RESPONSE OF CAMELINA TO NITROGEN, PHOSPHORUS, AND SULFUR

Grant D. Jackson
Montana State University, Conrad, MT
gjacksons@montana.edu (406) 278-7707

ABSTRACT

Camelina (*Camelina sativa)* has been introduced as feed stock for bio-products, but information about its nutrient requirements are lacking. Experiments were initiated to determine the seed yield, seed oil, N, P, K, and S content, and fatty acid composition of the oil response of camelina to N, P, and S additions and to determine if the response is related to appropriate soil tests. Data from six locations indicated that camelina needs about 80 lbs N/acre for optimum seed yields and oil content. Seed oil contents averaged about 40% and declined slightly with increasing N. Camelina responded to P fertilization at all locations with P soil test levels less than 12 ppm; however, camelina did not respond to S. Mean seed levels of N, P, K, and S were 3.9%, 0.5%, 0.8%, and 0.6%, respectively, and seed N and S content increased with increasing N while P and K concentration declined. Phosphorus and S fertilization did not affect the measured seed nutrient levels. The fatty acid composition of the oil was unaffected by N, P, or S fertilization.

INTRODUCTION

Consumption of biodiesel is expected to increase in the United States at a rate between 6-14% annually. The issue with biodiesel has been cost, and since 75 % of this cost is in the base oil ingredient, a crop with relatively low inputs could reduce biodiesel production costs. Camelina (McVay and Lamb, 2007) shows considerable promise as an oilseed suitable for bio-products and low-input cropping systems since it can be planted very early in the spring either by conventional or broadcast methods. This characteristic would allow the crop to be very competitive to traditional weed and insect pests without pesticides, as well as, a planting date before the usual spring grain planting season. This would allow a spreading of labor for producers who typically are rushed to complete spring planting within a narrow time frame. Experience indicates that a new crop has a better chance of becoming adopted if it can be planted and harvested before spring seeded small grains. Camelina seems "to fill the bill" for a widely adapted oilseed. A literature search on the nutrient requirements of camelina was conducted with mixed results (Putman et al., 1993; Robinson, 1987). For example one reference (Putman et al., 1993) indicates that the advantage of camelina is a low nutrient requirement, but in the same article, states that camelina probably has soil fertility needs similar to other crucifers of the same yield potential. Considerable canola fertilizer response data has been published in the past 15 years in Montana (Jackson, et al., 1993); however, before *Brassica napus* became the dominant canola species, research indicated that *B. napus* and *B. rapa* responded differently to phosphorus (P) and sulfur (S) fertilization. Thus some preliminary research on the response of camelina to nitrogen (N), P, potassium (K), and S is warranted or even necessary before fertilizer practices can be recommended for camelina production. Fertilizer recommendations can then be balanced with other production practices to maximize economic returns.

MATERIALS AND METHODS

Nitrogen rates of 0, 30, and 60 lbs N/acre, P_2O_5 rates of 0, 15, and 30 lbs/acre, and S rates of 0, 10, and 20 lbs/acre (0 and 15 lbs S/acre in 2006) were applied to 'Selena' camelina at several locations in 2005 and 2006. Due to funding cuts, only N treatments of 0, 30, 60, and 90 lbs N/acre were applied in 2007 at one location. Treatments were arranged in a randomized complete block design. Nitrogen as urea, 25 lbs/acre of potassium (K) as KCl, and S as potassium sulfate were applied while seeding in a band or approximately one inch above and to the side of the seed row or broadcast. Phosphorus fertilizer as 0-45-0 was applied with seed. Previous crops were conventional fallow or chemical fallow in 2005 and 2006 and barley in 2007. All plot areas were planted no-till except WTARC 2005. Soils were sampled initially for water, nitrate-N, and sulfate-S in one foot increments to a depth of three feet. Surface soil samples (0-6") were collected for standard soil analyses of pH, organic matter, phosphorus, etc. Soil test results are shown in Table 1. Plots were swathed and threshed with small plot equipment, and the seed weighed and tested for N, P, K, and S content, oil content, and fatty acid composition of the oil.

Table 1. Soil test results by location. Western Triangle Ag. Research Center. 2005-2007.

Test	Cut Bank 2005	Joplin 2005	WTARC 2005	Cut Bank 2006	Kalispell[1] 2006	WTARC 2007
pH	8.4	8.2	8.3	8.8	5.4	7.8
O.M. (%)	2.2	1.5	2.2	0.7	1.9	2.3
P (ppm)	7.4	10	12.1	5	46	28
K (ppm)	343	326	290	174	108	435
EC (mmhos/cm)	0.21	0.15	0.18	0.42	0.11	0.31
NO_3-N (lb/ac)	39	70	58	68	60	14
SO_4-S (lb/ac)	531	1476	2823	94	78	--

[1]Results from this location are from an 18" soil sample.

RESULTS AND DISCUSSION

The effects of N on camelina seed yield and oil content are shown in Figures 1 and 2. The Kalispell location was the only one that didn't have a positive or neutral yield response to N fertilization. These data indicate that producers need to have or apply about 80 lbs N/acre for optimum yield and oil content. Seed oil content usually averaged about 40 % except during 2007 and generally declined slightly with increasing N rate.

Camelina seed yields as affected by P and S fertilization are shown in Table 2. Since there were no significant interactions, only the main effects of P and S are shown. Four of the five locations responded to P, but P soil tests were all 12 ppm or less. The non-responding site had a very high soil test of 46 ppm. The responses were small, and, when soil tests are low or very low, growers should apply about 15 lbs of P_2O_5/acre and expect a yield increase of about 100 lb/acre. Sulfur fertilization did not affect seed yields in these experiments. Seed oil contents were unaffected by P or S fertilization (data not shown).

Seed content of N, P, K, and S, and seed fatty acid composition were determined at one location, Cut Bank, 2006. Nitrogen affected seed concentration of selected elements as shown in Table 3, and increasing N fertilizer increased N and S concentration but decreased P and K concentration. Phosphorus and S fertilization did not affect seed content of N, P, K, or S (data not shown). Mean N and S content of camelina was higher than reported for canola (Jackson, 2000), but P and K seed content was similar to canola. The oil was analyzed for seven fatty acids, and the fatty acid, carbon chain length, number of double bonds, and mean oil percentage are as follows: stearic (C18:0), 2.4%; oleic (C18:1), 16.3%; linoleic (C18:2), 19.1%; linolenic (18:3), 35.0%; arachidic (C20:1), 13.5%; EPA (C20:5), 2.1%; and DHA (C22:6), 0.6%. Nitrogen, P, and S generally did not affect fatty acid composition or concentration. Nitrogen fertilization increased stearic and decreased oleic slightly.

Table 2. Effect of phosphorus and sulfur on camelina seed yield. Western Triangle Ag. Research Center. 2005- 2006.

Treatment P_2O_5 or S	Location				
	Cut Bank 2005	Joplin 2005	WTARC 2005	Cut Bank 2006	Kalispell 2006
	----------lbs/acre----------				
Phosphorus Summary					
0	529 a	1391 ab	959 a	1582 a	1508 a
15	614 b	1386 a	1045 b	1757 b	1531 a
30	647 b	1524 b	1058 b	1670 ab	1497 a
P-value, Linear contrast	0.001	0.058	0.003	0.168	0.848
P-value, Quad. contrast	0.339	0.228	0.185	0.019	0.563
Sulfur Summary					
0	577 a	1430 a	1047 a	1644 a	1537 a
10	612 a	1437 a	1014 a	ND	ND
15	ND	ND	ND	1695 a	1487 a
20	601 a	ND	1001 a	ND	ND
P-value, Linear contrast	0.434	ND	0.152	ND	ND
P-value, Quad. contrast	0.385	ND	0.736	ND	ND

Yield means with the same letter are not significantly different according to the LSD (p=0.05).
ND = Not Determined.

Table 3. Effect of nitrogen on camelina seed nutrient content. Cut Bank location. Western Triangle Ag. Research Center. 2006.

N Rate, lbs N/acre	% N	% P	% K	% S
0	3.71 a	0.579 a	0.79 a	0.561 a
30	3.88 b	0.545 b	0.76 b	0.575 a
60	3.99 b	0.524 c	0.77 b	0.598 b
P-value, Linear contrast	0.001	0.001	0.045	0.036
P-value, Quad. contrast	0.628	0.323	0.056	0.452
Mean	3.86	0.549	0.77	0.578
CV (%)	5.76	5.01	5.5	6.30

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

Figure 1. Effect of Nitrogen on Camelina Seed Yield 2005-2007

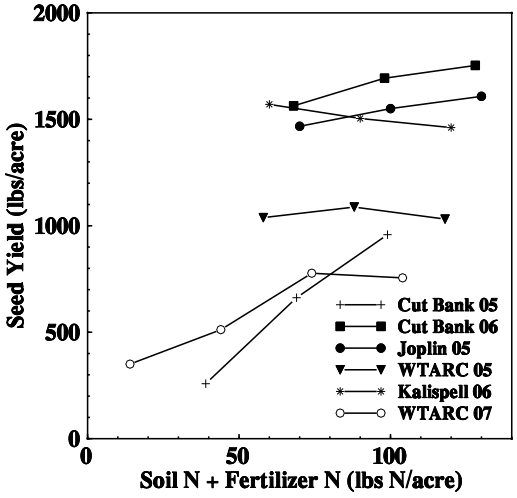
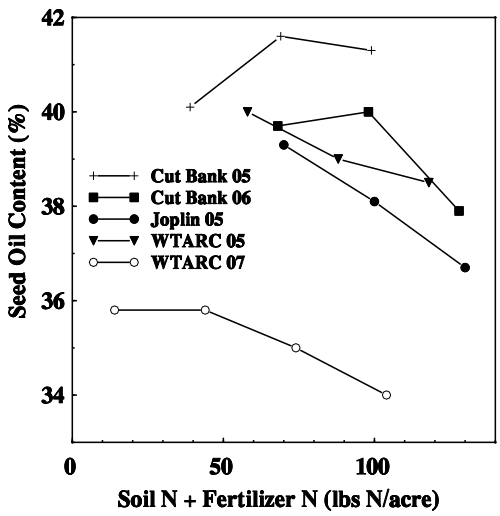


Figure 2. Effect of Nitrogen on Camelina Seed Oil Content 2005-2006



REFERENCES

Jackson, Grant D. 2000. Effects of nitrogen and sulfur on canola yield and nutrient uptake. Agron. J. 92:644-649.

Jackson, G.D., G.D. Kushnak, L.E. Welty, M.P Westcott, and D.M. Wichman. 1993. Fertilizing Canola. Montana AgRes. 10(2):21-24.

McVay, K.A. and P.F. Lamb. 2007. Camelina production in Montana. Mont. State Univ. Ext. Ser. MontGuide MT200701AG.

Putman, D.H., J.T. Budin, L. A. Field, and W.M. Breene. 1993. Camelina: A promising low-input oilseed. P. 314-322. In: J. Janick and J.E. Simon (eds.), New Crops. Wiley, NY.

Robinson, R.G. 1987. Camelina: A useful research crop and a potential oilseed crop. Minn. Agric. Exp. Stn. Bull. AD-SB-3275.