1.5 pt)	B, G D, I	37.7 a	219.1 a	256.7 a	1.1 a	22.2 a	1.9 a	282.0 a
16. Endura 70WP (2.5 oz)... 16. Bravo Weather Stik (1.5 pt)	B, G D, I	37.1 a	272.4 a	309.5 a	1.5 a	15.8 a	6.2 a	333.0 a
17. Headline 2.08EC (6 fl oz) .... 17. Endura 70WP (2.5 oz)... 17. Bravo Weather Stik (1.5 pt)	B, I D G	49.5 a	244.5 a	294.0 a	2.9 a	17.0 a	4.6 a	318.5 a
DACOM grower standard schedule 18. Amistar 80WP (2 oz) .... 18. Bravo Weather Stik (1.5 pt)	 E H, I	40.2 a	235.8 a	276.0 a	7.1 a	16.5 a	6.7 a	306.3 a
DACOM forecast schedule 19. Tanos 50WG (8 oz) + Bravo Weather Stik (1.5 pt) .... 19. Tanos 50WG (8 oz) .... 19. Amistar 80WP (2 oz)	 A C F	27.9 a	217.6 a	245.5 a	18.3 a	27.0 a	2.5 a	293.2 a

[1] The planting date was 10 May, 2005 with variety FL1867, and harvest was on 22 September. Fungicide application dates were: A= 5 Jul, B= 20 Jul, C= 28 Jul, D= 4 Aug, E= 8 Aug, F= 11 Aug, G= 18 Aug, H= 24 Aug, and I= 1 September. NA= not-applicable.

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

Research Project	**Field Test of the DACOM PLANT-Plus™ Decision Support System for Potato Early Blight and Late Blight Management at Lingle, WY, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Field plots were planted at the Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY; 4165 MSL: Mitchell clay loam soil, ph=7.9; overhead irrigation.
Plot Design	Randomized complete block design with four replications; plots were four rows (36-in row centers) X 20 ft 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, 2005 **Variety:** FL1867 **Fertilizer:** 140 lb N + 50 lb P_2O_5 **Herbicide:** Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A) on 18 May. Herbicides were water (irrigation) incorporated on 19 May. **Insecticide:** Aerial application of Asana (8 fl oz product/A) was made on 3 August for potato pysllid suppression.
Disease Development	On 27 July and 3 August foliar applications of *Alternaria solani* spores and hyphae (6.6 x 10^3 spores / ml measured for the 3 August inoculation) harvested from culture plates were made to the 5 ft in-row buffers of each plot in a total volume of 1.06 gal/1000 ft of row via a single-nozzle (8002 flat fan) equipped boom. The first inoculation date corresponded to when the 300 P-day threshold was reached based on the WISDOM disease forecasting model. Early blight lesions were first detected in the general plot area on 8 August, and their presence was verified by recovery of *Alternaria solani* in culture. Late blight was not detected at any time during the growing season.
Treatment Applications	The DACOM PLANT-Plus™ forecast model is a decision support system for timing potato early blight and late blight fungicide applications. The promotional literature states that the model functions by "predicting early and late blight infection events using advanced fungal life-cycle models and weather prediction models." The treatments necessary for comparison to the DACOM forecast model (treatment 1: nontreated check, treatment 18: grower standard schedule initiated when early blight lesions first appeared in the field, and treatment 19: DACOM forecast schedule) were replicated among 16 additional fungicide programs for early blight and late blight disease suppression. Fungicide applications for the 16 additional programs were initiated on 20 July (prior to inoculation) and all subsequent application dates are indicated in the Tables. Treatments 7-11 and 15-17 were made at a 14-day application interval, while treatments 2-6 and 12-14 were made at 7-day application intervals. All applications were made 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 and other Treatment Evaluations	Early blight disease severity was measured by counting lesions on foliage and then calculating the average number of lesions per leaflet for leaves collected on 20, 27 July; 3, 10, 17, 24, 31 August; and 7, 15 September. Six leaves were randomly selected from each treatment plot (two leaves each from the top, middle, and bottom third of the canopy) and the number of early blight lesions present on up to seven leaflets from each leaf were counted. Disease severity data from 3 August to 15 September were used to calculate the 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 15 September. A portion of the data is summarized in the Tables.
Harvest	Two rows by 10 ft were dug with a two-row mechanical digger on 22 September. Tubers were sorted and weighed to determine yield and grade on 26 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 to compare 7-day and 14-day spray programs ($P \leq 0.05$).

Results and Discussion

General: This was the first year of potato cultivation at SAREC, located near Lingle, Wyoming. Early blight disease development was moderate following inoculation. Lesions became more numerous in inoculated buffer rows and the first lesions were detected in the general plot area by 8 August. It is not known to what extent natural inoculum contributed to disease development. Despite having conditions favorable for late blight development in the region, late blight was not detected in the research plots nor was late blight found in any nearby fields. Phytotoxicity was not observed for any of the fungicide treatment programs. Potato psyllids were present in the plot area and caused some visible crop injury (psyllid yellows).

Disease severity data (the average number of early blight lesions per leaflet) collected on 17 August was the first data set that revealed significant differences among treatments (Table 1, $P \leq 0.05$). Ratings done prior to this date failed to reveal significant differences ($P \leq 0.05$). Data from leaves collected on 31 August revealed that all fungicide treatments except treatment 11 significantly reduced disease severity compared to the nontreated check (Table 1, $P \leq 0.05$). All fungicide programs significantly reduced the season-long AUDPC value compared to the nontreated check ($P \leq 0.05$). In general, fungicide programs made at 14-day application intervals were less effective as a group compared to the group of fungicide programs made at 7-day application intervals (linear contrast, $P \leq 0.05$). However, treatments 9, 16, and 17 were made at 14-day application intervals and were statistically equivalent to the most effective programs made at 7-day application intervals ($P \leq 0.05$).

Fungicide treatment effects on potato yield and quality are shown in Table 2. Both total yield and tuber quality were not affected by treatment (P=0.05). Lack of treatment effect is at least partially due to the late onset of early blight during in 2005. The proportion of total yield in each tuber quality category also was analyzed and found to be not significant (*P*=0.05).

DACOM: Treatments for comparison to the DACOM PLANT-Plus^{TM} decision support system (treatment 19: DACOM forecast schedule) were treatment 1 (non-treated check) and treatment 18 (grower standard schedule). The grower standard schedule (treatment 18) was initiated on 8 August when the early blight lesions were first detected in the plot area and subsequent applications were made on 18 August, 24 August, and 1 September (i.e., applications at 6 to 10 day intervals), for a total of four applications. The DACOM forecast schedule (treatment 19) indicated the need for fungicide applications on 5 July and 28 July, because conditions were favorable for late blight. The single fungicide application (Amistar) for early blight suppression was indicated by the model on 11 August. Disease severity estimates for treatments 18 and 19 were significantly less than that of the nontreated check for most evaluation dates ($P \leq 0.05$). The season-long disease severity (AUDPC) was reduced 62 percent by the grower standard and 47 percent by the DACOM model forecast schedule compared to the nontreated control which received no fungicide. Differences between the two fungicide programs were not significant ($P \leq 0.05$). As stated above, potato yields were not affected by treatment (*P*=0.05).

The annual review output available via the DACOM software is included in this report. This review indicates for the DACOM model forecast plots that a "large infection risk" (value 327) for early blight was not treated and that this specific event occurred between 10 August 8 PM and 11 August 7 AM. However, the hardcopy records from the growing season indicate that the advice module was accessed on:

8/10/05 at 11:31 AM with "treatment not needed" as the advice generated for both early and late blight.

8/10/05 at 1:44 PM with "treatment not needed" as the advice generated for both early and late blight.

8/11/05 at 11:54 AM with advice that stated "application of a systemic fungicide or application of a translaminar fungicide to be considered" based on D (7/27-8/10 4PM) = 80, C (8/10 4 PM to 8/11 1 AM) = 89, and B (8/11 1 AM to 8/11 7 AM) = 132 and A (8/11 7 AM to 8/12 11 PM) = 0, and A+ = 0. As a result of the "consider application" recommendation, Amistar was applied on 8/11/05 at noon. The total value at that time was 301 and this total had accumulated since the last spray application which was made on 7/28.

In summary, the annual review implies that during the ca. 22 hr period that elapsed between access on 8/10 at 1:44 PM and 8/11 at 11:54 AM, that an important early blight infection risk event occurred and that this event was not treated. However, this risk event did not appear in the model output during the growing season and is not in the hardcopy record. Therefore, there was no indication that an important risk event occurred in the DACOM model forecast plot during the growing season until at the time the annual review was printed. The risk event was to have occurred between "10 Aug 8PM and 11 Aug 7AM." Although the DACOM forecast plots were treated (Amistar) on 11 August (at noon), a minimum of 5 hr to a maximum of 16 hr after this event, the plot was considered to have not been treated in the annual review.

This apparent discrepancy was explained (paraphrased here) by DACOM officials (Harm Germs, email 10/31/05) to have probably resulted from the fact that during the growing season slight modifications were made in the early blight model for the crop stage portion. This change affected the model output, and resulted in a lower crop stage value having a greater effect on the modified model compared to when the forecasts were made during the growing season using the original model. Although Amistar was applied in a timely manner according to the forecast during the growing season, the annual review statement was based on the assumption that, since Amistar is considered to only have contact activity, the application on 11 August (noon) would have been made too late to stop the infection that occurred during the risk event.

In summary, the DACOM forecast model offers potential as a decision aid because it attempts to provide fungicide scheduling information during the growing season after early blight disease has been initiated. In contrast, local early blight suppression recommendations are to initiate fungicide applications based on when the first early blight lesions are detected and to eliminate applications late in the season if disease pressure is low and the crop is substantially bulked (and in the absence of late blight risk). Spore trapping data has revealed that the appearance of the first early blight lesions in the crop coincides with secondary spread of the fungus, which is the time when leaves need to be protected. Spore trap slides were collected near the DACOM plots in 2005. These slides have not yet been evaluated for the presence of spores. Once collected, data from spore trap slides can be compared to the DACOM model's prediction of sporulation events. This comparison should offer further insight into the accuracy and utility of the DACOM model. It is the opinion of this researcher that the ability of spores to persist on leaf surfaces and to have multiple germination (and infection) events needs to be re-considered in the model.

Table 1. Effects of foliar fungicide programs on potato early blight disease severity (G.D. Franc and W.L. Stump, Univ. of WY; 2005)

Treatment and rate (product/A)	Application dates[1]	Early blight lesions per leaflet					AUDPC[2]	% necrosis
		17 Aug	24 Aug	31 Aug	7 Sep	15 Sep		15 Sep
1. Nontreated check	NA	0.06 bc[3]	1.78 a	6.19 a	12.67 a	13.70 a	206.0 a	50.0 a
2. DPX-JE874-426 5SC (2.4 fl oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.15 bc	0.80 a	1.15 d	1.68 d-g	4.76 bcd	46.5 efg	8.5 d
2. Manzate Pro-Stick 75DF (1.5 lb)	C, F, H							
3. DPX-JE874-425 0.82SC (15 fl oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.00 c	0.36 a	0.67 d	1.33 efg	2.16 d	25.9 g	7.3 d
3. Manzate Pro-Stick 75DF (1.5 lb)	C, F, H							
4. DPX-JE874-425 0.82SC (7.5 fl oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.01 c	0.07 a	0.91 d	1.97 d-g	4.23 cd	38.7 fg	10.3 cd
4. Manzate Pro-Stick 75DF (1.5 lb)	C, F							
5. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I	0.01 c	0.08 a	1.14 d	0.67 g	3.26 cd	26.7 g	8.5 d
5. Manzate Pro-Stick 75DF (1.5 lb)	C, F, H							
6. Manzate Pro-Stick 75DF (2 lb)	B, C, D, F-I	0.02 c	1.30 a	1.57 bcd	2.66 c-g	5.17 bcd	60.9 d-g	8.5 d
7. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B	0.01 c	0.28 a	3.07 bc	3.98 bcd	6.05 bc	77.5 cde	17.0 bc
7. Manzate Pro-Stick 75DF (2 lb)	D, G, I							
8. Manzate Pro-Stick 75DF (1.5 lb)	B, D, I	0.23 ab	2.63 a	2.02 bcd	3.67 b-e	5.09 bcd	82.0 b-e	10.3 cd
8. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	G							
9. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, G	0.18 abc	0.35 a	1.41 bcd	3.34 c-f	4.54 bcd	57.0 d-g	8.5 d
9. Manzate Pro-Stick 75DF (2 lb)	D, I							
10. Manzate Pro-Stick 75DF (1.5 lb)	B, G, I	0.10 bc	2.96 a	1.83 bcd	4.61 bc	5.52 bc	90.9 bcd	10.3 cd
10. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb).	D							
11. Manzate Pro-Stick 75DF (1.5 lb)	B, D, I	0.35 a	1.09 a	5.22 a	5.70 b	7.43 b	119.6 b	17.0 bc
11. Manzate Pro-Stick 75DF (1.5 lb) + Super Tin 80WP (2.5 oz)	G							
12. Dithane DF NT (2 lb)	B, C, D, F-I	0.01 c	0.30 a	2.20 bcd	2.74 c-g	4.92 bcd	58.2 d-g	12.0 cd
13. Echo Zn 4.17F (2.125 pt)	B, C, D, F-I	0.04 bc	0.17 a	1.26 cd	1.24 fg	2.25 d	28.7 g	7.3 d
14. Bravo Weather Stik (1.5 pt)	B, C, D, F-I	0.12 bc	0.08 a	0.76 d	1.51 efg	3.50 cd	32.2 g	10.3 cd

Table 1 cont.

Treatment and rate (product/A)	Application dates[1]	Early blight lesions per leaflet					AUDPC[2]	% necrosis 15 Sep
		17 Aug	24 Aug	31 Aug	7 Sep	15 Sep		
15. Headline 2.08EC (6 fl oz)...	B, G	0.11 bc[3]	0.36 a	2.16 bcd	4.42 bc	5.58 bc	73.8 c-f	12.0 cd
15. Bravo Weather Stik (1.5 pt)..	D, I							
16. Endura 70WP (2.5 oz)	B, G	0.01 c	0.11 a	1.31 cd	2.84 c-g	3.25 cd	44.3 efg	10.3 cd
16. Bravo Weather Stik (1.5 pt)..	D, I							
17. Headline 2.08EC (6 fl oz)...	B, I	0.07 bc	0.17 a	1.06 d	1.18 fg	3.87 cd	33.4 g	7.3 d
17. Endura 70WP (2.5 oz)	D							
17. Bravo Weather Stik (1.5 pt)..	G							
DACOM grower standard schedule								
18. Amistar 80WP (2 oz)..	E, I	0.12 bc	0.46 a	2.31 bcd	3.86 bcd	7.45 b	79.0 cde	12.0 cd
18. Bravo Weather Stik (1.5 pt)..	G, H							
DACOM forecast schedule								
19. Tanos 50WG (8 oz) + Bravo Weather Stik (1.5 pt).........	A	0.02 c	0.58 a	3.19 b	4.94 bc	11.28 a	109.8 bc	23.5 b
19. Tanos 50WG (8 oz)	C							
19. Amistar 80WP (2 oz)...	F							

1 The planting date was 10 May, 2005 with variety FL1867, and harvest was on 22 September. Fungicide application dates were: A= 5 Jul, B= 20 Jul, C= 28 Jul, D= 4 Aug, E= 8 Aug, F= 11 Aug, G= 18 Aug, H= 24 Aug, and I= 1 September. NA= not-applicable.

2 Area under the disease progress curve for data collected from 3 Aug through 15 September.

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 potato yield and quality (G.D. Franc and W.L. Stump, Univ. of WY; 2005)

Treatment and rate (product/A)	Application dates[1]	Potato yield (cwt/A)						
		US#1			US#2	Grade B	Cull	Total
		(>10 oz)	(<10 oz)	total				
1. Nontreated check	NA	58.1 a[2]	222.2 a	280.2 a	6.2 a	23.2 a	5.4 a	315.1 a
2. DPX-JE874-426 5SC (2.4 fl oz) + Manzate Pro-Stick 75DF (1.5 lb) 2. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	36.3 a	237.9 a	274.2 a	1.7 a	20.5 a	4.3 a	300.7 a
3. DPX-JE874-425 0.82SC (15 fl oz) + Manzate Pro-Stick 75DF (1.5 lb) 3. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	34.4 a	223.2 a	257.6 a	1.5 a	22.8 a	8.5 a	290.5 a
4. DPX-JE874-425 0.82SC (7.5 fl oz) + Manzate Pro-Stick 75DF (1.5 lb) 4. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F	43.7 a	230.0 a	273.7 a	0.5 a	19.6 a	4.4 a	298.3 a
5. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb) 5. Manzate Pro-Stick 75DF (1.5 lb)	B, D, G, I C, F, H	46.1 a	233.6 a	279.7 a	1.0 a	19.0 a	6.9 a	306.6 a
6. Manzate Pro-Stick 75DF (2 lb)	B, C, D, F-I	31.4 a	222.9 a	254.3 a	1.9 a	24.7 a	1.9 a	282.8 a
7. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb) 7. Manzate Pro-Stick 75DF (2 lb)	B D, G, I	33.0 a	237.4 a	270.4 a	4.6 a	26.0 a	6.3 a	309.6 a
8. Manzate Pro-Stick 75DF (1.5 lb) 8. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, D, I G	33.2 a	189.8 a	223.1 a	0.0 a	21.4 a	1.9 a	246.4 a
9. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb) 9. Manzate Pro-Stick 75DF (2 lb)	B, G D, I	36.8 a	236.0 a	272.8 a	1.7 a	19.3 a	6.3 a	300.1 a
10. Manzate Pro-Stick 75DF (1.5 lb) 10. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (1.5 lb)	B, G, I D	48.8 a	243.8 a	292.6 a	7.9 a	19.0 a	1.9 a	321.3 a
11. Manzate Pro-Stick 75DF (1.5 lb) 11. Manzate Pro-Stick 75DF (1.5 lb) + Super Tin 80WP (2.5 oz)	B, D, I G	35.0 a	246.1 a	281.1 a	3.0 a	22.8 a	9.6 a	316.5 a

Table 2 cont.

Treatment and rate (product/A)	Application dates[1]	Potato yield (cwt/A)						
		US#1			US#2	Grade B	Culls	Total
		(>10 oz)	(<10 oz)	total				
12. Dithane DF NT (2 lb)..	B, C, D, F-I	31.8 a[2]	240.5 a	272.3 a	1.4 a	20.3 a	4.0 a	297.9 a
13. Echo Zn 4.17F (2.125 pt)..	B, C, D, F-I	38.2 a	225.4 a	263.6 a	3.3 a	20.1 a	9.5 a	296.5 a
14. Bravo Weather Stik (1.5 pt)..	B, C, D, F-I	45.4 a	226.1 a	271.5 a	2.3 a	19.6 a	3.2 a	296.6 a
15. Headline 2.08EC (6 fl oz).. 15. Bravo Weather Stik (1.5 pt)..	B, G D, I	37.7 a	219.1 a	256.7 a	1.1 a	22.2 a	1.9 a	282.0 a
16. Endura 70WP (2.5 oz)... 16. Bravo Weather Stik (1.5 pt)..	B, G D, I	37.1 a	272.4 a	309.5 a	1.5 a	15.8 a	6.2 a	333.0 a
17. Headline 2.08EC (6 fl oz).. 17. Endura 70WP (2.5 oz)... 17. Bravo Weather Stik (1.5 pt)..	B, I D G	49.5 a	244.5 a	294.0 a	2.9 a	17.0 a	4.6 a	318.5 a
DACOM grower standard schedule 18. Amistar 80WP (2 oz)... 18. Bravo Weather Stik (1.5 pt)..	 E, I G, H	40.2 a	235.8 a	276.0 a	7.1 a	16.5 a	6.7 a	306.3 a
DACOM forecast schedule 19. Tanos 50WG (8 oz) + Bravo Weather Stik (1.5 pt)......... 19. Tanos 50WG (8 oz)... 19. Amistar 80WP (2 oz)...	 A C F	27.9 a	217.6 a	245.5 a	18.3 a	27.0 a	2.5 a	293.2 a

[1] The planting date was 10 May, 2005 with variety FL1867, and harvest was on 22 September. Fungicide application dates were: A= 5 Jul, B= 20 Jul, C= 28 Jul, D= 4 Aug, E= 8 Aug, F= 11 Aug, G= 18 Aug, H= 24 Aug, and I= 1 September. NA= not-applicable.

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

Appendix 1: Annual review output for "Field Test of the DACOM PLANT-Plus™ Decision Support System for Potato Early Blight and Late Blight Management at Lingle, WY, 2005 (G.D. Franc and W.L. Stump, University of Wyoming, 2005).

```
--- Dacom PLANT-Plus Advicemodule -------------------------------
      Crop                    :  Potato
      Disease                 :  Phytophthora infestans (late blight)
      Date advice calculation     :  10/31/05 / 03:22 pm
--- Crop data ----------------------------------------------------------------
      Farm                    :  University of Wyoming
      Field                   :  Lingle 2
      Crop reference + size       :  EB05 Grower Standard  0.1 acres
      Variety                 :  FL 1867
      Crop purpose            :  Industry/chips
      Weather data            :  USA WY Lingle
      Weather forecast        :  HWS USA Torrington WY
--- Year survey -------------------------------------------------------------
      # 08/08/05 12:00 pm AMISTAR 80WG     2.00 oz./a  contact ok
      ! 08/12/05 11:00 pm - 08/14/05 06:00 pm   96 small infection risk
not treated
      ! 08/15/05 12:00 am - 08/15/05 02:00 pm   68 small infection risk
not treated
      # 08/18/05 12:00 pm BRAVO WS        1.50 pts./a  contact
      # 08/24/05 12:00 pm BRAVO WS        1.50 pts./a  contact
      # 09/01/05 12:00 pm AMISTAR 80WG     2.00 oz./a  contact
```

```
--- Dacom PLANT-Plus Advicemodule -------------------------------
      Crop                    :  Potato
      Disease                 :  Phytophthora infestans (late blight)
      Date advice calculation     :  10/26/05 / 04:30 pm
--- Crop data ----------------------------------------------------------------
      Farm                    :  University of Wyoming
      Field                   :  Lingle 2
      Crop reference + size       :  EB05 Dacom  Forecast  0.1 acres
      Variety                 :  FL 1867
      Crop purpose            :  Industry/chips
      Weather data            :  USA WY Lingle
      Weather forecast        :  HWS USA Torrington WY
--- Year survey -------------------------------------------------------------
      # 07/05/05 12:00 pm TANOS           7.99 oz./a
                   BRAVO WS        1.50 pts./a  curative (ok) contact
      # 07/27/05 12:00 pm TANOS           7.99 oz./a  curative OK
contact ok
      # 08/11/05 12:00 pm AMISTAR 80WG     2.00 oz./a  contact OK
```

```
--- Dacom PLANT-Plus Advicemodule -------------------------------
      Crop                    :  Potato
      Disease                 :  Alternaria solani (early blight)
      Date advice calculation     :  10/31/05 / 03:23 pm
--- Crop data ----------------------------------------------------------------
      Farm                    :  University of Wyoming
      Field                   :  Lingle 2
      Crop reference + size       :  EB05 Grower Standard  0.1 acres
      Variety                 :  FL 1867
      Crop purpose            :  Industry/chips
      Weather data            :  USA WY Lingle
      Weather forecast        :  HWS USA Torrington WY
--- Year survey -------------------------------------------------------------
      ! 07/05/05 03:00 am - 07/05/05 09:00 am   55 small infection risk
not treated
      ! 07/25/05 08:00 pm - 07/26/05 02:00 pm   96 small infection risk
not treated
      ! 08/01/05 10:00 pm - 08/02/05 10:00 am   72 small infection risk
not treated
      ! 08/03/05 11:00 pm - 08/04/05 11:00 am   73 small infection risk
not treated
      ! 08/05/05 06:00 am - 08/05/05 11:00 am  240 large infection risk
not treated
      # 08/08/05 12:00 pm AMISTAR 80WG     2.00 oz./a  contact OK
      ! 08/13/05 10:00 am - 08/14/05 04:00 pm  180 small infection risk
not treated
      ! 08/15/05 03:00 am - 08/15/05 12:00 pm  101 small infection risk
not treated
      ! 08/16/05 05:00 am - 08/16/05 11:00 am   74 small infection risk
not treated
      # 08/18/05 12:00 pm BRAVO WS        1.50 pts./a  contact
      # 08/24/05 12:00 pm BRAVO WS        1.50 pts./a  contact
      # 09/01/05 12:00 pm AMISTAR 80WG     2.00 oz./a  contact
```

```
--- Dacom PLANT-Plus Advicemodule -------------------------------
      Crop                    :  Potato
      Disease                 :  Alternaria solani (early blight)
      Date advice calculation     :  10/26/05 / 04:31 pm
--- Crop data ----------------------------------------------------------------
      Farm                    :  University of Wyoming
      Field                   :  Lingle 2
      Crop reference + size       :  EB05 Dacom Forecast  0.1 acres
      Variety                 :  FL 1867
      Crop purpose            :  Industry/chips
      Weather data            :  USA WY Lingle
      Weather forecast        :  HWS USA Torrington WY
--- Year survey -------------------------------------------------------------
      # 07/05/05 12:00 pm TANOS           7.99 oz./a
                   BRAVO WS        1.50 pts./a  contact
      ! 07/25/05 08:00 pm - 07/26/05 02:00 pm  118 small infection risk
not treated
      # 07/27/05 12:00 pm TANOS           7.99 oz./a  contact
      ! 08/05/05 06:00 am - 08/05/05 11:00 am   96 small infection risk
not treated
      ! 08/10/05 08:00 pm - 08/11/05 07:00 am  374 large infection risk
not treated
      # 08/11/05 12:00 pm AMISTAR 80WG     2.00 oz./a  contact OK
      ! 08/18/05 09:00 pm - 08/19/05 11:00 am   73 small infection risk
not treated
```

Research Project	**Management of Potato Black Dot with Foliar Fungicide Programs (LaGrange, WY), 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Research plots were inserted into a commercial field near LaGrange, WY located at 4587 MSL: sandy loam soil; overhead irrigation
Plot Design	Randomized complete block design with four replications; plots were four rows (36-in row centers) X 20 ft with 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows. Research plots were marked out of the commercially planted field in a uniform portion of the field.
Plot Management	**Planting Date:** 12 May, 2005 **Variety:** Russet Norkotah **Fertilizer:** 180 lb N + 100 lb K_2O + 180 lb P_2O_5 **Herbicide:** Dual II (1.5 pt product/A) + Sencor (1.0 pt product/A) pre-emerge. **Insecticide:** Insects were controlled as necessary using labeled rates; this included Thimet at hilling operations. Dimethoate (2 applications), and an aerial application of Asana (8 fl oz product/A). **Fungicide:** The treatments tested for black dot suppression were superimposed over the grower's fungicide program. Final details of the grower's program are not yet available, but were approximated as applications of Ridomil + Bravo WS on 15 June alternated with Dithane + SuperTin at 2 wk intervals until row closure. **Cropping History:** Field was previously in alfalfa. In mid-April the field was fumigated with Vapam (40 gal product/A) to manage Verticillium wilt.
Disease Development	No inoculations were made and all disease development was from natural sources. Early crop senescence (early dieing), due in part to a disease complex of early blight, Verticillium wilt and black dot, was apparent by mid-August.
Treatment Applications	Fungicide treatments consisted of spray programs initiated on 1 July and continued on a weekly basis for a total of 6 applications; all application dates are indicated in the Tables. Fungicide for all treatments was 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). All fungicide treatments were superimposed over the grower's fungicide program (see above).
Disease and other Treatment Evaluations	Black dot disease can contribute to an early potato crop decline. Therefore, crop vigor was evaluated on 14, 21, 28 July, 4, 11, 17, and 22 August. Vigor ratings include consideration of plant size, plant uniformity, color and overall appearance compared to the non-treated check and the non-treated buffer row of each plot. Ten stems per plot were randomly selected and rated for signs of black dot on 21 July, 4 and 7 August (data not shown). 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 11, 17, and 22 August. Early blight disease severity was measured by counting lesions on foliage and then calculating the average number of lesions per leaflet for leaves collected on 22 August. Six leaves were randomly selected from each treatment plot (two leaves each from the top, middle, and bottom third of the canopy) and the number of early blight lesions, on up to seven leaflets from each leaf were counted. Because it is difficult to objectively and quantitatively evaluate black dot in the field, 10 stems were randomly selected from individual plots on 22 August and assayed in the laboratory. Stems were washed with running tap water, surface disinfected by submersion in ca. 0.6% sodium hypochlorite for 30 seconds, rinsed with distilled water and allowed to air-dry. Stems were aseptically cut into 3 cross sectional disks, each approximately 1 cm thick. In order, the "top" disk was excised from the green portion of the stem ca. 2.5 cm above the soil line, the "middle" disk was excised from the stem at the soil line (transition of green to white on the stem), and the "bottom" disk was excised as closely to the intact stem tip as possible (where it attached to the seed tuber). Disks were placed on water agar plates (six disks; two stems per plate) for incubation for ca. two weeks at room temperature. Disks were viewed with the aid of a stereomicroscope for the presence of black dot acervuli/sclerotia with prominent setae present (signs). Black dot disease incidence was the number of stems with at least one disk developing black dot signs (10 = maximum incidence per plot) and disease severity was the number of disks per stem that developed black dot signs (top, middle, bottom disks; max rating = 3 per stem). The relevant data is presented in the Tables.
Harvest	Five hills were harvested by hand on 6 September. Tubers were sorted and weighed to estimate the yield and grade on 9 September. All yield data are summarized in Table 2.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

Black dot is caused by the fungus *Colletotrichum coccodes*. Black dot symptoms on tubers are frequently confused with silver scurf (*Helminthosporium solani*) and the black dot pathogen is often found in combination with early blight and wilt-type pathogens such as *Verticillium* in fields experiencing early vine senescence. The pathogen can infect stolons, stems below and above the soil line, as well as foliage. The relative economic impact of this pathogen is difficult to accurately measure due to its interaction with other pathogens, and comprehensive work on disease suppression has not yet been done. Properly placed fungicide applications should suppress various aspects of black dot disease development.

Early stand decline measured as crop vigor and crop necrosis was monitored over the season and results for relevant data are summarized in Table 1. By mid-August the field plot area began to decline as evidenced by foliar necrosis. Fungicide treatment effects were not evident for crop vigor or crop necrosis until 22 August ($P \leq 0.05$). By this date, most fungicide programs had maintained plant vigor and foliar necrosis was reduced compared to the nontreated check ($P \leq 0.05$). The Manzate Pro-stick program (treatment 5) and the early season Quadris application (treatment 7) were not significantly different from the nontreated check on any evaluation date (P=0.05).

Treatment effects for the black dot stem-disk assay are summarized in Table 2. The early season Quadris application (treatment 7) significantly reduced black dot incidence ($P \leq 0.05$). Also, the Super Tin/Manzate Pro-Stick program (treatment 6) and the early season Quadris application significantly reduced black dot disease severity ($P \leq 0.05$). All other fungicide programs except treatment 5 had the trend of reduced black dot incidence. Quadris (treatment 7) reductions of black dot disease severity and incidence were not correlated with plant vigor and foliar necrosis ratings, presumably because they were masked by early blight and Verticillium wilt. Foliar early blight was rated on 22 August and none of the treatments differed significantly (P=0.05). However, fungicide applications were concluded on 8 August and early blight pressure was moderate to severe by mid- to late-August. Although not rated directly in the stem assay, *Verticillium* microsclerotia were frequently observed growing on stem disks.

Treatment effects on potato yield and quality are summarized in Table 3. Total tuber yield and tuber quality was not affected by treatment (P=0.05). However the data did reflect a trend that fungicide treatments resulted in a greater total tuber yield and greater marketable tuber yield compared to the nontreated check.

Table 1. Effects of foliar fungicide programs on stand senescence as measured by plant vigor and foliar necrosis (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	Plant vigor (nontreated check = 5)				Foliar necrosis (%)		
		4 Aug	11 Aug	17 Aug	22 Aug	11 Aug	17 Aug	22 Aug
1. Nontreated check	NA	5.0 a	5.0 a	5.0 a	5.0 b	10.3 a	38.1 a	50.0 ab
2. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (2 lbs) 2. Manzate Pro-Stick 75DF (2 lbs)	A, C, E B, D, F	4.8 a	5.5 a	5.1 a	5.8 a	6.0 a	20.6 bcd	23.5 cd
3. Tanos 50WG (8 oz) + Manzate Pro-Stick 75DF (2 lbs) 3. Manzate Pro-Stick 75DF (2 lbs)	A, C, E B, D, F	4.8 a	5.0 a	5.6 a	5.8 a	4.8 a	14.5 d	20.3 d
4. Tanos 50WG (6 oz) + Super Tin 80WP (3.75 oz) 4. Manzate Pro-Stick 75DF (2 lbs)	A, C, E B, D, F	5.0 a	5.0 a	5.5 a	6.0 a	8.5 a	27.3 abc	27.3 cd
5. Manzate Pro-Stick 75DF (2 lbs)	A-F	5.0 a	4.8 a	5.3 a	5.0 b	10.3 a	31.0 ab	55.0 a
6. Super Tin 80WP (3.75 oz) + Manzate Pro-Stick 75DF (2 lbs)	A-F	5.3 a	5.0 a	5.9 a	5.8 a	4.8 a	17.0 cd	20.3 d
7. Quadris 2.08SC (15.4 fl oz)	A	5.0 a	5.0 a	5.4 a	5.5 ab	10.3 a	27.3 abc	36.0 bc

[1] The planting date was 12 May, 2005 with variety Russet Norkotah, and harvest was on 6 September. Fungicide application dates were: A= 1 July, B= 7 July, C= 14 July, D= 21 July, E= 28 July, F= 8 August, and NA= not-applicable.

[2] 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 early blight and black dot disease incidence and severity (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	Early blight lesions per leaflet	Black dot disease assay utilizing stem disks (22 Aug collection) [2]	
		22 Aug	Incidence (10 max)	Ave severity (3 max)
1. Nontreated check..	NA	11.54 a[3]	9.25 a	1.93 a
2. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (2 lbs)..	A, C, E	5.78 a	7.75 a	1.53 ab
2. Manzate Pro-Stick 75DF (2 lbs)	B, D, F			
3. Tanos 50WG (8 oz) + Manzate Pro-Stick 75DF (2 lbs)..	A, C, E	7.68 a	8.75 a	1.50 ab
3. Manzate Pro-Stick 75DF (2 lbs)	B, D, F			
4. Tanos 50WG (6 oz) + Super Tin 80WP (3.75 oz)..	A, C, E	4.76 a	8.25 a	1.40 ab
4. Manzate Pro-Stick 75DF (2 lbs)	B, D, F			
5. Manzate Pro-Stick 75DF (2 lbs)	A-F	6.96 a	9.75 a	1.75 ab
6. Super Tin 80WP (3.75 oz) + Manzate Pro-Stick 75DF (2 lbs)..	A-F	4.69 a	7.00 ab	1.15 b
7. Quadris 2.08SC (15.4 fl oz)	A	8.59 a	4.25 b	0.53 c

1 The planting date was 12 May, 2005 with variety Russet Norkotah, and harvest was on 6 September. Fungicide application dates were: A= 1 July, B= 7 July, C= 14 July, D= 21 July, E= 28 July, F= 8 August, and NA= not-applicable.

2 Ten stems per plot were randomly selected and assayed on water agar. Each individual stem was cut into 3 disks (top, middle and bottom). Disease incidence and severity was a measure of black dot sign development after incubation for ca. 2 wks. See the text for details.

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

Table 3. Effects of foliar fungicide programs on potato tuber yield and tuber quality (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	Potato yield (cwt/A)[2]						
		US#1			US#2	Grade B	Cull	Total
		(>10 oz)	(<10 oz)	total				
1. Nontreated check	NA	0.0 a[3]	217.6 a	217.0 a	18.8 a	62.3 a	0.0 a	298.7 a
2. Tanos 50WG (6 oz) + Manzate Pro-Stick 75DF (2 lbs) 2. Manzate Pro-Stick 75DF (2 lbs)	A, C, E B, D, F	41.4 a	262.9 a	304.3 a	9.2 a	49.2 a	0.0 a	362.7 a
3. Tanos 50WG (8 oz) + Manzate Pro-Stick 75DF (2 lbs) 3. Manzate Pro-Stick 75DF (2 lbs)	A, C, E B, D, F	34.5 a	262.9 a	297.5 a	9.1 a	55.7 a	0.0 a	362.1 a
4. Tanos 50WG (6 oz) + Super Tin 80WP (3.75 oz) 4. Manzate Pro-Stick 75DF (2 lbs)	A, C, E B, D, F	11.1 a	250.1 a	261.2 a	15.9 a	67.8 a	0.0 a	344.9 a
5. Manzate Pro-Stick 75DF (2 lbs)	A-F	40.4 a	208.2 a	248.5 a	11.7 a	62.4 a	0.0 a	322.6 a
6. Super Tin 80WP (3.75 oz) + Manzate Pro-Stick 75DF (2 lbs)	A-F	15.0 a	265.7 a	280.7 a	23.2 a	58.1 a	13.3 a	375.2 a
7. Quadris 2.08SC (15.4 fl oz)	A	41.6 a	281.8 a	323.4 a	8.5 a	43.5 a	0.0 a	375.4 a

[1] The planting date was 12 May, 2005 with variety Russet Norkotah, and harvest was on 6 September. Fungicide application dates were: A= 1 July, B= 7 July, C= 14 July, D= 21 July, E= 28 July, F= 8 August, and NA= not-applicable.

[2] Potato yields were based on the measured yield of 5 hills on 36-inch centers.

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

Research Project	**Management of Potato Insects with Seed Piece, In-Furrow, and Lay-by Insecticide Treatments, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences Dept-3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY; 4165 MSL: Mitchell clay loam soil, pH = 7.9; overhead irrigation.
Plot Design	Randomized complete block design with four replications; plots were four rows (36-in row centers) X 20 ft with 5 ft in-row buffer. All treatments were made to, and all data were collected from, the center two rows. Treatments required hand-cut seed and were planted by hand (12 inch in-row spacing) into an open furrow. After planting and treatment application these furrows were covered with a finishing disk.
Plot Management	**Planting Date:** 10 May, 2005 **Variety:** FL1867 **Fertilizer:** 140 lb N + 50 lb P_2O_5 **Herbicide:** Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A) on 18 May. Herbicides were water (irrigation) incorporated on 19 May.
Treatment Applications	The **seed piece** treatment was applied to freshly hand-cut seed on 9 May. Seed pieces (2-3 oz size) were sprayed with a hand-mister at a rate of 4 fl oz of water carrier per 100 lbs of seed. The **in-furrow** treatment was applied at planting on 10 May. Application was made in a 7-inch band directed over seed pieces already placed in an open furrow. Following application, all hand-planted furrows (40 seed pieces per treatment plot) were closed with a tractor-mounted finishing disc. After 95% crop emergence, the **lay-by** treatment was applied to the base of the plants on 21 June. Both the in-furrow and lay-by treatments were applied with the aid of a portable CO_2 sprayer with a boom equipped with a single #8002 flat fan nozzle. The total volume applied was 1.06 gal of carrier per 1000 row-ft at 45 psi boom pressure.
Potato Development	To determine if the seed piece or the in-furrow treatments had an effect on crop emergence, potato stands were determined on 3, 9, 16, and 21 June, and an area under the emergence progress curve (AUEPC) was calculated for treatments 1-3.
Insect Development	All insect population development relied on natural infestations. The buffer rows were left untreated to provide for greater pest pressure.
Insect Treatment Evaluations	Sweep net counts were conducted on 30 June, 7, 13, 21, 28 July, and 1, 17 August (4 sweeps along length of the plot). A portion of the data is shown in the Tables. Flea beetle and leaf hoppers were not separated out by the various species. Psyllid nymph populations were determined on the above dates by selecting 10 lower leaves at random from each plot and counting the number of pysllid nymphs.

Harvest	Potato yields were not determined.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

The potato seed piece and in-furrow insecticide treatment effects on crop emergence and final stand are summarized in Table 1. These treatments had no significant effect on emergence compared to the nontreated check (P=0.05). No phytotoxicity was observed in the treatment plots.

Insect pest pressure was light during the early season. Colorado potato beetles were occasionally observed in the plots (data not shown). Potato psyllid nymph and flea beetle numbers were low to moderate in 2005, with psyllid yellows (foliar toxicity attributed to feeding of psyllid nymphs) observed in the plots by late August. Psyllid nymphs were first observed on 13 July on plants growing in the field margins.

Treatment effects on psyllid nymph populations are summarized in Table 2. There were no significant treatment effects on psyllid populations from mid-July to mid August (P=0.05). However, weak trends revealed that mid-August psyllid nymph populations remained reduced for the seed piece, in-furrow and lay-by insecticide treatments compared to the nontreated check. Psyllid nymphs are notoriously difficult to control.

The effects of insecticide treatment on flea beetle populations are summarized in Table 3. Treatments had no significant effect on flea beetle populations at all evaluation dates (P=0.05). Data trends for 1 August revealed that the insecticide treatments had greater flea beetle populations compared to the nontreated check (P=0.05). Perhaps this trend indicates that these early treatments suppressed a flea beetle antagonist.

The effects of insecticide treatment on leaf hopper populations are summarized in Table 4. No treatments had an effect on leaf hopper populations on any of the evaluation dates compared to the nontreated checks (P=0.05).

Table 1. Effects of potato insecticide treatments on potato emergence (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and (rate) [1]	Application type, timing[2]	Potato stands (40 row ft)				
		3 June	9 June	16 June	21 June	AUEPC[3]
1. Nontreated check...	NA	14.5 a[4]	34.8 a	39.5 a	39.3 a	791.3 a
2. Cruiser 5SC (0.14 fl oz per 100 lb seed).........	Seed piece, A	10.3 a	32.3 a	39.0 a	39.5 a	737.1 a
3. Platinum 2SC (0.55 fl oz/1000 row ft)...........	In-furrow, B	13.0 a	34.3 a	39.5 a	39.5 a	777.1 a
4. Platinum 2SC (0.55 fl oz/1000 row ft)..........	Lay-by, C	NA	NA	NA	NA	NA

1 Treatments were planted into open furrows with hand-cut seed and then covered with a finishing disk. Seed pieces were cut on 9 May and all plots were planted on 10 May, 2005 with cultivar FL1867.

2 Timing A= 9 May, B= 10 May, C= 21 June, and NA= not applicable.

3 Area under the emergence progress curve for data collected from 3 through 21 June. Both the number and speed of emergence contribute to increased values.

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

Table 2. Effects of potato insecticide treatments on potato psyllid nymph populations (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and (rate) [1]	Application type, timing[2]	No. potato psyllid nymphs per 10 leaves				
		13 July	21 July	28 July	1 Aug	17 Aug
1. Nontreated check...	NA	0.0 a[3]	0.0 a	0.0 a	1.8 a	2.3 a
2. Cruiser 5SC (0.14 fl oz per 100 lb seed).........	Seed piece, A	0.0 a	0.5 a	0.3 a	0.0 a	0.5 a
3. Platinum 2SC (0.55 fl oz/1000 row ft)...........	In-furrow, B	0.0 a	0.0 a	0.0 a	0.3 a	0.8 a
4. Platinum 2SC (0.55 fl oz/1000 row ft)..........	Lay-by, C	0.0 a	0.5 a	0.5 a	0.0 a	0.3 a

1 Treatments were planted into open furrows with hand-cut seed and then covered with a finishing disk. Seed pieces were cut on 9 May and all plots were planted on 10 May, 2005 with cultivar FL1867.

2 Timing A= 9 May, B= 10 May, C= 21 June, and NA= not applicable.

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

Table 3. Effects of potato insecticide treatments on flea beetle populations (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and (rate) [1]	Application type, timing[2]	No. flea beetles per 4 sweep net sampling					
		30 Jun	7 Jul	13 Jul	21 Jul	28 Jul	1 Aug
1. Nontreated check.....................................	NA	1.3 a[3]	0.3 a	0.5 a	0.8 a	5.0 a	2.5 a
2. Cruiser 5SC (0.14 fl oz per 100 lb seed)..	Seed piece, A	0.3 a	0.0 a	0.0 a	0.0 a	5.5 a	4.5 a
3. Platinum 2SC (0.55 fl oz/1000 row ft).....	In-furrow, B	0.0 a	0.3 a	0.0 a	0.3 a	7.5 a	4.8 a
4. Platinum 2SC (0.55 fl oz/1000 row ft)....	Lay-by, C	0.0 a	0.0 a	0.5 a	0.8 a	8.0 a	5.0 a

1 Treatments were planted into open furrows with hand-cut seed and then covered with a finishing disk. Seed pieces were cut on 9 May and all plots were planted on 10 May, 2005 with cultivar FL1867.

2 Timing A= 9 May, B= 10 May, C= 21 June, and NA= not applicable.

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

Table 4. Effects of potato insecticide treatments on leaf hopper populations (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and (rate) [1]	Application type, timing[2]	No. leaf hoppers per 4 sweep net sampling		
		21 July	28 July	1 August
1. Nontreated check..	NA	1.5 a[3]	1.8 a	0.3 a
2. Cruiser 5SC (0.14 fl oz per 100 lb seed)......	Seed piece, A	0.8 a	0.8 a	0.5 a
3. Platinum 2SC (0.55 fl oz/1000 row ft).........	In-furrow, B	1.3 a	0.5 a	0.3 a
4. Platinum 2SC (0.55 fl oz/1000 row ft)........	Lay-by, C	2.3 a	0.3 a	1.0 a

[1] Treatments were planted into open furrows with hand-cut seed and then covered with a finishing disk. Seed pieces were cut on 9 May and all plots were planted on 10 May, 2005 with cultivar FL1867.

[2] Timing A= 9 May, B= 10 May, C= 21 June, and NA= not applicable.

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

Research Project	**Potato Vine Desiccation Efficacy when Tank-Mixed with Fungicide (Lingle, WY), 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY 4165 MSL: Mitchell clay loam soil, pH = 7.9; overhead irrigation
Plot Design	Randomized complete block design with four replications; plots were four rows (36-in row centers) X 20 ft with 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, 2005 **Variety:** FL1867 **Fertilizer:** 140 lb N + 50 lb P_2O_5 **Herbicide:** Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A) on 18 May. Herbicides were water (irrigation) incorporated on 19 May. **Insecticide:** Aerial application of Asana (8 fl oz product/A) on 3 August for potato pysllid.
Treatment Applications	Vine desiccation/fungicide treatments were made on 26 August. The crop at that time was still relatively green and vigorous and about 50% lodged. Environmental conditions at the time of treatment applications (noon) were an air temperature of 81 F, cloud free and with good soil moisture. Pysllid yellows was visible and early blight lesions were present in the research plot area. Treatments 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). Fungicides for treatments 3 and 4 were added to the desiccant (tank-mixed) immediately prior to treatment application. Gramoxone (paraquat) was included as a vine desiccation standard comparison.
Desiccation Treatment Evaluations	Vine desiccation was estimated by visually rating vines for the percentage of foliar and stem necrosis using the Horsfall-Barratt scale (0-11). Foliar and stem necrosis was rated on 29, 31 August, 7, and 15 September. For an overall measure of necrosis, an area under the desiccation progress curve (AUDePC) was calculated for both foliar and stem necrosis ratings. [An arbitrary value of “0” (no desiccation) was assigned to all plots for 28 August for calculation of the AUDePC.] Any lack of necrosis (green tissue remaining) increases the potential for tuber skinning (lack of skin set) and post-harvest disease development, and also represents potential sites for infection by the late blight fungus, as well as late season feeding sites for viruliferous aphids.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher’s protected LSD ($P \leq 0.05$).

Results and Discussion

All treatments increased foliar and stem necrosis (desiccation) compared to the nontreated control (Tables 1 and 2; $P \leq 0.05$). For both foliar and stem desiccation activity, tank-mixing Reglone (desiccant) with either fungicide had no effect on efficacy compared to Reglone applied alone (treatment 2; P=0.05). For stem necrosis ratings, Reglone tank-mixed with Kocide (treatment 3) had greater necrosis (AUDePC) compared to Reglone/Super Tin tank-mix (treatment 4; $P \leq 0.05$). The Gramoxone (paraquat) standard resulted in the most rapid desiccation and had the greatest AUDePC compared to all other treatments ($P \leq 0.05$). Therefore, tank mixes of Reglone with these fungicides did not exhibit reduced desiccant activity, and should provide added protection from late blight as vines decline in preparation for harvest.

Table 1. Effects of desiccant efficacy when tank-mixed with fungicides on foliar necrosis (G.D. Franc and W.L. Stump, Univ. of WY; 2005)

Treatment and rate (product/A)[1]	% foliage necrotic				AUDePC[2]
	29 Aug	31 Aug	7 Sep	15 Sep	
1. Nontreated check	0.0 b[3]	0.0 b	1.0 b	17.0 b	17.8 b
2. Reglone 3.73SC (2 pt) + X77	59.5 a	59.5 a	59.5 a	76.5 a	109.0 a
3. Reglone 3.73SC (2 pt) + X77 + Kocide 4.5LF	59.5 a	59.5 a	59.5 a	72.8 a	108.0 a
4. Reglone 3.73SC (2 pt) + X77 + Super Tin 80WP (3.75 oz)	59.5 a	59.5 a	59.5 a	79.8 a	110.0 a
5. Gramoxone 3SC (1.3 pt) + X77	59.5 a	59.5 a	64.0 a	76.5 a	110.9 a

[1] Treatments were applied on 26 August. Use rate of X77 was 0.125% volume:volume. For treatments 3 and 4, fungicide was added to the Reglone spray solution immediately prior to application.

[2] Area under the (foliar) desiccation progress curve. Delayed foliar desiccation rates and/or decreased total necrosis will contribute to a lower AUDePC.

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

Table 2. Effects of desiccant efficacy when tank-mixed with fungicides on stem necrosis (G.D. Franc and W.L. Stump, Univ. of WY; 2005)

Treatment and rate (product/A)[1]	% stems necrotic				AUDePC[2]
	29 Aug	31 Aug	7 Sep	15 Sep	
1. Nontreated check	0.0 a[3]	0.0 c	0.0 b	1.5 c	3.0 d
2. Reglone 3.73SC (2 pt) + X77	0.0 a	23.5 b	40.5 a	50.0 ab	77.5 bc
3. Reglone 3.73SC (2 pt) + X77 + Kocide 4.5LF	0.0 a	27.3 b	40.5 a	50.0 ab	78.6 b
4. Reglone 3.73SC (2 pt) + X77 + Super Tin 80WP (3.75 oz)	0.0 a	23.5 b	36.0 a	45.0 b	74.6 c
5. Gramoxone 3SC (1.3 pt) + X77	0.0 a	36.0 a	40.5 a	59.5 a	82.9 a

[1] Treatments were applied on 26 August. Use rate of X77 was 0.125% volume:volume. For treatments 3 and 4, fungicide was added to the Reglone spray solution immediately prior to application.

[2] Area under the (stem) desiccation progress curve. Delayed stem desiccation rates and/or decreased total necrosis will contribute to a lower AUDePC.

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

Research Project	**Russet Norkotah Potato Clone Performance Trial; Wyoming Results, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071 Gary Leever Potato Certification Association of Nebraska P.O. Box 339 Alliance, NE 69301-0339
Field Plot Details	Plots were located at the Sustainable Agricultural Research & Extension Center (SAREC) near Lingle, WY; 4165 MSL: Mitchell clay loam soil, pH = 7.9; overhead irrigation.
Plot Design	Randomized complete block design with three replications; plots were one row (36-in row centers) X 15 ft long (15 plants seed pieces per plot).
Plot Management	**Planting Date:** 26 May, 2005 **Variety:** FL1867 **Fertilizer:** 150 lb N + 80 lb P_2O_5 + 20 lb S. **Herbicide:** Pre-emergence application of Dual II (1.33 pt product/A) + Prowl 3.3EC (1.5 pt product/A) on 30 May. **Insecticide:** Lay-by application of Platinum (0.55 fl oz product/1000 ft) on 21 June. Aerial application of Asana (8 fl oz product/A) on 3 August for potato pysllid.
Potato Development	Potato stands were determined on 9, 16, 21, 30 June, and 5 July. An area under the emergence curve (AUEPC) was also calculated using this data. Emergence data are summarized in Table 1.
Harvest	The center 10 feet of each plot was harvested with a one-row mechanical digger on 22 September. Tubers were sorted and weighed to determine yield and grade categories on 26 September. All yield and tuber quality data are summarized in Table 2.
Statistical Analysis	ANOVA with three replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$). Replicated data can be found in the Appendix 1.

Results and Discussion

Potato stand averages and the rate of plant emergence (AUEPC) for the various Russet Norkotah clones are summarized in Table 1. Plots were planted on 26 May, plant emergence started in most plots by 16 June, the average plant emergence was approximately 75 percent by 21 June, and final stand counts were collected on 5 July. There were no significant differences observed among the clones for any of the data collected (P=0.05). Total yields and yields of each tuber class are summarized in Table 2. There were no significant differences among clones for tuber yield or tuber quality (P=0.05).

Table 1. Emergence and final plant stand comparisons among Russet Norkotah clones at Lingle, Wyoming (G.D. Franc and W.L. Stump, Univ. of WY & G. Leever, PCAN, 2005).

Russet Norkotah Clone	Potato stand averages (per 15 row ft and 3 replications) 15 plants = 100% emergence					AUEPC[1]
	9 June	16 June	21 June	30 June	5 July	
1. Nebraska LT	0.0 a[2]	1.0 a	13.3 a	15.0 a	15.0 a	228.5 a
2. Nebraska LW	0.0 a	4.0 a	15.0 a	15.0 a	15.0 a	264.5 a
3. Nebraska LS-2	0.0 a	1.7 a	13.3 a	15.0 a	15.0 a	232.5 a
4. Nebraska LS-1	0.0 a	1.7 a	11.0 a	14.3 a	14.3 a	212.2 a
5. Nebraska LS-3	0.0 a	2.3 a	13.7 a	14.3 a	15.0 a	234.2 a
6. Texas 278	0.0 a	3.3 a	12.7 a	14.0 a	14.3 a	230.0 a
7. Texas 223	0.0 a	2.0 a	14.3 a	14.7 a	14.7 a	237.3 a
8. Texas 112	0.0 a	2.0 a	13.7 a	14.3 a	14.3 a	230.2 a
9. Colorado #8	0.0 a	2.7 a	12.7 a	14.3 a	14.7 a	229.2 a
10. Colorado #3	0.0 a	2.7 a	14.7 a	14.3 a	14.7 a	241.2 a
11. Regular from Thompson source	0.0 a	1.7 a	13.3 a	15.0 a	15.0 a	232.5 a
12. Regular from Schekall source	0.0 a	2.0 a	12.3 a	15.0 a	15.0 a	228.5 a

1 Plots were planted on 26 May, 2005. An area under the emergence progress curve was calculated for data collected from 9 June through 5 July. Both the total number and speed of emergence contribute to increased AUEPC values.

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

Table 2. Tuber yield and tuber quality comparisons among Russet Norkotah clones at Lingle, Wyoming (G.D. Franc and W.L. Stump, Univ. of WY & G. Leever, PCAN, 2005).

Russet Norkotah Clone	Potato yield (cwt/A)						
	US # 1						
	(>10 oz)	(<10 oz)	total	US#2	Grade B	Culls	Total
1. Nebraska LT	6.5 a[1]	110.8 a	117.3 a	3.9 a	52.3 a	9.7 a	183.2 a
2. Nebraska LW	15.2 a	131.2 a	146.4 a	23.2 a	59.1 a	4.6 a	233.3 a
3. Nebraska LS-2	34.8 a	140.4 a	175.2 a	15.5 a	51.5 a	3.1 a	245.4 a
4. Nebraska LS-1	15.5 a	111.3 a	126.8 a	9.9 a	41.4 a	5.8 a	183.9 a
5. Nebraska LS-3	9.4 a	123.9 a	133.3 a	4.8 a	41.9 a	4.4 a	184.4 a
6. Texas 278	40.9 a	147.1 a	188.0 a	14.8 a	44.8 a	8.0 a	255.6 a
7. Texas 223	25.9 a	118.1 a	144.0 a	10.2 a	51.5 a	16.0 a	221.7 a
8. Texas 112	6.1 a	89.1 a	95.2 a	6.5 a	33.4 a	5.6 a	140.6 a
9. Colorado #8	26.6 a	116.2 a	142.8 a	8.7 a	43.3 a	5.6 a	200.4 a
10. Colorado #3	28.6 a	120.5 a	149.1 a	15.0 a	46.8 a	3.9 a	214.7 a
11. Regular from Thompson source	26.6 a	143.3 a	169.9 a	11.9 a	37.8 a	8.0 a	227.5 a
12. Regular from Schekall source	34.1 a	113.7 a	147.8 a	5.8 a	40.9 a	7.7 a	202.3 a

[1] Plots were planted on 26 May, 2005. 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, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY 4165 MSL: Mitchell clay loam soil, pH = 7.9; overhead irrigation
Plot Design	Randomized complete block design with four replications; plots were four rows (30-in row centers) X 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:** 18 April, 2005 **Variety:** Monohikari **Fertilizer:** 215 lb N + 70 lb P_2O_5 + 20 lb S **Herbicide:** Post-emergence applications of Betamix (24 oz product/A) + Upbeet (1 oz product/A) on 18 May, and Progress Beta (21 oz product/A) + Stinger (3 fl oz product/A) on 25 May.
Disease Development	Immediately following fungicide applications on 21 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 8-12 leaf stage when inoculated. Shortly after inoculation, plots were cultivated to move soil and then irrigated (0.5 inch) to create conditions that favored infection. Inoculum used in 2005 was prepared at the USDA lab in Ft. Collins, CO using *Rhizoctonia solani* AG2-2 cultured on grain.
Treatment Applications	Fungicides were applied (7-inch band) to the plant crowns on 21 June (immediately prior to inoculation), and for half-rate split application treatments, the second half-rate application was made on 5 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 (2 x 20 row ft) were determined on 9 June. Rhizoctonia root and crown rot incidence ratings were expressed as a percentage of the initial plant stand to standardize disease ratings. Rhizoctonia crown rot incidence was rated on 5, 13, and 20 July. 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 5 July through 20 July. Additionally, plots were visually rated for the percentage of total canopy necrosis present on 13, 20, 27 July, 3, and 15 August, and an AUDPC also was calculated for this data collection period. At harvest, a final harvestable beet root count was determined. Harvested beet roots were those that had less than 50% of the root volume lost due to rot. Rhizoctonia disease severity,

	incidence and root yield were determined harvested beet roots. Disease severity was determined by visually estimating the surface area of beet root affected by decay while disease incidence was the percentage of the harvested roots with any visible decay.
Harvest	Two treated rows X 5 ft were dug by hand on 6 October and total root yields were determined. The percentage of total sucrose was determined by Western Sugar's laboratory.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$). Because severe disease resulted in some treatment plots with no beets present at harvest time, no statistics were run on the percentage of sugar lost to molasses, as well as disease incidence and severity present at harvest.

Results and Discussion

Rhizoctonia root and crown rot (RRCR) developed quickly following inoculation on 21 June, and symptoms appeared within 2 weeks. Early RRCR symptoms observed in the plots were rapidly wilting leaves with petioles darkened near the crown. All plants in the nontreated inoculated check were symptomatic by 13 July and dead by 27 July. The nontreated non-inoculated check (treatment 1) showed low naturally occurring disease pressure mid to late summer with only 1.4% of the plants symptomatic by 20 July. Therefore, most disease development in the plots resulted from inoculum applied on 21 June. Rapid and severe RRCR development following inoculation provided for a rigorous test of fungicide efficacy in 2005. **The rapid onset of disease in 2005 is expected to render the half-rate split application treatments less effective for disease suppression, compared to years in which disease onset is less rapid.**

Fungicide treatment effects on RRCR incidence and severity are summarized in Tables 1 and 2. Quadris and Gem treatments were included as benchmarks from prior studies to facilitate comparison among years. Initially, all fungicide treatments provided an equivalent incidence of RRCR (Table1: P=0.05). By 13 July, treatment differentiation was evident ($P \leq 0.05$). Gem was not as effective as the other fungicide treatments for both disease incidence and canopy necrosis AUDPC values ($P \leq 0.05$). The JAU6476 full rate (treatment 5) resulted in less RRCR incidence on 13, 20 July than did the half-rate split application of JAU6476 ($P \leq 0.05$). Quadris applied at the full rate and the half-rate split application had no significant differences in disease incidence on these rating dates (P=0.05). Late season crop necrosis (Table 2) revealed that by mid-August extensive foliar necrosis correlated with RRCR was evident and ranged from 31 (treatment 4) to 100% (treatment 2) in the inoculated plots. The treatments most effective at suppressing the season-long foliar necrosis associated with RRCR, included both Quadris treatments, Moncut, and the full-rate single application of JAU6476. These treatments all had statistically equivalent foliar necrosis AUDPC values (Table2: P=0.05).

Treatment effects on harvestable beet root counts, root yield and root quality are summarized in Table 3. Due to the severe disease pressure following inoculation, no beet roots were recovered from the nontreated inoculated check and plots treated with Gem. The Quadris treatments significantly improved the number of harvested beet roots and beet root yield compared with the other treatments, and were statistically equivalent to the nontreated non-inoculated check (*P*=0.05). Moncut had yields that were intermediate between Quadris and the JAU6476 treatments (*P*=0.05). The percentage of total sucrose for treatments that yielded roots was similar to that of the nontreated non-inoculated check, except for the split application of JAU6476 ($P\leq 0.05$). The percentage of sugar lost to molasses ranged from 1.0 to 1.4 percent for treatments that yielded roots. These results indicate that this field trial was a vigorous test of fungicide efficacy. Rapid disease development following inoculation favored the full-rate single application JAU6476 treatment, as opposed to the split applications. Moncut also shows efficacy for RRCR management.

Table 1. Effects of banded fungicide applications on Rhizoctonia root and crown rot (RRCR) incidence (G.D. Franc and W.L. Stump, University of WY; 2005).

Treatment and rate (oz ai/1000 ft)[1]	Application dates[2]	Initial Stand (40 row ft)	RRCR incidence as a percentage of initial stand			AUDPC[3]
		9 June	5 July	13 July	21 July	
1. Nontreated non-inoculated check	NA	105.0 a[4]	0.0 b	0.0 e	1.4 e	4.8 e
2. Nontreated inoculated check	NA	96.5 a	52.4 a	100.0 a	100.0 a	1414.3 a
3 Quadris 2.08SC (0.15)	A	106.5 a	0.0 b	10.9 de	23.1 d	162.2 d
4 Quadris 2.08SC (0.075)	A, B	109.3 a	0.0 b	13.8 d	23.1 d	184.6 d
5. JAU6476 4SC (0.16)	A	103.0 a	0.0 b	9.9 de	20.1 d	144.7 de
6. JAU6476 4SC (0.08)	A, B	108.5 a	2.2 b	27.5 c	40.1 c	359.9 c
7. Gem 25WP (0.10)	A	96.5 a	2.1 b	41.2 b	58.7 b	526.9 b
8. Moncut 70DF (0.73)	A	101.8 a	0.7 b	19.4 cd	23.5 d	232.0 cd

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 21 June, 2005 (8-12 leaf stage) immediately following fungicide application.

2 Application dates were A= 21 June, B= 5 July, and NA= not-applicable.

3 Area under the disease progress curve for data collected from 5 through 21 July.

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; 2005).

Treatment and rate (oz ai/1000 ft)[1]	Application dates[2]	RRCR severity as a percentage of total canopy necrosis					AUDPC[3]
		13 July	20 July	27 July	3 August	15 August	
1. Nontreated non-inoculated check..........................	NA	0.0 e[4]	0.5 e	2.0 e	2.0 e	3.0 f	25.8 e
2. Nontreated inoculated check................................	NA	88.0 a	97.0 a	100.0 a	100.0 a	100.0 a	359.8 a
3 Quadris 2.08SC (0.15)	A	3.0 de	17.0 cd	17.0 d	36.0 cd	36.0 e	129.5 d
4 Quadris 2.08SC (0.075)	A, B	4.0 d	10.3 d	17.0 d	23.5 d	31.0 e	117.0 d
5. JAU6476 4SC (0.16)	A	4.8 cd	14.5 cd	23.5 cd	40.5 c	50.0 cd	140.9 cd
6. JAU6476 4SC (0.08)	A, B	12.0 bc	27.8 c	40.5 c	45.0 c	55.0 c	165.6 c
7. Gem 25WP (0.10)	A	17.0 b	59.5 b	76.5 b	89.8 b	98.5 b	250.1 b
8. Moncut 70DF (0.73)	A	8.5 bcd	14.5 cd	27.8 cd	36.0 cd	40.5 de	141.4 cd

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 21 June, 2005 (8-12 leaf stage) immediately following fungicide application.

2 Application dates were A= 21 June, B= 5 July, and NA= not-applicable.

3 Area under the disease progress curve for data collected from 13 July through 15 August.

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) severity on beet root characteristics at harvest (G.D. Franc and W.L. Stump, University of WY; 2005).

Treatment and rate (oz ai/1000 ft) [1]	Application dates [2]	Beet root yield and quality				Disease incidence and disease severity at harvest [3]	
		Beet no. per 10 row ft	Beet yield (tons/A)	% total sucrose	% sugar lost to Molasses [3]	Symptomatic beets (%)	Surface area of root decayed (%)
1. Nontreated non-inoculated check..........................	NA	17.5 a[4]	17.3 a	15.3 a	1.0	1.3	0.5
2. Nontreated inoculated check................................	NA	0.0 e	0.0 d	0.0 c	NA	NA	NA
3 Quadris 2.08SC (0.15)	A	11.0 b	12.8 ab	13.7 ab	1.0	32.4	17.0
4 Quadris 2.08SC (0.075)	A, B	11.8 b	12.7 ab	13.8 ab	1.2	30.0	20.8
5. JAU6476 4SC (0.16)	A	4.5 cd	5.7 c	14.4 ab	1.2	44.6	23.5
6. JAU6476 4SC (0.08)	A, B	3.3 de	5.2 c	10.5 b	1.0	50.0	12.0
7. Gem 25WP (0.10)	A	0.0 e	0.0 d	0.0 c	NA	NA	NA
8. Moncut 70DF (0.73)	A	7.0 c	9.2 bc	13.3 ab	1.4	42.1	17.0

1 All applications were made in a 7-inch banded spray in 1.06 gal/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 21 June, 2005 (8-12 leaf stage) immediately after the first fungicide application.

2 Application dates were A= 21 June, B= 5 July, and NA= not-applicable.

3 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 October 6, 2005.

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

Research Project	**Banded JAU6476 Fungicide Effects on Sugar Beet Vigor and Root Yield in the Absence of Disease, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY 4165 MSL: Mitchell clay loam soil, ph=7.9; overhead irrigation.
Plot Design	Randomized complete block design with four replications; plots were four rows (30-in row centers) X 20 ft with a 5 ft in-row buffer. Fungicide treatments were made to, and all data were collected from, the center two rows.
Plot Management	**Planting Date:**18 April, 2005 **Variety:** Monohikari **Fertilizer:** 215 lb N + 70 lb P_2O_5 + 20 lb S **Herbicide:** Post-emergence applications of Betamix (24 oz product/A) + Upbeet (1 oz product/A) on 18 May, and Progress Beta (21 oz product/A) + Stinger (3 fl oz product/A) on 25 May.
Treatment Applications	The fungicide JAU6476 was applied to the crown of each plant (8-12 leaf stage) in a 7-inch band on 21 June. 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.
Vigor Ratings	Relative sugar beet plant vigor was evaluated on 13, 20 July, 3, and 20 August. Vigor ratings took into consideration plant size and overall appearance compared to the nontreated check (=5) and also to the nontreated buffer row (=5) of each plot. Values >5 indicate improved vigor.
Harvest	One 20 ft row of the two treated rows was harvested on 6 October and the total root yield was determined. The percentage of total sucrose was determined by Western Sugar's laboratory.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

The fungicide JAU6476 is active against Rhizoctonia and significantly suppressed Rhizoctonia root and crown rot development in nearby inoculated plots (see: **Rhizoctonia Root and Crown Rot Management with Banded Fungicide Applications to Sugar Beet Crowns, 2005**). Data reported herein are for plots in which no Rhizoctonia inoculations were made, in order to determine if there was a measurable benefit from JAU6476 application in the absence of significant disease.

Approximately 1.4 percent of the plants developed Rhizoctonia root and crown rot in a nearby nontreated check treatment (see: **Rhizoctonia Root and Crown Rot Management with Banded Fungicide Applications to Sugar Beet Crowns, 2005**). Therefore, there was no appreciable disease development that could contribute towards any improved productivity measured in the JAU6476-treated plots. The application of JAU6476 had no significant effect on sugar beet vigor, sugar beet root yield or sucrose content compared to the nontreated check (Table 1, $P = 0.05$). Although not significant, these same data reveal the trend that JAU6476 application improved plant vigor, as well as increased beet root yield and sucrose compared to the nontreated check ($P = 0.05$).

Table 1. Effects of a banded JAU6476 fungicide application on sugar beet vigor, sugar beet root yield and sucrose content (G.D. Franc and W.L. Stump, University of WY; 2005).

Treatment and rate (oz ai/1000 ft)[1]	Beet vigor (nontreated check = 5)				Beet root yield and quality		
	13 July	20 July	3 August	15 August	Yield (tons/A)	% total sucrose	% sugar lost to molasses
1. Nontreated check	5.0 a[2]	5.0 a	5.0 a	5.0 a	10.3 a	15.7 a	1.3 a
2. JAU6476 4SC (0.16)	5.8 a	5.3 a	5.3 a	5.3 a	12.2 a	16.0 a	1.1 a

1 The fungicide application date was 21 June to 8-12 leaf stage beets. The application was made in a 7-inch banded spray in 1.06 gal/1000 row ft at 45 psi boom pressure.

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

Research Project	**Cercospora Leaf Spot and Powdery Mildew Management in Sugar Beet with Foliar Fungicide Programs, 2005**
Research Team Tel: 307-766-2397 FAX: 766-5549 francg@uwyo.edu	G.D. Franc and W.L. Stump University of Wyoming College of Agriculture- Plant Sciences, Dept 3354 1000 E. University Ave. Laramie, WY 82071
Field Plot Details	Field plots were at the Sustainable Agricultural Research & Extension Center (SAREC) located at Lingle, WY 4165 MSL: Mitchell clay loam soil, pH = 7.9; overhead irrigation was applied.
Plot Design	Randomized complete block design with four replications; plots were four rows (30-in row centers) X 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:** 18 April, 2005 **Variety:** Monohikari **Fertilizer:** 215 lb N + 70 lb P_2O_5 + 20 lb S **Herbicide:** Post-emergence applications of Betamix (24oz product/A) + Upbeet (1 oz product/A) on 18 May; and post application of Progress Beta (21 oz product/A) + Stinger (3 fl oz product/A) on 25 May
Disease Development	On 10 August, one greenhouse-grown sugar beet plant infected with powdery mildew was transplanted into the buffer row of each treatment plot. Additionally, on 3 and 10 August, a foliar application of *Cercospora beticola* spores (concentration not determined) was made to the border row of each plot in a total volume of 1.06 gal/1000 ft of row via a single-nozzle (8002 flat fan).
Treatment Applications	Foliar fungicide applications indicated as A, B, and C in the Tables, were made on 11, 24 August, and 8 September, 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 10, 17, 24 August, and 1, 7, 15, 22 September. The lesions on five randomly selected leaves per plot were counted and an average was calculated for each plot. For the 10 August evaluation, an average was calculated for all experimental plots, and this number was used as the initial disease level (1.65 lesions/leaf). Disease severity data from 10 August through 22 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 was observed on field edges in late September, but was not observed in the treatment plots.
Harvest	One 20 ft row of the two treated rows was harvested on 6 October and the total beet root yield was determined. The percentage of total sucrose was determined by Western Sugar's laboratory.
Statistical Analysis	ANOVA with four replications. Mean separations were done using Fisher's protected LSD ($P \leq 0.05$).

Results and Discussion

Cercospora leaf spot (CLS) development in the plots was light to moderate in 2005. Disease severity in the Platte river valley was generally light and sporadic in 2005. Therefore, the two inoculations made to research plots most likely contributed to the increased local disease pressure observed. However, cool night temperatures in August prevailed and severe CLS failed to develop. In hindsight, initiating fungicide treatments at least one week earlier (to coincide with inoculation of border rows) would probably have resulted in a better separation of treatment effects. Phytotoxicity due to fungicide treatment was not observed in the plots. Although powdery mildew was observed on plants along field edges in late September, powdery mildew was not observed in the treatment plots and was not rated.

Fungicide program effects on CLS development are shown in Table 1. By 24 August, most fungicide programs reduced CLS lesions compared to the untreated check ($P \leq 0.05$). Final AUDPC values revealed that all treatments except Rubigan (8 fl oz) reduced AUDPC values compared to the nontreated check ($P \leq 0.05$). Garlic (10% v:v) was among the treatments that significantly reduced season-long Cercospora compared to the nontreated check ($P \leq 0.05$). In general, the most effective Cercospora suppression fungicide programs included Eminent, Gem, Headline, Mankocide, and/or Super Tin.

Fungicide program effects on sugar beet root yields and sucrose content are summarized in Table 2. Fungicide programs had no significant effect on sugar beet root yield or sugar content compared to the nontreated check (P=0.05).

Table 1. Effects of foliar fungicide programs on Cercospora leaf spot management (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	Number of Cercospora lesions per leaf						CLS AUDPC[2]
		17 Aug	24 Aug	1 Sep	7 Sep	15 Sep	22 Sep	
1. Nontreated check	NA	7.8 a[3]	23.9 a	80.9 a	157.2 a	94.0 ab	155.3 ab	3155.0 a
2. Gem 4.17SC (3.5 fl oz) 2. Eminent 125SL (13 fl oz) 2. Super Tin 80WP (3.75 oz)	A B C	3.2 a	2.1 c	13.1 b	6.7 d	6.6 d	7.6 e	257.9 e
3. Eminent 125SL (13 fl oz) 3. Gem 4.17SC (3.5 fl oz) 3. Super Tin 80WP (3.75 oz)	A B C	7.9 a	5.0 c	20.5 b	16.7 d	51.6 a-d	38.1 cde	878.3 cde
4. Manzate Pro-Stick 75DF (1.5 lb) 4. Kocide 2000 35WP (3.75 lb)	A, C B	7.9 a	5.2 c	25.1 b	84.0 b	109.1 a	115.3 abc	2084.3 b
5. Manzate Pro-Stick 75DF (1.5 lb) 5. Super Tin 80WP (3.75 oz)	A, C B	9.8 a	8.7 bc	9.3 b	41.8 bcd	76.8 abc	82.4 b-e	1360.7 bcd
6. ManKocide 61.1WG (2.5 lb)	A-C	2.8 a	7.2 c	15.3 b	31.2 cd	24.9 cd	42.5 cde	739.5 cde
7. Rubigan 1EC (6 fl oz)	A-C	14.6 a	8.5 bc	31.9 b	45.1 bcd	49.4 a-d	80.8 b-e	1363.5 bcd
8. Rubigan 1EC (8 fl oz)	A-C	5.8 a	7.8 c	30.6 b	74.2 bc	101.4 ab	179.8 a	2227.4 ab
9. Rubigan 1EC (6 fl oz) + Sulfur 6SC (0.67 gal)	A-C	10.9 a	19.8 ab	36.3 b	11.5 d	52.0 a-d	93.7 bcd	1283.0 b-e
10. Eminent 125SL (13 fl oz) 10. Headline 2.08EC (12 fl oz)	A, C B	0.7 a	5.6 c	10.3 b	39.3 bcd	43.2 bcd	42.2 cde	870.9 cde
11. Eminent 125SL (13 fl oz) 11. Super Tin 80WP (5.0 oz)	A, C B	3.6 a	2.3 c	21.9 b	8.0 d	13.6 cd	28.0 de	455.6 de
12. Headline 2.08EC (12 fl oz) 12. Super Tin 80WP (5.0 oz)	A, C B	1.3 a	3.3 c	13.7 b	11.6 d	28.0 cd	39.6 cde	563.4 cde
13. Garlic GP 1SC (10% v:v)	A-C	0.7 a	5.9 c	28.8 b	72.7 bc	70.8 abc	90.0 b-e	1610.9 bc

1 Fungicide application dates were: A= 11 August, B= 24 August, and C= 8 September. NA= not-applicable.

2 Cercospora leaf spot area under the disease progress curve was calculated for data collected from 10 August through 22 September. The initial amount of disease present was 1.65 lesions/leaf (measured on 10 August). Border rows of field plots received foliar inoculations with *Cercospora beticola* 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 for Cercospora leaf spot management on sugar beet root yield and quality (G.D. Franc and W.L. Stump, Univ. of WY; 2005).

Treatment and rate (product/A)	Application dates[1]	Beet root yield and quality		
		Yield (tons/A)	% total sucrose	% sugar lost to molasses
1. Nontreated check	NA	14.7 a[2]	15.7 a	1.2 a
2. Gem 4.17SC (3.5 fl oz)	A	16.7 a	16.0 a	1.0 a
2. Eminent 125SL (13 fl oz)	B			
2. Super Tin 80WP (3.75 oz)	C			
3. Eminent 125SL (13 fl oz)	A	16.8 a	16.2 a	1.1 a
3. Gem 4.17SC (3.5 fl oz)	B			
3. Super Tin 80WP (3.75 oz)	C			
4. Manzate Pro-Stick 75DF (1.5 lb)	A, C	14.3 a	15.8 a	1.2 a
4. Kocide 2000 35WP (3.75 lb)	B			
5. Manzate Pro-Stick 75DF (1.5 lb)	A, C	17.4 a	16.1 a	1.2 a
5. Super Tin 80WP (3.75 oz)	B			
6. ManKocide 61.1WG (2.5 lb)	A-C	14.4 a	16.2 a	0.9 a
7. Rubigan 1EC (6 fl oz)	A-C	12.1 a	15.0 a	1.1 a
8. Rubigan 1EC (8 fl oz)	A-C	12.6 a	16.1 a	1.2 a
9. Rubigan 1EC (6 fl oz) + Sulfer 6SC (0.67 gal)	A-C	11.8 a	16.4 a	1.1 a
10. Eminent 125SL (13 fl oz)	A, C	14.6 a	15.8 a	1.1 a
10. Headline 2.08EC (12 fl oz)	B			
11. Eminent 125SL (13 fl oz)	A, C	17.2 a	16.4 a	1.1 a
11. Super Tin 80WP (5.0 oz)	B			
12. Headline 2.08EC (12 fl oz)	A, C	13.2 a	15.6 a	1.2 a
12. Super Tin 80WP (5.0 oz)	B			
13. Garlic GP 1SC (10% v:v)	A-C	9.3 a	16.0 a	1.1 a

[1] Fungicide application dates were: A= 11 August, B= 24 August, and C= 8 September. NA= not-applicable.
[2] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

FISCAL YEAR FY 2005
Report for the:

SUDDEN OAK DEATH NATIONAL SURVEY: WYOMING

Project Duration: April 1, 2005 – December 31, 2005

Prepared by: G. D. Franc

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I. Background and Justification

Sudden Oak death (SOD) is caused by the fungus-like organism *Phytophthora ramorum*. This organism was first recovered from diseased plants in Germany and the Netherlands in 1993 and subsequently was found in the United States (California) in 1995. Since its discovery in North America, thousands of oak trees have died along the western coast of the United States and numerous others are in declining health. Certain native California oak and at least 40 other native and horticultural species are hosts for the fungus, with various symptoms and signs resulting from infection. The 2004 widespread dispersal of infected plant material strongly suggests that infection can occur in the absence of symptoms.

The epidemiology of this disease is not well characterized and assumptions have been made about its spread and the ecological conditions favoring pathogen survival. Research is underway to elucidate epidemiological aspects of this disease. For now, disease management has concentrated on the intensive surveys to detect and destroy infected plants, thereby, eliminating the pathogen. Environmental conditions enabling pathogen establishment in natural settings are not well characterized. Infected plant material transplanted into environments otherwise unfavorable for pathogen spread may serve to protect the organism in an asymptomatic host. At least several potential hosts are present in Wyoming. For example, the natural range of Douglas fir overlaps with urban areas in Wyoming where susceptible landscape plants are likely to be placed.

During the spring of 2004, it was determined that one to several west coast nurseries had this disease present in some of their nursery stock. Trace-forward surveys in 2004 revealed that the pathogen was distributed to several states via shipment of infected nursery stock. Most recently, infected nursery stock was detected in early 2005 and a new survey (Wyoming portion reported herein) was conducted to identify infected nursery stock. The survey goal was to identify infected nursery stock or potential infection foci so that the pathogen could be eliminated. Surveys in 2005 tested trace-forwards as well as secondary and tertiary shipments of plant material that could place Wyoming's greenhouse and horticultural industry at risk. If a survey conducted according to protocol fails to detect SOD, this will enable sale and shipment of plant materials from Wyoming. On the other hand, if the pathogen is detected by survey before it is widespread, eradication of the infestation is more likely to protect the healthy plant community.

II. Objective

The objective is to survey nurseries identified with host plants and associated host plants susceptible to infection by *P. ramorum*. Up to 20 sites identified by the Wyoming Department of Agriculture in cooperation with the USDA APHIS PPQ will be surveyed in Wyoming using criteria found in the USDA APHIS PPQ Surveyor's Manual. The University of Wyoming Cooperative Extension plant pathology program will offer training on disease recognition and also will conduct analysis of plant samples for pathogen detection.

III. Results or Benefits Expected

Samples will be identified by a unique number that characterizes the location including the latitude and longitude, host, collection date, and other relevant information as outline on page 11 of the Surveyor's manual. All diagnostic results for each sample number will be summarized by the Cooperator into a local database. These data will be entered into the NAPIS database by Margaret Rayda, Wyoming State Survey Coordinator. This data entry component is a function of the CORE Project funded through Pest Detection. The first record for the State and/or County will be entered within **48 hours** of confirmation of identification by a qualified identifier. All other required records, both positive and negative, will be entered **within two weeks** of confirmation. All records are to be entered into the NAPIS and GPDN databases by **December 1, 2005** to enable their inclusion in the yearly WR Statistical Report.

IV. Approach

Sample Collection and Testing: The twenty collection sites will be determined by the Wyoming Department of Agriculture (WDA) and the USDA APHIS PPQ office in Cheyenne, WY. Sample collection and sample collection protocols will be as determined by these two entities following the guidelines of the USDA APHIS PPQ Surveyor's Manual. Samples will be delivered to the Cooperator in Laramie, WY for processing. The Surveyor's Manual Addendum II reveals that Wyoming is located in zone IV, with a survey priority of July-August, 2005.

The Cooperator will provide training on disease recognition to WDA site inspectors in June or early July. In addition to collecting and testing symptomatic plant tissue as per the guidelines, it is anticipated that additional sample collection will be done. Up to 40 samples per site will be tested (600 samples total). The Cooperator will conduct the testing protocol for *P. ramorum* detection and identification as per guidelines provided by Mary Palm (March, 2004), or as published in appropriate updates. Briefly, primary screening of samples will be performed by ELISA, optionally followed by plating to PARP medium, as outlined in the testing protocol. Secondary screening also will include ELISA re-resting, DNA recovery and submission to the national testing lab, and/or PCR detection by qualified individuals.

Reporting: A report summarizing the testing procedure and results will be provided to Margaret Rayda for inclusion into the CORE annual report and sample information will be entered into the GPDN PDIS data base.

Results for FY05:

The Wyoming nursery stock survey was conducted in July and August, as per USDA inspection priority guidelines for the Zone IV region. Sample collection exceeded requirements because samples with few or no symptoms also were submitted for testing. Samples received at the University of Wyoming were logged-in and tested. A sub-sample from each sample was weighed and placed in an individual sample extract bag. GEB2 buffer was added in the proper ratio and initial testing was via ELISA DAS (*Phytophthora* pathoscreen kit PSA 92600; Agdia Inc., agdia.com) performed according the testing protocol. Positive test samples and negative controls (both lilac and non-lilac) were included in each test. Sample reaction intensities were read with a spectrophotometer at 405 nm with a hard copy printout. Results were reported to Margaret Rayda, as local schedules permitted.

Fourty-three establishments in 18 counties were visited during the 2005 survey. A total of 67 field samples were tested during the survey. Additional check samples were processed. The counties surveyed are summarized in Table 1 along with information on visual inspections (samples not submitted) and the number of greenhouses inspected at which no known hosts were present. All samples submitted for testing, except two, were negative for the presence of *Phytophthora*. The two ELISA-positive samples were both lilac collected from Laramie county. These samples were re-tested in ELISA and one proved negative while the second was positive for *Phytophthora*. Regardless, DNA extraction was performed on both samples according to the protocol and the DNA extract was submitted for testing via PCR. Both DNA samples submitted to the USDA proved negative for *P. ramorum* in the PCR test. In summary, *P. ramorum* was not detected in any of the samples collected during the survey.

Table 1. Sudden Oak Death survey results for Wyoming FY05.

2005 Wyoming *Phytophthora ramorum* Survey Summary * Generated by Wyoming Pest Detection Program –www.uwyo.edu/capsweb					
	# TESTED SAMPLES			**# DIFFERENT SPECIES**	**# GREENHOUSES**
COUNTY	**# NEG**	**# POS**	**# PENDING**	**NEGATIVE - VISUALLY**	**WITH NO HOSTS**
ALBANY	0	0	0	0	0
BIG HORN	0	0	0	0	1
CAMPBELL	5	0	0	3	0
CARBON	0	0	0	0	0
CONVERSE	2	0	0	3	1
CROOK	10	0	0	3	0
FREMONT	3	0	0	3	0
GOSHEN	0	0	0	0	7
HOT SPRINGS	0	0	0	0	0
JOHNSON	5	0	0	4	0

LARAMIE	18	0	0	17	7
LINCOLN	1	0	0	1	0
NATRONA	4	0	0	3	0
NIOBRARA	0	0	0	0	0
PARK	0	0	0	0	2
PLATTE	1	0	0	1	3
SHERIDAN	0	0	0	0	0
SUBLETTE	1	0	0	1	0
SWEETWATER	9	0	0	5	0
TETON	1	0	0	1	0
UINTA	2	0	0	2	0
WASHAKIE	0	0	0	0	3
WESTON	5	0	0	4	0
YELLOWSTONE	0	0	0	0	0
TOTAL	**67**	**0**	**0**	**51**	**24**

67	P. RAMORUM NEGATIVE LAB TESTED RECORDS SENT TO NAPIS	
51	P. RAMORUM NEGATIVE VISUAL RECORDS SENT TO NAPIS	
24	NO HOST GREENHOUSE RECORDS SENT TO NAPIS	
142	TOTAL RECORDS SENT TO NAPIS	
43	ESTABLISHMENTS VISITED	(2004 = 30)
18	SURVEYED COUNTIES	(2004 = 12)

* Two suspect samples of lilac from Laramie county tested positive in the ELISA test at UW on 7/22/05. These
plants were in close proximity to each other, along with other lilac and *Viburnum* species.

* A second ELISA test was conducted on these samples at UW on 7/22/05. The Common White Lilac proved negative and the Hollandia Blue Lilac was positive a second time.

* Both samples were delivered to the CSU lab on 7/25/05, for DNA extraction. The CSU lab forwarded the DNA
to the USDA lab on 7/26/05 for final determination.

A training program on disease and SOD recognition was presented to inspectors prior to performing the greenhouse site visits. Training material on disease recognition and alternate hosts was provided by G. D. Franc via power point presentations at Cheyenne, WY. Training material included adaptation of resources provided by the USDA APHIS PPQ and other materials provided by the University of Wyoming Cooperative Extension plant pathology program. First detector training also was provided by the same instructor as part of the Great Plains Diagnostic Network training program. Disease recognition skills were considered important to ensure that the appropriate tissue was sampled during the SOD survey.

All data reported herein were entered into the NAPIS data base on or before August 12, 2005. These data also were entered into the National Plant Diagnostic Network PDIS database prior to December 1, 2005. **End of report**

2005 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 2005 Cercospora leaf spot survey tested the fungicide reaction of 141 *Cercospora beticola* isolates recovered from 56 fields: ten fields from Colorado, ten fields from Montana, thirty-five fields from Nebraska, and one field from Wyoming. All isolates were tested for sensitivity to benzimidazole (Benlate®, Topsin®), triphenyltin hydroxide (Super Tin®, Agritin®), tetraconazole (Eminent®), propiconazole (Tilt®), azoxystrobin (Quadris/Amistar®), and pyraclostrobin (Headline®). No appreciable insensitivity was observed for these fungicides, except benzimidazole; 44.6 percent of the fields surveyed had a benzimidazole insensitive isolate present. Similar surveys initiated in 1998 throughout the High Plains revealed that fields with at least one benzimidazole insensitive isolate present increased from a low of 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 widespread in High Plains sugar beet fields. Therefore, reliance on benzimidazole for Cercospora leaf spot suppression is not advised. Isolate reaction to diethofencarb in 2005 and 2004 revealed that all isolates insensitive to benzimidazole were sensitive to diethofencarb (negative cross resistance), indicating the likely presence of a single mutation conferring benzimidazole resistance. Results also suggest diethofencarb plus benzimidazole use as a potential tank mix to suppress the spectrum of isolates present in the field. However, this approach had limited success in other production regions because tank mixes resulted in isolates insensitive to both diethofencarb and benzimidazole. The availability of other effective fungicide chemistries for the control benzimidazole insensitive isolates further reduces our need to incorporate diethofencarb into fungicide programs. The 2005 survey revealed that, with the exception of benzimidazole, our fungicide chemistries remain effective and that fungicide resistance management must be practiced by growers.

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 2005 survey consisted of leaf samples collected from 63 fields throughout the High Plains growing region: 14 fields from Colorado, 10 fields from

Montana, 36 fields from Nebraska, and three fields from Wyoming. Leaf samples were air-dried and stored for approximately two months prior to recovery attempts. Up to several recovery attempts were made for each sample so that each field was represented by at least one fungal isolate, and a maximum of six isolates was tested per field. Cercospora isolates were successfully recovered from 56 of the 63 fields.

Fungicide sensitivity tests:

The media for testing the strobilurin fungicides azoxystrobin (Quadris/Amistar®) 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 as per label instruction and cooled to approximately 50°C. Stock suspensions of 500 ppm benzimidazole (Benlate®), triphenyltin hydroxide (Super Tin®, Agritin®), tetraconazole (Eminent®), propiconazole (Tilt®), azoxystrobin (Quadris/Amistar®), and pyraclostrobin (Headline®) were prepared in sterile distilled water. A stock suspension of 2500 ppm of diethofencarb was prepared in 5 mL of acetone. Stock suspensions were added to achieve concentrations in the media listed below. Thirteen 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 (BM) 5 ppm, triphenyltin hydroxide (TPTH) 1 ppm, tetraconazole 1 ppm, propiconazole 1 ppm, azoxystrobin 1 ppm, pyraclostrobin 1ppm, and diethofencarb 5 ppm.

Each isolate recovered from infected leaves was cultured onto a SBLEA source plate, incubated for 12 to 14 days at 23°C with a 12 hr photoperiod and allowed to dry down 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 μL aliquots of the conidia suspension. Therefore, for each isolate tested there were seven amended plates plus glycerol and PDA non-amended control plates. All nine 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 in each batch as a positive and negative control. 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 percent inhibition of radial growth for each test isolate grown on fungicide-amended media was compared to its growth on its corresponding 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 computing the percentage of growth inhibition in the presence of fungicide. The percent inhibition for each isolate was then calculated with the following equation, [(non-amended control – amended)/non-amended control X 100]. Isolates producing colonies with diameters greater than 3 mm after 7 days of incubation had some degree of "insensitivity" to the fungicide present in the amended medium. However, from a practical standpoint, isolates that exhibited 20 percent or less inhibition (at least 80% or more growth) in the presence of a specific fungicide were considered to be insensitive to that fungicide.

Results and Discussion

A total of 141 isolates were recovered in 2005 from 56 sugar beet fields with symptoms of Cercospora leaf spot. For seven of the fields we failed to recover *C. beticola* due to lack of sufficient lesions or the presence of other organisms. Each isolate was recovered from a separate foliar lesion. All isolates were tested for growth on the nine different media plates. The known benzimidazole sensitive and insensitive *C. beticola* isolates from prior surveys also were tested and reacted consistently on the test media, indicating that the test protocol was performed correctly.

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. No insensitivity to triphenyltin hydroxide, tetraconazole, propiconazole, azoxystrobin, or pyraclostrobin was detected. However, a total of 47 isolates (33.3 percent) were found to be insensitive to benzimidazole at 5 ppm. Nebraska had the greatest percentage of insensitive isolates (43.9 percent) followed by Colorado (33.3 percent), Montana (4.2 percent), and Wyoming (0 percent).

The number of **fields** in which at least one benzimidazole insensitive isolate was detected are shown in Table 2. Overall, 44.6 percent of the fields tested in the High Plains region had detectable benzimidazole insensitivity in 2005. Nebraska had the greatest number of fields represented with 35 fields tested and 54.3 percent (19/35) of these fields had at least one benzimidazole insensitive *C. beticola* isolate; five of these 19 fields had a mixed population of sensitive and insensitive isolates. In Colorado, 50 percent (5/10) of the fields exhibited had at least one benzimidazole insensitive isolate; three of these five fields had mixed populations. Montana had 10 percent (1/10) of the fields with an insensitive isolate detected (also a mixed population). Wyoming had no insensitive isolates detected (0/1). 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 and pyraclostrobin fungicides are shown in Table 3. In general, isolates had greater inhibition of growth in the presence with pyraclostrobin compared to azoxystrobin. These results parallel field trials that revealed pyraclostrobin suppressed Cercospora leaf spot more effectively than did azoxystrobin. None of the isolates tested in the survey were considered insensitive because all were inhibited in their growth by greater than 20 percent. However, one isolate from Montana (Big Horn county) grew 59 percent (41 percent inhibition) in the presence of azoxystrobin.

Isolate inhibition in the presence of 1 ppm tetraconazole and propiconazole fungicides are summarized in Table 4. In the presence of tetraconazole the majority of the isolates had 100 percent growth inhibition (none of the isolates grew in the presence of these fungicides) and propiconazole inhibited all growth of all isolates.

Isolate inhibition in the presence of triphenyltin hydroxide at 1 ppm are summarized in Table 5. The majority of the isolates were inhibited 100 percent at 1 ppm, with only two isolates (one each from NE and WY) exhibiting 90-99% inhibition.

Isolate inhibition in the presence of benzimidazole at 5 ppm are summarized in Table 6. Isolates either were completely inhibited or not inhibited at all (<9 percent inhibition). Forty-six of the 141 isolates were inhibited less than 9 percent (91 percent or greater growth) in the presence of benzimidazole. The distribution of these isolates in the High Plains was discussed above for Table 1. 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 percent in 2003, followed by a three year decline to 45 percent in 2005. Results reveal the consistent trend that benzimidazole insensitivity is widespread in High Plains sugar beet fields. Therefore, reliance on benzimidazole for Cercospora leaf spot suppression is not advised. Trends for the most recent three years suggests a steady decline in the number of fields with benzimidazole resistant isolates, perhaps the result of decreased benzimidazole use. Although the field fungicide-use data is incomplete, no fields sampled in 2005 indicated the use of benzimidazole for the 2005 field season. Additionally, thirty-two percent of the fields considered to be insensitive to benzimidazole, also had at least one sensitive isolate recovered from the same field (mixed population).

Tests with diethofencarb reveal that all isolates insensitive 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 and 2005 surveys. The availability of other effective fungicide chemistries for the control of benzimidazole insensitive isolates further reduces our need to incorporate diethofencarb into fungicide programs. The 2005 survey reveals that our fungicide chemistries remain effective and that fungicide resistance management must be practiced by growers.

Table 1. The number of insensitive *Cercospora beticola* isolates (20 percent or less growth inhibition in the presence of the indicated fungicide) recovered in 2005 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)	0	0	0	0	0
Pyraclostrobin (1)	0	0	0	0	0
Tetraconazole (1)	0	0	0	0	0
Propiconazole (1)	0	0	0	0	0
TPTH (1)	0	0	0	0	0
Benzimidazole (5)	10	1	36	0	47
Total isolates tested	30	24	82	5	141

* Azoxystrobin 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 percent or less inhibition) present. Isolates were recovered in 2005 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)	5	1	19	0	25
Total fields tested	10	10	35	1	56

* Azoxystrobin 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/Amistar), and pyraclostrobin (Headline) fungicides. Isolates were recovered from symptomatic leaves collected in 2005 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

Percent inhibition*	Number of isolates within a category									
	azoxystrobin (1 ppm)					pyraclostrobin (1 ppm)				
	CO**	MT	NE	WY	Total	CO	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	0	0	0	0	0	0	0	0	0
30-39	0	0	0	0	0	0	0	0	0	0
40-49	0	1	0	0	1	0	0	0	0	0
50-59	0	0	2	0	2	0	0	0	0	0
60-69	1	0	7	2	10	0	0	1	0	1
70-79	5	1	9	0	15	0	0	2	0	2
80-89	9	5	17	2	33	4	0	8	0	12
90-99	6	2	24	1	33	10	6	16	4	36
100	9	15	23	0	47	16	18	55	1	90
Total tested	30	24	82	5	141	30	24	82	5	141

* 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 2005 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

Percent inhibition*	Number of isolates within a category									
	Tetraconazole (1 ppm)					Propiconazole (1 ppm)				
	CO**	MT	NE	WY	Total	CO	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	0	0	0	0	0	0	0	0	0
30-39	0	0	0	0	0	0	0	0	0	0
40-49	0	0	0	0	0	0	0	0	0	0
50-59	0	0	0	0	0	0	0	0	0	0
60-69	0	0	0	0	0	0	0	0	0	0
70-79	0	0	0	0	0	0	0	0	0	0
80-89	0	0	1	0	1	0	0	0	0	0
90-99	10	1	19	0	30	0	0	0	0	0
100	20	23	62	5	110	30	24	82	5	141
Total tested	30	24	82	5	141	30	24	82	5	141

* 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 2005 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

Percent inhibition*	Number of isolates within a category				
	Triphenyltin (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	0	0	0
70-79	0	0	0	0	0
80-89	0	0	0	0	0
90-99	0	0	1	1	2
100	30	24	81	4	139
Total tested	30	24	82	5	141

* 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 2005 from Colorado, Nebraska, Montana, and Wyoming sugar beet fields.

Percent inhibition*	Number of isolates within a category				
	benzimidazole (5 ppm)				
	CO**	MT	NE	WY	Total
0-9	9	1	36	0	46
10-19	1	0	0	0	1
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	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	20	23	46	5	94
Total tested	30	24	82	5	141

* 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 (1998-2005) 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
Colorado	19/36 53%	14/29 48%	9/23 39%	18/29 62%	3/5 60%	17/21 81%	9/12 75%	5/10 50%
Montana	0/19 0%	1/5 20%	3/5 60%	6/11 55%	0/1 0%	3/5 60%	2/6 33%	1/10 10%
Nebraska	4/33 12%	8/39 21%	8/32 25%	7/29 24%	21/27 78%	13/16 81%	16/20 80%	19/35 54%
Wyoming	NT*	0/1 0%	0/1 0%	NT	1/1 100%	3/3 100%	0/2 0%	0/1 0%
Total	23/88 26%	23/74 31%	20/61 33%	31/69 45%	25/34 74%	36/45 80%	27/40 68%	25/56 45%

* NT=Not tested

Products Tested in 2005 Research Studies.

Product	**Class***	**Manufacturer**	**Composition**
Asana XL 0.66 EC	I	Dupont Agricultural Products Wilmington, DE 19880-0402	8.4% Esfenvalerate
Bravo Weather Stik 6F	F	Syngenta Crop Protection, Inc. P.O. Box 18300 Greensboro, NC 27419	54% Chlorothalonil
Cruiser 5SC	I	Syngenta Crop Protection, Inc.	47.6% Thiamethoxam
DPX-JE874-425 0.825SC	F	Dupont	9.2% Famoxadone
DPX-JE874-426 5SC	F	Dupont	52.8% Famoxadone
Dithane NT 75DF	F	Dow AgroSciences LLC Indianapolis, IN 46268	75% Mancozeb
Echo ZN 4.17F	F	Sipcam Agro USA, Inc. 70 Mansell Ct., Suite 230 Roswell, GA 30076	38.5% Chlorothalonil
Eminent 125SL	F	Sipcam Agro USA, Inc.	11.6% Tetraconazole
Endura 70WP	F	BASF Corp. 26 Davis Dr. Research Triangle Park, NC 27709	70% Boscalid
Folicur 3.6F	F	Bayer Corp. Agricultue Division P.O. Box 4913, Hawthorn Rd Kansas City, MO 64120	38.7% Tebuconazole
Garlic GP 1SC	F	Garlic GP LTD Co. San Antonio, TX 78218	98.2% Garlic juice
Gem 25WP	F	Bayer Corp.	25% Trifloxystrobin
Gem 4.17SC	F	Bayer Corp.	38.5% Trifloxystrobin
Gramoxone 3SC	H	Syngenta Crop Protection, Inc.	43.8% Paraquat dichloride
Headline 2.08EC	F	BASF Corp.	22.9% Pyraclostrobin
Headline SBR	F	BASF Corp.	Co-pack of Headline and Folicur
JAU6476 4SC	F	Bayer Corp.	Information not provided
JE874 50WG	F	Dupont Agricultural Products Wilmington, DE 19880-0402	Information not provided
Kocide 2000 35WP	F	Dupont	53.8% Copper hydroxide
Manex 4F	F	Dupont	37% Maneb
ManKocide 61.1WG	F	Griffin Corp PO Box 1847, Rocky Ford Rd Valdosta, GA 31603-1847	46% Copper hydoxide 15% Mancozeb 3% Zinc oxide
Manzate Pro-Stick 75DF	F	Dupont	75% Mancozeb
Moncut 70DF	F	Gowan Co. PO Box 5569 Yuma, AZ 85366-5569	70% Flutolanil
Penncozeb 75DF	F	Cerexagri 900 First Ave. King of Prussia, PA 19406	75% Mancozeb
Platinum 2SC	I	Syngenta Crop Protection, Inc.	21.6% Thiamethoxam
Quadris 2.08SC	F	Syngenta Crop Protection, Inc.	22.9% Azoxystrobin
Reglone 3.73SC	H	Syngenta Crop Protection, Inc.	37.3% Diquat dibromide
Rubigan E.C. 1EC	F	Gowan Co.	12% Fenarimol

Sulfer 6SC	F		
Super Tin 80WP	F	Dupont	80% Triphenyltin hydroxide
Tanos 50WG	F	Dupont	25% Cymoxanil + 25% Famoxadone
X77	S	Loveland Industries, Inc. P.O. Box 1289 Greeley, CO 80632-1289	Nonionic surfactant

* F= fungicide, I= insecticide, H=Herbicide, and S= surfactant