Niger Thistle Response to Nitrogen Fertilizer

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Introduction

Niger thistle (*Guizotia abyssinica* (L.f.) Cass.) is an annual plant which belongs to the sunflower family. The crop is used exclusively as bird seed in the U.S.A., but is valued as an oilseed in other countries. Currently, the entire U.S. usage of niger (approximately 32,000 metric tons annually) is imported.

Initial evaluations of niger in Minnesota and North Dakota showed that the cultivar(s) planted were not adapted to the relatively short growing season in this region (Robinson, 1986; Diaz, 1993). The selection of an earlier-maturing cultivar ('Earlybird') was the basis for the current cycle of niger research by the University of Minnesota and North Dakota State University. Planting rate studies in 2000 and 2001 (7 site-years) showed that, compared to rates as low as 0.6 kg ha^{-1}, seeding rates of 6.7 and 10.1 kg ha^{-1} resulted in higher yields, faster canopy closure to suppress weeds, and more uniform flowering and maturation (Kandel et al., 2004).

Although herbicides have been labeled for niger in Minnesota and North Dakota and insect and disease pests have been identified, relatively little is known about agronomic management of the crop. The effect of nitrogen (N) fertilization is a recurring question.

Objective

The objective of this project was to study the effects of four N fertilizer rates on disease development, lodging, maturity, and yield of niger thistle at three seeding rates.

Materials and Methods

Field experiments with the cultivar 'Earlybird' were conducted in a randomized complete block design with four replicates at the North Dakota State University Carrington, Langdon, and North Central (Minot) Research Extension Centers (2002-2003), the NDSU research site at Prosper (2002), and on-farm locations in northwest Minnesota (St. Hilaire and Oklee in 2002, Thief River Falls in 2003). Plot size was approximately 1.5 x 6.7 m, with 0.15-0.30 m row spacing (Table 1).

Four N fertility levels and three seeding rates were arranged in a factorial configuration. On fields with a soil test of approximately 45 kg NO_3^--N ha^{-1} in the top 60 cm (Table 1), N rates of approximately 0, 23, 45, 67 kg fertilizer N ha^{-1} (see footnote 1 on Table 3) were compared. The best seeding rate in previous trials (6.7 kg ha^{-1}) was compared to one lower and one higher rate (3.4 and 10.1 kg ha^{-1}, respectively).

Table 1. Site 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 (kg ha^{-1}, 0 - 60 cm)	43	43	53	47	62	35	53	65	38
P (ppm, 0 - 15 cm)	52	20	16	7	24	12	17	82	15
K (kg ha^{-1}, 0 - 15 cm)	239	460	185	102	511	275	nd[1]	330	539
pH	8.0	7.2	7.9	7.5	7.7	6.2	nd	7.0	6.3
Organic Matter (g kg^{-1})	32	37	35	29	64	41	nd	34	31
Row Spacing (cm)	18	15	15	15	30	18	15	15	15.00
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.	1 Sept	15 Sept.
Combine Date	16 Oct.	26 Sept.	14 Oct.	15 Oct.	15 Oct.	6 Oct.	15 Sept.	11 Sept	6 Oct.

[1]not determined

Niger two months after planting.

Niger thistle at flowering.

Results and Discussion

The cultivar Earlybird matured within the growing season at all sites. Across seeding rates, stand decreased as N fertilizer increased in Oklee, but no relationship was observed at the other sites (data not shown). Increasing the seeding rate reduced the time to flowering at all sites except Prosper, where it had no effect, while increasing the rate of N fertilizer had a minimal effect at the North Dakota sites (data not shown). In Oklee and Thief River Falls, increasing N rates also advanced the development of flowering.

Niger thistle seeding rates of 3.4 kg ha^{-1}, left, and 10.1 kg ha^{-1}, right.

Increasing the seeding rate tended to increase plant height at maturity, but the difference was only significant at St. Hilaire (Table 2). 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 was not affected by treatments at the other sites where this parameter was measured (data not shown).

Table 2. Niger plant height (m) at maturity in response to seeding rate and nitrogen level, 2002-03.

Treatment	Carrington	St. Hilaire	Oklee	Minot	Langdon	Thief River Falls	Mean
	2002				2003		
Seeding Rate	m						
(kg ha^{-1})							
3.4	1.36	0.66	1.13	0.64	0.90	1.21	0.98
6.7	1.38	0.78	1.17	0.65	0.92	1.19	1.01
10.1	1.36	0.82	1.16	0.66	0.91	1.22	1.02
LSD (0.05)	NS	0.07	NS	NS	NS	NS	
N Level							
(approximate kg total N ha^{-1})[1]							
45	1.29	0.70	1.10	0.66	0.92	1.22	0.98
67	1.36	0.75	1.17	0.65	0.91	1.20	1.00
90	1.38	0.74	1.18	0.66	0.90	1.20	1.01
112	1.45	0.82	1.16	0.66	0.90	1.21	1.03
LSD (0.05)	NS	0.09	0.06	NS	NS	NS	

[1]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 45, 67, 90, 112; St. Hilaire = 53, 75, 98, 120; Oklee = 47, 70, 92, 115; Minot = 45, 67, 90, 112; Langdon = 53, 67, 90, 112; Thief River Falls = 65, 88, 110, 132.

Niger thistle maturing.

Yield increased numerically with seeding rate at most sites, but the response was only significant at Langdon and St. Hilaire in 2002 (Table 3). A higher plant density will tend to increase the uniformity of maturation, but may increase problems with *Sclerotinia sclerotiorum* 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. Yields in excess of 760 kg ha^{-1} at Langdon in both years are considered exceptional and the yields of approximately 550 kg ha^{-1} at Carrington in 2003 and Oklee are very good. Severe lodging, excess moisture, drought, late planting, and grasshopper damage contributed to reduced yields in the other site-years.

Pollination of niger thistle.

Table 3. Niger yield (kg ha^{-1}) 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	kg ha^{-1}										
(kg ha^{-1})											
3.4	345	696	274	533	350	223	570	762	466	130	436
6.7	387	744	404	534	320	258	615	763	474	140	464
10.1	409	898	423	610	328	255	469	770	503	130	479
LSD (0.05)	NS	90	86	NS[1]	NS	NS	NS	NS	NS	NS	
N Level											
(approximate kg total N ha^{-1})[2]											
45	390	803	275	577	nd[2]	266	578	813	534	122	484
67	422	805	349	575	311	244	547	741	492	123	460
90	363	784	394	543	326	235	557	769	481	140	459
112	349	726	449	541	362	229	522	738	415	120	445
LSD (0.05)	NS	NS	100	NS	NS	NS	NS	NS	78	NS	
Mean	381	779	367	556	332	246	551	766	481	134	463
C.V. (%)	23.9	--	--	--	22.0	10.1	39.6				

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

[2]Actual values of the total N levels at each site: Carrington 2002 and 2003 = 45, 67, 90, 112; Langdon 2002 = 43, 67, 90, 112; St. Hilaire = 53, 75, 98, 120; Oklee = 47, 70, 92, 115; Minot = 45, 67, 90, 112; Langdon 2003 = 53, 67, 90, 112; Thief River Falls = 65, 88, 110, 132.

An economic analysis of production costs in North Dakota has shown the break-even yield to be 348 kg ha^{-1} and this value included a $50 ha^{-1} management fee for the grower (S. Metzger, personal communication). 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 break-even level and late planting (which can be corrected) undoubtedly contributed to the poor performance in two of the remaining three sites. Although a U.S. market is already established, marketing domestic production continues to be a major challenge in the adoption of niger thistle.

Summary

These results provide further evidence of the potential for niger as an alternative crop in the Northern Plains. Adapted cultivars are available and agronomic management is being refined. Productivity at low seeding rates and the lack of response to N fertilizer suggest that niger is a low-input crop. However, marketing of farm production continues to limit adoption.

Literature Cited

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Acknowledgments

The authors wish to thank J. Rau, J. Forde, L. Sheen, C. Wolf, T. Indergaard, T. Ingebretson, Betty Montgomery and Paula Petersen for capable technical assistance and M. Friedt for poster preparation.

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