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Nitrogen and Sulfur Fertilization Effects on Camelina Sativa in West Central Kansas

Abstract

Camelina sativa is early maturing and possesses characteristics that make it a good fit as a rotation crop in dryland wheat cropping systems. Nitrogen (N) and sulfur (S) play very important roles in oilseed production, including camelina. This study was conducted over 3 years to determine N and S rates necessary for optimum camelina production in west central Kansas. The experiment was set up as randomized complete blocks with four replications in a split-plot arrangement. Treatments were two sulfur rates (0 and 18 lb/a) as the main plots, and four N rates (0, 20, 40, and 80 lb/a) as the sub-plot. Sulfur application did not affect stand count, biomass yield, harvest index, seed yield, oil and protein content. However, stand count, biomass yield, seed yield, and protein content were affected by N application ($P < 0.05$). Average oil and protein content were 28.1% and 33.9% respectively. The optimum N rate for yield was 20 lb N/a, which produced around 680 lb/a seed yield. Based on soil test levels of 25 lb N/a, N requirement for camelina production is 45 lb N/a.

Keywords

Camelina, nitrogen, and sulfur

Nitrogen and Sulfur Fertilization Effects on *Camelina Sativa* in West Central Kansas

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Summary

Camelina sativa is early maturing and possesses characteristics that make it a good fit as a rotation crop in dryland wheat cropping systems. Nitrogen (N) and sulfur (S) play very important roles in oilseed production, including camelina. This study was conducted over 3 years to determine N and S rates necessary for optimum camelina production in west central Kansas. The experiment was set up as randomized complete blocks with four replications in a split-plot arrangement. Treatments were two sulfur rates (0 and 18 lb/a) as the main plots, and four N rates (0, 20, 40, and 80 lb/a) as the sub-plot. Sulfur application did not affect stand count, biomass yield, harvest index, seed yield, oil and protein content. However, stand count, biomass yield, seed yield, and protein content were affected by N application ($P < 0.05$). Average oil and protein content were 28.1% and 33.9% respectively. The optimum N rate for yield was 20 lb N/a, which produced around 680 lb/a seed yield. Based on soil test levels of 25 lb N/a, N requirement for camelina production is 45 lb N/a.

Introduction

Cultivation of *Camelina sativa* in Europe dates as far back as 1000 BC. The crop has been referred to as "gold of pleasure," linseed dodder, and large-seeded false flax. Interest in camelina as a potential crop in the Great Plains has increased because of its lower requirements for inputs such as water, pesticide, and fertilizer compared with other crops. Another advantage is that it is early maturing, requiring only 85 to 100 days to mature. Camelina seed has high oil content with unique properties for both industrial and nutritional applications. The oil contains about 60% polyunsaturated fatty acids, mainly linolenic (18:2n-6) [about 15 and 40% α-linolenic acid (18:3n-6)], 30% monounsaturated, and 6% saturated fatty acids. Compared with other oilseed crops, camelina oil is very high in α-linolenic acid, an omega-3 fatty acid that is essential in human and animal nutrition. Because of its higher omega-3 fatty acid content, camelina oil has been promoted as a dietary supplement in human and animal nutrition. In addition to these applications, the oil has agricultural uses (seed coating, animal feed), industrial applications (biolubricants), and may be used as biofuel. Research has shown that camelina yield ranges from lows of 300 lb/a to highs of 1,800 lb/a depending on biotic and abiotic factors influencing production in the growing locations.

Nitrogen plays an important role in plant physiological functions and is a component of chlorophyll, protein, and enzymes. Previous studies indicate that camelina has a lower N requirement than other oilseed crops such as sunflower and canola. Another nutrient of importance in oilseed production is sulfur, which is associated with protein and chlorophyll development and resistance to cold and water stress. Nitrogen and sulfur are strongly correlated with protein content in oilseed crops. Camelina responds to N and S with high yields and seed quality. Past findings on camelina N and S requirements have been location specific. This study was conducted to determine the N and S requirements for optimum yield of camelina grown in west central Kansas.

Procedures

The experiment was conducted at Kansas State University Agricultural Research Center near Hays, KS (38° 51' N/99° 20' W; elevation: 2005 ft.) on no-till ground into wheat stubble in 2013 and 2015, and sorghum in 2014. The experimental design was a randomized complete block with four replications in a split-plot arrangement. Individual plot sizes were 30 ft × 10 ft. Fertilizer treatments were 0, 20, 40, and 80 lb/a N, and S rates of 0 and 18 lb/a. Sulfur was the main factor, and N was the sub-plot factor. Blaine Creek, a released spring camelina variety, was planted in this study at 5 lb/a. Half-doses of the N fertilizer treatments were applied at the time of planting, and the remaining half-doses were applied after emergence. In the course of the season, data collected included stand count, biomass yield, and seed yield (adjusted to 8% moisture). Oil content was analyzed after seed harvest using FT-NIR Near-Infrared spectrophotometer (NIRS). Seed N was analyzed using Leco CN Analyzer and then used to determine the protein content.

Results

Stand count at maturity was statistically different among N treatments. The control had the highest stand count and was significantly different from 20, 40, and 80 lb N/a treatments (Table 1). Stand count at maturity was higher in 2014 than 2015 (Table 2). Biomass production was higher for 40 and 80 lb N/a treatments, and was significantly different from the control (Figure 1). Biomass production was not different when 20 and 40 lb N/a was applied. Average biomass yield was 3,100 lb/a. Sulfur application had no significant ($P > 0.05$) effect on seed yield. Camelina seed yield was positively affected by N application.

Nitrogen application increased yield, but not beyond 40 lb N/a treatment. Yield was highest when N was applied at 20 and 40 lb/a, and they were significantly different from 0 lb N/a (Figure 2). Seed yield in 2014 and 2015 was around 750 lb/a and was significantly different from yield of 400 lb/a in 2013 (Fig. 3). The difference in yield between years may be due to variation in precipitation among years. The study location received cumulative rainfall of 6.8 in., 11.2 in., and 8.5 in. in 2013, 2014, and 2015 respectively, during camelina growing season (April 15 to July 18). Harvest index was higher in 2014 and was significantly different from 2015 (Table 2).

There was significant difference in protein content among N treatments. Nitrogen applied at 80 lb/a had the highest protein content and was significantly different from the other N treatments (Table 1). Protein content was different among the lower N rate treatments. Camelina protein content was higher in 2015 than 2014 (Table 2). There was a difference in oil content between years (Figure 4). Camelina seeds had more oil content in 2014 than in 2015. Average protein and oil content were 33.9% and 28.1% respectively.

Table 1. Effect of nitrogen treatment on stand count and protein content

Nitrogen rate (lb/a)	Stand count at maturity (per sq. ft.)	Protein (% db)
0	9.3[a]	33.7[b]
20	8.2[b]	33.6[b]
40	8.5[b]	33.9[b]
80	8.2[b]	34.1[a]
Standard error	0.5	0.2

Treatment means within the same column followed by same letter(s) are not significantly different (P < 0.05).

Table 2. Stand count, seed harvest index (HI), protein and oil content (%) of camelina in 2014 and 2015

Year	Stand count at maturity (per sq. ft.)	Harvest index (HI)	Protein (% db)	Oil (%)
2014	9.7[a]	0.2[a]	33.1[b]	29.5[a]
2015	7.5[b]	0.1[b]	34.6[a]	26.7[a]
Standard error	0.4	0.01	0.2	0.2

Treatment means within the same column followed by same letter(s) are not significantly different (P < 0.05).

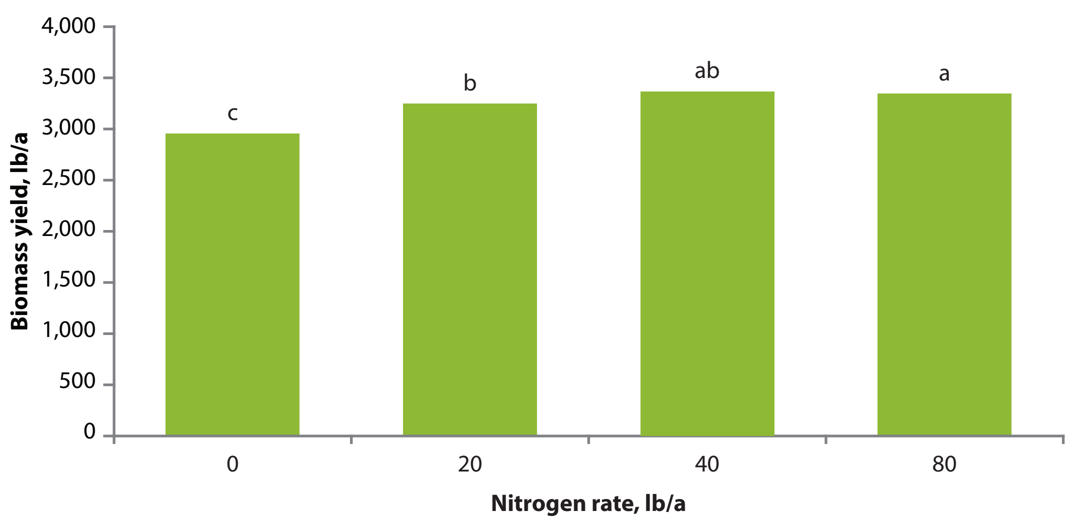

Figure 1. Effect of nitrogen application on biomass yield. Means followed by the same letter(s) are not significantly different at P>0.05.

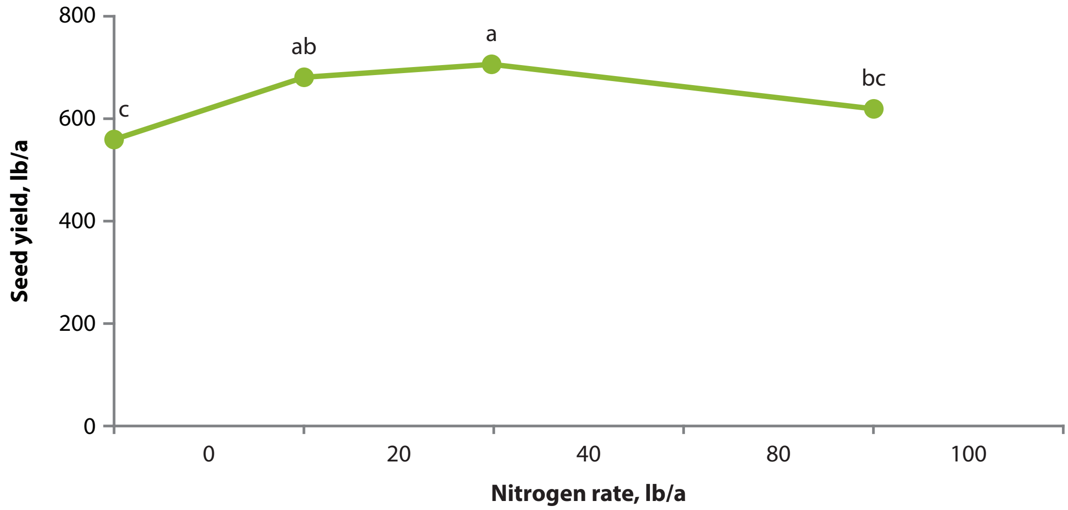

Figure 2. Effect of nitrogen application on seed yield. Means followed by the same letter(s) are not significantly different at P>0.05.

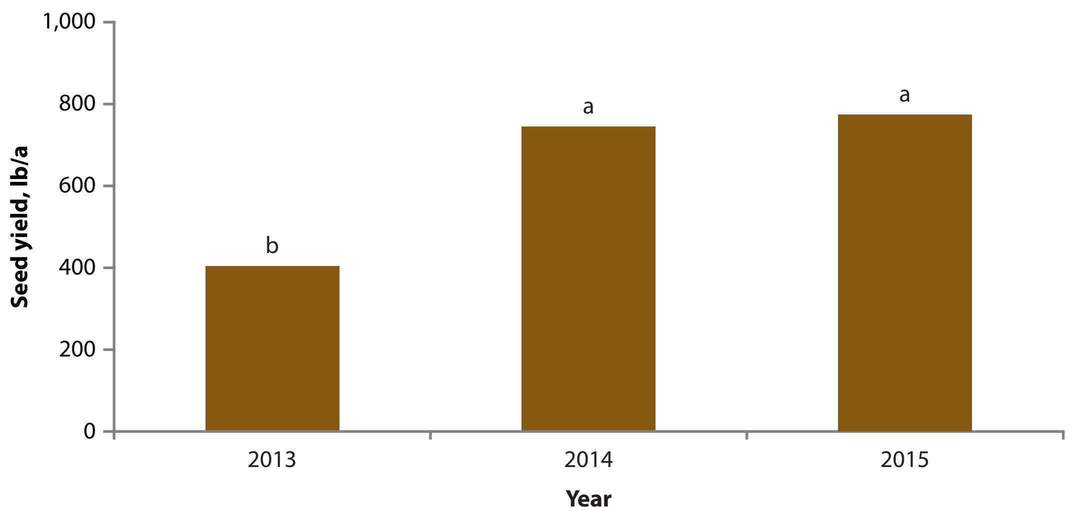

Figure 3. Average camelina yield in year 2013, 2014, and 2015, Agricultural Research Center–Hays. Means followed by the same letter(s) are not significantly different at P>0.05.

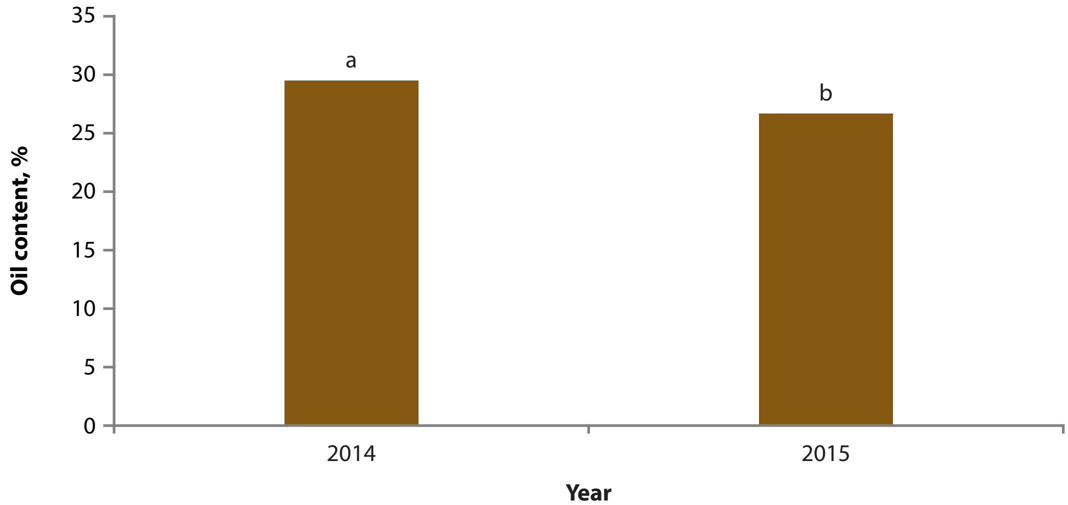

Figure 4. Average camelina oil content in 2014, and 2015. Means followed by the same letter(s) are not significantly different at P>0.05.