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 2010. Plots were 7 rows wide 6-inch spacing between rows and 20 ft. row length and were planted with a double disk Almaco plot drill on 9 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 2009 in the center of each plot 6-8 days prior to the initiation of flowering at the rate of 80 grams of straw. Treatments are listed in Table 1. Early flower growth stage application was made on 6 Jul (wind speed 10 MPH from the W and air temperature 66° F at 9:30 a.m.) and late bloom growth stage application on 14 Jul (wind speed 2 MPH from the SW and air temperature 66° F at 9:00 a.m.). An untreated check was included as a control (Table 1). Fungicide was applied with a CO_2 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 winter wheat was produced on this site in 2009. The soil was tilled in the fall with a chisel plow with attached spring tooth harrows once. 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.

Pasmo disease was assessed on leaves on 6, 13 and 21 Jul and 3 and 19 Aug and the stems on 21 Jul and 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 25 Aug 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) was 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).

Results and Discussion

The supplemental watering system was not used in 2010 due to excessive distance from the water source. Pasmo disease developed less intensely in 2010 than in previous studies that received supplemental water. The flax matured earlier in 2010 than 2009 and was harvested nearly a month earlier. At the 6 Jul assessment date the Headline treatment had lower disease score than Quash (3 oz. /a), Q8X63, Stratego Pro with Induce, Picoxystrobin with Induce and Luna Privilege with Induce, Table 1. No differences in foliar disease were measured on 13 Jul. At the 21 Jul assessment date Quash (4 oz. /a), both Picoxystrobin treatments without Induce and LEM17 had lower disease scores than some of the other fungicides. Only the picoxystrobin treatments had lower disease scores than the untreated. At the 3 Aug assessment date several treatments were statistically better than the untreated. The list includes all treatments **except;** LEM 17 and Quash. At the 19 Aug all the leaves had senesced. Several treatments had lower disease levels than the untreated when comparing the AUDPC (area under the disease progress curve. These treatments included both two fungicide application treatments, both Picoxystrobin without Induce and Q8X63, ProPulse with Induce and both Stratego Pro treatments. Pasmo was not present on the stem at the first sample date and at very low levels at the second sample date. No differences were measured with this assessment indicating a questionably value in quantifying disease with this method in some environments. Many of the disease survey assessments use incidence on the stem to determine prevalence of Pasmo. Several treatments increased yield. The most effective treatments were two fungicide timings and the Stratego Pro with Induce. Ineffective treatments for increasing yield included LEM17, ProPulse and Quash as a single treatment. Only the high rate of LEM17 and Quash failed to increase test weight over the untreated. All fungicide applications increased seed weight compared to the untreated. Oil was not statistically affected by fungicide treatment in this study. All fungicide applications reduced the dark brown damaged seed count in the sample compared to the untreated. No differences were determined for damage seed for black or scabby seeds. In previous studies at Langdon we have been unable to isolate any pathogen from any of the visually scabby seed. This damage may be related to weathering which would not be affected by a fungicide application.

Headline, the only commercially labeled fungicide for use on flax again increased yield over the untreated. Several other fungicide treatments also were effective in increasing yield. Some of the new fungicides offer different mode of action and should benefit growers if a label could be obtained. The results of this study and the Carrington study will be forwarded to the fungicide suppliers in hopes of generating interest in further testing and label acquisition of one or more of the fungicides for use on flax.

Table 1. Pasmo leaf and stem disease score, yield, test weight, seed weight, oil and visually damage seed by category, Langdon, 2010.

Fungicide	Fungicide/ Adjuvant Rate/acre	Supplier	Leaf Disease Score 6 Jul	13 Jul	21 Jul	3 Aug	19 Aug	AUDPC	Stem Disease Score 21 Jul	19 Aug
Untreated			2.25	3.50	4.75	7.75	9.0	303.3	0	1.5
Headline	6 fl. oz.	BASF	1.50	3.50	5.00	6.25	9.0	277.9	0	1.0
LEM17	24 fl. oz.	DuPont	1.75	2.75	3.75	7.75	9.0	282.8	0	1.0
LEM17	16 fl. oz.	DuPont	2.25	3.75	4.00	6.75	9.0	277.1	0	1.0
Luna Privilege	6.84 fl. oz.	Bayer	1.75	3.75	5.25	5.50	9.0	270.6	0	1.0
Luna Privilege + Induce	6.84 fl. oz. +0.125%v/v	Bayer	2.75	4.00	5.25	6.25	9.0	288.5	0	1.3
Penncozeb and Proline	2 lb. and 5.7 fl. oz.	UPI and Bayer	2.25	3.50	4.00	4.75	8.8	238.4	0	1.0
Penncozeb and Quash	2 lb. and 3 oz.	UPI and Valent	2.00	3.75	4.50	5.25	9.0	256.9	0	1.0
Picoxystrobin	6 fl. oz.	DuPont	2.25	2.75	3.50	5.25	9.0	237.1	0	1.0
Picoxystrobin	4 fl. oz.	DuPont	1.75	2.75	3.50	5.25	9.0	235.6	0	1.0
Picoxystrobin + Induce	6 fl. oz. + 0.25%v/v	DuPont	2.75	3.50	4.00	6.25	9.0	268.1	0	1.0
ProPulse	10.26 fl. oz.	Bayer	2.00	3.50	5.00	5.75	9.0	270.6	0	1.5
ProPulse + Induce	10.26 fl. oz. +0.125%v/v	Bayer	2.25	3.25	4.25	5.00	9.0	246.4	0	1.0
Q8X63	19.2 fl. oz.	DuPont	2.50	4.00	4.25	4.75	9.0	248.0	0	1.0
Quash	3 oz.	Valent	2.50	3.25	5.75	6.75	9.0	298.0	0	1.3
Quash	4 oz.	Valent	2.00	3.75	3.75	7.25	9.0	281.8	0	1.3
Stratego Pro	4.65 fl. oz.	Bayer	2.25	2.75	4.25	6.25	9.0	264.8	0	1.3
Stratego Pro + Induce	4.65 fl. oz. +0.125%v/v	Bayer	2.50	3.00	5.00	5.50	9.0	264.3	0	1.0
LSD $_{(0.05)}$			0.8	NS	1.20	1.28	NS	37.6	0	NS
Source of Variation										
Replicate			0.0480	<0.0001	0.0100	<0.0001	0.4005	<0.0001		0.7633
Treatment			0.0962	0.1052	0.0072	<0.0001	0.4736	0.0095		0.2333
% C.V.			25.4	20.2	19.1	15.2	1.3	9.9		27.9

Fungicide	Fungicide/ Adjuvant Rate/acre	Application Timing	Yield Bu./a	Test Weight Lb./bu.	Seed Weight g/1000	Oil %	Visually Damaged Seed Count/100 Dark Brown	Black	Scabby 1	Scabby 2
Untreated			28.2	52.0	5.18	40.4	5.24	2.8	1.2	0.4
Headline	6 fl. oz.	Late bloom	34.4	53.2	5.80	42.7	0.24	1.7	0.3	0.2
LEM17	24 fl. oz.	Late bloom	31.4	52.2	5.53	42.2	1.22	2.2	0.7	0.0
LEM17	16 fl. oz.	Late bloom	32.7	53.2	5.70	42.3	0.46	3.4	0.0	0.5
Luna Privilege	6.84 fl. oz.	Late bloom	37.3	53.0	5.76	44.2	0.47	0.3	0.7	1.0
Luna Privilege + Induce	6.84 fl. oz. +0.125%v/v	Late bloom	34.5	53.2	5.53	42.1	0.00	5.3	0.0	0.5
Penncozeb and Proline	2 lb. and 5.7 fl. oz.	Early and late bloom	38.6	53.6	6.01	43.0	0.96	1.9	0.0	0.2
Penncozeb and Quash	2 lb. and 3 oz.	Early and late bloom	39.9	53.6	5.95	43.3	0.86	1.0	1.0	0.7
Picoxystrobin	6 fl. oz.	Late bloom	32.7	53.5	5.80	42.3	0.22	1.0	0.7	0.5
Picoxystrobin	4 fl. oz.	Late bloom	35.4	53.8	5.78	43.1	0.70	1.2	0.0	0.2
Picoxystrobin + Induce	6 fl. oz. + 0.25%v/v	Late bloom	35.7	53.6	5.77	42.6	1.20	2.2	5.9	1.2
ProPulse	10.26 fl. oz.	Late bloom	32.3	53.4	6.07	43.1	0.70	0.2	0.4	0.5
ProPulse + Induce	10.26 fl. oz. +0.125%v/v	Late bloom	33.3	53.5	6.02	41.8	0.49	1.2	0.0	0.5
Q8X63	19.2 fl. oz.	Late bloom	35.0	53.6	5.87	43.3	0.47	1.1	1.6	0.9
Quash	3 oz.	Late bloom	33.3	53.3	5.76	42.0	0.67	2.3	0.2	0.2
Quash	4 oz.	Late bloom	32.9	52.6	5.67	43.4	1.08	0.9	0.4	0.2
Stratego Pro	4.65 fl. oz.	Late bloom	35.3	53.9	5.81	42.7	0.44	2.3	0.5	1.6
Stratego Pro + Induce	4.65 fl. oz. +0.125%v/v	Late bloom	38.7	53.6	6.11	43.2	0.24	3.1	0.7	1.0
$LSD_{(0.05)}$			5.8	1.0	0.04	NS	2.12	NS	NS	NS
Source of Variation										
Replicate			0.0056	<0.0001	0.0073	<0.0001	0.2739	<0.0001	0.4054	0.6543
Treatment			0.0303	0.0170	0.0022	0.2406	0.0098	0.1174	0.2937	0.6675
% C.V.			11.7	1.3	4.6	3.4	171.8	106.5	308.2	158.9