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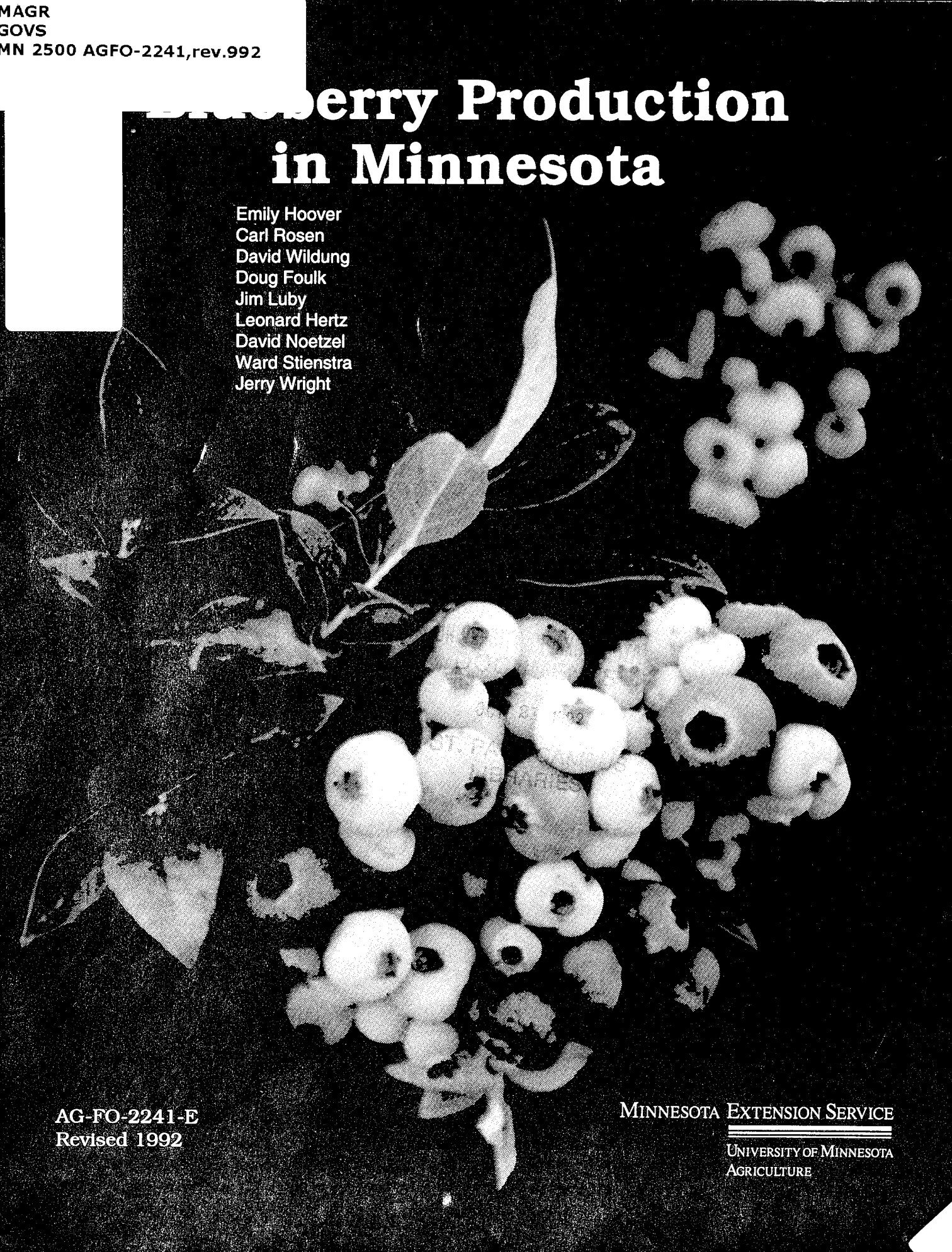

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Blueberry Production in Minnesota

Minnesota's harsh climate has made successful blueberry production difficult. But that fact is changing with the University of Minnesota's introduction of blueberry cultivars with good winter hardiness, minimum upright growth, and large fruit. Given proper site selection and cultural methods, these cultivars, once established, offer Minnesota growers the potential for long-term (thirty years or more) blueberry production.

Choosing a Cultivar Recommended for Minnesota

Blueberry cultivars released from the U of M breeding program produce flavorful fruit on short-statured bushes that can survive typical Minnesota winter temperatures. Choose the cultivar that best meets your needs. **Table 1** summarizes the cultivars' characteristics. All listed cultivars require an average of five years before producing a large harvest and up to ten years before reaching mature size.

Plants

Most plants available from nursery sources are propagated by tissue culture rather than the traditional cutting method. Evidence suggests that young tissue-cultured plants are more vigorous than cutting propagated stock and produce correspondingly higher numbers of flower buds, owing to improved development of basal and lateral branches.

Several plant sizes are available, both bare root and in containers. **Table 2** outlines the various types and recommended uses.

Larger plants are ready for direct field planting in a prepared site. Small plants should be grown in containers or placed in nursebeds for at least one growing season before being transplanted to the field.

Table 2. Types of blueberry plants available for purchase

Type description for planting	Application
Liners 3-6"	Nursebed
1-yr-old Nursebed or field	7-12", cup-size rootball
2-yr-old Field planting	12-18", quart-size rootball
3-yr-old Field planting	18-30", 1/2-gallon-size root

Nursebed

The nursebed is an intensively managed space designed to promote additional root and shoot development and allow for the purchases of smaller, less expensive plants. It is constructed by forming a raised bed of acid peat moss 8 to 10 inches deep. A support frame around the perimeter of the bed will hold the moss in place.

Transfer bare-rooted plants to the bed and space 8 to 12 inches apart. Pots should be removed from containerized stock. Growing plants will require shading and protection from wind until they become acclimated to full sun and surrounding conditions. Moisture levels must be monitored closely. The use of drip tubing or soaker hose is preferable to overhead sprinklers.

Fertilize every 2 weeks during active growth with a water soluble acid reacting fertilizer such as Peter's Acid Special (21-7-7) or Miracid (30-10-10). Micronutrient needs can be satisfied by adding a trace ele-

Table 1. Characteristics of Northblue, Northsky, Northcountry, and St. Cloud blueberries

	Northblue	Northsky	Northcountry	St. Cloud
Fruit yield	3-12 pounds/bush	1-5 pounds/bush	2-7 pounds/bush	3-9 pounds/bush
Fruit characteristics	Large, dark blue, firm; good fresh flavor; processed flavor superior to many highbush cultivars.	Med, sky blue, sweet; mild aromatic flavor; processed flavor superior to many highbush cultivars.	Med, sky blue, sweet; fresh flavor similar to wild lowbush blueberry; ripens 5 days earlier than Northblue.	Med., dark blue, very firm; sweet flavor, crisp texture; excellent storage capability; ripens 5 days earlier than Northblue.
Plant characteristics	30-40 inches tall. Large, glossy, dark green leaves turn red in fall.	10-30 inches tall; dense foliage; short stems.	15-25 inches tall; spreading.	30-50 inches tall; upright; requires a second cv for pollination.

ment mixture such as S.T.E.M. (soluble trace element mixture) at half strength to the fertilizer solution once a month. Follow label rates. Discontinue fertilizer applications in summer when growth slows.

Bedded blueberry plants need to be protected during winter. Snow is an excellent insulator and can be used to protect plants in the nursebed against injury caused by severe winter temperatures and drying winds. However, since timing and amount of snowfall is unpredictable, a mulch or artificial covering can be applied when plants go dormant.

Before covering plants, strip off any remaining leaves and apply a protective fungicide such as Captan. This will help prevent potential fungal activity. Uncontrolled rodents can also pose a problem. Commercially prepared poison baits containing zinc phosphide are convenient and easy to use.

The winter protection cover, consisting of two layers of plastic with a mulch layer between, can now be installed. First dig a shallow trench around the edge of the nursebed. Cover the plants with plastic. Place 1 foot of straw or hay on top and cover with a second sheet of plastic. Secure the border by laying edges of plastic in the trench and covering with soil. The plastic-straw-plastic sandwich will insulate the blueberry plants from extreme low temperature, prevent desiccation (drying out), and allow for easy removal the following spring.

Selecting and Preparing a Site

Blueberries require moist but well-drained acidic soil. Choose a frost-free level or gently sloping site in full sun with good air circulation. Surface and internal soil drainage are essential, since only a few hours of standing water may kill the plants; still they need a constant moisture supply.

Soils

Open, porous soils such as sandy loams and coarse sands with a high organic matter content will best provide the aeration needed. If the soil is sandy and has little organic matter, add 1 1/2 to 2 cubic feet of peat per plant to the soil. Be sure to mix peat in thoroughly with the soil. Clay soils that are acidic and high in organic matter may also be used for blueberry plantings. However, aeration and drainage are often poor and plants on these soils may develop root problems.

Peat and muck soils should be avoided. These soils are wet and cold in the spring, and often are located in low-lying areas, subjecting the plants to spring frost damage and standing water. In late summer, the soil releases a high amount of nitrogen, which delays the plants' hardening before winter and increases chance of winter injury.

pH

Soil tests should be used to assess and adjust soil pH. A soil pH of 4.5 to 5.5 is optimum for blueberry production. A pH higher than 5.8 may cause iron chlorosis, characterized by interveinal yellowing of the leaves. If the pH is too high, add acid peat or acid-forming salts to the soil according to soil test results. Fine-textured soils with pH values above 7.0 should not be used unless amended with acid peat for commercial blueberry production.

Elemental sulfur is one chemical that can be used to lower pH. Because it reacts slowly with the soil, elemental sulfur should be applied and incorporated to plow depth the year before planting. The soil type, present pH, and the desired pH are used to determine the amount of elemental sulfur needed. **Table 3** provides guidelines for elemental sulfur use. Test soil pH 3 to 4 months after initial application. If soil pH is not in the desired range, reapply according to **Table 3.**

Table 3. Elemental sulfur application rates to change soil pH to 4.5

Initial pH	Amount of sulfur to apply			
	Sand, loamy sand		Sandy loam, loam	
	lb/1000 ft²	*lb/acre*	*lb/1000 ft²*	*lb/acre*
7.0	19	800	58	2500
6.5	15	650	46	2000
6.0	12	525	35	1500
5.5	8	350	24	1000
5.0	4	170	12	500

Iron sulfate also can be used to lower soil pH. This material reacts faster than elemental sulfur but is more expensive. Multiply the rate of elemental sulfur needed by seven to determine the amount of iron sulfate needed. Although aluminum sulfate also lowers pH, it can be toxic to roots, so is undesirable as a soil acidifying amendment.

Acid sphagnum peat incorporated prior to planting at the rate of 1 to 2 cubic feet per plant will provide a favorable root environment for establishing blueberries in soils with a high pH. The positive effects of acid peat will last 6 to 10 years. Unless other measures are used, the pH of the soil will eventually increase.

Use of ammonium sulfate (21 percent nitrogen) as the nitrogen source will also help maintain a low soil pH. Refer to **Table 4** for application rates of nitrogen. Do not use ammonium sulfate at rates higher than those recommended for supplying nitrogen. Excessive nitrogen available late in the growing season can increase winter injury potential.

Table 4. Nitrogen recommendations for blueberries

Age of planting	Amount of nitrogen (N) to apply[1]
	— — — — lb/A — — — —
1 year	30
2 year	40
3 year[2]	50

[1] On mineral soils, on high organic-matter soils, lower rates by 10-20 lb/A.
[2] Base subsequent N fertilizer recommendations on leaf analysis and plant vigor.

Planting

Although planting can be done in either spring or fall, spring is preferable to benefit from spring rains and to avoid loss of plants due to frost heaving. Dormant stock should be planted as early in spring as field conditions permit. Planting blueberries which have already leafed out should be delayed until frost danger has passed. After the rows have been marked out, the holes are dug by hand or with a tractor-mounted auger. Holes should be 1 foot deep and not less than 1 foot in diameter. Space individual plants 3 to 4 feet apart, in rows 6 to 10 feet apart, depending on the type of equipment used. Spacing plants 4 feet apart in rows 8 feet apart yields a plant density of 1360 plants per acre. At 3-foot intervals with rows 8 feet apart, 2000 plants are required per acre. At planting the root system should be loosened, especially if containerized, to prevent root spiralling and root girdling which can result in weakened plants 5 to 6 years after planting.

Depth of planting is also a critical factor. Because blueberry plants possess fine, somewhat delicate root systems, planting too deeply or not deeply enough may cause root damage which results in poor plant growth and reduced plant longevity. Setting in plants at the same depth they were in the container or nursebed produces the best results.

Pollination

Bees pollinate blueberries. Although not necessary for production, cross-pollination (among different cultivars) results in larger berries and earlier ripening. In mixed plantings, alternate cultivars every 4 rows or every 4 to 5 plants in the row. Large acreages will require 1 honeybee hive per acre. The cultivar, St. Cloud, does require a pollinator.

Cultivation

Cultivation should be no more than 2 inches deep since 90 percent of blueberry roots are in the top 6 inches of soil. To reduce root injury due to cultivation, a mulch or orchard grass between the rows can be used to keep weeds down. Mulching 2 to 4 inches deep and 1 to 2 feet around blueberry plants increases plant growth and yield by insulating roots from high temperatures, increasing organic matter, and retaining moisture. Mulching also helps control weeds. Peat moss, shredded leaves, straw, wood chips, or sawdust can be used. When using sawdust, double the nitrogen application or add 2 pounds of ammonium sulfate per 100 pounds of mulch. When adding mulch, make sure to keep mulch a few inches away from the base of the plant.

Pruning

For new plantings, prune off flower buds and weak, spindly growth, leaving enough vegetative growth to support future crops. Bushes should not bear the first 2 years after planting: if flowers develop, they should be removed. After 2 seasons, allow a crop to develop. Prune out weak canes.

Pruning young and mature plants encourages production of large, high-quality fruit. Pruning increases berry size, encourages earlier blooming, and reduces winter injury. Plants should be pruned when dormant and before buds swell.

Prune mature bushes (5 years older) to remove diseased and dead wood, old canes, soft basal fall growth, twiggy growth clusters, and weak lateral shoots. Remove canes 5 years and older each year. Pruning cuts should be to the ground or to a low growing lateral. Allow from 1 to 3 new canes to develop each year.

Fertilization

Initial fertilizer use should be based on soil analysis made before planting. For established plantings, leaf analysis (discussed later), soil analysis, and observation of plant vigor indicate fertilizer needs. Avoid excessive fertilizer application particularly on new plantings as blueberries are very susceptible to salt injury. Fertilizer application is often necessary to provide optimum level and balance of nutrients for plant growth; however, fertilizer cannot make up for poor insect and disease control or correct severe damage due to winter injury.

Of all the essential elements, nitrogen usually gives blueberries the greatest growth response. Nitrogen fertilizer requirements increase as the plant grows older and yields increase **(Table 4)**. Nitrogen fertilizers in the ammonium form (for example, ammonium sulfate, urea) leave acid residues and are most suitable for blueberries growing on a soil with a pH greater than 4.8. Blueberries on soils with a pH less than 4.8, have responded well to ammonium nitrate fertilizer. Fertilizer containing nitrogen in the nitrate form only (for example, nitrate of soda) increases soil pH and should be avoided. For new plantings, nitrogen

Table 5. Phosphorus recommendations for blueberries[1]

Phosphorus (P) soil test (PTM[2])	Amount of phosphate (P_2O_5) to apply (lb/A)
0-10	100
11-20	50
21-30	25
30 +	0

[1] Recommended rates are for new and 1-year old plantings. Base subsequent P fertilizer applications on leaf analysis as well as soil tests.
[2] Parts per million. PPMx2 = lb/Ashould be sidedressed when the second flush of growth starts.

Table 6. Potassium recommendations for blueberries[1]

Potassium (K) soil test (PPM)	Amount of potash (K_2O) to apply (lb/A)
0-25	150
26-50	100
51-75	50
76-100	25
100 +	0

[1] Recommended rates are for new and 1-year old plantings. Base subsequent K fertilizer applications on leaf analysis as well as soil tests.

should be sidedressed when the second flush of growth starts. For established plantings, nitrogen should be applied in spring. Blueberries on very sandy soils may benefit from split nitrogen applications—half the recommended rate in spring at bud break and the remainder at petal fall. Applications late in the growing season may increase the potential for winter injury. If manure is used, reduce applications by about 5 pounds nitrogen per acre for each ton of manure applied.

When soil test results indicate a need, potassium should be applied as potassium sulfate or potassium-magnesium sulfate and phosphorus as superphosphate or triple superphosphate. Use potassium-magnesium sulfate if soil magnesium is low. Potassium chloride (0-0-60) should be avoided as high rates are detrimental to blueberry growth. Refer to **Tables 5** and **6** for phosphorus and potassium recommendations. If soil test magnesium level is less than 100 pounds per acre, then magnesium containing fertilizer (potassium-magnesium sulfate or Epsom salts) should be applied. For new plantings, phosphorus, potassium, and magnesium should be applied and incorporated the year prior to planting. For established plantings, applications can be sidedressed in spring.

In blueberry plantings, the absorbing roots extend out about as far as the branches. Apply fertilizer in a broad band, followed by irrigation. To reduce the chances of salt injury (characterized by browning of leaf tips and margins), do not apply excessive amounts of fertilizer, avoid concentrating fertilizer near the crown of the plant, and distribute fertilizer evenly over the outer edge of the root zone.

Healthy, mature plants should produce several whips near ground level, laterals from 4 to 6 inches long, and up to 20 leaves per shoot. Poor vigor and leaf discoloration often indicate lack of fertilizer. These symptoms can also result from other conditions such as soil compaction, poor drainage, insects, disease, or fertilizer burn. All of these will weaken the root system of the plant.

Table 7 shows the nutrient deficiency symptoms frequently found in blueberries.

Table 7. Common nutrient deficiencies in blueberries and suggested treatments

Deficient nutrient	Symptoms	Treatment
Nitrogen	Stunted growth; yellowing of older leaves, followed by reddening and death of leaves	Apply nitrogen fertilizer in the form of ammonium sulfate.
Iron	Interveinal chlorosis (yellowing between leaf veins); affects youngest leaves first; stunted basal leaves.	Adjust soil to proper pH and use ammonium sulfate as the nitrogen source. For temporary treatment, spray foliage with ferrous sulfate or chelate, or treat soil with iron chelate. (1 ounce for new bushes, 4 ounces for established plants).
Potassium	Death of the terminal growing tip; scorching of the margins of the older leaves.	Apply potassium sulfate or potassium-magnesium sulfate according to soil recommendations.
Magnesium	Pale green between leaf veins and on the margins of lower leaves of very vigorous shoots; symptoms begin at berry-ripening.	Apply magnesium sulfate (Epsom salts) to the soil at a rate of about 70 pounds per acre.

Leaf Analysis

When used properly, leaf analysis provides a valuable tool in determining fertilizer needs for established blueberry plantings. Many factors affect the nutrient composition of leaves. Soil moisture, soil structure, native soil fertility/pH, and fertilizer practices all have direct effects on nutrient uptake. Crop load, cultivar, and cultural practices such as weed control and pruning can also alter leaf nutrient composition. Leaf analysis can be used to determine the nutrient levels in the leaf, but the exact causes for high or low leaf nutrient levels may not be apparent based on leaf analysis alone. Whenever possible, consider the factors just listed when interpreting leaf analysis results.

The basis behind leaf analysis is that maximum yields are associated with optimum ranges of nutrients in the leaf. If the level of a nutrient falls outside this range, corrective measures should be taken. **Table 8** shows nutrient concentrations for each element in blueberry leaves considered to indicate deficient, optimum, or excessive conditions.

Table 8. Foliar nutrient levels in established blueberry plants sampled during initial harvest

Nutrient	Deficient (below)	Optimum (within)	Excessive (above)
		percent	
Nitrogen	1.60	1.70-2.10	2.20
Phosphorus	0.08	0.10-0.40	0.80
Potassium	0.30	0.35-0.70	0.95
Calcium	0.20	0.35-0.80	1.00
Magnesium	0.09	0.12-0.25	0.45
Sulfur	0.10	0.12-0.30	—
		parts per million	
Iron	60	70-200	400
Manganese	25	50-600	700
Zinc	8	9-30	80
Copper	4	5-20	100
Boron	20	25-70	200

Optimum nutrient ranges in the leaves are based on samples collected at a particular growth and leaf stage maturity. Leaves sampled too early or late in the season may not be interpreted accurately using the values just listed. Obtaining a representative sample at the proper growth stage is important to avoid erroneous interpretations. The following instructions should be used as a guide for proper sampling procedures:

- Leaf samples should be collected just prior to harvest or during the first week of harvest (July 1 - 20).
- At least 10 bushes should be sampled. Bushes should be of the same age and cultivar, growing on a relatively uniform soil of the same fertility. Bushes not typical of the planting should be avoided.
- The most recently matured leaf from fruiting shoots should be selected. This usually corresponds to leaf 4 to 6 from the shoot tip. Collect a total of 50 leaves from 10 bushes (about 5 leaves per bush). Leaves showing insect, disease, or mechanical damage should not be sampled. Leaves that show symptoms thought to be nutritional should be compared with leaves from healthy plants.
- If leaves are dirty or dusty, rinse two or three times in deionized water. Do not let the leaves soak in the water as the nutrients can leach out. Dried leaves should not be rinsed. Place rinsed leaves in a clean perforated paper bag and dry at room temperature. Do not use plastic bags unless the samples have been previously dried.

Contact your county extension agent or local nursery dealer for information about tissue testing laboratories in your area.

Irrigation

Blueberry plants on well drained sandy soils will require frequent, light supplemental irrigations since the root systems are fibrous and shallow (8-18 inches). Reddened foliage, wilting, browning leaf margins, thin, weak shoots, early defoliation, and decreased fruit set are all symptoms of inadequate moisture.

Because the new root growth of young starter plants may be reduced by soil conditions which are either too dry or too wet, and because plants may wilt quickly in hot, dry weather until established, careful soil moisture monitoring will be necessary. Soil moisture content should be allowed to dry to 30 to 50 centibars of tension between irrigations. Addition of a surface mulch will help reduce the frequency of irrigations while protecting young roots from excessive water evaporation and increased soil temperature during hot days.

Mature plants require between .75 and 1.75 (with at least 1) inches of water per week depending on climatic conditions after fully leafed (during the growing season and) through the harvest period to maximize berry size, quality, and yield. Irrigation should continue during late summer and early fall when the fruit buds for next year's crop are developing. Field experience suggests that soil moisture content in the top foot of soil should be maintained between field capacity and a soil water deficit of 30 to 40% between fruit sizing and late summer growth. On sandy soils this is equal to a soil tension of 40 to 60 centibars. Soil tension can be monitored by tensiometers or electrical resistance blocks placed in the active root zone of a couple plants. More information on these tools is described in Minnesota Extension Bulletin AG-FO-3875 *Irrigation Water Management Considerations of Sandy Soils in Minnesota.*

Blueberries can effectively be irrigated by either sprinkler or trickle irrigation systems. Portable sprinkler systems like single handmove lateral, solid set or

small travelling gun (which distributes water evenly by spraying overhead), are cost effective and are most commonly used. Solid set overhead sprinklers should be used if frost protection is desired during spring bloom.

Trickle or drip irrigation can also be used to apply supplemental water to the blueberry plants. Trickle systems deliver water under very low pressure through small orifice emitters regularly spaced on a plastic tube located along each plant row. The applied water is distributed only within the rooting area. Some tubing products may be installed above or below ground. Since only the row area is wetted, foliage remains dry and weed development between rows is reduced.

Emitters of some trickle products can become clogged by substances in the irrigation water. Filters must be used to remove suspended particles such as sand and silt. Chemical water treatment may need to be used to (will) help prevent clogging caused by algae, iron bacteria and mineral precipitation.

Pest Management

Several insect pests and diseases attack blueberry plants and fruit. Good cultural practices will help prevent these problems. Prune to remove diseased, broken, and insect-infested branches and to increase air circulation around the plant. Control weeds which may harbor insects and remove plant debris, including overripe fruit, from the ground.

To control the more serious blueberry pests, a chemical spray program may be needed (**Tables 9** and **10**). Some of the insects and diseases mentioned may be important in your planting while others may be minor or nonexistent.

Table 9. Disease spray schedule for blueberries

Time	Disease	Treatment*
Delayed dormant (beginning of bud swell)	Phomopsis Mummy Berry	Lime sulfur 5 gal/ acre[a]
Green tip (new leaf buds are 1/16" green tip)	Canker Fusicoccum Phomopsis Mummy Berry	Captan 2 1/2-5 lbs.
Pink Bud (blossom buds are full pink)	Canker Mummy Canker	Benlate and Captan 1 and 2 lbs. Funginex 24 fl. oz. Max 5 applications
Bloom 25%	Same as pink bud	
Petal fall	Same as pink bud	
Cover[b] (after petal fall)	Canker and fruit rots	Captan 2 1/2-5 lbs.
Post harvest[a]	Canker	Captan 2 1/2-5 lbs.

* Fungicide rate per acre.

[a] If canker is serious and season is wet, treat every 4 to 6 weeks until leaf drop.

[b] Lime sulfur should be used only once in the spring and should never be combined with another fungicide or insecticide. It may be used again in late fall when about two-thirds of the leaves have fallen.

Fungal Diseases

Diseases and insects which have been found in Minnesota are marked with an asterisk.

Mummy Berry (*Monilinia vaccinii-corymbosi*), a serious blueberry fungus disease, first appears on the shoots, causing them to curl up, blacken, and die. Blossom infection appears on ripening berries. The fruit turns light pink instead of blue, shrivels, hardens, and falls to the ground. The fungus overwinters in the berry and becomes active the following spring.

***Stem Cankers** are caused by two important fungi (*Fusicoccum putrefaciens* and *Phomopsis vaccinii*). The infection usually on younger stems starts as a small reddish spot on the canes. As the spots grow they gradually girdle the stem, causing it to suddenly wilt and die. This occurs during periods of dry, warm weather, and may be confused with drought symptoms. These fungi overwinter on infected twigs and stems. Infected canes should be cut out well below the infected area. All discarded prunings should be burned.

***Fusicoccum Canker** is found on current season shoots as well as 1 and 2 year old stems. The lesion first is a small red area on the stem and develops into an elliptical, brownish-purple lesion several inches long. In mature lesions you may see black fungal fruiting structures called pycnidia.

***Phomopsis Canker** is also found on 1, 2, and 3 year old stems. On older stems the canker area feels flat and pycnidia are also present. Young cankers on current year stems may be only 1 to 2 inches long and red to brown. Stems infected the past year will wilt and die during dry periods the next year. Winter injury, frost, and mechanical breaking of twigs create infection entry points.

***Botrytis Blight** (gray mold) attacks ripening fruit, twigs, blossoms, and foliage. The fungus (*Botrytis cinerea*) causes rotting of ripening fruit and produces gray-brown structures on infected tissues. The most critical period for infection is during bloom. The fungus, which overwinters in organic matter and twigs on the ground, is present every year, but causes serious losses mainly when cool, damp weather persists for several days. Cultural control methods include encouraging air circulation by proper pruning and avoiding overfertilization, which encourages growth of highly susceptible succulent tissue. Frost injury to blossoms (and leaves) will increase susceptibility to infection.

***Phytopthera Root Rot** is a fungal disease which may be identified by sudden wilting of the plant without apparent reason. Additionally, gently tugging the plant may remove it entirely; examination of the root system may reveal dark brown or black root color or general deterioration of the root system. Infected plants may exhibit weak growth and low vigor.

To prevent Phytopthera, avoid low areas where drainage is poor and heavy, compacted soils. A

Table 10. Insect spray schedule for blueberries

Time	Pest	Treatment
Pink bud	Leafroller	Lannate 90SP (.5 lb/acre)
Bloom 25%	Leafrollers, Inchworms	Dipel (1.0 lb/acre) or Thuricide (2.0 qt/acre)[a]
Petal fall	Plum Curculio, Leafminer, Leafroller	Guthion 50 WP (1.5 lb/acre)[b] or Imidan 50 WP (2.0 lbs/acre)
	Cherry Fruitworm Cranberry Fruitworm	Guthion 50 WP (1.5 lb/acre)[b] Imidan 50WP (2.0 lbs/acre)
Cover	Blueberry Leafminer Leafroller, Blueberry Aphids	Carbaryl 50 WP (2 lb/acre) or Lannate SP (.5 lb/acre) Diazinon 50WP (2 lb/acre) or Guthion 50WP (1.5 lb/acre) Imidan 50 WP (2 lb/acre)
Post harvest, early fall	Crown Girdler	Methoxychbor 50 WP (1.5 lb/acre)

[a] Never use a chemical insecticide when blueberries are in bloom to prevent harm to bees. The bacterial insecticides Thuricide and Dipel may be applied. Use these biological agents when leafrollers or inchworms are abundant and could cause economic damage before post-pollination spray is applied. Either material is compatible with Captan 50WP or Benlate 50WP, which may be used when plants are in bloom.
[b] Guthion has a 24 hour re-entry interval.

Ridomil® drench may be useful in sites where plant vigor and development have been poor.

Anthracnose, most often a post harvest fruit rot, can also be found on young twigs. The fungal spores are spread by rain and wind and overwinter in diseased twigs and fruit.

***Powdery Mildew** (*Microshaera penicillata var. vacinii)* is a white fungus which spreads over the upper surfaces of the leaves. It may cause leaves to become chlorotic and defoliate prematurely.

Bacterial Disease

***Crown gall**, caused by *Agrobacterium tumefaciens* enters roots through wounds. The bacteria causes the plant to develop galls or swellings on roots and lower stems. Infected plants are weaker and often may be stunted. Severely infected plants should be removed and destroyed.

Viral Diseases

Stunt Virus causes yellowing of leaf margins and areas between lateral veins and development of smaller, cupped leaves. Often there is a proliferation of lateral shoots on infected branches. Diseased plants will live for many years, gradually declining in vigor. Cultural control methods include destroying infected plants, controlling sucking insects such as the leafhopper which transmit the virus, and planting virus-free plants.

Shoestring Virus causes reddish streaks of varying lengths on new shoots in spring, especially on surfaces facing the sun. Affected leaves, often at the base of the plant and on shoots left during pruning, are narrow and pointed or straplike, and may appear reddish. Ripe berries are often pink instead of blue, and production is drastically reduced. As with other viruses, symptoms appear gradually and the plant lives in a state of reduced vigor for several years. Cultural control methods include removing and burning infected plants, controlling aphids that transmit the virus, and planting virus-free plants.

Red Ringspot Virus causes red spots with rings on the upper surface of leaves. It first appears on older leaves, and may cause red blotches on the stem. Cultural control methods are the same as for blueberry stunt virus.

Insects

Blueberry Blossom Weevil chews on the developing blossoms, causing them to turn purple, remain unopened, and drop. It may also feed on the leaves. Cultural control includes clean cultivation of the blueberry field and surrounding areas where the weevil may overwinter.

***Blueberry Leafminer** is both a leafminer and leafroller. It forms a triangular tent and feeds within it. Blueberries can sustain high populations of these insects before production is reduced.

***Blueberry Maggot** is probably the most serious insect pest of cultivated blueberries. The eggs are laid under the skin of the berry, and the maggot stays in the ripe berry. Clean harvest and prompt picking aid in its control.

Blueberry Stem Borer feeds on the inside of the cane and induces wilting of the tip. It can be controlled by cutting off wilted tips below evidence of insect work.

Cherry Fruitworm feeds on the developing berries. Prune out dead twigs, where these insects overwinter, and use clean cultivation to help control this pest.

Cranberry Fruitworm feeds on the developing berries. The larvae spin webs around the berry cluster. Clean cultivation aids in its control.

***Oblique Leafrollers** can move from apple to blueberry where it forms a characteristically webbed leaf. Although damage can occur as severe defoliation, especially on Northsky or Northcountry, it is rarely severe enough to warrant chemical control.

***Cranberry Rootworms and Grubs** are only a problem in fields not thoroughly prepared before planting. Fields should lie fallow at least 1 year between blueberry plantings, with repeated disking in hot weather to destroy all roots. White grubs may be a problem if sawdust used for mulching contains grubs or roots.

***Plum Curculio** feeds on both leaves and blossoms and later on the berries. It is most troublesome in poorly cultivated and mulched fields. Clean cultivation provides good control.

Foliar insects such as the **Forest Tent Caterpillar** may occasionally defoliate blueberry plants, especially when the planting is near a wooded area.

Chemical Control of Pests

The following spray schedule is a guide for control of insects and diseases. Canker diseases develop early in production fields and later the berry diseases will be more important. The canker diseases will be more important or more damaging in wet conditions. Fungal spore release depends on moisture, as does infection. The use of the fungicides should be targeted into the wet conditions when disease can spread. In dry springs, summers, or falls plants need less treatment. Well-pruned plants with little dead wood or active cankers also will require less fungicide treatment. Bushes can have good quality stems with healthy new growth without cankers. When or if cankers develop, use fungicides.

Table 9 gives the fungicide rate per acre and assumes the product is mixed in 200 gallons of water. This is considered a dilute spray. When spraying, the goal is to completely wet the foliage and stems. The lower portion of the stems (branches) should also receive thorough coverage as several branches at that level often have significant canker disease.

Weed Control

It is essential to control perennial weeds, such as quackgrass, nutsedge, or Canada thistle, the year before planting by fallow planting, repeated tillage, or with an application of Roundup herbicide.

Herbicides for Blueberries

***Surflan* (75 W)** can be used both on newly planted and established blueberries. Apply at the rate of 2.5-5.0 pounds per acre in spring before weeds emerge or in the fall. Use lower rate on light-textured soils. It may be combined with Princep in established planting for broad spectrum, season-long weed control.

Poast and ***Fusilade 2000*** are effective only on grasses and can be used on nonbearing blueberries only. Apply at least 1 year prior to harvest at the rate of 1.5 pints per acre to actively growing annual grasses, 6 to 8 inches tall. Add 2 pints of crop oil per acre. For quackgrass control, apply at the rate of 2 1/2 pints per acre when grass reaches 6 to 8 inches.

***Devrinol* (50WP)** can be applied at the rate of 4-6 pounds per acre in the spring to weed-free ground. It must be incorporated into the soil by tillage, irrigation, or rainfall following application. Use on established or newly planted blueberries.

***Princep* (80WP)** should be used at a rate of 3 to 5 pounds per acre or 4G at a rate of 75 to 125 pounds per acre in established plantings. Apply in early spring or fall before annual weeds germinate. Use the lower rate on light sandy soils and young plantings. Avoid continued use on lightsoils. Not effective on muck soils.

***Sinbar* (80WP)** can be applied at a rate of 1 to 2 pounds per acre only in established plantings that are at least 3 years old. **Use the lower rate on sandy soils.** Effective control on most annual weeds and suppression of growth of some perennial weeds is achieved with proper application. High rates may damage desirable plants; avoid direct spray contact on the blueberry plants.

***Gramoxone super* 1.5 E** should be applied as a directed spray at the rate of 3 to 5 pints per acre with 50 to 100 gallons per acre plus nonionic surfactant in spring before buds break. Avoid contact with new shoots. Use the higher rate when perennial weeds are present.

***Norosac* (4G)** applied at a rate of 100 to 150 pounds per acre will control annual weeds and certain perennial weeds such as quackgrass. Apply in late fall when daily temperatures are below 45°F or early spring before plants begin to grow.

***Solicam* (80 WP)** can be applied to established blueberries before weeds emerge. Use 2.5 to 5 pounds per acre, using the lower rate on sandy soils. Solicam is more effective on annual grasses than on broadleaf weeds.

***Kerb* (50 WP)** is most effective on grasses but will control several broadleaf weeds. Apply to established blueberries at the rate of 2-4 pounds per acre in early spring. It is not effective on soils with a high organic matter content.

***Roundup* (3E)** Use as a directed spray or spot treatment. Do not allow spray to contact blueberries. Be careful of drift.

Since many pesticides are being reviewed for safety and some are being withdrawn for specific crops, it is essential to read the pesticide label and follow the instructions as a final authority on pesticide use.

Birds

Birds can be a serious pest of blueberry fruit. Robins, starlings, blackbirds, and other species can cause physical damage to the plant and economic loss to the grower. Fruit loss may be well over 50% of the crop and is generally more severe in smaller plantings or in more wooded locations. Bird control measures fall into two categories: scare devices and physical barriers.

Scare devices include noise and visual stimuli aimed at deterring pests. Propane-powered cannons produce a bang resembling a loud shotgun blast. A timer can regulate the frequency of detonations. Another noise scare system is designed to disperse birds by playback of recorded distress calls and other amplified noises. Visual scare devices such as imitation bird predators, specially designed balloons, and flashing ribbon have all been used to disrupt bird activity. Such visual devices may need to be frequently relocated to maintain their effect. Scare devices generally do not seem to retain their effectiveness for extended periods of time.

Protective netting is probably the best option for keeping birds from the fruit. The netting is placed over the plants as the berries begin to ripen and removed after harvest. The smaller mesh nettings (1/4-1/2") have two benefits in that they pull fewer berries off the plant when the netting is removed for picking, and, as noted below, provide significant winter protection in years of light snowfall. Netting may also be placed over a frame above the plants.

Rabbits and deer may also damage blueberry plantings. Consult your county extension agent for appropriate local control methods.

Winter Protection

Winter injury can occur to half high blueberries when temperatures reach -25 to -30° F without protection. Prolonged cold increases the likelihood of injury. Winter wind desiccation can damage plants. Bushes are also susceptible to sunscald injury in late winter. Typically, winter injury occurs to shoot tissue resulting in stem dieback and crop loss. Normally, plants recover by sending out new shoots but may require considerable pruning of dead shoot tissue. Crop production will return to normal the next season. Recent studies have suggested that half-high blueberry plantings in Minnesota benefit from use of a winter protection system in years in which snow cover of at least 12 inches deep is not present. A winter protection system provides a warmer environment than ambient air temperature in mid-winter, prevents wind desiccation and sunscald, and moderates air temperature fluctuations in late winter and early spring, resulting in less dieback of branches and improved survival of fruit buds. In a year of light snowfall, use of a winter protection system has the potential to double fruit yields.

Materials which provide significant winter protection include spunbonded polyester fabrics such as Reemay® and Kimberly Farms Tree and Row Covers® and, 1/4-1/2" bird netting. Bird netting has the added advantage of being useful during both the growing and winter seasons, thus increasing its cost-effectiveness. Bird netting can be used for several seasons, whereas row covers usually can only be used for one season due to fabric tearing. Winter row covers that cover several rows at a time require less time and labor to apply. Winter protection materials should be applied in late fall before significant snowfall occurs and removed in early spring before bud break.

Additional winter protection considerations include selecting a site where snow fills in deeply, planting of windbreaks and shelter belts, erecting a snow fence to catch snow, and utilizing long narrow plantings oriented to catch maximum snow fall.

Harvesting

The harvest season for Minnesota blueberry cultivars extends for 2 to 5 weeks depending on the weather, crop size, and plant vigor. Healthy vigorous plants or plants with small crops will usually ripen most fruit in 2 weeks or less. Plants which are heavily fruiting, stressed, or low in vigor will take 3 or 4 weeks to ripen fruit. Selective pruning can be used to avoid overcropping and maintain plant vigor.

The blueberry fruit turns blue before it is fully ripe. The acid level continues to fall for 3 to 7 days after the fruit turns blue. The underside of the berry (the pedicel end) will turn from pink to full blue when it is fully ripe. Growers usually allow 20 to 30 percent of the crop to ripen before beginning harvest to avoid picking too much unripe fruit.

Pickers should be instructed to harvest only fully blue fruit. The berries do not ripen evenly on the cluster, so it is important to recognize and pick only the fully ripe berries. Pick only when dry, and keep handling to a minimum to preserve the whitish, waxy surface bloom of the berry which protects it from fruit molds. Store blueberries between 32° F and 40° F.

A mature planting (6 to 10 years old) may produce up to 1,000 pounds per acre each week during a 2 to 5 week harvest period. Cultivar selection can lengthen the picking season. A pick-your-own operation where each customer takes home an average of 10 pounds may require up to 100 pickers per acre each week.

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