

FLAX FUNGICIDE APPLICATION FOR REDUCING THE EFFECTS OF PASMO DISEASE

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MATERIALS AND METHODS

This study was designed as a randomized complete block with four replicates, and was conducted at the Langdon Research Extension Center, NDSU at Langdon, North Dakota (N48° 45.3', W98° 17.5') and conducted in 2009. Plots were 7 rows wide with 6 inches between rows and 20 ft row length and were planted with a double disk Almaco plot drill on 7 May. Seeding rate was 2.8 million PLS^{-acre}. An untreated plot was planted between treated plots to collect and minimize spray drift to the adjacent plots. Crop production practices recommended by North Dakota State University Extension Service were followed (Kandel, 2007).

The Canadian cultivar CDC Bethune was used in this study. The plots were artificially inoculated with pasmo by spreading infected straw collected from 2008 in the center of each plot 6-8 days prior to flowering at the rate of 80 grams of straw. Treatments are listed in Table 1. Treatments with the commercial fungicide Headline (Pyraclostrobin, BASF Corporation, Agricultural Products 26 Davis Drive, Research Triangle Park, NC 27709) were included as a subset of the study in a factorial arrangement at three application rates (6, 9, and 12 fl oz/ acre) and three timings (early, late and post bloom growth stage). Early flower growth stage application was made on 16 July, late bloom growth stage application on 23 July and post bloom application on 30 July. A sequential application at early flower and late bloom growth stage was included for some treatments and an untreated check as a control (Table 1). Fungicide was applied with a CO₂ backpack spray unit equipped with a three nozzle boom operated at 40 psi with Spraying Systems XR8001 nozzles oriented vertically delivering 9.2 GPA.

The soil type was a Barnes/Svea complex (fine-loamy, mixed superactive Frigid, Calcic Hapludolls/mixed superactive Frigid, Pachic Hapludolls) (Soil Survey Staff, 2008). Hard red spring wheat was produced on this site in 2008. The soil was tilled in the fall with a chisel plow with attached spring tooth harrows three times. In spring prior to planting and tilling, N fertilizer (28-0-0) was broadcast on the site to bring the soil and applied N level to 75 lb acre⁻¹. The site was tilled with a spring tooth cultivator equipped with 23 cm sweeps on 18 cm spacing with attached spring tooth harrows immediately before planting.

An impact-type sprinkler system was installed with orifices spaced 30 x 40 feet, and was operated after the inoculum was applied to wet the residue. The sprinklers were manually operated for about 2 hours on three additional dates to create a favorable environment for disease infection and development. Soil water was increased as a result of the irrigation. Care was taken to minimize the amount of water applied so lodging did not occur. Pasm disease was assessed on leaves on 23 July, 4, 19 and 31 Aug and the stems on 31 Aug. The leaves were assessed

using the 1-9 scale with 1 = no sign of disease and 9 = high disease severity and leaf death. Stem severity was assessed using the 1-9 scale with 1 = no sign of disease and 9 = high disease severity and plant death. The plot was harvested on 18 Sept with a Hege plot combine and the threshed sample collected. Yield, test weight, seed weight and oil concentration were determined. Area under disease progress curve (AUDPC) and relative area under disease progress curve (rAUDPC) were calculated for each location. The data were analyzed with analysis of variance separating means with Fischer's protected least significant differences ($P \leq 0.01$) with SAS (SAS, 1999).

DISCUSSION

This trial is a consolidation of projects with multiple objectives. Part of the trial is a basic screen of fungicides and application timings and is presented in Table 1. The data is sorted by yield. A second objective was to repeat an evaluation of Headline rate and application timing and is presented in table 2. The sample from this portion of the trial will be tested for fungicide affects on germination and will be reported later. Disease severity developed later in the season than in previous years and yield and fungicide response reflect the season. The most effective treatments as measured by AUDPC included two applications of Proline, and application of Penncozeb and Proline, also early and late bloom and a single application of 12 fl. oz./acre of Headline at late bloom. No differences in treatments were measured at the 7 July sample date. Early timings of Headline, Penncozeb, and the 5 fl oz rate of Proline reduced disease severity on the leaves compared to the untreated, the 5.7 fl oz rate of Proline, a herbicide timing of Headline. The post bloom applications were generally not as effective in reducing disease severity at the 4 Aug assessment date as early timings. By the 19 Aug assessment date the low rates of Headline were not as effective as the higher rates and the early timings were not as effective as two timings and the late bloom timings. Post bloom timings were most effective in reducing disease severity at the 31 Aug assessment date. Pasm disease on the stem was affected most by later timings and Headline rates 6 fl oz/acre or greater. Fungicide was very effective in increasing yield with the exception of Headline at the 3 fl oz/acre rate, Proline at 5.7 fl oz/acre rate and the split timing of Penncozeb. The most effective treatments for increasing yield included Headline post and late bloom at 6 and 9 fl oz/acre, post and early bloom Headline at 12 fl oz/acre, all single treatments of Headline at 6 fl oz/acre and the split timing of Penncozeb and Proline. Test weight was the lowest when no fungicide was applied and when the Headline was applied at herbicide timing and greatest with the highest yielding treatments describe previously. Oil concentration was increased over the untreated with split fungicide applications of Headline, the Penncozeb/Proline combination and by 9 and 12 fl oz rates of Headline at early and late bloom.

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Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Series Classification Database [Online WWW]. Available URL: "<http://soils.usda.gov/soils/technical/classification/scfile/index.html>" [Accessed December 9, 2007].

Table 1. PasmO leave and stem disease severity, yield, test weight and oil concentration by Headline rate and application timing and confidence intervals by source of variation Langdon , 2009

Fungicide	Fungicide Rate	Application Timing	PasmO Disease Severity (1-9)							Yield (bu/a)	Test	
			Leaves				Stem				Weight (lb/bu)	Oil %
			7 July	4 Aug	19 Aug	31 Aug	31 Aug	AUDPC ^b	rAUDPC ^c			
untreated			2.3	4.8	9.0	9.0	7.0	240.6	0.063	50.9	51.1	46.2
Headline^a	3 fl oz	early bloom	1.5	2.5	8.3	8.8	4.8	196.1	0.052	53.5	52.1	47.5
Headline	3 fl oz	herbicide	2.3	4.0	8.8	9.0	6.0	227.6	0.060	55.2	51.1	47.4
Proline	5.7 fl oz	early bloom	2.0	4.5	8.0	9.0	4.5	223.0	0.059	55.8	52.1	46.3
Penncozeb	1 lb + 1 lb	early and late bl.	1.3	2.5	5.8	8.3	3.5	159.5	0.042	56.0	52.5	47.4
Headline	9 fl oz	early bloom	1.5	2.5	7.5	8.8	3.8	186.4	0.049	56.8	52.7	48.2
Headline	12 fl oz	late bloom	2.3	3.0	3.8	4.8	1.0	126.3	0.033	56.9	52.8	48.0
Headline and Headline	3 and 6 fl oz	herbicide and e. bl.	1.8	2.5	6.8	8.8	3.0	178.0	0.047	57.4	52.3	48.0
Proline	5 fl oz	early and late bl.	1.3	2.0	3.5	5.0	1.0	105.9	0.028	57.6	53.2	47.5
Headline	12 fl oz	post bloom	2.3	4.0	5.8	5.8	1.0	170.8	0.045	59.2	52.6	47.4
Headline	6 fl oz	early bloom	1.5	2.8	6.5	8.3	1.8	173.9	0.046	59.3	52.7	47.4
Headline	12 fl oz	early bloom	2.5	3.0	5.8	7.5	1.3	168.8	0.044	59.4	52.5	48.7
Headline	6 fl oz	late bloom	1.8	3.8	7.3	8.5	1.3	199.4	0.052	59.5	52.5	48.3
Headline	9 fl oz	post bloom	2.3	3.8	6.0	6.3	1.0	173.5	0.046	60.4	53.4	48.0
Headline	9 fl oz	late bloom	2.3	2.8	4.8	7.5	1.3	151.1	0.040	60.9	52.9	48.8
Headline	6 fl oz	post bloom	1.5	2.8	6.0	7.0	1.5	170.3	0.045	61.5	53.1	47.7
Penncozeb and Proline	2 lb. and 5.7 fl oz	early and late bl.	2.0	2.3	4.8	6.3	1.5	136.4	0.036	63.7	52.8	47.6
LSD (P=0.05)			NS	1.2	1.7	1.6	2.3	36.5	0.01	6.0	0.6	1.4
% C.V.			47.5	26.2	19.2	14.7	62.1	14.6	14.6	7.3	0.8	2.0

^aBolded treatments supported by BASF.

^bArea under the disease progress curve (AUDPC) = $\sum[(W_{i+n} + W_i) / 2] [t_{i+1} - t_i]$ where W_i = disease severity at the i th observation, t_i = time in days at the i th observation, and n = total number of observations.

^cRelative area under the disease progress curve (rAUDPC) = AUDPC values divided by the total area of the graph.

Table 2. PasmO disease, yield , test weight and oil concentration by Headline rate and application timing and confidence intervals by source of variation Langdon , 2009 (Subset of Table 1).

Fungicide Rate	Fungicide Timing Growth stage	PasmO Disease Severity (1-9)					Yield (bu/a)	Test Wt (lb/bu)	Oil (%)
		Leaves				Stem			
		7 July	4 Aug	19 Aug	31 Aug	31 Aug			
6 fl oz		1.6	3.0	6.6	7.9	1.5	58.9	52.8	47.8
9 fl oz		2.0	3.3	6.1	7.5	1.1	59.4	53.0	48.3
12 fl oz		2.3	3.3	5.1	6.0	2.0	58.5	52.6	48.0
		NS	NS	0.9	1.0	NS	NS	NS	NS
	Early	1.8	2.8	6.6	8.2	2.3	58.5	52.6	48.1
	Late	2.1	3.2	5.9	6.9	1.2	59.1	52.7	48.3
	Post	2.0	3.8	5.3	6.3	1.2	59.2	53.0	47.7
LSD		NS	NS	0.9	1.0	1.0	NS	NS	NS
Rate		0.1835	0.6502	0.0078	0.0018	0.1740	0.9261	0.1241	0.4093
Timing		0.8129	0.0695	0.0211	0.0036	0.0465	0.9473	0.0866	0.2983
Rate*Timing		0.8150	0.6927	0.0139	0.1164	0.1577	0.7644	0.4010	0.4401
% C.V.		48.9	31.2	18.3	16.9	75.8	9.3	0.8	2.1