NUTRIENT MANAGEMENT guide
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# Irrigated and Dryland Canola

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Recommendations in this nutrient management guide apply to spring or winter canola (*Brassica napus* or *Brassica rapa*) grown under irrigated or dryland management in rotation with a variety of crops. Recommendations for nitrogen, phosphorus, sulfur, potassium, zinc, boron, and lime are covered in this guide.

## Growing conditions

**Soil:** Sand, loamy sand, loam, silt loam, silty clay loam

**Soil organic matter content:** 1 to 4 percent

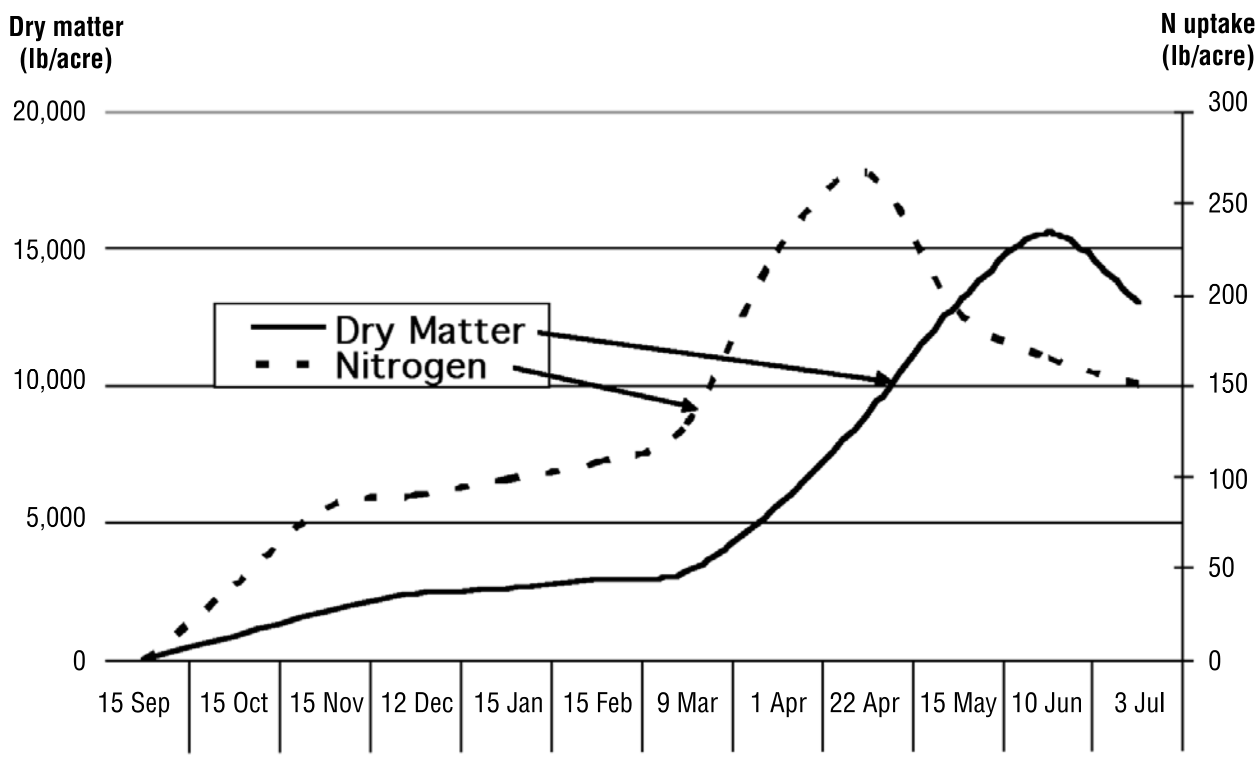


Figure 1.—Average dry matter accumulation and N uptake of a winter canola crop (3,000 lb/acre yield) at Pendleton, Oregon, based on 1997–1998 and 1998–1999 crop years.

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# Nitrogen (N)

Canola assimilates nitrogen to form major plant components, primarily amino acids, the building blocks of proteins. Adequate nitrogen is essential for high yield and good seed quality.

Figure 1 shows nitrogen uptake of winter canola by crop stage. This figure illustrates the importance of both amount and timing of available nitrogen. A 3,000-lb/acre canola seed crop takes up about 250 lb N/acre.

Of equal or greater importance is the timing of uptake. Note that approximately half of the N uptake occurs by the spring rosette stage, and most of the remainder occurs during the 45-day period between spring rosette (March 5) and early bloom (April 20). N uptake during this period is approximately 2 lb/acre/day. Adequate available N must be present in the soil to ensure uptake during this rapid growth period. Total N uptake is complete by first bloom. Plant nitrogen declines after bloom begins due to loss of above-ground tissue (blossom and leaf fall) and use of some nitrogen for root growth.

Note that only about half of the dry matter accumulation is complete at maximum N uptake. Dry matter accumulation does not reach its maximum until pod filling (June 10 in Figure 1). Dry matter declines after pod fill due to tissue loss from leaf fall.

If applying split N applications, base the timing of application on crop stage rather than on calendar dates. The dates for specific growth stages depend on weather conditions, location, and whether the crop is fall or spring canola. In warmer parts of the Columbia Basin, crop stage may be advanced by 2 to 3 weeks. In cooler areas, crop stage may be delayed by 2 to 3 weeks.

## Calculating the nitrogen application rate

Nitrogen is the most limiting nutrient for canola production. There are four steps to determining a nitrogen application rate.

1. Determine expected yield.
2. Select or fine tune the canola nitrogen requirement.
3. Account for soil nitrogen.
4. Adjust the nitrogen application rate based on cropping history and past crop performance.

An explanation of each of these steps follows.

### *1. Expected yield*

Determine a reasonable expected yield for the field, based on the availability of irrigation water or available soil profile water, expected rainfall, planting date, and yield history. As a guide for first-time canola growers, Table 1 shows expected winter canola yields for early and late planting dates in Oregon based on average winter wheat yield. These values can be adjusted for specific seasonal or site conditions.

### *2. Nitrogen requirement*

The nitrogen requirement is the amount of N needed to produce a given weight of seed yield. Because soils, weather conditions, and agronomic practices can influence nitrogen uptake, the nitrogen requirement for canola ranges from 6.5 to 7.5 lb N/100 lb of expected seed yield. To determine the nitrogen requirement, multiply the expected yield (cwt/acre) by an appropriate value between 6.5 and 7.5. Adjust the N requirement within this range for specific fields and growing conditions.

Table 1.—Expected winter canola yield based on average winter wheat yield (summer fallow) for Oregon.

| | | | | | |
|---|---|---|---|---|---|
| | | | **(bu/acre)** | | |
| **Average winter wheat yield** | 40 | 50 | 60 | 70 | 80 |
| **Expected winter canola yield** | | | **(lb/acre)** | | |
| Planted before September 20 | 1,600 | 2,000 | 2,400 | 2,800 | 3,200 |
| Planted September 20–October 10 | 1,200 | 1,500 | 1,800 | 2,200 | 2,600 |

Table 2.—Nitrogen requirement for canola for various expected yields (based on 7 lb N/cwt seed yield/acre) rounded to nearest 5 lb of N.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Expected yield (lb/acre) | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 3,500 | 4,000 |
| Nitrogen recommendation (lb/acre) | 70 | 105 | 140 | 175 | 210 | 245 | 280 |

Table 3.—Nitrogen adjustment for dryland canola to compensate for wheat yield (straw production) that exceeds the long-term field average.

| Higher-than-average yield of previous wheat crop (bu/acre) | Corresponding increase in straw production (lb/acre) | Increase nitrogen application rate by (lb/acre) |
|---|---|---|
| +10 | 1,000 | 15 |
| +20 | 2,000 | 25 |
| +30 | 3,000 | 35 |

As a starting point, we recommend applying 7 lb N/100 lb of expected yield. Table 2 shows nitrogen requirements for various expected yields using this value.

### *3. Soil test nitrogen adjustment*

Collect samples from the effective root zone (usually 2 feet on irrigated fields or 3 feet in dryland cropping systems) in 1-foot increments, and analyze for nitrate-nitrogen ($NO_3$-N). Also analyze samples from the surface foot for ammonium-nitrogen ($NH_4$-N). Add the nitrogen for all depths to estimate total soil test nitrogen.

If sampling in the spring before summer fallow, add 20 to 40 lb N/acre to the soil test results to account for mineralization that will occur during fallow. Mineralization depends on soil moisture and organic matter. In drier areas, use the lower value in this range.

Subtract soil test N from the nitrogen requirement to arrive at a nitrogen recommendation.

### *4. Cropping history adjustment*

Nitrogen “tie-up” in crop residue (immobilization) temporarily reduces plant-available nitrogen in the soil. Immobilization can be a problem when large quantities of cereal straw or corn stalks are present.

When planting *dryland canola* on fallow or annual crop residue, use the previous crop’s grain yield to estimate nitrogen immobilization. Increase nitrogen application rates if grain yield from the previous wheat crop exceeded the long-term field average by 10 bu/acre or more (Table 3).

Table 4.—Nitrogen adjustment for irrigated canola to compensate for crop residue from a previous irrigated crop of wheat, corn, barley, or oats.

| Previous crop | Increase N application rate by (lb/acre) |
|---|---|
| Winter wheat | 60 |
| Spring wheat | 45 |
| Field corn | 60 |
| Barley or oats | 40 |

For *irrigated* canola, adjust the nitrogen rate based on the previous crop. Add additional nitrogen (Table 4) to compensate for residue following wheat, corn, barley, or oats if straw/stover was not harvested or burned. Because of the low residue levels and high residue N content of vegetable, grass seed, and legume crops, do not add additional nitrogen following these crops.

## Sulfur (S)

Sulfur is the second most limiting nutrient in canola production. Adequate sulfur is required for optimum yield and seed quality. Canola requires about 1 lb of sulfur for each 100 lb of expected yield. Because winter precipitation can move plant-available sulfate-sulfur ($SO_4$-S) below the root zone, canola sometimes shows sulfur deficiency (pale yellow color and poor growth) in early spring.

Low or moderate soil test S (Table 5) indicates that sulfur fertilization is warranted. Even when soil test levels are high, it is advisable to apply a low rate of sulfur. Take into account the history of S applications and crop response. If soil test levels are low or medium on fields with no recent history of sulfur application, on irrigated sandy-textured soils, or on annually cropped fields, apply sulfur at a rate of 1 lb S/100 lb of expected seed yield.

## Phosphorus (P)

A phosphorus application should increase canola yield when soil test levels are 5 ppm or less (Table 6). A phosphorus application is not recommended when soil test values are greater than 15 ppm. Crop response to P in fields with soil test values of 6 to 15 ppm is variable. Effects of P fertilization in these fields are best evaluated by conducting on-farm experiments. The probability of a yield response from a phosphorus application increases when yield potential is high, canola is annual cropped, or especially when canola is seeded late in the fall or early in the spring.

### Sulfur soil samples

Collect soil samples for sulfur ($SO_4$-S) analysis from the top 2 feet of the soil profile.

The test is not definitive, and reported values are best thought of as an index of availability. Irrigation water analysis, field experience, and on-farm experimentation provide valuable information about the need for sulfur in canola.

Table 5.—Sulfur fertilizer recommendations. **Note:** Do not base a decision to apply sulfur on soil test results alone. See the discussion above for more information.

| Soil test sulfate-sulfur ($SO_4$-S) (ppm) | Plant-available index | Amount of sulfur (S) to apply (lb/acre) |
|---|---|---|
| 0–5 | Low | 20–40 * |
| 6–10 | Moderate | 10–40 * |
| Over 10 | High | 10 |

*Rate depends on expected yield and field history.

Table 6.—Phosphorus fertilizer recommendations.

| Soil test phosphorus* (P) (ppm) | Plant-available index ** | Amount of phosphate ($P_2O_5$) to apply*** (lb/acre) |
|---|---|---|
| 0–5 | Very low | 25–30 |
| 6–10 | Low | 20–25 |
| 11–15 | Moderate | 15–20 |
| Over 15 | High | None |

*Top 1 foot of soil.

**Plant-available index is correlated to sodium bicarbonate-extractable phosphorus only and does not apply to other test methods.

***Recommended application rates apply to banded or subsurface shank applications.

Table 7.—Potassium fertilizer recommendations.

| Soil test potassium (K) (ppm) | Plant-available index* | Amount of potassium ($K_2O$) to apply (lb/acre) |
|---|---|---|
| 0–75 | Very low | 100 |
| 76–100 | Low | 75 |
| 101–125 | Moderate | 0–60 |
| Over 125 | High | None |

*Plant-available index is correlated to sodium bicarbonate-extractable potassium or ammonium acetate extractable potassium and does not apply to other test methods.

Table 8.—Zinc fertilizer recommendations.

| Soil test zinc (Zn) (ppm) | Plant-available index* | Amount of zinc (Zn) to apply (lb/acre) |
|---|---|---|
| 0–0.4 | Very low | 5–10 |
| 0.5–0.8 | Low | 0–5 |
| 0.9–2.0 | Moderate | None |
| Over 2 | High | None |

*Plant-available index is correlated to DTPA-extractable Zn only and does not apply to other test methods.

Optimum efficiency is achieved by banding phosphorus at planting. Placement of either liquid or dry material with the seed, below the seed, or below and to the side of the seed is recommended. Subsurface shank applications are also effective. Broadcast applications are not as effective as band applications.

# Potassium (K)

Potassium concentrations in most soils are high or very high (>100 ppm extractable K). Fertilizer applications of K generally are not needed. However, sandy-textured irrigated soils and fields with a history of hay production may require additions of potassium. Table 7 gives potassium fertilizer recommendations.

# Zinc (Zn)

Zinc fertilization of canola has not been researched in the Pacific Northwest. Generally, zinc applications are not economical on most field crops. On-farm experiments with fertilization should be limited to small acreages. The potential for a yield response increases when DTPA-extractable soil test zinc values (surface foot) are less than 0.3 ppm, soil phosphorus levels are moderate to high, and soil pH is greater than 7.5.

A zinc application rate of 5 lb/acre is appropriate (Table 8). A 10 lb/acre application should last for several years. Less zinc is needed when banded.

# Boron (B)

Boron is a micronutrient that occasionally might limit canola yields. Boron deficiency on canola has not been observed in the Pacific Northwest and is extremely rare in most Canadian production areas. Likely symptoms of B deficiency are deformed, curled, and rough-skinned leaves with torn margins; yellow to brown spots in the interveinal areas of leaves; and red to brownish-purple new leaves.

Unfortunately, current soil test methods may not consistently predict economic responses to B fertilizer in canola. If B deficiency is suspected, we advise applying B fertilizer to a small, carefully marked test strip in an affected area of the field. Visual observations and yield from the treated and untreated areas can help determine whether there is a positive response. Apply B according to soil test levels as shown in Table 9 (page 6).

Table 9.—Boron fertilizer recommendations.

| Soil test boron (B) (ppm) | Plant-available index* | Amount of boron (B) to apply: Foliar/banded (lb/acre) | Amount of boron (B) to apply: Broadcast (lb/acre) |
|---|---|---|---|
| 0–0.1 | Very low | 1–2 | 0.5–1.0 |
| 0.1–0.2 | Low | 1 | 0.5 |
| 0.3–0.5 | Moderate | 0–1 | 0–0.5 |
| Over 0.5 | High | None | None |

*Plant-available index is correlated to hot water extractable B only and does not apply to other test methods. a

Both soil and foliar applications of boron fertilizer can be effective. Foliar applications can be applied with herbicides. Soil-applied B can be broadcast incorporated or banded. Ensure that B fertilizers do not come into contact with the seed at planting time. Never band boron with seed.

Because of the narrow range between B sufficiency and toxicity, be sure that foliar applications do not exceed 0.3 lb/acre and be sure to uniformly apply the correct amount of soil-applied B.

Response to micronutrients other than zinc and boron is rare. Copper, manganese, and iron fertilization usually is not required and should be addressed on an individual basis.

Canola is well suited to high-pH soils. When soil pH exceeds 8.5, the likelihood of response to micronutrient applications increases.

## Increasing soil pH (acid soils)

Irrigation and nitrogen applications have lowered the pH of some soils in eastern Oregon. Canola is somewhat tolerant to acid soils (pH of 5.0 to 5.4), but yield reduction is fairly common in fields with a pH of 5.0 or less. A lime application should correct this problem. Lime application rates should be based on soil texture and lime score (Table 10). Lime score is a relative indication of a product's ability to increase soil pH.

**Table 10.**—Recommended lime application rates.

| Soil texture | Lime rate* (ton/acre) |
|---|---|
| Sand or loamy sand | 0.5–1.0 |
| Sandy loam | 1.0 |
| Very fine sandy loam | 1.0 |
| Silt loam | 1.0–2.0 |

*Lime rate is based on lime score of 100. Adjust the rate based on lime score. For example, sugar lime commonly has a score of 50 and would require a 2-ton application to equal 1 ton of a 100-score product.

## Decreasing soil pH (alkaline soils)

Canola yield may be reduced where soil pH is greater than 8.5. Alkaline (high pH) soils are the product of landscape position, climate, and/or the characteristics of the soil parent material. High soil pH also may result from poor-quality irrigation water.

Soil pH can be decreased by applying high rates (1 or more ton/acre) of elemental sulfur, but doing so rarely is economical. Reduce the detrimental effects of high soil pH by using acid-producing fertilizer products such as ammonium sulfate, elemental sulfur, or monoammonium phosphate. Banded applications will increase the solubility of micronutrients in the band.

# *Example fertilizer application rate calculations*

## Example 1. Dryland canola

Canola is seeded in the fall into summer fallow in a 14-inch rainfall zone. The previous crop was winter wheat with a yield of 65 bu/acre, which is an average yield. Minimum tillage practices were used during the fallow year. Crop residue was not removed or burned. No sulfur applications have been made in recent years. Soil tests were taken in the spring prior to fertilizing during fallow.

**Information available:**

- A previous crop of wheat
- Expected yield of 2,500 lb/acre
- Soil test N = 75 lb N/acre
- Soil test P = 18 ppm
- Soil test sulfate-sulfur = 7 ppm
- Soil test K = 225 ppm
- Soil test Zn = 0.8 ppm
- Soil test B = 0.15 ppm

| **Nitrogen** | **(lb/acre)*** |
|---|---|
| **Nitrogen requirement** | |
| (Expected yield) x (per-lb N requirement) | |
| (2,500 lb/acre) x (7 lb N/100 lb) | **175** |
| **Subtract soil test nitrogen** | |
| 0–12" (nitrate + ammonium) | 30 |
| 12–24" (nitrate) | 30 |
| 24–36" (nitrate) | 15 |
| **Total soil test nitrogen** | 75 lb |
| **Additional nitrogen from mineralization** | 20 lb |
| **Nitrogen application rate** | **80 lb/acre** |

*Nitrogen rate rounded to nearest 5 lb.

**Additional nutrients to apply (see appropriate tables)**

Sulfur: 25 lb/acre
Phosphorus: none
Potassium: none
Zinc: none
Boron: 0.5 lb/acre broadcast
Lime: none

## Example 2. Irrigated canola

Canola is seeded in the fall following a 10-ton/acre sweet corn crop. Sweet corn residue was not removed. Irrigation will be with a center pivot and will meet full water needs. Effective rooting depth will be 2 feet due to frequent replacement of soil water.

**Information available:**

- A previous crop of sweet corn
- Expected yield of 4,000 lb/acre
- Soil test N = 150 lb N/acre
- Soil test P = 28 ppm
- Soil test sulfate-sulfur = 4 ppm
- Soil test K = 75 ppm
- Soil test Zn = 1.5 ppm
- Soil test B = 0.15 ppm
- Soil pH = 5.5

| **Nitrogen** | **(lb/acre)*** |
|---|---|
| **Nitrogen requirement** | |
| (Expected yield) x (per-lb N requirement) | |
| (4,000 lb/acre) x (7 lb N/100 lb) | **280** |
| **Subtract soil test nitrogen** | |
| 0–12" (nitrate + ammonium) | 90 |
| 12–24" (nitrate) | 60 |
| **Total soil test nitrogen** | 150 lb |
| **Add N for residue tie-up** | 0 lb |
| **Nitrogen application rate** | **130 lb/acre** |

*Nitrogen rate rounded to nearest 5 lb.

**Additional nutrients to apply (see appropriate tables)**

Sulfur: 40 lb
Phosphorus: none
Potassium: 100 lb/acre
Zinc: none
Boron: 1 lb/acre broadcast in irrigation water
Lime: none

## Example 3. Dryland spring canola

Canola is seeded in the spring following winter wheat that yielded 10 bushels above average. Residue was not removed or burned.

**Information available:**

- A previous crop of winter wheat
- Expected yield of 1,500 lb/acre
- Soil test N = 45 lb N/acre
- Soil test sulfate-sulfur = 4 ppm
- Soil test P = 7 ppm
- Soil test K = 475 ppm
- Soil test Zn = 0.1 ppm
- Soil test B = 0.4 ppm
- Soil pH = 6.2

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| **Nitrogen** | **(lb/acre)*** |
|---|---|
| **Nitrogen requirement** | |
| (Expected yield) x (per-lb N requirement) | |
| (1,500 lb/acre) x (7 lb N/100 lb) | **105** |
| **Subtract soil test nitrogen** | |
| 0–12" (nitrate + ammonium) | 20 |
| 12–24" (nitrate) | 15 |
| 24–36" (nitrate) | 10 |
| **Total soil test nitrogen** | 45 lb |
| **Add N for residue tie-up** | 15 lb |
| **Nitrogen application rate** | **75 lb/acre** |

*Nitrogen rate rounded to nearest 5 lb.

**Additional nutrients to apply (see appropriate tables)**

Sulfur: 20 lb/acre
Phosphorus: 25 lb/acre
Potassium: none
Zinc: 5 lb/acre
Boron: none
Lime: none

## For more information

Wysocki, D.J., S. Ott, M. Stoltz, and T.C. Chastain. 1991. Variety and planting date effects on dryland canola. OSU Agricultural Experiment Station Special Report 894, pp. 32–37.

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