Flax Response to Nitrogen and Seeding Rates

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Abstract

A field trial was conducted in 2001-03 by North Dakota State University to evaluate flax (*Linum usitatissimum* L.) Response to selected soil nitrogen (N) levels and seeding rates. Soil N levels included an untreated check (soil NO_3-N < 67.2 kg ha^{-1} sampled at the 0- to 61-cm depth) and 67.2, 100.8, and 134.4 kg N ha^{-1}. 'Cathay' flax was seeded at 22.4, 35.8, and 49.3 kg ha^{-1}, and also at 62.7 kg ha^{-1} in 2002-03. Soil N levels of ≤ 100.8 kg N ha^{-1} were sufficient for highest seed yield in the trial. Soil N did not impact plant lodging. Generally seed oil content decreased with > 67.2 kg N ha^{-1}, and alpha linolenic acid (ALA) concentration decreased with increasing soil N rates. Seeding rates of 22.4 kg ha^{-1} (average of 355 plants m^{-2}) resulted in similar seed yield and plant lodging as higher rates.

Introcuction

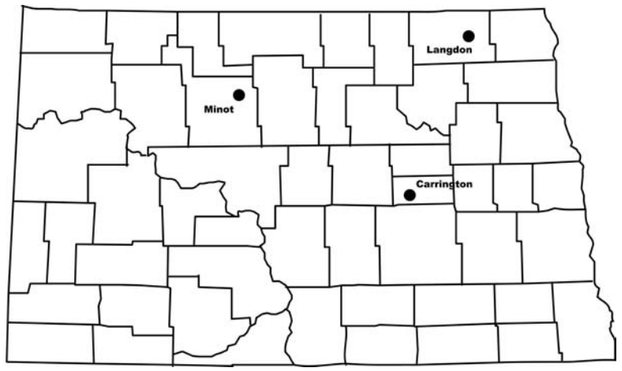
North Dakota State University recommendations for flax production are 3.4 kg N for each 35.2 liters of yield goal. Seeding rate recommendations range from 22.4 to 50.4 kg ha^{-1}, depending on yield goal. Currently, research is needed to confirm these recommendations for intensely-managed flax.

Objectives

- Determine flax plant lodging and seed yield response to increasing soil N levels and seeding rates.
- Determine the influence of soil N on seed oil content and ALA concentration.

Materials and Methods

The field trial was conducted on loam soils in 2001-03 at the NDSU Research Extension Centers in Carrington, Langdon and Minot. Experimental design was a randomized complete block with a split-plot arrangement and four replications. Main plots were soil N treatments and sub-plots were seeding rates. Soil N levels included an untreated check (soil NO_3-N < 67.2 kg ha^{-1} sampled at the 0- to 61-cm depth) and 67.2, 100.8, and 134.4 kg N ha^{-1} (seed yield goals of < 22.4, 22.4, 33.6, and 44.8 kg ha^{-1}, respectively). Pre-trial soil N levels varied by site-year: Carrington 34.7 to 59.4 kg ha^{-1}; Langdon 41.4 to 56 kg ha^{-1}; and Minot 19.0 to 61.6 kg ha^{-1}. Fertilizer N was preplant broadcast applied to reach the selected soil N levels. 'Cathay' flax was seeded at 22.4, 35.8, and 49.3 kg ha^{-1}, and also at 62.7 kg ha^{-1} in 2002-03.



North Dakota research locations.

Acknowledgments

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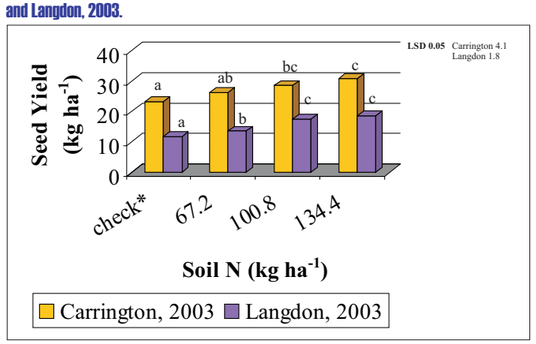
Results and Discussion

Soil N

Seed yield. Soil N affected flax seed yield at two of eight site-years (Figure 1). At the two site-years, yield generally increased up to 100.8 kg ha^{-1} of soil N. Plant lodging at each site-year generally did not differ among N rates (data not shown). The only exception was at Carrington in 2003, but lodging was minimal and had no effect on yield. Also, there were no significant soil N by seeding rate interactions for lodging or yield.

Figure 1. Flax response to soil N (across seeding rates), Carrington and Langdon, 2003.



*untreated check soil N (0- to 61-cm depth): Carrington = 34.7 and Langdon = 56.0 kg ha^{-1}.

Untreated, left, versus 67.2 kg N ha^{-1}, right, Carrington, 2003.

Oil content. Seed oil content decreased with increased soil N in six of eight site-years (Table 1). Oil content generally decreased with soil N > 67.2 kg ha^{-1}.

Table 1. Soil N affect on flax seed oil content, ND, 2001-03.

Soil N	Langdon 2001	Minot 2001	Carrington 2002	Minot 2002	Carrington 2003	Langdon 2003	Average
(kg ha^{-1})			Seed Oil %				
check	39.7b	-	40.3a	43.1a	46.5a	43.8a	42.7
67.2	41.1a	42.1a	40.5a	43.3a	45.6b	43.6a	42.7
100.8	38.0c	41.3b	39.6b	42.8b	44.9c	42.3b	41.5
134.4	40.8a	41.6b	38.9c	43.0a	43.6d	42.2b	41.7
LSD 0.05	*0.7*	*0.4*	*0.7*	*0.3*	*0.6*	*0.8*	--

ALA concentration. ALA concentration was affected by soil N in five of eight site-years (Table 2). ALA generally decreased with increased soil N.

Table 2. Soil N affect on ALA concentration of seed oil, ND, 2001-03.

Soil N	Minot 2001	Minot 2002	Carrington 2003	Langdon 2003	Minot 2003	Average
(kg ha^{-1})			ALA (%)			
check	--	51.9a	54.3a	56.6ab	50.8a	*53.4*
67.2	48.3a	51.9a	53.3b	56.9a	50.0c	*52.1*
100.8	47.3b	51.4b	52.7c	56.2b	50.3b	*51.6*
134.4	47.8ab	51.3b	51.8d	55.5c	50.4b	51.4
LSD 0.05	*0.6*	*0.3*	*0.3*	*0.5*	*0.3*	--

Seeding Rates

Seed yield. Flax seeding rate had minimal effect on seed yield. Yield was affected by seeding rate in two of eight site-years (Figure 2). Seeding rates of 22.4 kg ha^{-1} generally provided similar seed yield as higher rates. Seed yield averaged across site-years and soil N was 21.3, 21.4, 20.5, and 21.1 kg ha^{-1} with seeding rates of 22.4, 35.8, 49.3, and 67.2 kg ha^{-1}, respectively. Plant lodging did not differ among seeding rates (data not shown). Trial average and range of flax plant density (three to four weeks after planting) across site-years based on seeding rates are shown in Figure 3. With minimal effect on yield with seeding on a kg ha^{-1} basis, there would appear to be no advantage with using a more precise seeding rate based on the number of pure live seeds ha^{-1}.

Figure 2. Flax yield response to seeding rates (across soil N), Langdon and Minot, 2002.

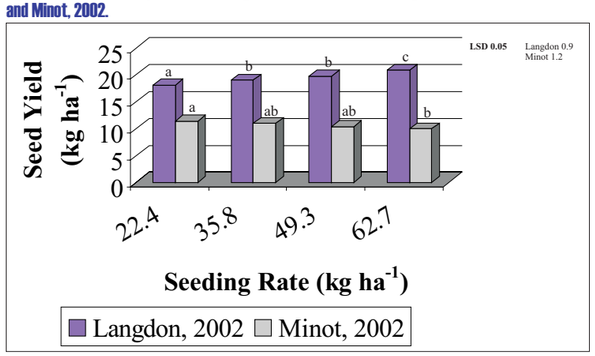
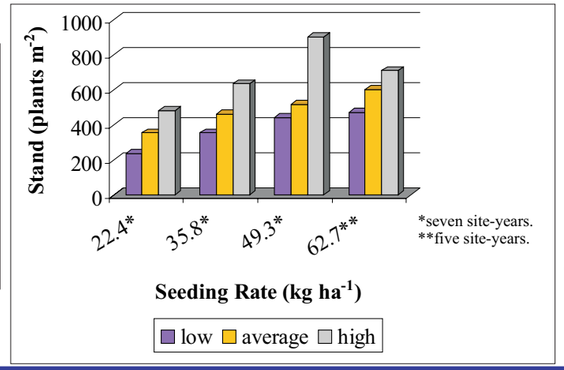


Figure 3. Flaxplant density with seeding rates, Carrington, Langdon, and Minot, 2001-03.



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