Fertilizing Flax

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Nitrogen

In contrast to the aggressive fertilizer nitrogen strategy used in wheat production, a more conservative approach is used with flax.

Although yield increases are possible when nitrogen is applied to flax, other factors are often more important than nitrogen rate. Excessive nitrogen rates may actually reduce yield potential by stimulating more vegetative growth, causing greater susceptibility to disease and lodging.

For these reasons, the formula for nitrogen application is similar to previous recommendations (3 X Yield Goal), but there is a need to impose an upper limit of 80 lb. N/acre from residual soil nitrate-N and nitrogen amendments into the equation. Since most growers would be reluctant to choose a yield goal of under 25 bu./acre, a more appropriate recommendation would be to use a flat rate of 80 lb. N/acre as the base rate.

Nitrogen recommendation for flax

80 lb. N/acre - STN - PCC
 STN = soil test nitrate-N sampled to 2 feet in depth
 PCC = previous crop N credit (40 lb. N/acre if the previous crop was an annual legume)

In our soils, the use of this conservative formula will not result in under-fertilization of flax with nitrogen. In years where higher yields are possible, mineralization of organic matter N will easily supply the extra needs of the flax crop. In years with more normal or depressed yields due to environment, the N rate will be high enough to nourish the crop, but not high enough to promote disease or lodging.

The use of an 80 lb./acre base N rate is supported by previous work in Canada, South Dakota and North Dakota, as well as recent N calibration work at NDSU (Table 1). In the North Dakota studies, seed oil content was generally reduced at rates greater than 60 lb. N/acre, and alpha linolenic acid content of the oil was reduced in five of eight site years with increasing N rates.

Table 1. Summary of N rate studies at Carrington and Langdon, 2001-2003.

N lb./acre	C* 2000	C 2001	C 2002	C 2003	L 2001	L 2002	L 2003
		Yield, bu/acre					
Check**	—	23.7	19.9	20.7	18.0	12.6	15.7
60	26.2	25.8	19.6	23.4	16.8	13.3	17.8
90	26.6	25.5	21.9	25.5	16.6	10.5	20.6
120	23.3	30.8	20.4	27.6	18.3	13.3	22.1
Significance	NS	NS	NS	3.7	NS	NS	1.6

* C = Carrington, L = Langdon

** Check residual N levels, lb./acre:
Carrington 2000, 36; Carrington 2001, 44; Carrington 2002, 53; Carrington 2003, 31-53; Langdon 2001, 38; Langdon 2002, 37; Langdon 2003, 37-50 lb/acre.

Nitrogen may be applied as anhydrous ammonia preplant. However, it is advisable to apply the anhydrous at a slight angle to the intended direction of planting so that if seedling damage does occur, no large gaps will develop within a row (Figure 1).

Figure 1.Spring wheat seedling damage from a fall anhydrous ammonia application in high carbonate soils.

Click here or on photo for a larger view.

Urea or liquid sources of nitrogen may be applied preplant and incorporated into the soil prior to seeding. Manure rates should be modest, as predicting the actual nitrogen availability from the manure is difficult.

Phosphate

Flax is not very responsive to phosphate (P) fertilizer. Mycorrhizae are soil fungi that live in a symbiotic relationship between most plants (except for those in the mustard and lambsquarter families). The mycorrhizae receive carbohydrates from the plants, and in return, the plant receives mineral nutrients from the mycorrhizae, particularly phosphate. Mycorrhizae hyphae (small root-like structures, Figure 2) explore the soil within a couple feet of the host plant and are very good at mobilizing P from the soil and transferring it to the host. Research in Manitoba has shown that when flax is not fertilized with P, yield is maintained and mycorrhizae infection is high. When flax receives fertilizer P, banded or broadcast, mycorrhizae infection is reduced.

Figure 2.Mycorrhizae fungi (vesicular arbuscular mycorrhizae) infection of a flax root *(left)*. The netting-like filaments are mycorrhizae hyphae. The dark circles are the arbusculs, where the transfer of nutrients between host and fungi occur. At the right, a flax root without mycorrhizae infection. *(Images courtesy of Dr. Marcia A. Monreal, Microbiologist, Agriculture and Agri-Food, Brandon, MB).* Click here for a larger view.

Most of the P application studies conducted on flax in Canada and the United States show no yield increase with P fertilizer. Therefore, it appears unlikely that flax will show an economic response to P application unless the soil is extremely low in available P. Table 2 illustrates typical results in the two countries.

Table 2. Summary of 15 site years of phosphate application to flax. *(Rasc, 1980, Canada.)*

Soil test P levels	Number of sites	Yield, bu./acre	
		No P applied	20 lb./acre P_2O_5
Very Low	3	17	16
Low	3	15	14
Medium	4	19	17

High	5	18	17

An exception to this may be to flax seeded following fallow or a non-mycorrhizae supporting crop. However, it would be best to choose another crop in these circumstances than seed flax after fallow.

Since yield increase is seldom achieved through the application of P, no P fertilizer is recommended directly to flax. However, maintaining soil test P for wheat, corn and other crops, including flax, is important.

Growers should increase the frequency of soil testing for P between crops so the appropriate amount of P is applied to nourish other more responsive crops in the rotation.

Phosphate can be applied to flax to serve as a carrier for zinc (Zn), but the grower should not expect a yield increase due to the P portion of the application. Some sources of P fertilizers also contain some cadmium. Application of some sources of unnecessary P fertilizer with flax may increase seed cadmium concentration.

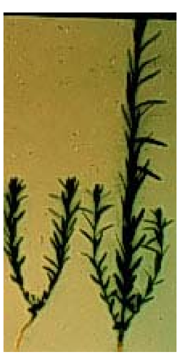
Fertilizer placement with seed

Flax germination and young flax seedlings are sensitive to fertilizer salts and free ammonia. Growers who insist on application of fertilizer with the seed should limit the application to maximum N levels with the seed as shown in Table 3. Application of banded P may increase susceptibility to zinc deficiency unless zinc fertilizer is added.

Table 3.Maximum rates of N that can be placed in the seed row with flax. Alberta Ag, 2002.

	Width of fertilizer spread in the row											
	1 inch (disc or knife)			**2 inches (hoe opener)**			**3 inches (sweep)**			**4 inches (sweep)**		
Row Spacing	6"	**9"**	12"	6"	**9"**	12"	6"	**9"**	12"	6"	**9"**	12"
Seed bed utilization, %	17	11	8	33	22	17	50	33	25	67	44	33
	Pounds of N per acre											
Sandy Loams	10	5	0	20	15	10	30	10	15	40	25	20
Loam to clay loam	15	10	5	30	20	15	40	30	20	50	35	30
Clay	20	15	10	40	30	20	50	40	30	60	45	40

Zinc



If soil zinc levels (DTPA extract) are less than 1 ppm, application of zinc is recommended. Zinc deficiency is expressed as a condition known as "chlorotic dieback" (Figure 3). Zinc-deficient plants are pale and the growing point may die (Moraghan, 1978). Later in the season, the plants may sprout new shoots from lower nodes and form a candelabra appearance and maturity may be delayed.

Figure 3.Zinc deficiency in flax — "chlorotic dieback." Death of terminal bud stimulates growth of stems from axillary buds, resulting in a candelabra effect.

Application of 5-10 lb. Zn as Zn-sulfate in larger granules the seeding year may not be fully effective immediately. Application the fall before seeding may allow better Zn dispersion for more efficient crop utilization the following spring. Fine granular Zn-sulfate is available and 3-5 lb./acre Zn could be applied through granular herbicide applicators prior to seeding with more immediate results. Side-banded treatments of 1 qt./acre Zn-chelate or an ammoniated Zn liquid fertilizer may also be effective. Rescue foliar treatments can be used, but some yield loss may have already taken place. It is best to soil test prior to seeding and if Zn is deficient, apply Zn at or before seeding.

Potassium

Low potassium levels are possible in some sandy soils. If low soil potassium levels are found, apply broadcast rates as indicated in Table 4. Avoid a general application of 0-0-60, potassium chloride, where possible, especially when growing food grade flax seed. Chloride binds chemically with cadmium in the soil and increases cadmium concentration in the seed. On the other hand, application of Zn decreases cadmium absorption in flax and other crops. Other options for potassium sources include potassium sulfate, or a liquid fertilizer derived from potassium hydroxide.

Table 4.Nutrient recommendations for flax. *(N and K)*

Yield goal	Soil N plus fertilizer N required	VL	L	M	H	VH
		Soil Test Potassium, ppm				
		0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'	K_2O, lb/acre				
30	80	58	41	24	7	0
40	80	77	54	32	10	0
50	80	96	68	40	12	0

Iron chlorosis

Iron chlorosis is often confused with Zn deficiency, and sometimes they appear together. Iron chlorosis is most likely in early spring during cold, wet weather. The chlorosis appears as yellowing of upper leaves and is interveinal. The condition may be more severe in saltier areas of a field.

Foliar applications of iron are seldom effective in increasing yield, although they may green up the crop. In most years, the chlorosis will quickly disappear with warmer, drier weather.

Other nutrients

Sulfur deficiency is seldom reported, but over-application of nitrogen or lack of adequate soil levels of sulfur may result in deficiency on low organic matter, coarse textured soils. A reliable soil test for sulfur is not available. If there are low organic matter, coarse textured soils on a field with a history of sulfur deficiencies in other crops, application of a soluble sulfate source to these areas before planting should prevent possible nutrient stress.

Flax is an ancient crop. There is evidence that it was cultivated in the Middle East as early as 7000 BC.

Ancient Egyptians used it extensively as a fiber crop for linen production, while other peoples utilized the seed for food as well as the fiber.

Today, growers in Canada and the United States grow seed flax varieties.

For detailed information on general flax cultivation, see NDSU Extension Service publication A-1038 "Flax Production in North Dakota."

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For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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