NITROGEN FERTILIZATION OF NIGER THISTLE

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Field experiments were conducted in a randomized complete block design with four replicates at the NDSU Carrington, Langdon, and North Central (Minot) Research Extension Centers (2002-2003), the NDSU research site at Prosper (2002), and on-farm locations in NW Minnesota (St. Hilaire and Oklee in 2002, Thief River Falls in 2003). Plot size was approximately 5' x 22', with 6-7" row spacing.

Four N fertility levels and three seeding rates were arranged in a factorial configuration. On fields with a soil test of approximately 40 lbs. NO_3^--N / acre in the top 24 inches (Table 1), N rates of approximately 0, 20, 40, and 60 lbs. fertilizer N / acre (see footnote 1 on Table 2) were compared. Since plant population frequently impacts disease incidence, maturation and harvest management, the best seeding rate in previous trials (6 lbs. / acre) was compared to one lower and one higher rate (3 and 9 lbs. / acre, respectively). With the exception of Prosper 2002 and Minot 2003, plots were sown in May (Table 1). Data were recorded on stand establishment, days to flowering, pest occurrence, days to maturity, plant height, lodging, seed yield, and seed oil concentration.

The trials were successfully established at all sites and matured within the growing season, even when planted on 13 June 2002 in Prosper and 11 June 2003 in Minot. This result is additional evidence of the adaptation of the EarlyBird cultivar for this region.

As expected, plant stand increased with seeding rate (Table 2). Across seeding rates, stand decreased as N fertilizer increased in Oklee, but no relationship was observed at the other sites. Increasing the seeding rate reduced the time to flowering at all sites except Prosper, while increasing the rate of N fertilizer had a minimal effect at the North Dakota sites (Table 3). Due to the distance to the trials in Minnesota, the percent bloom on a given day was evaluated. Increasing the seeding rate advanced flowering at all Minnesota sites. In Oklee and Thief River Falls, increasing N rates also advanced the development of flowering.

Table 1. Soil and planting data in the niger management trials, 2002-03.

Soil Test Data	Carrington	Langdon	St. Hilare	Oklee	Prosper	Carrington	Langdon	Thief River Falls	Minot
	2002					2003			
N (lbs / acre) -- 0-24"	38	38	47	42	55	31	47	58	34
P (ppm)	52	20	16	7	24	12	17	82	15
K (lbs / acre)	213	410	165	91	455	245	nd	294	480
S (0-6)	nd[1]	nd	32	16	1	nd	nd	40	18
S (6-24)	nd	nd	30	32	32	nd	nd		516
Zn (ppm)	nd	0.5	0.54	0.24	nd	nd	nd	2.8	0.7
Cu (ppm)	nd	nd	nd	0.29	nd	nd	nd		nd
							nd		
pH	8.0	7.2	7.9	7.5	7.7	6.2	nd		6.3
Organic Matter (%)	3.2	3.7	3.5	2.9	6.4	4.1	nd		3.1
E.C. (0-6)	nd	nd	0.36	0.21	0.60	0.12	nd		0.38
E.C. (6-24)	nd	nd	0.38	0.30	0.74	0.23	nd		0.8
Row Spacing	7"	6"	6"	6"	12"	7"	6"	6"	6"
Planting Date	20 May	20 May	17 May	14 May	13 June	30 May	20 May	8 May	11 June
Swath Date	4 Oct.	16 Sept.	27 Sept.	1 Oct.	2 Oct.	29 Sept.	5 Sept.		15 Sept.
Combine Date	16 Oct.	26 Sept.	14 Oct.	15 Oct.	15 Oct.	6 Oct.	15 Sept.		6 Oct.

[1]not determined

[2]40 lbs P_2O_5 / acre broadcast and incorporated prior to planting

Table 2. Niger stand establishment (plants/ft.^{2}) in response to seeding rate and nitrogen level, 2002-03.

Treatment	Carrington	Langdon	St. Hilare	Oklee	Minot	Carrington	Langdon	Thief River Falls	Mean
	---------- 2002 ----------					---------- 2003 ----------			
Seeding Rate (lb / acre)									
3	5.4	5.1	4.2	6.0	5.1	3.5	6.7	5.0	5.1
6	10.3	8.4	8.7	10.6	10.0	5.2	9.1	8.6	8.9
9	15.2	10.9	14.2	15.3	15.3	6.9	13.8	12.3	13.0
LSD (0.05)	1.2	1.3	1.1	1.0	2.6	0.8	1.9	1.0	
LSD (0.01)	1.6	1.7	**	**	3.5	1.1	2.6		
N Level (approximate lbs total N / acre) [1]									
40	11.0	8.3	8.6	11.6	9.8	5.5	10.6	8.6	9.2
60	9.6	8.1	8.8	11.2	10.1	5.2	9.4	8.6	8.9
80	9.9	8.2	9.7	10.8	8.8	5.0	9.6	8.7	8.8
100	10.7	7.8	9.0	9.0	9.6	5.0	9.9	8.5	8.7
LSD (0.05)	1.4	NS	NS	1.2	NS	NS	NS	NS	
LSD (0.01)	NS	NS	NS	**	NS	NS	NS		

** denotes a statistically significant difference among means at P < 0.01

[1]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 40, 60, 80, 100; Langdon 2002 = 38, 60, 80, 100; St. Hilaire = 47, 67, 87, 107; Oklee = 42, 62, 82, 102; Minot = 40, 60, 80, 100; Langdon 2003 = 47, 60, 80, 100; Thief River Falls = 58, 78, 98, 118.

Table 3. Relative time to niger thistle flowering in response to seeding rate and nitrogen level, 2002-03.

Treatment	Carrington[1]	Langdon[1]	St. Hilaire[2]	Oklee[3]	Prosper[1]	Carrington[1]	Langdon[1]	Thief River Falls[4]	Mean[5]
	---------- 2002 ----------					---------- 2003 ----------			
Seeding Rate (lb / acre)									
3	80	73	5	28	32	68.4	68	51	64
6	80	73	12	34	32	67.8	67	58	64
9	79	71	17	37	32	67.4	67	66	63
LSD (0.05)	NS[6]	NS	5	7	NS	0.3	0.5	2.1	
N Level (lbs fertilizer N added) [7]									
0	80	71	12	27	32	67.7	67	56	64
20	79	72	11	30	32	67.8	67	59	64
40	80	73	11	38	32	68.2	67	59	64
60	80	72	11	37	32	67.8	67	59	64
LSD (0.05)	NS	NS	NS	8	NS	0.4	NS	2.5	
Mean	80	72	11	33	32	68	67	58	64

[1]Days after planting [2]% flowering on 6 August [3]% flowering on 14 August [4]% flowering on 28 July

[5]Only includes data from Carrington, Langdon, and Prosper [6]Differences among means are not statistically significant

[7]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 40, 60, 80, 100; Langdon 2002 = 38, 60, 80, 100; St. Hilaire = 47, 67, 87, 107; Oklee = 42, 62, 82, 102; Minot = 40, 60, 80, 100; Langdon 2003 = 47, 60, 80, 100; Thief River Falls = 58, 78, 98, 118.

Increasing the seeding rate tended to increase plant height at maturity, but the difference was only significant at St. Hilaire (Table 4). Plant height in 2002 increased with the addition of N fertilizer at the two Minnesota sites and in Carrington, but not in Minot. No effect was observed in 2003. Seed test weight increased with seeding rate at Langdon in 2002 and decreased with N fertilization in Thief River Falls, but not at the other sites where this parameter was measured (Table 5).

Differing niger thistle flowering timings in relation to seeding rate and nitrogen level.

Table 4. Niger plant height (inches) at maturity response to seeding rate and nitrogen level, 2002-03.

Treatment	Carrington	St. Hilaire	Oklee	Minot	Carrington	Langdon	Thief River Falls	Mean
	---------- 2002 ----------				---------- 2003 ----------			
Seeding Rate (lb / acre)								
3	53.6	26.1	44.5	25.0	nd	35.6	47.5	38.7
6	54.3	30.6	46.0	25.6	nd	36.1	46.8	39.9
9	53.7	32.4	45.7	26.0	nd	35.7	48.1	40.3
LSD (0.05)	NS	2.9	NS	NS	---	NS	NS	
N Level (approximate lbs total N / acre) [1]								
17	--	--	--	24.0				
40	50.7	27.4	43.3	26.1	nd	36.3	48.2	38.7
60	53.4	29.7	45.9	25.4	nd	35.7	47.1	39.5
80	54.3	29.3	46.5	25.9	nd	35.6	47.2	39.8
100	57.1	32.4	45.8	26.1	nd	35.5	47.5	40.7
LSD (0.05)	NS	3.4	2.2	1.5	---	NS	NS	
LSD (0.01)				2.0				
Mean	53.9	29.7	45.4	25.5	---	35.8	47.5	

[1]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 40, 60, 80, 100; Langdon 2002 = 38, 60, 80, 100; St. Hilaire = 47, 67, 87, 107; Oklee = 42, 62, 82, 102; Minot = 40, 60, 80, 100; Langdon 2003 = 47, 60, 80, 100; Thief River Falls = 58, 78, 98, 118.

Table 5. Niger test weight (lb / bushel) in response to seeding rate and nitrogen level, 2002-03.

Treatment	Carrington	Langdon	Carrington	Langdon	Thief River Falls	Mean
	------- 2002 --------		---------- 2003 ----------			
Seeding Rate (lb / acre)						
3	42.2	38.1	47.4	43.2	44.7	43.1
6	41.2	39.0	47.3	42.9	44.5	43.0
9	42.0	41.2	47.5	43.2	44.8	43.7
LSD (0.05)	NS	1.5	NS	NS	NS	
N Level (lbs fertilizer N added) [1]						
0	41.4	39.8	47.8	43.2	45.0	43.4
20	42.3	40.1	47.3	43.0	45.0	43.5
40	42.2	39.3	47.0	43.0	44.6	43.2
60	41.3	38.6	47.4	43.2	43.9	42.9
LSD (0.05)	NS	NS	NS	NS	0.6	
Mean	41.8	39.4	47.4	43.1	44.7	

[1]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 40, 60, 80, 100; Langdon 2002 = 38, 60, 80, 100; St. Hilaire = 47, 67, 87, 107; Oklee = 42, 62, 82, 102; Minot = 40, 60, 80, 100; Langdon 2003 = 47, 60, 80, 100; Thief River Falls = 58, 78, 98, 118.

Yield increased numerically with seeding rate at most sites, but the response was only significant at Langdon and St. Hilaire in 2002 (Table 6). Based upon these results, the seeding rate recommendation should be increased from 6 to 9 lbs / acre. A higher plant density will tend to increase the uniformity of maturation, but may increase problems with Sclerotinia and other diseases. Small, but statistically significant, yield increases were observed with increasing levels of N fertilizer at St. Hilaire. However, at all other sites and in the overall means across sites, N fertilizer did not affect yield. Although this result is somewhat surprising, it may be due to the evolution of the crop on low-N soils, resulting in plants which are excellent N-scavengers or efficient N-users. Mean yield by site was highly variable, but encouraging when yield-limiting factors are considered. The yield of nearly 700 lbs. / acre at Langdon in both years is considered exceptional and the yields approaching 500 lbs. at Carrington in 2003 and Oklee are very good. Yields at Carrington in 2002 were undoubtedly affected by severe lodging, which complicated the swathing process, while the plots in St. Hilaire were stressed by excess moisture. Prosper plots were sown very late (13 June) and a yield of almost 300 lbs. / acre speaks well for the fit of the EarlyBird cultivar in this region. Growing conditions in Minot were extremely dry for much of both seasons and 2003 yields were further compromised by late planting and grasshopper damage.

Table 6. Niger yield (lb / acre) as influenced by seeding rate and nitrogen level, 2002-03.

Treatment	Carrington	Langdon	St. Hilaire	Oklee	Prosper	Minot	Carrington	Langdon	Thief River Falls	Minot	Mean
	2002						2003				
Seeding Rate (lb / acre)											
3	307	620	244	475	312	199	508	679	415	116	388
6	345	663	360	476	285	230	548	680	422	125	413
9	364	800	377	543	292	227	418	686	448	116	427
LSD (0.05)	NS	80	77	NS[1]	NS	NS	NS	NS	NS	NS	
N Level (approximate lbs total N / acre) [3]											
40	347	715	245	514	nd[2]	237	515	724	476	109	431
60	376	717	311	512	277	217	487	660	438	110	410
80	323	698	351	484	290	209	496	685	428	125	409
100	311	647	400	482	322	204	465	657	370	107	396
LSD (0.05)	NS	NS	89	NS	NS	NS	NS	NS	69.5	NS	
Mean	339	694	327	498	296	219	491	682	428	119	412
C.V. (%)	23.9				22.0	10.1	39.6				

[1]Differences among means are not statistically significant at $P < 0.05$

[2]not determined

[3]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 40, 60, 80, 100; Langdon 2002 = 38, 60, 80, 100; St. Hilaire = 47, 67, 87, 107; Oklee = 42, 62, 82, 102; Minot = 40, 60, 80, 100; Langdon 2003 = 47, 60, 80, 100; Thief River Falls = 58, 78, 98, 118.

An economic analysis of production costs has shown the break-even yield to be 310 lbs. / acre and this value includes a $20 / acre management fee for the grower. Based upon this benchmark, the yields obtained in this trial are very encouraging. Mean yields from seven of the 10 site-years are higher than this benchmark and late planting (which can be corrected) undoubtedly contributed to the poor performance in two of the remaining three sites.