A PACIFIC NORTHWEST EXTENSION PUBLICATION

CAMELINA

Nutrient Management Guide for the Pacific Northwest

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Photo: Tom Chastain

Camelina (*Camelina sativa* L. Crantz) is an oilseed crop used in the production of omega-3 fatty-acid-rich vegetable oils, animal feed, cosmetics, dust-control additives, biodiesel, and aviation fuel. It is a member of the Brassicaceae family, which also includes other oilseed crops such as canola and rapeseed. Camelina is a drought-tolerant, low-input crop that grows well on marginal soils and is grown under dryland production throughout the U.S. Pacific Northwest.

This publication provides soil fertility recommendations for dryland and rainfed camelina production in areas of the Pacific Northwest that receive more than 12 inches of rain per year, with the majority of the rainfall occurring between October and May and minimal rainfall from June through September. Nitrogen (N) and sulfur (S) recommendations are based primarily on fertilizer trials conducted on nonirrigated camelina fields in Oregon, Washington, and Idaho (Wysocki, et al., 2013). Recommendations for soil pH adjustments, phosphorus (P), and potassium (K) are based on camelina research in other regions and on Pacific Northwest recommendations for canola.

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PNW 718 • February 2019

Soil sampling

Soil sampling should be done around preplant, as preplant fertilizer applications will provide sufficient nutrients to sustain the plant throughout the growing season.

Collect soil samples from 0- to 12-inch and 12- to 24-inch depths within the 2 weeks prior to planting. Recommended soil analyses are listed in Table 1. An additional 24- to 36-inch-depth sample may be needed for dryland production areas in eastern Oregon and eastern Washington. If this additional sample is taken, add its nitrate and ammonium to the first- and second-foot values before using Table 2 (page 3) to determine the N application rate.

Nitrogen (N)

Nitrogen recommendations in this publication are based on 9 site-years of data from Wysocki, et al. (2013). In this study, N fertilizers were applied at rates ranging from 0 to 100 lb N/acre to camelina production fields in Pendleton, Oregon; Corvallis, Oregon; Moscow, Idaho; and Pullman, Washington, in 2008, 2009, and 2010.

When sufficient amounts of N and S fertilizers were supplied, average seed yields for the Pendleton, Corvallis, and Moscow/Pullman sites were 1,835, 2,009, and 2,198 lb/acre, respectively. Seed yield response to total available N (soil test N + fertilizer N) varied dramatically, depending on year and location. Yield response decreased as soil test N increased, indicating that soil N levels were sufficient on some fields to reduce the N fertilizer requirement. These findings were not surprising, given the sharp contrast in environmental conditions among sites. For example, average annual precipitation at the Corvallis site was 43 inches per year, while the Moscow/Pullman and Pendleton sites received only 27 and 17 inches per year of rainfall, respectively.

In contrast, optimum yield potential was directly correlated to a combination of soil test N (0- to 24-inch depth) and fertilizer N over all 9 site-years. Optimum yield reached maximum levels when combined soil and fertilizer N was 157 lb N/acre or greater (Figure 1). These results indicate that camelina required 160 lb N/acre soil + fertilizer N to achieve maximum seed yield.

Photo: Tom Chastain

Camelina stand at 56 days after planting, near Corvallis, Oregon

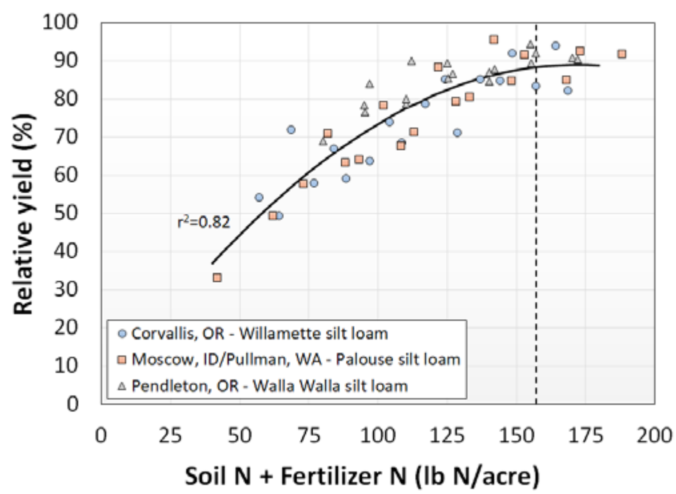

Figure 1. Optimum yield response to soil N (ammonium-N + nitrate-N) + fertilizer N. Data points represent N treatment means for relative yield by year and location. Samples were collected from 2008 to 2010 at three rainfed/dryland locations in the Pacific Northwest. Soils were sampled to the 2-foot depth at Moscow/Pullman and to the 4-foot depth at Pendleton. Adapted from Wysocki, et al. (2013).

Table 1. Recommended preplant soil analyses for camelina production systems

Soil pH	Recommended analyses (0–12 inches)	Recommended analyses (12–24 inches)
Acidic soil conditions (pH < 7.0)	pH, buffer pH, nitrate-N, ammonium-N, Bray P, ammonium acetate K, sulfate-S, DTPA Zn, hot water B	Nitrate-N, ammonium-N, sulfate-S
Alkaline soil conditions (pH > 7.0)	pH, lime content, nitrate-N, ammonium-N, Olsen P, ammonium acetate K, sulfate-S, DTPA Zn, hot water B	Nitrate-N, ammonium-N, sulfate-S

For more information, see *A Guide to Collecting Soil Samples for Farms and Gardens* (EC 628) and *Soil Test Interpretation Guide* (EC 1478).

These findings suggest that a static N rate approach is more appropriate than a traditional lb N/lb seed yield recommendation, as total seed yield was influenced more by climate and location than by N rate. Recommended N application rates are given in Table 2.

For many oilseed crops, optimizing oil quality and seed oil content is a primary concern; thus, seed oil content is often considered when determining N application rates. High quantities of total available N (soil N + applied N) may result in increased seed protein content and reduced seed oil concentration. Several studies from Canada have found a reduction in camelina seed oil content with increasing N application rates (Urbaniak, et al., 2008; Malhi, et al., 2014). However, Wysocki, et al. (2013) showed that N application rate had no effect on camelina seed oil content at three locations in the Pacific Northwest. A study conducted by Montana State University also found that increasing N application rates did not influence camelina seed oil concentration (Jackson, 2008).

In the Pacific Northwest, total oil yield typically takes precedence over seed oil content. Over 9 site-years, Malhi, et al. (2014) found that total oil yields were maximized at N rates similar to those that maximized seed yields, despite reductions in oil content with increasing N rate. Thus, adjusting N application rates to maximize oilseed content is not recommended for camelina production in the Pacific Northwest. It should be noted, however, that excessive amounts of N in the soil could potentially lower oil content in the seed.

Nitrogen "tie-up" (immobilization) in crop residue temporarily reduces plant-available soil N. Immobilization can be a problem when large quantities of straw residue are present. In fields with small grain or corn residues, increase the N application rates in Table 2 by 50 lb N/acre. For more information on how to account for N immobilization from straw residues, see *Irrigated and Dryland Canola* (EM 8943).

Phosphorus (P)

No P fertilizer application studies have been conducted in camelina production systems in the Pacific Northwest. However, seed yield has been shown to increase with P applications in Montana. Researchers at Montana State University conducted P application rate studies over 5 site-years in dryland camelina production systems throughout Montana (Jackson, 2008). For Olsen soil P concentrations between 5 and 28 ppm, camelina seed yield consistently increased by 99 to 175 lb/acre as P application rates increased from 0 to 30 lb P_2O_5/acre. Phosphorus recommendations in Table 3 are based on these findings.

Phosphorus may be banded or broadcast. Banding P with the seed or within 2 inches of the seed can maximize early P accessibility by the roots.

Photo: Tom Chastain

Camelina pods near harvest maturity, near Corvallis, Oregon

Table 2. Nitrogen application rates for camelina production on nonirrigated fields in the Pacific Northwest

Soil test N (0–24 inches)		
If soil test N is (ppm)[1,3]	If soil test N is (lb/a)[2,3]	Apply this amount of N (lb/a)
0	0	140 to 160
5	40	100 to 120
10	80	60 to 80
15	120	20 to 40
Above 20	160	0

[1]Soil test N (ppm) = average nitrate-N (NO_3-N) + ammonium (NH_4-N) concentration in the first- and second-foot depths of the soil profile.
[2]Soil test N (lb/acre) = sum of NO_3-N + NH_4-N amounts in the first- and second-foot depths.
[3]Soil NO_3-N alone may be used when NH_4-N values are not available.

Table 3. Phosphorus application rates for camelina production on nonirrigated fields in the Pacific Northwest

Soil test P (0–12 inches)		
If the Bray 1 soil test for P is (ppm)	If the Olsen soil test for P is (ppm)	Apply this amount of phosphate (P_2O_5) (lb/a)
0 to 30	0 to 20	30
30 to 45	20 to 30	15
Above 45	Above 30	0

Potassium (K)

Potassium fertilizer studies in camelina production systems are extremely limited. Potassium recommendations in this guide are based on recommendations for canola production in the Pacific Northwest, as camelina and canola share many physiological characteristics. Canola crops can take up 130 to 270 lb K/acre, with 7 to 50 lb K/acre transferred to the seed (Grant and Bailey, 1993).

Yield response to K fertilization is rarely observed in canola production systems. However, conditions such as sandy soils and crop residue removal can create a K-limiting environment. Potassium fertilizer recommendations are listed in Table 4.

Potassium may be broadcast or banded. Banded applications should not exceed 100 lb N + K_2O/acre to prevent germination issues related to salt burn.

Sulfur (S)

Sulfur is often considered a critical nutrient for brassica oilseed crops such as canola and camelina. Applications of 22 lb S/acre increased camelina seed yield, seed protein content, and polyunsaturated fatty acid percentage at multiple sites in the Maritime Provinces of eastern Canada (Jiang, et al., 2013).

In contrast, trials in Oregon, Washington, Idaho, and Montana found no camelina seed yield response to S fertilization when N was nonlimiting (Wysocki, et al., 2013; Jackson, 2008; Mohammed, et al., 2017). As a precaution, growers can apply 10 to 20 lb S/acre to avoid any potential reduction in yield or oil quality.

Soil pH

The ideal soil pH range for camelina is 5.6 to 6.5, although camelina can tolerate pH values as low as 5.0. Lime applications can be used to correct acidic soil conditions. Table 5 shows lime recommendations to raise soil pH to 5.6. If you are east of the Cascades, ask the laboratory if they use the full-strength or quarter-strength SMP buffer test, as lime recommendations differ significantly between these two tests.

For more information regarding liming west of the Cascades, see *Applying Lime to Raise Soil pH for Crop Production (Western Oregon)* (EM 9057). East of the Cascades, see *Eastern Oregon Liming Guide* (EM 9060).

Where there will be little or no incorporation of lime, such as in no-till fields, lime application rates should not exceed 1 to 2 ton/acre, as the applied lime will affect only the top 1 to 2 inches of soil. For more information, see *Evaluating Soil Nutrients by Depth* (EM 9014).

Where soil pH is greater than 8.5, yields are likely to be reduced. Under these conditions, the crop will benefit from lowering soil pH. Acid-producing fertilizer products, such as ammonium sulfate, elemental S (if economical), or monoammonium phosphate (MAP), can help to reduce soil pH. However, in some cases, particularly on calcareous soils, it may be impossible to lower soil pH with fertilizer products and management practices. For more information on soil acidification methods, see *Acidifying Soil for Crop Production: Inland Pacific Northwest* (PNW 599).

Table 4. Potassium application rates for camelina production on nonirrigated fields in the Pacific Northwest

If the soil test for K (0- to 12-inch depth) is (ppm)	Apply this amount of K_2O (lb/a)
0 to 50	100 to 125
50 to 100	75 to 100
100 to 150	0 to 75
Above 150	0

Table 5. Lime recommendations for camelina production systems in the Pacific Northwest

If the SMP buffer test for lime is (0–6 inches)	West of the Cascades, full-strength SMP test	East of the Cascades, full-strength SMP test	East of the Cascades, quarter-strength SMP test
		Apply this amount of lime[1] (t/a)	
6.4	0	0	0
6.2	1.0	1.0	0.3
6.0	1.7	2.0	0.4
5.8	2.5	2.0	0.6
5.6	3.2	2.0	0.8
5.4	3.9	2.0	1.0
5.2	4.7	2.0	1.2
5.0	5.4	2.0	1.4

[1]Lime recommendations are based on 100-score lime. Recommendations are for fields that are tilled at least once every 5 years.

Zinc (Zn) and boron (B)

Most soils in the Pacific Northwest contain sufficient amounts of Zn and B to support optimal oilseed production. Thus, applications of Zn or B fertilizers to brassica oilseed crops usually are not economical and are unlikely to produce a yield response. However, Zn or B applications may be of some benefit where deficiencies have been detected in other crops.

If the DTPA Zn concentration is below 0.4 ppm and soil pH is greater than 7.5, a Zn application of 5 to 10 lb/acre may be considered.

If the soil test B concentration is below 0.2 ppm, consider broadcasting 1 to 2 lb B/acre or foliar-applying 0.3 lb B/acre. Boron can cause toxicities if the recommended rate is exceeded or if application is nonuniform. Therefore, it may be more practical to apply B only when a deficiency is expected for a specific field. To prevent B toxicity issues, avoid banding B.

For more information

Extension publications

Acidifying Soil for Crop Production: Inland Pacific Northwest (PNW 599). https://catalog.extension.oregonstate.edu/pnw599

Applying Lime to Raise Soil pH for Crop Production (Western Oregon) (EM 9057). https://catalog.extension.oregonstate.edu/em9057

Eastern Oregon Liming Guide (EM 9060). https://catalog.extension.oregonstate.edu/em9060

Evaluating Soil Nutrients and pH by Depth in Situations of Limited or No Tillage in Western Oregon (EM 9014). https://catalog.extension.oregonstate.edu/em9014

A Guide to Collecting Soil Samples for Farms and Gardens (EC 628). https://catalog.extension.oregonstate.edu/ec628

Irrigated and Dryland Canola Nutrient Management Guide (EM 8943). https://catalog.extension.oregonstate.edu/em8943

Response of Camelina to Nitrogen, Phosphorus, and Sulfur (Fertilizer Facts 49, Montana State University). http://landresources.montana.edu/fertilizerfacts/documents/FF49CamelinaNPS.pdf

Soil Test Interpretation Guide (EC 1478). https://catalog.extension.oregonstate.edu/ec1478

Research publications

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Urbaniak, S., C. Caldwell, V. Zheljazkov, R. Lada, and L. Luan. 2008. The effects of cultivar and applied nitrogen on the performance of *Camelina sativa* L. in the Maritime Provinces of Canada. Canadian Journal of Plant Science 88:111–119.

Wysocki, D., T. Chastain, W. Schillinger, S. Guy, and R. Karow. 2013. Camelina: Seed yield response to applied nitrogen and sulfur. Field Crops Research 145:60–66.

Published February 2019