Cercospora Leaf Spot Fungicide Screening Trials

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Introduction: Cercospora Leaf Spot (CLS) is the most destructive foliar disease to impact sugar beet production in the SMBSC growing area. Without effective new fungicides, controlling the disease has become more difficult. Without a new "silver bullet", the key to controlling CLS will be utilizing best management practices that include an appropriately timed fungicide program that utilizes multiple modes of action.

Objective: High levels of Cercospora inoculum and a favorable environment for the development of CLS have been major contributors in causing losses to profitability in sugar beet production in recent years. Due to the high levels of disease pressure, an effective fungicide program is necessary to grow a profitable crop. Trials need to be conducted to test the efficacy of individual fungicides and season long fungicide programs.

Materials and Methods: Two trials were conducted as randomized complete block with four replications. The Program Trial was located near Clara City and the Fungicide Screening Trial was located near Hector, MN. These trials evaluated fungicides in a program setting, but also for individual efficacy. The Clara City site was planted on April 24th using Crystal M977. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 2.47 lbs./acre of pulverized leaves from the previous year that were infected with CLS. The inoculum was spread evenly across the site with a Gandy Orbit-Air applicator on June 28th. Six fungicide applications were made in the Program Trial beginning June 30th and continuing on a ten to twelve-day spray interval. The Hector site was planted on April 29th using Crystal M977. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 3.1 lbs./acre of pulverized leaves from the previous year that were infected with CLS. The inoculum was spread evenly across the site with a Gandy Orbit-Air applicator on July 8th. Five fungicide applications were made in the Fungicide Screening Trial beginning July 12th and continuing on a ten to twelve-day spray interval.

Applications were made using a custom-made tractor mounted sprayer traveling 3.3mph with a spray volume of 20gpa and 60psi, utilizing XR11002 spray nozzles. Each plot consisted of six rows that were 40ft in length. The sprayer used CO^2 as a propellant and was designed to apply the treatment to the center four rows, leaving rows one and six untreated. Plots were rated for foliar damage using the (1-9) KWS (Kleinwanzlebener Saatzucht) scale with one being disease free and nine being completely necrotic. The center two rows of each six row plot were harvested on September 10th at the Hector site and on September 23rd at the Clara City site using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the lifter and a sample of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS version 9.4.

Program Trial Results: Few significant differences were found in the yield and quality parameters of the Program Trial (Table 1). The untreated check had significantly lower yield and quality parameters compared to all other treatments. The program with Badge SC as the tank-mix partner in all applications had significantly lower tons per acre and ESA than most of the other treatments. The remainder of the programs were very similar with regard to yield.

More differences were observed in the visual foliar ratings (Table 2). The untreated check had a significantly higher rating throughout the season than all other treatments. The programs that contained copper tank-mix partners had higher foliar ratings than programs that only used EBDC products for tank-mix partners. All programs that utilized EBDC in every application had similar foliar ratings.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	13.2 b	31.6 d	10.9 b	217.5 b	6861.1 c	89.9
Standard Program	15.3 a	43.1 ab	12.8 a	255.9 a	11015.6 ab	90.3
Standard Program w/ 2 Badge	15.7 a	42.8 bc	13.3 a	265.9 a	11375.6 a	91.1
Standard Program w/ 2 Ultim	15.5 a	43.8 ab	13.1 a	262.2 a	11486.2 a	91.2
Standard Program w/ All Badge	15.3 a	40.1 c	12.9 a	257.4 a	10346.5 b	91.1
Standard Program w/ All Ultim	15.4 a	43.0 ab	13.1 a	262.8 a	11290.6 a	91.7
Standard Program w/ Regev	15.6 a	43.7 ab	13.0 a	260.7 a	11387.0 a	90.3
Standard Program w/ 2 Proline	15.4 a	44.2 ab	12.9 a	257.1 a	11357.7 a	90.3
Standard Program w/ Provysol	15.4 a	45.2 ab	13.1 a	261.9 a	11672.1 a	91.2
Standard Program w/ Veltyma	15.5 a	45.7 a	12.9 a	257.9 a	11768.0 a	89.9
Mean	15.2	42.3	12.8	255.9	10856.0	90.7
CV%	2.4	4.5	4.0	4.0	5.9	1.8
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.798
lsd (0.05)	0.53	2.78	0.74	14.8	933.9	ns

Table 1: Yield parameter results for the Program Trial. Values with different letters are significantly different. Table 5 contains a full description of each treatment.

Treatment	30-Jul	6-Aug	16-Aug	25-Aug	8-Sep	15-Sep
Check	3.9 a	5.2 a	8.3 a	9.0 a	9.0 a	9.0 a
Standard Program	1.2 c	1.4 d	1.7 g	2.7 e	3.4 ef	3.9 e
Standard Program w/ 2 Badge	1.3 c	1.6 cd	2.4 de	3.7 cd	4.7 d	5.4 cd
Standard Program w/ 2 Ultim	1.4 c	1.7 c	2.5 d	3.7 d	4.8 d	5.4 d
Standard Program w/ All Badge	2.0 b	2.3 b	3.8 b	4.9 b	6.4 b	7.2 b
Standard Program w/ All Ultim	1.7 b	2.0 b	3.0 c	4.0 c	5.3 c	5.9 c
Standard Program w/ Regev	1.4 c	1.6 cd	2.1 ef	2.7 e	3.7 e	3.9 e
Standard Program w/ 2 Proline	1.3 c	1.6 cd	1.9 fg	2.7 e	3.4 ef	4.0 e
Standard Program w/ Provysol	1.4 c	1.7 c	1.9 fg	2.6 e	3.5 ef	4.2 e
Standard Program w/ Veltyma	1.4 c	1.7 c	1.8 g	2.6 e	3.2 f	3.8 e
Mean	1.7	2.1	2.9	3.9	4.7	5.3
CV%	10.7	9.4	6.4	6.6	5.5	6.5
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.26	0.28	0.27	0.37	0.38	0.50

Table 2: Foliar ratings for the Program Trial using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Table 5 contains a full description of each treatment.

Fungicide Screening Trial Results: Several significant differences were found in the yield and quality parameters of the Fungicide Screening Trial (Table 3). The untreated check had substantially lower yield and quality parameters than any of the other treatments. The treatments with only one mode-of-action and the Inspire XT with Oxidate 5.0 treatment had numerically lower extractable sugar per acre (ESA) than almost all other treatments with two modes-of-action.

The foliar ratings had similar results with the check having significantly higher ratings throughout the season and the treatments with only one mode-of-action also having higher foliar ratings than most treatments that contained two modes of action. Treatments that contained the tank-mix of Proline and Manzate Prostick had significantly lower ratings than all other treatments.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	13.0	27.1 f	10.1	202.8	5516.5 e	86.6
Manzate Prostick	13.8	31.1 abcde	10.8	215.1	6666.1 cd	86.3
Proline	14.1	29.6 def	11.3	224.8	6622.5 d	87.8
Proline + Manzate Prostick	14.2	32.0 abcde	11.3	225.7	7228.5 abcd	87.6
Lucento + Manzate Prostick	14.2	32.1 abcde	11.3	225.7	7248.5 abcd	87.2
Topguard + Manzate Prostick	13.9	32.8 abcde	11.2	224.0	7336.4 abcd	88.2
Regev + Manzate Prostick	13.8	34.4 ab	11.0	220.4	7546.9 abc	87.6
Timorex Act + Manzate Prostick	13.8	30.9 bcde	10.9	218.4	6759.7 bcd	87.4
Neem Oil + Manzate Prostick	13.7	31.5 abcde	10.9	217.4	6831.7 bcd	87.6
Eminent VP + Manzate Prostick	14.0	33.8 abc	11.1	221.3	7436.7 abcd	87.1
Inspire XT	14.0	29.4 ef	11.3	225.0	6614.2 d	87.9
Inspire XT + Manzate Prostick	13.9	31.9 abcde	10.9	217.7	6931.2 bcd	86.6
Proline(3.46oz) + Inspire2.0 + Manzate Prostick	14.1	32.2 abcde	11.2	223.7	7213.2 abcd	87.2
Proline(5.7oz) + Inspire2.0 + Manzate Prostick	14.1	33.7 abc	11.3	226.2	7634.8 ab	88.1
Inspire XT + Manzate Prostick + Microthiol	14.3	34.7 a	11.6	231.0	8000.5 a	88.4
Inspire XT + Badge SC	14.3	30.5 cdef	11.5	229.0	6974.7 bcd	87.8
Agri Tin + Manzate Prostick	14.0	32.7 abcde	11.1	221.7	7245.8 abcd	87.0
Provysol + Manzate Prostick	14.1	33.3 abc	11.2	223.0	7427.8 abcd	87.2
Inspire XT + Manzate + Vacciplant	14.4	31.4 abcde	11.6	231.8	7263.3 abcd	88.1
Inspire XT + Oxidate 5.0	13.7	30.6 cdef	10.7	213.7	6575.8 d	86.5
Delaro + Proline(1.7oz) + Manzate Prostick	14.0	33.2 abcd	11.3	225.6	7480.7 abcd	88.2
Delaro Complete + Proline(1.7oz) + Manzate P.	14.0	32.2 acbde	11.2	224.4	7234.2 abcd	88.1
Mean	14.0	31.9	11.1	222.2	7081.3	87.5
CV%	3.5	8.2	5.0	4.9	9.2	1.2
Pr>F	0.1398	0.031	0.168	0.1818	0.0031	0.235
lsd (0.05)	ns	3.7	ns	ns	920.8	ns

Table 3: Yield parameter results for the Fungicide Screening Trial. Values with different letters are significantly different.

Treatment	6-Aug	16-Aug	30-Aug	8-Sep
Check	4.1 a	6.4 a	9.0 a	9.0 a
Manzate Prostick	2.3 de	2.6 fgh	5.0 d	5.8 de
Proline	2.1 efg	2.4 gh	4.7 d	5.9 de
Proline + Manzate Prostick	1.5 i	1.7 i	2.3 h	3.3 i
Lucento + Manzate Prostick	2.0 fg	2.4 gh	3.7 fg	4.7 h
Topguard + Manzate Prostick	2.0 fg	2.6 fgh	3.5 g	4.7 h
Regev + Manzate Prostick	2.4 de	2.6 fgh	4.2 e	5.3 fg
Timorex Act + Manzate Prostick	2.5 cd	3.0 de	4.9 d	5.5 ef
Neem Oil + Manzate Prostick	2.9 b	3.3 cd	5.7 c	6.4 c
Eminent VP + Manzate Prostick	2.2 efg	2.6 fgh	3.8 efg	4.8 gh
Inspire XT	3.0 b	3.6 bc	6.7 b	7.6 b
Inspire XT + Manzate Prostick	2.1 efg	2.6 fgh	4.1 ef	5.1 fgh
Proline(3.46oz) + Inspire2.0 + Manzate Prostick	1.6 hi	1.8 i	2.1 hi	2.8 ij
Proline(5.7oz) + Inspire2.0 + Manzate Prostick	1.6 i	1.8 i	1.9 hi	2.5 j
Inspire XT + Manzate Prostick + Microthiol	1.9 g	2.3 h	3.9 efg	4.8 h
Inspire XT + Badge SC	2.8 bc	3.2 d	5.5 c	6.3 cd
Agri Tin + Manzate Prostick	2.3 def	2.6 fgh	3.9 efg	4.6 h
Provysol + Manzate Prostick	2.2 defg	2.7 efg	4.0 ef	4.8 gh
Inspire XT + Manzate + Vacciplant	1.9 gh	2.8 ef	3.8 efg	4.9 gh
Inspire XT + Oxidate 5.0	2.9 b	3.8 b	6.7 b	7.8 b
Delaro + Proline(1.7oz) + Manzate Prostick	1.3 i	1.7 i	1.8 i	2.6 j
Delaro Complete + Proline(1.7oz) + Manzate P.	1.5 i	1.9 i	2.1 hi	2.7 j
Mean	2.2	2.7	4.2	5.1
CV%	10.8	9.6	7.7	7.2
Pr>F	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.34	0.37	0.46	0.52

Table 4: Foliar ratings for the Fungicide Screening Trial using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different.

Conclusion: The results of the Fungicide Screening trial indicate that a CLS fungicide program that uses multiple modes of action in a single application will have superior performance over a program that applies only a single mode of action. The results of the Program Trial indicate that EBDC is a superior tank-mix partner over copper products, but the Fungicide Screening Trial shows that copper products can still be beneficial as a tank-mix partner, just not as good as EBDC. Proline continues to be the superior triazole product with all other triazoles and tin products being similar. No new products performed better than those currently utilized for CLS control. The performance of Proline and Manzate Prostick are similar to the results from previous studies.

Treatment		Rate/Acre	Application Code
Check	n/a	n/a	n/a
Standard Program	Proline	5.7 oz	A
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ 2 Badge	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABDE
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ 2 Ultim	Ultim	2.5 lbs	CF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABDE
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ all Badge	Badge SC	32 oz	ABCDEF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ all Ultim	Ultim	2.5 lbs	ABCDEF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ REGEV	SuperTin	8 oz	BDF
	REGEV	8.5 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	AE
w/ 2 Proline	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ Provysol	SuperTin	8 oz	BDF
and Lucento	Lucento	5.5 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Provysol	4 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program	Proline	5.7 oz	A
w/ Veltyma	SuperTin	8 oz	BDF
and Lucento	Lucento	5.5 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Veltyma	8 oz	E
	Masterlock	6.4 oz	ABCDEF

Table 5: Program Trial treatment list. The application code indicates when the product was applied in the six spray program treatments.

Treatment	Application Rate per Acre
Check	n/a
Manzate Prostick	2 lbs
Proline	5.7 oz
Proline	5.7 oz
Manzate Prostick	2 lbs
Lucento	5.5 oz
Manzate Prostick	2 lbs
Topguard	14 oz
Manzate Prostick	2 lbs
REGEV	8.5 oz
Manzate Prostick	2 lbs
Timorex Act	29.8 oz
Manzate Prostick	2 lbs
Neem Oil	40 oz
Manzate Prostick	2 lbs
Eminent VP	13 oz
Manzate Prostick	2 lbs
Inspire XT	7 oz
Inspire XT	7 oz
Manzate Prostick	2 lbs
Proline	3.56 oz
Inspire 2.0	6.84 oz
Manzate Prostick	2 lbs
Proline	5.7 oz
Inspire 2.0	6.84 oz
Manzate Prostick	2 lbs
Inspire XT	7 oz
Manzate Prostick	2 lbs
Microthiol Disperss	5 lbs
Inspire XT	7 oz
Badge SC	2 pints
Agri Tin	8 oz
Manzate Prostick	2 lbs
Provysol	5 oz
Manzate Prostick	2 lbs
Inspire XT	7 oz
Vacciplant	14 oz
Manzate Prostick	2 lbs
Inspire XT	7 oz
Oxidate 5.0	1 %
Delaro	11 oz
Proline	1.7 oz
Manzate Prostick	2 lbs
Delaro Complete	11 oz
Proline	1.7 oz
Manzate Prostick	2 lbs

Table 6: Fungicide Screening Trial treatment list.