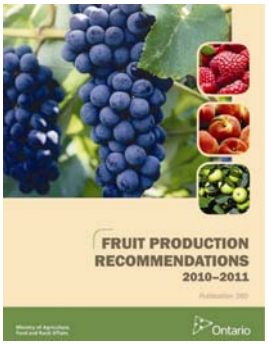

Chapter 5: Berry Crops

Berry Crop Nutrition

Blueberries, Highbush

- Blueberries perform best on acidic, well-drained soils with high organic matter content.
- Before you plant, test the soil to determine the pH and fertilizer requirements.
- Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will draw soil moisture away from plant roots so be sure it is thoroughly moistened before planting.

pH requirements

- Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically through the use of sulphur or peat moss. For this reason, choose the site for blueberry production carefully.
- If the soil pH is too high but less than 6.5, acidify through the incorporation of elemental sulphur and/or acidic peat moss prior to planting. See Table 5-1. *Amount of Sulphur Required to Lower Soil pH,* on this page.
- Incorporate sulphur at least one year prior to planting to allow sufficient time for the sulphur to acidify the soil.
- Check the soil pH annually in the plant row and add sulphur when necessary.

Fertilizer for blueberries

Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N) if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid using the nitrate form of nitrogen. Avoid fertilizers containing lime filler as they will raise the pH of the soil. In the spring after planting, apply a total of 12 g of actual nitrogen per bush in a split application. Increase the rate of nitrogen each year until a total of 36–48 g per bush is applied. Apply the nitrogen just prior to bud break, petal fall and early July. Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. On older bushes, apply most of the fertilizer under the outer spread of the branches. See Table 5-2. *Nitrogen Requirements for Highbush Blueberries,* on this page.

Table 5-1. Amount of Sulphur Required to Lower Soil pH (kg/ha)

Soil type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1,100	110
Example: The initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8. The soil pH must be lowered by 6.2–4.8 = 1.4 units. Therefore, 1.4 x 750 = 1,050 kg/ha of sulphur is required.		

Table 5-2. Nitrogen Requirements for Highbush Blueberries

Plant Age	April 1–15	May 15	July 1
	(g N per plant)		
Newly planted	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 94, for soil test interpretation. A single application of phosphorus at soil preparation time is usually all that is required. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in the spring under the outer branches of the bushes, as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (22% potash, 11% magnesium) or potassium sulphate (50% potash). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60).

Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg per ha is required where a confirmed deficiency exists. Use magnesium sulphate (Epsom salts, 9.5% Mg) or sulphate of potash magnesia (21% potash, 11% Mg). Since sulphate of potash magnesia contains potash, adjust the rate of

application to coincide with potash requirements. For foliar sprays, 1.9 kg Mg per 1,000 L of water (20 kg magnesium sulphate, Epsom salts) with at least 2,000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

Leaf analysis

Leaf tissue analysis can help to assess the nutrient status of the plants and more accurately determine fertilizer requirements. In late July, take leaf samples from halfway down the new shoot growth of the current season. For adequate representation, collect at least 100 leaves throughout the sampling area. Separately sample areas with different soil, plant vigour, fertility programs, etc. See Table 5-4. *Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves,* on this page.

Table 5-3. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries

Phosphorus				Potassium		
		Phosphate required kg P_2O_5 per ha				Potash required kg K_2O per ha
Soil test (ppm P)*	**Rating**	**New plantings**	**Established plantings**	**Soil test (ppm K)****	**Rating**	
0–3	HR	140	100	0–15	HR	130
4–5		130	90	16–30		120
6–7		120	80	31–45		110
8–9		110	70	46–60		100
10–12		100	70	61–80		90
13–15		90	60	81–100		80
16–20	MR	70	50	101–120	MR	70
21–25		60	40	121–150		60
26–30		50	30	151–180		40
31–40		40	20			
Above 40	LR	0	0	Above 180	LR	0

* 0.5 M sodium bicarbonate extract.
** 1.0 N ammonium acetate.
HR, MR, LR, denote, respectively: high, medium, and low probabilities of profitable crop response to applied nutrient.

Table 5-4. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves

Element	Acceptable Range
Nitrogen (N)	1.7–2.3%
Phosphorus (P)	0.15–0.4%
Potassium (K)	0.36–0.7%
Calcium (Ca)	0.3–0.8%
Magnesium (Mg)	0.12–0.3%
Manganese (Mn)	150–500 ppm
Iron (Fe)	30–100 ppm
Zinc (Zn)	10–100 ppm
Boron (B)	15–50 ppm
See Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 239, for a list of laboratories that provide leaf analysis.	

Currants and Gooseberries

It is essential to apply and incorporate required materials such as phosphorus, potassium, organic matter and lime before you plant currants and gooseberries because these materials do not move through the soil easily.

Prepare the soil and adjust pH as required, as determined by a soil test at least a year before planting. This will ensure the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil organic matter should be at least 2–3% to promote good drainage, aeration and moisture retention.

Apply 45 tonnes/ha or 4.5 kg/m^2 of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used, but these materials should be well decomposed by planting time. For more information on organic matter, see Soil Management at *www.ontario.ca/crops*.

pH requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming of soil may be required to raise soil pH to 6.1.

If lime is needed, apply at least 6-12 months before planting. For more information on lime, consult *Soil pH and Liming,* page 32. Micronutrients may become limiting if soil pH is outside the recommended range.

Fertilizer before planting

Incorporate phosphorus and potassium fertilizer into the soil in early spring a few days before planting. Incorporate nitrogen before planting or apply in a band around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen. If planting takes place in the fall, incorporate required phosphorus before planting but delay application of nitrogen and potassium until the following spring.

Nitrogen (N)

Incorporate or band 5 g of actual nitrogen per bush in the planting year.

Phosphorus (P)

Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. See Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 94, for more information. Recommended phosphorus rates to meet plant requirements must be incorporated prior to planting. Phosphorus does not move easily through the soil to the roots. This makes it difficult to effectively incorporate phosphorus after the crop is planted. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

Potassium (K)

Test the soil before planting and apply the required amount of potassium according to the soil test results. See Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 94. Currants and gooseberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60). Use sulphate of potash or sulphate of potash magnesia instead.

Fertilizer in established plantings

Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, reduce rates to the percentage of area that will receive fertilizer. If the fertilizer is banded, band 30 cm from the base of the plant.

Nitrogen (N)

Apply 10 g nitrogen per bush in the year after planting. In subsequent years, apply 20 g per bush.

Potassium (K)

Apply according to soil test results. If a soil test is not available, assume a moderate level and apply as indicated in Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 94.

Raspberries

Raspberries have a fine, fibrous root system and perform best on a deep, well-drained soil. Raspberry soils need good water retention ability and a high organic matter content of approximately 3%. For more information on organic matter, see Soil Management at *www.ontario.ca/crops*.

One year before planting raspberries, test the field soil for phosphorus, potassium, magnesium and pH. Adjust soil pH and organic matter if necessary. Plant a weed-smothering cover crop and incorporate it into the soil to build up organic matter. Apply well-composted manure (45 tonnes of cattle manure per ha)

and incorporate into the soil the year before planting.

pH requirements

Raspberries grow best at a soil pH of 5.5–6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 12 months before planting. For more information on lime, consult *Soil pH and Liming,* page 32. Micronutrients may become limiting when soil pH falls outside the recommended range.

Fertilizer for raspberries

Nitrogen (N)

Recommended nitrogen rates are found in Table 5-5. *Recommended Nitrogen Rates for Raspberries,* on this page. Avoid the application of excessive nitrogen. It can reduce the number of berries per cane and cause excessive vegetative growth. Sources of nitrogen and nitrogen equivalents are presented in Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 35.

For summer and fall-bearing raspberries, apply nitrogen in early spring (late March to early April). Late applications may lead to winter injury. For fall bearing raspberries, winter injury is not a concern because canes are removed each spring. However, ripening may be delayed where nitrogen is applied in excess.

Table 5-5. Recommended Nitrogen Rates for Raspberries

	kg N per ha per season
Planting year	30–40
Second year	40–60
Third and following years	45–75
Use the lower rates on non-irrigated crops and heavier soils. Apply higher rates to irrigated crops and sandier soils.	
See Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, page 239.	

Phosphorus (P) and Potassium (K)

Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test.

Incorporate phosphorus prior to planting to correct phosphorus deficiencies, as phosphorus does not move readily through the soil. Do not apply more phosphorus than is required; excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

If the soil test recommends high rates of potash, use sulphate of potash (0-0-50) or sulphate of potash magnesia (0-0-22). Raspberries are sensitive to chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0-0-60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 35.

Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Sample the soil every two to three years.

Leaf analysis

Collect fully expanded mature raspberry leaves from fruiting canes in late July. See Table 5-6. *Ranges for Nutrient Levels in Raspberry Leaves,* on this page. These ranges provide a guide for interpretation of results. Variation can occur because of cultivars, soil type and cultural practices.

Table 5-6. Ranges for Nutrient Levels in Raspberry Leaves

Element	Range
nitrogen (N)	2.0–3.5%
phosphorus (P)	0.2–0.5%
potassium (K)	1.0–2.0%
calcium (Ca)	0.8–2.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
copper (Cu)	5–20 ppm
boron (B)	20–60 ppm
See Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 239, for a list of laboratories that provide leaf analysis.	

Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries develop. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Provide an optimum environment for strawberry root growth to obtain a profitable, perennial planting.

One year before planting strawberries, adjust soil pH and organic matter. Plant a weed-smothering cover crop and incorporate it into the soil to build up organic matter. Apply well-composted manure (45 tonnes of cattle manure per ha) and incorporate into the soil the year before planting. Test the field soil for phosphorus, potassium, magnesium and pH.

pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH, however some micronutrients become less available outside this range, particularly when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil pH and Liming,*

page 32.

Fertilizer for new plantings (the planting year)

Phosphorus (P)

Use soil test results to determine the best rate of phosphorus to apply. Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 94, shows soil test values and fertilizer requirements for new strawberry plantings. Incorporate phosphorus into the soil before you plant. Soils differ in the amount of phosphorus available to plants. Generally, fields cultivated for a long time require less phosphorus than recently developed fields.

Starter Solutions:

To help the plant establish, particularly if the soil is cold, use a starter fertilizer solution. Plant uptake of soil phosphorus can be reduced when soils are cold. Use a starter solution high in phosphorus such as 10-52-10, 6-24-6 or 10-24-0. Follow the manufacturer's suggested application rate.

Potassium (K)

Use soil test results to determine the best rate of potassium to apply. Incorporate potassium into soil before planting. Side dressing of potassium is not generally recommended.

Nitrogen (N)

Nitrogen can be applied with the phosphorus and potassium or as a side dressing two to three weeks after planting. Apply 50 kg of N per ha. See Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 35, for nitrogen content of fertilizers. Apply an additional 25–35 kg N per ha in mid-August to further invigorate plants as they initiate fruit buds for the next year's crop.

Use whatever form of nitrogen is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply when leaves are wet. Urea forms of nitrogen may volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem.

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease.

Adjust nitrogen rates proportionately if manure was applied. See Table 3-11. *Average Fertilizer Replacement Values For Different Types Of Manure,* page 36. For more information about food safety and the environmental effect of manure application, please see *Use manure responsibly* and *Manure and food safety,* page 36.

Fertilizer for established plantings

Nitrogen (N)

Do not apply nitrogen in the spring, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigour, which results in softer fruit and dense canopies. This increases the potential for botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by one or two days.

Benefits have been reported from the application of low rates of nitrogen (10–20 kg N per ha) to coarse-textured soils in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

The best time to apply nitrogen in established fields is at renovation. After you mow the foliage, apply 50 kg N per ha using whatever form of nitrogen is most economical. See Table 5-7. *Recommended Nitrogen (N) Rates for Strawberries,* page 98. Brush pelleted forms such as ammonium nitrate off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. Urea forms of nitrogen can volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem. Apply an additional 25–35 kg N per ha in mid-August to assist the development of next year's fruit buds.

Ensure soils are well irrigated after renovation, throughout the summer and in early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

Phosphorus (P)

If a soil test shows phosphorus is needed, apply at renovation with nitrogen and potassium. Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils.

Potassium (K)

Apply potassium, as determined by a soil test, with nitrogen and phosphorus at renovation. This allows incorporation. Use soil tests to determine what rate to apply and use leaf analysis to adjust rates. Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

Table 5-7. Recommended Nitrogen (N) Rates for Strawberries

	Before planting or 2–3 weeks after planting	**Renovation (after harvest)**	**Mid-Aug.**
Planting years	50 kg N per ha		25–30 kg N per ha
Established plantings		50 kg N per ha	25–30 kg N per ha

Leaf analysis

Leaf analysis can help assess the nutrient status of strawberry plants and more accurately determine fertilizer requirements. Take leaf samples by July 1 for fruiting or August 20 for non-fruiting plantings. Collect at least 50 fully expanded, recently matured leaves with petioles removed. Sample different varieties and plantings separately. See Table 5-8. *Optimum Nutrient Level Range of Strawberry Leaves,* on this page, for interpretation of leaf analysis values.

Table 5-8. Optimum Nutrient Level Range of Strawberry Leaves*

Nutrient	**Optimum Range**
nitrogen (N)	2.0–3.0%
phosphorus (P)	0.20%–0.50%
potassium (K)	1.5%–2.5%

calcium (Ca)	0.5%–1.5%
magnesium (Mg)	0.25%–0.50%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
boron (B)	20–60 ppm
* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before August 20 in non-fruiting fields.	
See Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, page 239, for laboratories that provide leaf analysis.	

Micronutrients for Berry Crops

Deficiencies of micronutrients are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem. Leaf analysis is more effective than soil analysis to evaluate a crop's micronutrient status. See *Micronutrients,* page 41, for additional information.