

## Flax Response to Nitrogen and Phosphorus Fertilization

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### Introduction

Flax has the potential to become a major source of oil for bio-diesel or bio-products because it is well adapted to Montana's climate and provides a needed rotational crop for inclusion into the dominant, small grain cropping system of Montana. Historically flax was an important crop in Montana. According to the Montana Agricultural Statistics Service, the first reported harvested flax acreage occurred in 1902, and peaked at 515,000 acres in 1943. Flax acreage gradually declined and no harvested acreage was reported from 1978 until 1998. Flax acreage appeared again in 1999 and has steadily increased to 53,000 harvested acres in 2005. In Montana, flax nutrient management information is non-existent; therefore, fertilizer experiments were initiated with the following objectives: to evaluate seed yield, oil content, and oil quality response of dryland flax to nitrogen (N) and phosphorus (P) fertilization in North Central Montana.

### Methods

Flax was planted in a randomized complete block, factorial design with the following fertilizer treatments: 0, 30, and 60 lb N/ac as urea, applied as broadcast, or banded, and 0, 15, and 30 lb P<sub>2</sub>O<sub>5</sub>/ac as triple super phosphate applied with the seed. In addition, all plots received 25 lb K<sub>2</sub>O/ac as KCl applied broadcast. All locations, except at WTARC, were planted no-till into previously fallowed land or following barley. Flax was seeded into

tilled fallow at WTARC. Soil test results are shown in Table 1.

### Results

Seed yield results of the N responsive sites are presented in Figure 1. In general, optimum flax seed yields occurred near 100 lb N/ac, although most yields had not completely reached a plateau at the highest fertilizer N rate. The Cut Bank and Sunburst locations in 2004 had high yield variability and high soil N levels and are not shown. Yields at Sunburst in 2005 were higher than at the other sites, because this site received much more July and August precipitation than the other locations. Average yields ranged from 425 to 1243 lb seed/ac in 2004 and 792 to 1527 lb/ac in 2005. As shown in Table 2, only WTARC in 2004 and Joplin in 2005 responded to P; however, the Sunburst location in 2005 had a significant N x P interaction. Average seed oil contents ranged from 40.2 to 42.2% (data not shown). Seed oil concentration declined slightly at six locations as N levels increased. In 2004, P fertilization increased seed oil content slightly at WTARC but did not affect seed oil concentration at the remaining locations. Fatty acid composition of seed oil was generally unaffected by N or P fertilization. Uptake of N by flaxseed ranged from 32 to 55 lb N/ac, and P uptake ranged from 10 to 15 lb P<sub>2</sub>O<sub>5</sub>/ac, respectively.

# Fertilizer

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Table 1. Soil test results by location, 2004-2005.

Test	Cut Bank		Joplin		Sunburst		WTARC	
	2004	2005	2004	2005	2004	2005	2004	2005
pH	9.1	8.4	8	8.2	8.1	6.5	8.6	8.3
O.M. (%)	1.9	2.2	1.3	1.5	1.9	3.7	2.4	2.2
P (ppm)	4.5	7.4	18.9	10	40.2	27.5	16.4	12.1
K (ppm)	228	343	366	326	436	568	246	290
NO <sub>3</sub> -N 0-3 ft (lb/ac)	92	39	57	70	97.6	28	81	58
SO <sub>4</sub> -S 0-3 ft (lb/ac)	129	531	2089	1476	2827	153	820	5521

Table 2. Effect of P fertilization on flax seed yield, 2004-2005.

P <sub>2</sub> O <sub>5</sub> Rate (lb/ac)	Year - Location							
	2004				2005			
	Cut Bank	Joplin	Sunburst	WTARC	Cut Bank	Joplin	Sunburst	WTARC
	Flax seed yield (lb/ac)							
0	723 a	1002 a	440 a	1214 a	999 a	869 a	1548 a	840 a
15	730 a	999 a	433 a	1291 b	1018 a	942 b	1537 a	764 a
30	702 a	1023 a	402 a	1226 ab	1027 a	938 b	1495 a	771 a
	Probability of N and P interactions and summary statistics							
Interaction	0.674	0.711	0.897	0.392	0.142	0.955	0.029	0.133
Mean Yield	718	1008	425	1243	1015	916	1527	792
CV (%)	17.3	9	12.3	6.8	7.8	8.1	4.8	31.1

Yield means with the same letter are not significantly different according to the LSD (P=0.05).

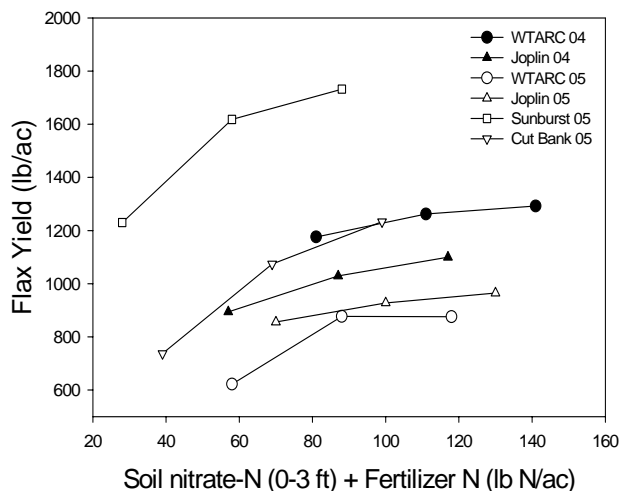


Figure 1. Effect of N on flax seed yield.

### Fertilizer Facts:

- Optimum N levels including soil nitrate-N (0-3 ft) and fertilizer N should be approximately 80 to 100 lb N/ac.
- Flax seed oil content averages about 41% and will decline slightly with increasing N level.
- Flax response to P is unpredictable, but when it occurs, maximum response is at 15 lb P<sub>2</sub>O<sub>5</sub>/ac.
- Uptake of P<sub>2</sub>O<sub>5</sub> by flax seed is about 10 to 15 lb P<sub>2</sub>O<sub>5</sub>/ac.
- Uptake of N by flax seed is approximately 32 to 55 lb N/ac.
- Fatty acid content of flax seed is apparently unaffected by N or P fertilization.

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