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Caneberries

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Several types of caneberries are produced commercially in Oregon, including summer-bearing and primocane-fruiting red raspberries, black raspberries (blackcaps), and blackberries. This publication addresses nutrient assessment and application for caneberries produced in western Oregon.

In this area, caneberries typically are planted on Aloha, Jory, Newburg, Willamette, Woodburn, or Saum soils. Spacing usually is 2.5 ft x 10 ft for raspberries and 4 to 6 ft x 10 ft for blackberries. Recommendations in this publication are based on research and experience with caneberry production in this setting.

The use of fertilizer should be part of a complete management package. Nutrient application influences yield, fruit quality, fruit maturity, and sustained plant vigor. Management practices—from selection of certified plants to pre- and postharvest irrigation—must be performed in an appropriate and timely manner so that plants can benefit from applied nutrients.

Nutrient application is not a substitute for poorly timed irrigation, late harvest, or failure to control insects, diseases, rodents, or weeds. Soil properties such as low pH and/or poor drainage can be significant limiting factors in obtaining high berry yields. Increasing fertilizer rates or adding nutrients already in adequate supply will not correct these limiting factors.

Growers, with the assistance of county Extension faculty and field representatives, should consider nutrient needs of each field. Routine collection and analysis of soil and tissue samples are helpful in determining the need for nutrient applications.

To assist with interpretation of soil and tissue analysis data, keep records of weather, disease problems, nutrient application rates, and timing. Observations of annual growth (cane number, diameter, height, fruiting lateral length), yield, leaf color, and fruit quality (amount of rot and drupelet set) are also helpful in determining nutrient needs.

The goal of fertilization for any high-value crop is to remove limitations to yield and quality by supplying the crop with ample nutrition in advance of demand. Nutrient application should be based on soil and plant analyses and grower experience. Consider potential returns from your fertilizer investment, as well as environmental stewardship and governmental regulation. A fertilizer application should be "bio"logically sound and produce a measurable change in plant growth or nutrient status. The biological change caused by a fertilizer application is expected to increase fruit yield or quality and produce a return on your investment.

Caneberry plants require chemical elements from air, water, and soil to ensure adequate vegetative growth and fruit production. When levels of these nutrients in the plant are low, growth and yield may be affected. Severely reduced nutrient supply can lead to visible nutrient deficiency symptoms such as leaf discoloration and distortion (Figures 1 and 2). Routine collection and analysis of tissue

Figure 1.—Nitrogen-sufficient red raspberry (left) and nitrogen-deficient red raspberry (right).

Figure 2.—Nitrogen-sufficient red raspberry (left) and nitrogen-deficient red raspberry (right).

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samples can detect low nutrient concentration before visible symptoms or yield reduction occurs.

Plant tissue analyses indicate which elements are accumulated in adequate, deficient, or excessive amounts. Changes in tissue analysis may not occur for 1 to 2 years after nutrient application to a perennial crop such as raspberries or blackberries, especially when immobile materials (phosphorus, potassium, and lime) are applied to the soil surface (topdressed).

Tissue testing is based on a consistent sampling time, selection of the appropriate plant part, and "standards" for comparison. The following sections provide directions for collection of soil and tissue samples.

Tissue testing

Mineral nutrients such as nitrogen (N), phosphorus (P), and potassium (K) are added through fertilizers to supplement the supply from the soil. By analyzing dried plant tissues for their nutrient content (tissue testing), you can evaluate the adequacy of mineral nutrients. This information will help you decide whether fertilizer is needed and, if so, how much and what kind to apply.

Tissue testing can be used for any of the following:

- Predicting fertilizer needs of annual crops
- Diagnosing problems
- Evaluating a fertilizer program for perennial crops

Tissue testing can be used to monitor and adjust fertilizer use during early growth stages of annual crops such as potatoes, sugar beets, or lettuce. Tissue testing can help growers anticipate fertilizer needs for these crops.

In contrast, tissue test results are not very useful for predicting current-season fertilizer needs for perennial crops such as raspberries and blackberries. In part, this is due to the minimal short-term effect of fertilizer on yield in perennial crops. Therefore, tissue testing in producing caneberries is best used for end-of-season evaluation of a fertilizer program for the next year.

If problems such as poor growth or discoloration of canes appear during the growing season, you can use a comparative tissue test to check for possible nutrient deficiencies. You can collect samples to diagnose deficiencies at any time during the season. However, if not sampling during late July or early August (see "When to sample"), you also must collect a sample from an unaffected area for comparison.

Before using tissue testing to predict or evaluate fertilizer needs, you need the following information, which is provided in this publication:

- Sampling time (stage of development)
- Plant part to sample
- Normal or sufficient concentration range for each nutrient so you can interpret results

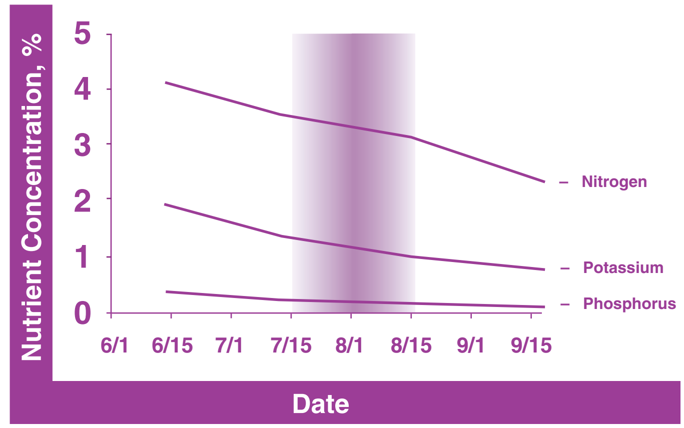

Figure 3.—The change in nitrogen (N), phosphorus (P), and potassium (K) concentration in leaves of 'Meeker' raspberries during the 2001 growing season. Tissue sampling should be done when leaf nutrient concentrations are relatively stable (shaded area).

When to sample

Tissue samples should be collected when nutrient concentration is stable. Samples collected just a few days apart during periods of rapid change in nutrient concentration can give quite different results. Changing N, P, and K concentration in leaves of 'Meeker' red raspberry primocanes is illustrated in Figure 3. Tissue concentration changes rapidly early in the growing season; compare the late-July and early-August tissue concentrations to mid-June tissue concentrations.

Tissue levels of N and K changed substantially during the season but reached a stable level in late July and early August. Samples collected during this period should produce consistent analytical results.

Figure 3 also illustrates the danger in collecting samples in late September. Nitrogen concentrations decrease as plants enter dormancy, so these samples may not give an accurate picture of the situation during the growing season.

Collect raspberry and blackberry tissue test samples during the stable period—late July to early August. Sampling raspberry tissue at any other time is not recommended except when samples are collected for comparative tissue testing to check for possible nutrient deficiencies.

Part of caneberry plant to sample

Do not mix cultivars in a tissue sample. Collect 50 of the newest fully expanded primocane leaves about 12 inches from the tip. Select only one leaf per primocane. A single sample should not represent an area of more than 5 acres or contain leaves from more than 50 primocanes.

Collect leaves that are free of disease or other damage, if possible. Pick leaves so that the petiole (stem) remains with the leaf. Do not wash the leaf samples. Put leaves in a paper bag (not plastic). Air dry them or send them to a laboratory as soon as possible. To avoid spoilage, ship fresh (moist) samples early in the week to ensure delivery before the weekend.

A list of laboratories that perform tissue analyses is available in publication EM 8677, *A List of Analytical Laboratories Serving Oregon*.

Frequency of sampling

Ideally, you should sample caneberry tissue from all fields annually. However, you may feel annual sampling is not necessary or financially feasible. Regardless of whether or not you sample every year, develop a plan for regular sampling.

Begin with fields that are not growing or yielding as desired. Annual sampling from these fields will be necessary until the problem is identified or corrected.

Divide the remainder of your acreage into two or three groups. Sample from a group of fields each year. Thus, you will sample one-half or one-third of the acreage each year.

Interpreting laboratory results

Compare laboratory results to the values in the tables found on pages 5–7 to determine whether sufficient nutrients were supplied by the soil and your fertilizer program.

Review cane growth and yield from last season. Choose the combination of tissue analysis and crop growth listed below that corresponds to your situation. Follow the instructions given for the appropriate category.

- **Low tissue analyses and abundant cane growth.** For summer-bearing red raspberries, canes should be 7 to 9 ft high and ½ inch in diameter. Cane growth of 12 to 15 ft for trailing types ('Boysen,' 'Logan,' 'Marion,' 'Kotata,' and 'Thornless Evergreen') is adequate.

  If cane growth is luxurious, don't apply additional fertilizer. This situation usually is caused by oversupply of N. Below-normal N and high vigor also can occur on canes with little or no crop. Lower-than-normal tissue nutrient concentrations are common with excessive cane growth. In this situation, low tissue nutrient concentration occurs when the tissue nutrient content is diluted by intensive growth. This condition should correct itself when growth returns to normal. Do not apply extra fertilizer, especially N, to correct low tissue concentrations when cane growth is excessive.
- **Low tissue analyses and weak cane growth.** If canes are weak, discolored, or stunted, apply fertilizer at rates recommended by your local office of the OSU Extension Service.
- **Normal tissue analyses and cane growth.** If tissue analyses and cane growth are within the normal range, continue with your current fertilizer program.
- **Above-normal tissue analyses and weak cane growth.** If canes are weak, discolored, or stunted, and the tissue analyses are above normal, look for stress from pests, drainage, drought, frost, or other factors.
- **Above-normal tissue analyses and cane growth.** If tissue analyses are above normal and cane growth is adequate or above normal, reduce the amount of fertilizer you have been applying, especially N.

Other considerations

Tissue analysis results outside the normal range cannot always be attributed to your fertilizer program. Insufficient mineral nutrient concentration can be caused by saturated or dry soils; high temperatures; frost; shade; weed, insect, or disease pressure; or herbicide injury.

Several fungicides contain plant nutrients. Because tissue samples are not washed before analysis, high copper (Cu), manganese (Mn), or zinc (Zn) might be the result of fungicide residue. High boron (B) and Zn also can occur if liquid or foliar fertilizer is used.

Collecting soil samples

Soil analysis is more useful before planting than after planting. Obtain soil samples in the summer or fall before planting to estimate amounts of nutrients and lime needed. After planting, soil analyses can be helpful in diagnosing problems, such as low soil pH or presence of excessive salts.

Fertilizer is commonly applied in a wide band centered on the caneberry rows. The band application concentrates nutrients, complicating soil sampling. Growers are well aware of the concentration of nutrients that occurs horizontally or between rows when fertilizer is placed in a band on the soil surface. However, they often neglect to think about vertical stratification. Repeated applications of N, P, and K in a band will depress soil pH and increase soil test P and K in the surface layer of soil. Neither P nor K is mobile in the soil; they will remain where placed, resulting in decreasing soil test P and K with depth.

Additional information about soil sampling is available in EC 628, *Soil Sampling for Home Gardens and Small Acreages*, and PNW 570-E, *Monitoring Soil Nutrients Using a Management Unit Approach*.

Nitrogen (N)

N requirement varies with yield, cane growth, plant age, soil type, irrigation, rainfall, and cultivar. Cane growth is an initial indicator of N sufficiency. Some caneberries are more vigorous than others and may require less N to give the desired amount of cane growth. Less N is required in the planting year than in subsequent years.

Excess N adversely affects yield and can promote vigorous vegetative growth. Excessive vegetative growth leads to longer, thinner primocanes with longer-than-normal internodes (distance between buds), thus reducing yield per cane. Excess N also can produce longer laterals on floricanes, increasing the risk of breakage during machine harvest as well as the risk of fruit diseases. When excess N is applied in late winter or early spring, fruit firmness may be reduced because a considerable portion of this fertilizer N goes to the fruit.

N fertilization should be based on tissue N concentration, cane vigor, yield, and irrigation practices. Tissue N concentration from sampling in late July or early August should be between 2.3 and 3.0 percent. See "Interpreting laboratory results" for more information.

Raspberries

In summer-bearing red raspberries, fertilizer N that is applied early (before new primocane emergence or when primocanes are less than 6 inches tall) is taken up by the new primocanes and by the fruiting laterals and fruit on the floricanes. When fertilizer N is applied when green fruit are present (approximately 1 month before first harvest), most of the fertilizer N is taken up by the primocanes and little goes to the fruit.

Research suggests that a split application of fertilizer N is best for maintaining current-season yield and good primocane growth for next season's yield. Apply half of the N about a week before primocane emergence and half about a month before first harvest.

Summer-bearing red raspberries have been shown to use about 40 percent of their stored N per year; thus, good stored reserves of N (in primocanes, crown, and roots) are important for sustaining yields.

Research suggests that delaying removal of spent floricanes after harvest can allow more time for N in the dying canes to be moved to the crown and roots, thus conserving N in the plant. In some cases, however, early "caning out" is best for disease management. Floricane prunings that are flailed and left in the field have been shown to contribute to the organic N available to the plants in subsequent years.

In general, summer-bearing red raspberries (e.g., 'Meeker,' 'Cascade Delight,' 'Coho,' 'Willamette') need 30 to 50 lb fertilizer N/acre in the establishment year and 50 to 80 lb fertilizer N/acre in subsequent years. For primocane-fruiting or fall-bearing red raspberries (e.g., 'Amity,' 'Heritage,' 'Summit'), add an additional 20 lb N/acre at bloom. For black raspberries (e.g., 'Munger'), apply 20 to 40 lb N/acre in the establishment year and 40 to 60 lb N/acre in subsequent years.

Blackberries

Trailing blackberries are produced in either an every-year (EY) or an alternate-year (AY) system. In the EY system, fruit is produced every year, with the primocanes (next year's fruiting canes) trained under the row during fruiting and trained on the wire either in late August or, more commonly, in February. In AY production, only primocanes are produced in the nonfruiting or "off year"; they are trained as they grow and fruit the following "on year" as floricanes. The primocanes are not managed in the "on year," and all canes are cut to just above crown height in October of the on-year to repeat the cycle.

Research has shown that trailing blackberries ('Kotata') allocate current-season fertilizer N to primocanes, fruiting laterals, and fruit. The following year, roots, the crown, and floricanes are a source of stored fertilizer N for growth of fruiting laterals and fruit.

Little stored N is used for early-season primocane growth. Thus, it is important to fertilize EY and AY trailing blackberries with N every year to sustain good growth and yield. A split application of fertilizer N is recommended. Apply half of the N about a week before primocane emergence and half about a month before first harvest.

In EY production, with February training, it is best to remove the spent floricanes in late fall or winter rather than immediately after harvest to conserve plant N. In the on-year of AY production, do not cut the plants to crown height before October; otherwise, regrowth of primocanes will deplete N reserves.

As a general rule for trailing blackberries, apply 30 to 50 lb N/acre in the establishment year and 50 to 70 lb N/acre in subsequent years. In 'Thornless Evergreen,' experience suggests mature plants can respond well to rates of 60 to 80 lb N/acre.

Little N research has been done on erect (e.g., 'Navaho,' 'Kiowa') or semierect (e.g., 'Chester Thornless,' 'Triple Crown') blackberries. However, we do know that these types of blackberries respond similarly to trailing blackberries in their use of new fertilizer N and reserves. These varieties are grown only in EY systems. As a general rule, apply 30 to 50 lb N/acre in the establishment year(s) and 50 to 80 lb N/acre in subsequent years. Use the higher rates for semierect types.

Other considerations

Nitrogen can be efficiently applied with P and K. Apply fertilizer in a wide band, about 2 feet wide and centered on the row. Nitrogen can be lost from surface-band applications if soils have been limed recently and the fertilizer is not washed into the soil by rain or irrigation within 1 or 2 days after application.

Caneberries use the nitrate form of nitrogen more readily than the ammonium form. Nitrate nitrogen is soluble in water and moves into soil or the plant rapidly, but it's also leached easily from soil.

Because nitrate nitrogen generally is more expensive than ammonium forms, many growers apply urea or other ammoniacal sources of nitrogen. Ammonium nitrogen is less easily leached because it binds to soil particles. However, it is converted into the nitrate form through a process called nitrification.

Soil pH is one factor controlling nitrification. Figure 4 illustrates relative nitrification of ammonium nitrate, ammonium sulfate, and urea. Urea and ammonium nitrate act similarly when the soil pH is 6.0 but differently at

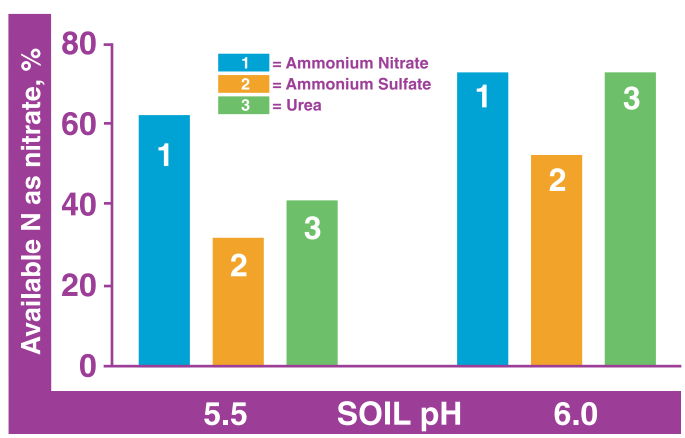

Figure 4.—Relative nitrification of N fertilizers at two levels of soil pH (Hyslop Farm, spring 1985, 140 lb N/acre applied March 7, sampled April 23).

pH 5.5. All N sources nitrify faster at pH 6.0 than 5.5. Ammoniacal N is rapidly converted to nitrate in warm, moist soil with a pH above 6.0. In the Willamette Valley, this conversion can be 50 percent complete 3 to 10 weeks after an early spring application.

Use of most common nitrogen fertilizers increases soil acidity and lime need. Table 1 shows the effect of increasing N rate on soil pH in four southern Willamette Valley soils. Urea or other ammoniacal N sources acidify the top 3 inches of soil approximately 0.1 pH unit for each 100 lb N/acre. For example, when nitrogen is applied at the rate of 140 lb/acre, the soil pH decreases by approximately 0.14 pH unit. If 140 lb N/acre is used for 3 years, soil pH will decline approximately 0.4 pH unit.

Thus, the use of nitrogen fertilizer beyond crop need has a double cost. The first cost—the N fertilizer itself—is not offset by increased yield or economic return. Second, the additional nitrogen acidifies soil, which then requires additional lime to raise the soil pH. Application of 50 lb N/acre above crop need will require an additional 0.3 to 0.6 ton lime/acre in 3 years.

Of the commonly available N sources, ammonium sulfate is the most acidifying. Urea, the most common solid or dry N source, is less acidifying than ammonium sulfate because the N in urea undergoes a different process to become plant-available. As the urea initially reacts with enzymes in the soil, the soil pH rises slightly, partially offsetting acidification produced by subsequent reactions.

Although foliar applications have been shown to be an efficient way to apply micronutrients such as zinc and boron, they have not been shown to be a very effective way of applying nitrogen. Thus, broadcast granular applications or liquid applications through drip irrigation systems are recommended .

Phosphorus (P)

Most soils in the Willamette Valley contain adequate P for caneberry production. Definitive research showing yield or growth response from P is not available for caneberries. Trial applications can be helpful in determining P need for individual fields when tissue P is below normal. See Table 2 for guidance.

Table 2.—Phosphorus recommendations for caneberries based on late-July to early-August tissue test (producing berries) or Bray soil test (preplant).

If the soil test for P is (ppm):	If tissue P is (%):	Apply this amount of phosphate (P_2O_5) (lb/a):
0–20	<0.16	60–80
21–40	0.16–0.18	0–60
>40	>0.19	0

Although we speak and write about P, or phosphorus, the analysis on a fertilizer bag is expressed as P_2O_5. For example, the “20” in 16-20-0 represents 20 percent P_2O_5. The expression is a tradition used in the fertilizer industry. Fertilizer rates are given as P_2O_5, since this is the industry standard.

Surface application of P is less effective than subsurface banding due to lack of P mobility in soil. Rates in Table 2 are for subsurface bands. For the fastest and most efficient movement of P to caneberry roots, place bands adjacent to hills on each side of the row and 4 to 6 inches deep. Testing for 3 to 5 years may be necessary before changes are seen. Double or triple the P rate in Table 2 for a preplant, broadcast, incorporated application.

Rock phosphate can be used by growers practicing organic production. Rock phosphate material has approximately 30 percent P_2O_5 and a solubility above 50 percent. Not all rock phosphates react or release P at the same rate. Finely ground rock phosphate mined in North Carolina applied to a P-deficient soil produced wheat yields comparable to those produced by superphosphates when applied at double the rate of superphosphates.

Potassium (K)

K is essential for caneberry production. However, the amount of K fertilizer (expressed as K_2O) required is not well defined. Good fruit firmness sometimes is attributed to adequate tissue K levels. No documentation exists to support the idea that higher-than-adequate tissue concentration increases cold hardiness.

Use soil tests to determine preplant K fertilization. Plant analysis is the best indicator of K need after

Table 1.—Soil pH and lime rates required to raise the soil pH in grass seed fields after 3 years of nitrogen applications at three application rates.[a]

	Dayton silt loam		Concord silt loam		Bashaw silty clay loam			Amity silt loam	
N rate	Soil pH	Lime (ton/a)[b]	Soil pH	Lime (ton/a)[b]	Soil pH	Lime (ton/a)		Soil pH	Lime (ton/a)[b]
0	5.9	0	6.2	0	5.4	4.3[c]	6.0[b]	7.1	0
135	5.5	1	5.8	1.1	4.9	4.7	6.4	6.6	0
270	5.2	2	5.6	1.5	4.8	5.0	6.9	6.0	1

[a] Sampled November 2000
[b] Lime to pH 6.0
[c] Lime to pH 5.6

crop establishment. Generally, no relationship exists between soil and tissue K levels. High surface soil K and low tissue K may indicate a gravelly subsoil low in K, inadequate irrigation, diseases, or other production problems.

In fields 2 years old or older, K can be banded or broadcast, alone or in combination with N, P, and possibly other fertilizers. Table 3 indicates K fertilizer rates based on soil and tissue testing.

Table 3.—Potassium recommendations for caneberries based on late-July to early-August tissue test (producing berries) or ammonium acetate soil test (preplant).

If the soil test for K is (ppm):	If tissue K is (%):	Apply this amount of potash (K_2O) (lb/a):
<150	<1.0	60–100
151–350	1.0–1.25	40–60
>350	>2.0	0

In new plantings, broadcast and incorporate one-half to two-thirds of the K requirement before planting and band the remaining one-half to one-third with N and P after planting. Do not include more than 40 to 60 lb K_2O/acre in N-P-K mixtures banded after planting. Excessive amounts of banded K may burn new roots, particularly in sandy soils.

Potassium is commonly supplied by potassium chloride (0-0-60, also called muriate of potash), potassium sulfate (0-0-50-18), potassium-magnesium sulfate (0-0-22-22), and potassium nitrate (14-0-45). Potassium chloride usually is less expensive than the other sources.

When using potassium chloride to supply high rates of K (more than 75 lb K_2O/a), you also apply a substantial amount of chloride. Much is said about detrimental effects of chloride on caneberry production, but no documentation exists to substantiate the comments. Even without data to support damage to caneberry production or canes from chloride, be cautious when applying more than 75 lb K_2O/acre.

One way to keep costs manageable and reduce chloride application is to mix K sources or use potassium chloride as a primary source mixed with some potassium sulfate. Potassium sulfate and potassium-magnesium sulfate also provide nutrients other than K and are most useful when sulfur and/or magnesium are needed in addition to K.

Sulfur (S)

Sulfur deficiencies in caneberry crops are not common in the Pacific Northwest. Soil S concentrations usually are adequate because S often is added with other nutrients. Fertilizer materials such as ammonium sulfate (21-0-0), potassium sulfate (0-0-50), potassium-magnesium sulfate, and gypsum contain sulfur. Use of a physical mix of urea and ammonium sulfate, urea-sul, is a common way to supply S in western Oregon.

Like nitrogen, S is a key component of proteins. Tissue S concentrations between 0.11 percent and 0.20 percent generally are adequate. The N:S ratio typically is 15:1. Sulfur is likely to be deficient if the ratio is greater than 20:1.

For example, when tissue N is 3 percent, a 15:1 N:S ratio would represent 3 percent N and 0.2 percent S. For this tissue N concentration, a tissue S concentration of 0.1 percent would be low, creating an N:S ratio of 30:1. When using the ratio approach, be sure tissue N and S are not both low.

Sulfur soil tests are difficult to use in western Oregon and Washington. Sulfur in the sulfate form, SO_4, is moderately mobile in soil; therefore, preplant application is not as critical as for lime, P, and K. A preplant application usually is not needed. If sulfur deficiency is suspected or documented, you can add S preplant, but also will need to add it regularly thereafter.

When S applications are needed, 30 to 40 lb S/acre is adequate. Sulfur can be added with N fertilizer. Gypsum is a common source of S and has little impact on soil pH.

Micronutrients

Boron (B)

Small amounts of boron are critical for bud break and fruit set of caneberries Boron deficiency results in small fruit, decreased yields, and, in severe situations, cane dieback. Table 4 provides B fertilizer recommendations based on soil or tissue tests. Note, however, that soil tests are less effective at predicting B needs for fruit crops than are tissue tests.

Boron applications without soil or tissue tests are not recommended. In an Oregon trial, continued application of B reduced yields 2 years in 5 when tissue B was adequate.

Boron should be broadcast or applied as a foliar spray. It can be added to most sprays, particularly Bordeaux mixture. Foliar boron applications in fall or spring prior to bloom are effective. Do not band apply boron.

If an analysis of a mid-July to mid-August tissue sampling is below 30 ppm B, spray sodium pentaborate (20 percent B) in fall at a concentration of 2 lb sodium pentaborate in 100 gal water. If you use dry B formulations, apply in spring before bud break.

Table 4.—Boron recommendations for caneberries based on late-July to early-August tissue test (producing berries) or hot water extractable soil test (preplant).

If the soil test for B is (ppm):	If tissue B is (%):	Apply this amount of boron (lb/a):
<0.5	<25	2–2.5
0.5–1.5	26–30	1–2
>1.5	>30	0

Other micronutrients

No increase in growth or yield of caneberries resulting from the application of other micronutrients has been documented in western Oregon.

Lime

Acidity, or pH, is the most commonly determined chemical characteristic of soil. Acidity is a measure of the hydrogen ion concentration in soil solution. Soil solution is water held by the soil particles. Soil pH determines a soil's general suitability for root growth.

Soil acidity or alkalinity is measured and expressed as soil pH. Soil pH is measured on a scale from 0 to 14. Soil pH values below 7 indicate acidic soil, and numbers above 7 indicate basic or alkaline soil. As pH numbers decrease, soil acidity (the hydrogen ion concentration) increases. Lime is added to acidic soil to raise the pH. Amendments such as elemental sulfur are added to basic soil to reduce the pH.

Soil pH tells us the chemical condition roots will experience. As soil pH decreases, the solubility of iron, zinc, manganese, and aluminum increases. The concentration of manganese and aluminum can reach levels that are toxic or at least inhibit root growth. Crop sensitivity to manganese and aluminum varies. Caneberries are moderately sensitive.

As soil pH increases, the solubility of iron, zinc, and manganese decreases. The concentration of manganese and iron can reach levels that are deficient, causing yellowing of leaves.

For optimum caneberry production, maintain soil pH between 5.6 and 6.5. A test for soil pH determines whether lime is required. A second soil test, the lime requirement (or buffer) test (sometimes called SMP) estimates the amount of lime needed. SMP are the initials of Shoemaker, McClean, and Pratt, the creators of the test.

Lime is most effective when mixed with the soil. Therefore, lime should be applied before planting caneberries.

Lime is recommended when the soil pH is 5.6 or below, or when calcium (Ca) levels are below 5 meq Ca/100 g of soil. However, if total bases exceed 20 meq/100 g on fine-textured (clayey) soils, lime probably is not needed unless the pH is below 5.2. Estimate the rate of lime application from Table 5.

Table 5.—Preplant lime recommendations for caneberries (tons/acre of 100-score lime needed to raise pH of surface 6 inches of soil).

If the SMP is:	Apply this amount of lime (ton/a):[a]
<5.2	5
5.2–5.6	4–3[b]
5.7–5.9	3–2
6.0–6.2	2–1

[a] Rates based on 100-score lime.

[b] The higher lime rate is required for the lower SMP buffer value.

Increase the lime rates in Table 5 by 1 to 2 tons/acre before establishment of a new field. Mix lime into the soil at least several weeks before planting. A lime application is effective over several years.

Sandy soils to which fertilizers have not been recently applied sometimes record low pH and high SMP buffer values. In such cases, a light application of 1 to 2 tons lime/acre should suffice to neutralize soil acidity.

For acid soils low in magnesium (Mg) (less than 1.0 meq Mg/100 g of soil), 1 ton dolomitic lime/acre can be used as a source of Mg. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

For existing plantings, monitor raspberry and blackberry leaf manganese (Mn) concentration as an indicator of declining soil pH. As soil pH declines, Mn availability increases, and leaf Mn concentration rises. If leaf Mn during late July and early August is above 300 ppm, check soil pH.

Topdressing is the logical method for lime application to established plantings. A topdress lime application should not exceed 2 tons/acre. Topdressed lime moves downward ½ to 1 inch a year until reaching a depth of 2 to 3 inches. Low soil pH below the 3-inch depth will not be corrected by topdressing lime.

Fertilizer Guide 52, *Fertilizer and Lime Materials,* available from the OSU Extension Service, provides additional information on lime, including a definition of lime score and an explanation of SMP buffer.

Manure

Manure is an excellent source of plant nutrients and serves as a soil conditioner. However, because of its variable nutrient content, increased handling requirement, and nutrient release characteristics, manure requires greater skill on the part of the grower than do commercial fertilizers. Table 6 provides average nutrient contents of manures.

Table 6.—Nutrient and water content of fresh manures.

Kind of manure	Nutrient and water content (%)			
	Water	N[a]	P_2O_5	K_2O
Dairy	87	0.50	0.16	0.44
Beef	82	0.65	0.43	0.53
Poultry	73	1.30	1.02	0.50
Hog	84	0.45	0.27	0.40
Sheep	73	1.00	0.36	1.00
Horse	60	0.70	0.25	0.60

[a] About 25 percent of the N is available the first year.

Using manure to supply plant nutrients requires handling more material compared to commercial fertilizers. Consider an application of 70 lb N/acre. For this N rate, 152 lb urea (46 percent N)/acre would be required. The same amount of N from manure, assuming 1 percent N, requires 7,000 lb/acre. Also, additional manure (5,000 to 7,000 lb/acre) would be required for the first year, as not all of the N is initially available.

The conversion of unavailable N to the available form occurs throughout the growing season. If plant demands exceed the rate of conversion, a deficiency occurs. Conversely, if conversion to available forms is high late in the season, unwanted late-season growth may result.

Losses of nitrogen exceeding 50 percent can occur during manure storage or after application to the surface of the soil. Nitrogen loss is least when fresh manure is spread and worked into the soil immediately.

Manure can serve as a source of weeds and pests. Unless livestock have been fed on weed-free feed, use aged manure that has been composted at temperatures high enough to kill seeds. Aged and composted manures contain lower nitrogen concentrations than fresh manure.

Growers report that centipede-like organisms called symphylans are introduced to western Oregon caneberry fields with manure application. This association is a puzzle since symphylans feed on germinating seeds and young roots. Therefore, weed-free or plant-free free manure should not contain symphylans. High-temperature composting should reduce problems associated with manure-introduced symphylans. If you use manure, check for symphylans before application.

For more information

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