

NITROGEN FOR BEARING CRANBERRIES IN NORTH AMERICA

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Nitrogen for Bearing Cranberries in North America

Nitrogen application, either from commercial fertilizers such as ammonium sulfate or from organic sources such as fish waste, is essential for cranberry production. This publication addresses the amount, timing, and source of nitrogen (N) for bearing cranberry beds in North America. The information provided about the pathways of N in soil and the physiology of nitrogen use in cranberry plants will help you better understand fertilizer recommendations and adapt them to your situation.

This publication focuses on producing beds. Fertilizer practices for new and young beds are quite different.

Pathways of nitrogen

The air we breathe contains about 80 percent nitrogen. Our bodies do not use this N; we simply expel it. The same is true for cranberry plants; they cannot use atmospheric N. To be used by plants, atmospheric N must be converted to a plant-available form, either through the fertilizer

manufacturing process or through conversion by specialized soil microbes.

Some nitrogen becomes available through precipitation during electrical storms. In rural areas where electrical storms are common, 2 to 10 lb N/a can become available to cranberry plants from storms each year.

Although two forms of plant-available N exist—ammonium (NH_4^+) and nitrate (NO_3^-)—cranberry plants use only the ammonium form.

Thus, fertilizer sources recommended for cranberries contain only ammonium nitrogen. Suitable fertilizers may have ammonium-N in a soluble form, such as ammonium sulfate, or in a form readily converted to ammonium such as urea or organic N.

Figure 1 (page 2) shows the pathways of nitrogen in cranberry production.

Nitrogen in the soil

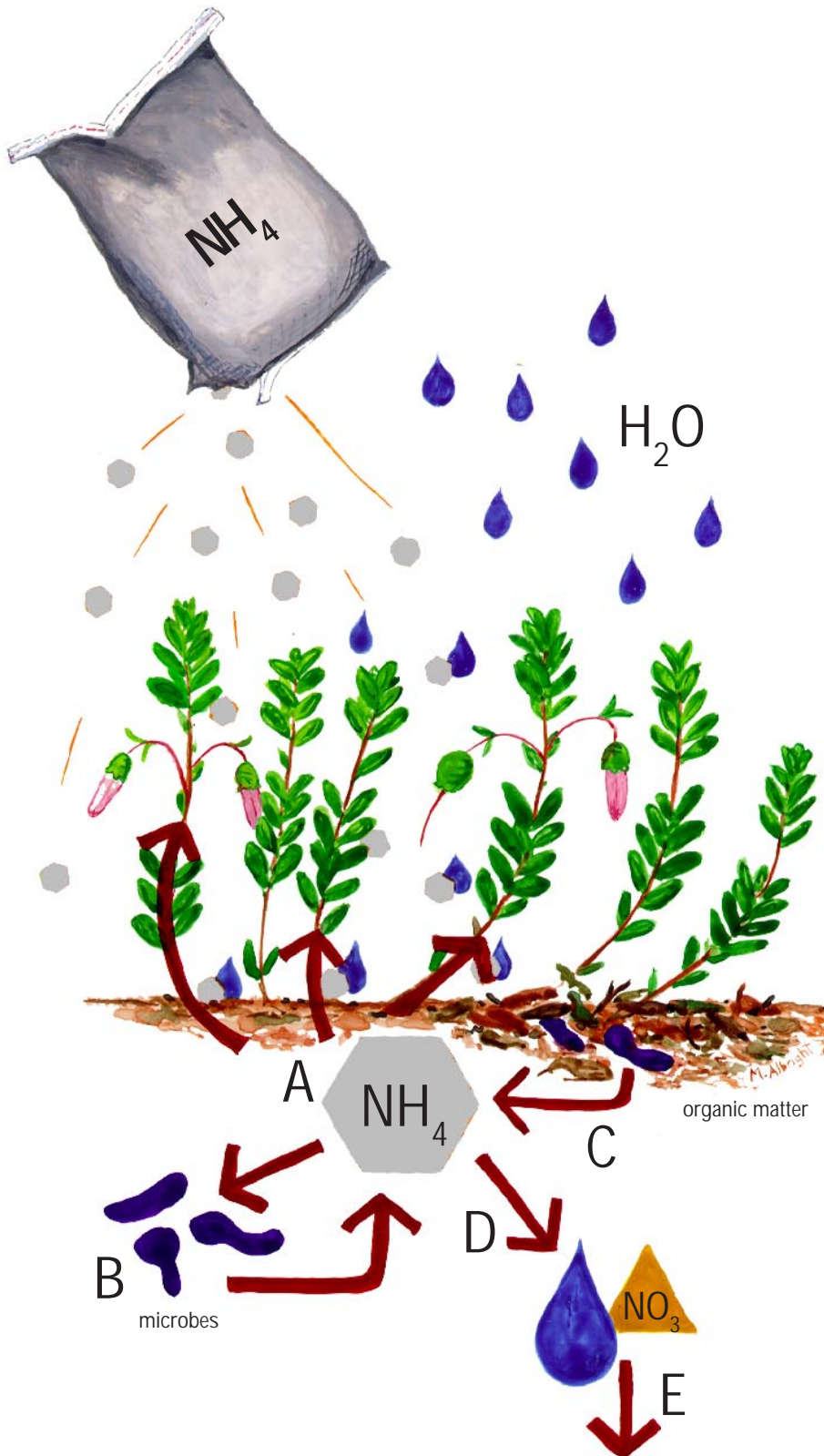
Ninety-five to 99 percent of the nitrogen in soil is in the organic form, which is not readily available to plants. This N becomes available only when

microbes decompose soil organic matter and convert organic nitrogen to ammonium-N.

Soils containing large amounts of organic matter, such as peat and muck materials, provide more N to cranberries than do sandy soils low in organic matter. In some years, organic soils can supply all of the nitrogen needed for cranberry growth and production. In sandy soils or organic soils with mineral surface horizons, N fertilizer is needed every year.



Figure 1.—Pathways of nitrogen in cranberry production.



A Ammonium-N from a recent fertilizer application dissolves in soil water and is taken up by the cranberry plant. Ammonium-N is immediately available for plant use. At hook stage, it can move into new cranberry growth in 24 hours or less.

B Ammonium-N is used by microbes for growth and reproduction much as it is used by cranberry plants.

C Microbes also add ammonium-N to the soil. This ammonium-N can originate in decaying plant material, such as dropped cranberry leaves, or in applied organic material such as fish fertilizer. Peat-based beds, beds with duff layers, and soil high in organic matter provide N to cranberries in this way. Organic N must be transformed to ammonium-N (mineralized) before being taken up by the cranberry plant.

D Ammonium-N can be converted to nitrate by soil microbes. This reaction is suppressed at soil pH normal for cranberry production.

E Nitrate is not useful to cranberry vines and can be leached. It is a contaminant when leached to groundwater.

Table 1 shows typical organic matter content of soils in North American cranberry-producing areas. Figure 2 shows the distribution of soil types in selected North American cranberry-growing areas.

Soil organic matter content can be estimated from the soil organic carbon content, which, like soil organic nitrogen, is a fraction of total soil organic matter. To estimate soil organic

matter, multiply soil organic carbon content by 1.7.

See the box titled “Soil organic matter and nitrogen dynamics” (page 4) for more information about nitrogen dynamics in the soil.

Table 1.—Typical soil organic matter content in cranberry-producing areas of North America.

Soil type	Regions	Percent organic matter
Sand	Massachusetts, Wisconsin, Québec, Oregon, Washington	0.5
Mixed mineral and organic soils (layered)	Massachusetts, Wisconsin, New Jersey, Québec, Oregon, Washington	3.2–6
Organic	British Columbia, New Jersey, Washington	25–68

Figure 2.—Distribution of soil types in selected North American cranberry-growing areas.

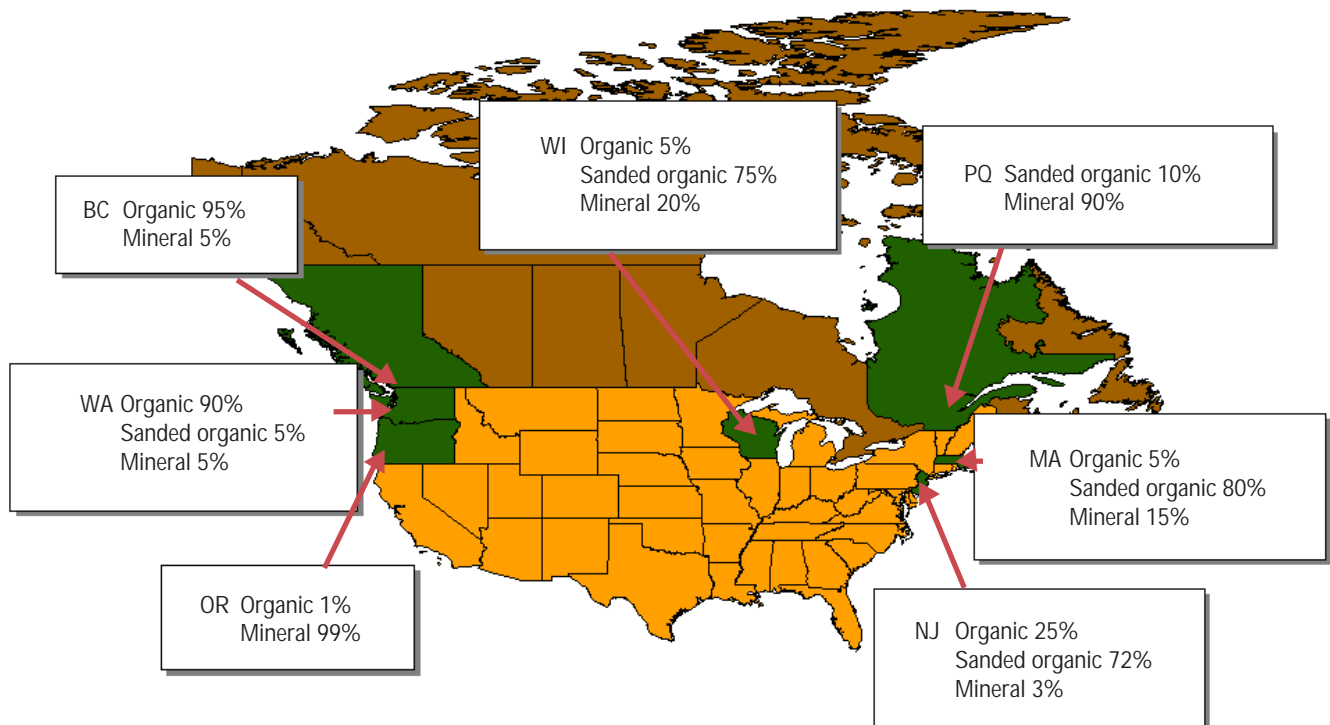
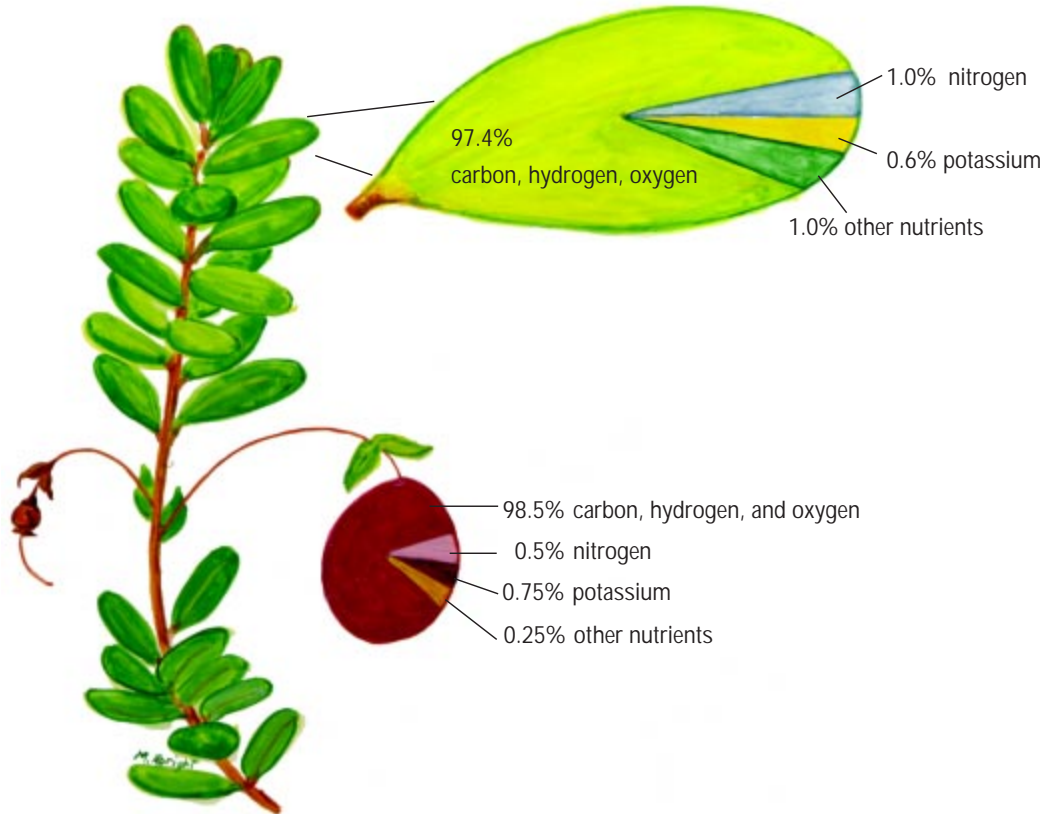


Figure 3.—Nutrient composition of dry cranberry leaves and fruit.



Soil organic matter and nitrogen dynamics

Nitrogen transformations occur as soil microbes (fungi, bacteria, and actinomycetes) decompose organic matter, thus creating plant-available forms of nitrogen (Figure 1). The conditions that promote these reactions—warm and moist—are those that also are best for plant growth.

However, the rate of decomposition also is influenced by other factors that affect the number and types of organisms present. In highly decomposed organic soils, the microbe population usually is high, so the rate of decomposition is rapid. Predominantly mineral soils occur where cranberries are planted directly in sand or where bogs have been sanded repeatedly so that native peat is more than 12 inches below the surface. The higher the soil organic matter content, the more N will become available. Relating soil organic matter content to the amount of plant-available N in a given season is difficult because availability varies with environmental conditions (Figure 9, page 10).

Soil pH also influences organic matter decomposition by influencing soil microbes. Typically, bacteria do not function well when soil pH is below 6.0. Fungi are more tolerant of low pH, but even they are less active when soil pH is below 5.0.

Organic matter is converted to plant-available ammonium-N even at the lowest pH levels reported in cranberry beds. However, the conversion of ammonium to nitrate is reduced at lower soil pH, a favorable occurrence for cranberry production.

In addition to being a source of N, soil organic matter increases the soil's water-holding capacity, which is especially important in sandy soils, and contributes to a soil's cation exchange capacity (CEC)—the soil reservoir of nutrients such as calcium, magnesium, and potassium. In cranberry soils, organic matter provides most of the CEC. Finally, organic matter promotes pore space, which improves soil aeration and provides a good environment for root penetration and uniform distribution.

Nitrogen in the cranberry plant

Dried cranberry leaves contain approximately 1 percent N, and dried cranberry fruit about 0.5 percent N. A concentration of 1 percent may seem small, but it makes N the most abundant mineral element in cranberry plants (Figure 3). More than 95 percent of leaf and fruit dry matter consists of carbon, hydrogen, and oxygen or compounds made up of these elements (carbohydrates).

Nitrogen is critical to the formation and accumulation of carbohydrates. In addition, it is found in nucleic acids, which contain and transfer genetic information. Nitrogen also is found in chlorophyll, where its presence is critical to the transformation of light energy into chemical energy within plants.

Once taken up by plant roots, N is moved readily to stems and leaves. Nitrogen is mobile within plants and can move from existing leaves and stems into new growth if insufficient soil N is available. Thus, nitrogen deficiency symptoms typically are found first in older and lower leaves.

A comparison of old and new shoots shows the amount of N moved to new growth during a season. In the bed illustrated in Figure 4 (data from an 'Early Black' crop), new shoots contain 45 lb N/a at harvest,

while old stems and leaves contain only 25 lb N/a.

Nitrogen mobility within plants extends beyond movement from old leaves to new leaves. Nitrogen in the perennial portion of the vines (stems) also is moved to new shoots and fruit before old leaves fall from the plant.

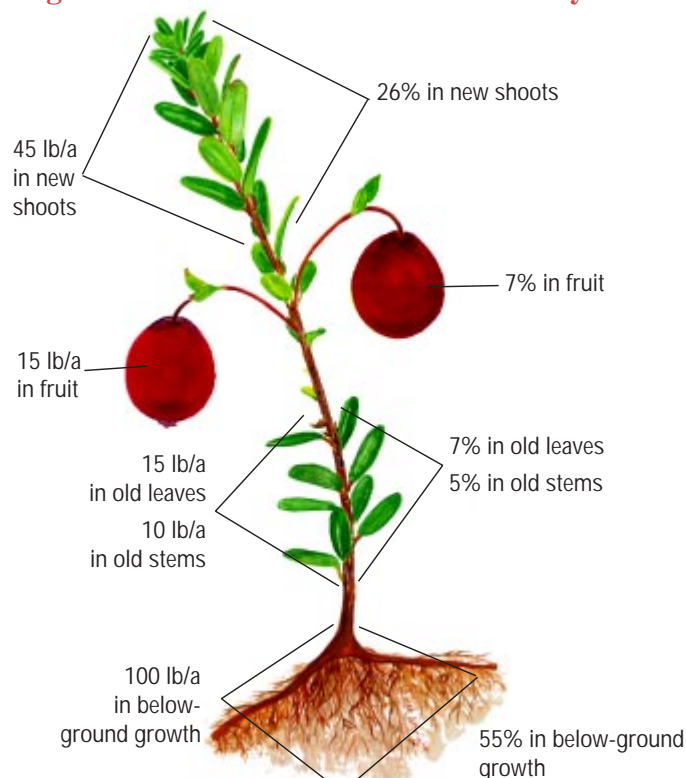
In the example in Figure 4, the total amount of N in plant tissue is approximately 185 lb N/a. About one-third (60 lb) is in shoots and fruit produced during the current season.

A small portion of this aboveground N is removed

with fruit at harvest. For example, a 200 bbl/a crop contains about 15 lb N/a. Some old leaves are removed from the bed as "trash" along with the fruit, causing an additional loss of N.

We generally think about N in cranberry fruit and leaves since they are the portions of the plant we see. However, more than 50 percent of the total N in a cranberry bed at season's end can be in the root system. In the Figure 4 example, roots contain 100 lb N/a of the total of approximately 185 lb N/a.

Figure 4.—Distribution of N in cranberry tissue.*



*'Early Black' cranberry

Timing of N use and fertilizer application

As one of the essential elements in the plant, N is required for the cranberry to complete its growth cycle. In commercial cranberry beds, the supply of N must be regulated so that carbohydrates and other plant resources are used to produce fruit rather than excessive vegetative growth. Cranberry producers regulate N supply to plants by

carefully timing fertilizer applications.

Timing of N use by cranberry plants

Demand for nitrogen by cranberry vines fluctuates throughout the growing season as a function of plant growth rate and developmental stage (Figure 5). Plant N demand is high during periods of active growth.

In cranberries, active growth is greatest during three periods: early growth,

fruit set, and bud set. These developmental stages span the entire growing season, so N must be available to the plant throughout the season.

Early growth is the period when the plant initiates top and root growth. It begins with a visible new flush of stems and leaves (bud break through roughneck). This is the period of maximum upright elongation.

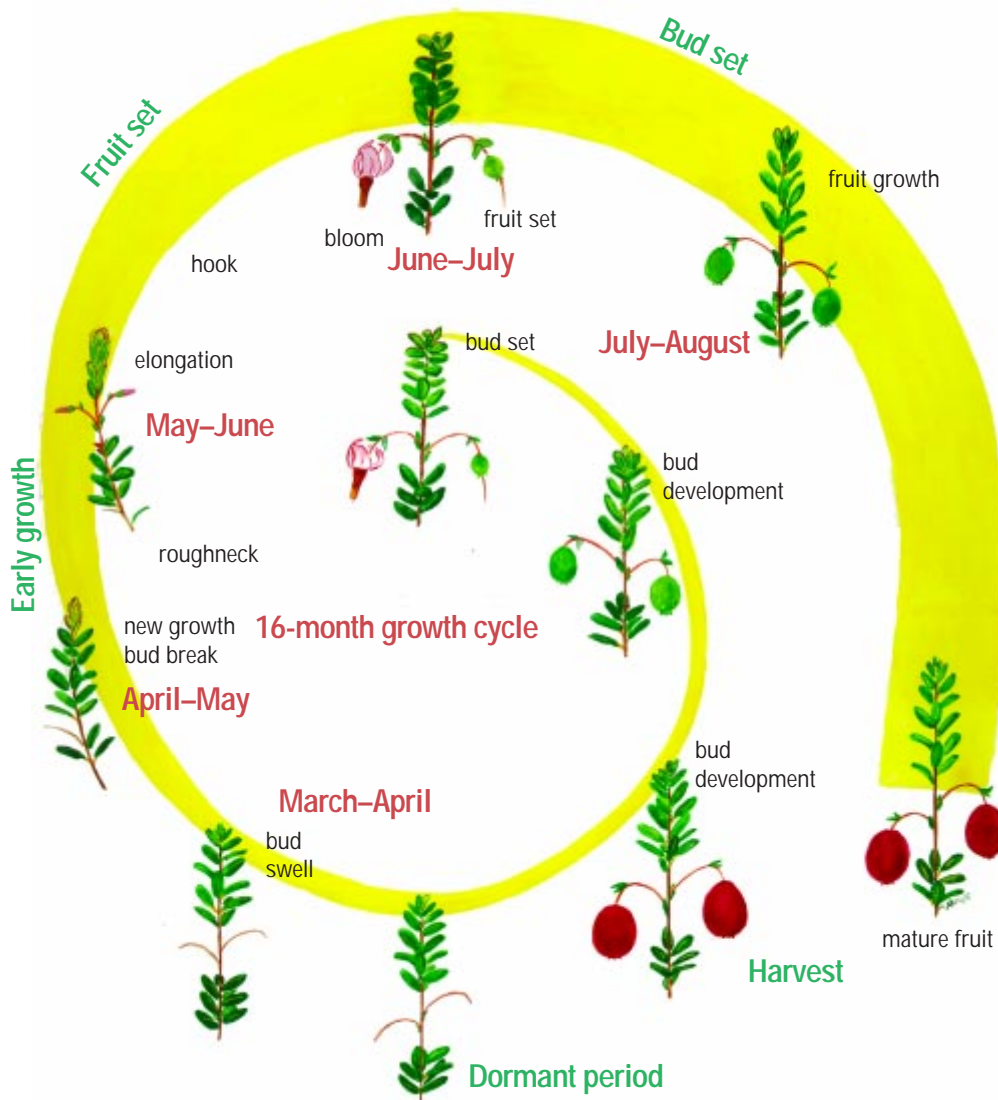
Each variety has a range of upright growth associated with optimum fruit production. Figure 6 shows four varieties and the average upright length of each associated with optimal yield in several growing regions. Insufficient upright length indicates low vigor and is correlated with reduced yields. Excessive upright growth, on the other hand, can reduce yields.

Fruit set is another period of active growth. Fruit set occurs after the flower is pollinated and seeds begin to form. An individual fruit's peak N use occurs when seeds and first flesh are forming—a 2-week period following pollination. Cranberry plants flower and set fruit for several weeks, and N demand is high throughout this period.

Once a fruit is set, its demand for N drops considerably. Most of the increase in fruit size after the 2-week period following pollination is due to the accumulation of water and carbohydrates.

Next year's flower buds begin to develop during or soon after fruit set. During this stage (*bud set*), N is needed for both fruit

Figure 5.—The 16-month cranberry growth and development cycle.



development and flower bud formation. Thus, N deficiency at this time can reduce both the current year's fruit size and next year's bud development. Excessive nitrogen during this period, however, leads to vine overgrowth and delayed, reduced floral bud development, a condition commonly called "blown buds."

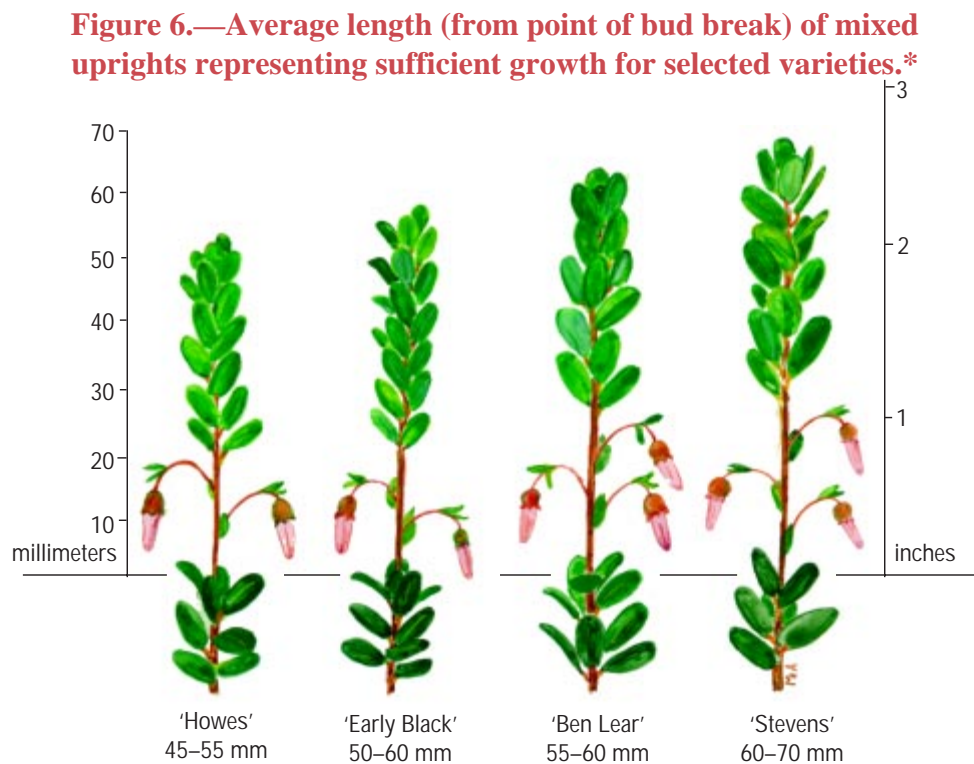
Timing of N fertilizer application

Because the timing of N use by cranberry plants varies with growing region and variety, the optimal time for fertilizer application also varies. Figure 7 shows optimal application timing for various regions.

Regardless of growing area, N is applied at midbloom (early fruit set), fruit set, and bud set. The need to supply fertilizer N during the early growth period depends on the availability of soil N. The availability of soil N depends on the supply of N from soil organic matter and on soil temperature. See Figure 9 (page 10) for information about soil organic matter supply of N.

Although cranberry plants require N during all stages of growth, fertilizer applications should focus on the critical developmental periods described above. During other periods, plant demand for N is low and generally can be supplied by N stored in the plant or soil.

Notice in Figure 7 that in only one situation is a preharvest application



*Research performed in New Jersey and Massachusetts

Figure 7.—Optimal nitrogen fertilizer application timing for cranberry production.



Area	Variety	Early growth	Early fruit set	Late fruit set	Bud set	Preharvest
BC	'Stevens'	NH ₃	NH ₃	NH ₃	NH ₃	
MA	'Early Black'	NH ₃	NH ₃	NH ₃	NH ₃	
NJ	'Early Black'		NH ₃	NH ₃	NH ₃	
OR	'Stevens'		NH ₃	NH ₃	NH ₃	
WA	'McFarlin'	NH ₃	NH ₃	NH ₃	NH ₃	
WI	'Stevens'	NH ₃	NH ₃	NH ₃	NH ₃	NH ₃

suggested, and no applications are suggested after harvest. Late applications of N can encourage growth when the plant needs to be dormant. Don't apply N fertilizer after harvest.

Late-season N application (late August to early September) can correct serious deficiencies indicated by tissue tests. Light fertilizer applications at this time can enhance the development of poorly developed buds. Before applying fertilizer at this developmental stage, be certain a deficiency exists. If so, make a *light* application—no more than 5 lb N/a.

An experiment with N fertilizer on N-deficient

'Stevens' cranberries in Oregon illustrates the above discussion about N timing. Fertilizer N applied at or before fruit set was taken into the cranberry plant in larger amounts than fertilizer N applied after fruit set.

Amount of N to apply

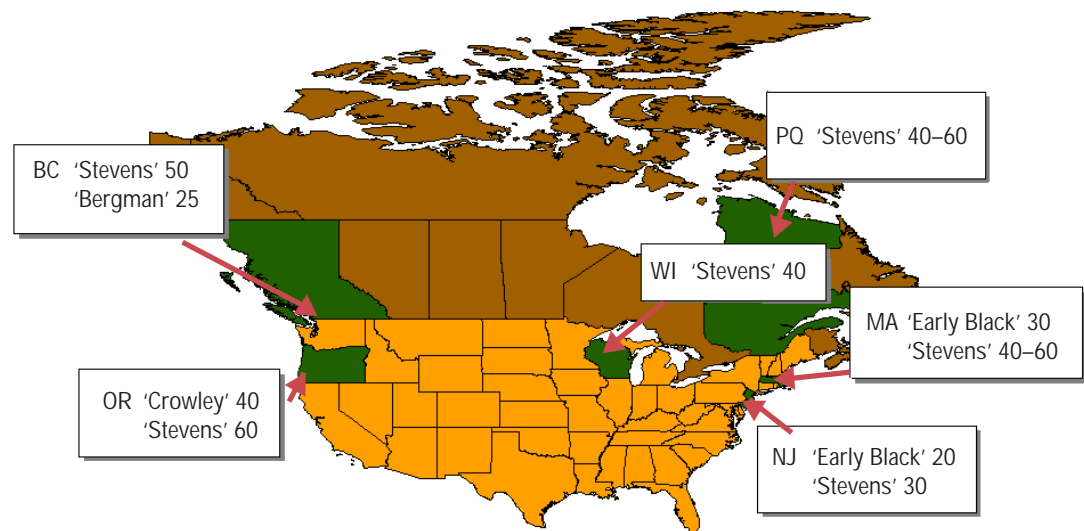
One way to estimate the N requirement is to develop a simple balance sheet of N inputs and outputs. An example is shown in the box titled "Nitrogen balance sheet" on page 9.

The studies used for the balance sheet example were conducted in Oregon and Massachusetts on two varieties, 'Early Black' and

'Stevens.' If we assume that the calculated 40 lb N/a requirement might vary by 50 percent due to site differences and fertilizer efficiency, the amount of N needed from fertilizer is between 20 and 60 lb/a. For comparison, Figure 8 shows optimal N rates from fertilizer field trials.

Almost universally, plots that receive no N for 3 years yield poorly. Field research has shown that optimal production occurs when cranberries are supplied with moderate rates of N fertilizer (Figure 10, page 13). In field trials, yields generally increased as applied N increased, up to some maximum. With further increases in applied N, yield declined.

Figure 8.—Optimal nitrogen fertilizer application rates from selected cranberry production areas.*



*Pounds per acre

Nitrogen balance sheet

A balance sheet is one approach to calculating fertilizer N need. To determine the amount of N fertilizer needed, this method takes into account N inputs (from soil organic matter) and losses (to decay and harvest). The following example is based on existing research data and a 200 bbl/a crop. Based on a 16-month crop cycle, the balance sheet begins in late July, when most, if not all, of the crop's N has been taken up by cranberry plants.

Explanation

Line 1—The beginning balance represents N in cranberry tissue (pounds per acre) late in the season. This value is calculated by multiplying the percent N in each type of tissue (leaves, stems, and fruit) by the dry mass of each. In this example, the beginning balance is 185 lb N/a.

Line 2 (debit)—We assume that one-half of all old growth, including most old leaves, is removed during harvest and postharvest management activities. Old leaves contain 20 lb N/a, so 10 lb N/a is removed in old leaves. Fruit contains 15 to 20 lb N/a, all of which is removed at harvest. Thus, a total of 25 to 30 lb N/a is removed in old leaves and fruit.

Line 3 (debit)—Half of the roots are replaced each season. Roots contain 100 lb N/a, so replacing half of the roots requires 50 lb N/a.

Line 4 (credit)—Approximately 10 percent of the N in roots comes from current-season fertilizer. The other 90 percent comes from the soil, decaying tissue, and translocation from old roots. Thus, of the 50 lb N/a used in new root growth, 45 lb/a comes from these nonfertilizer sources ($50 \times 0.9 = 45$ lb N). Enter this amount as a credit from the soil.

Line 5 (debit)—New shoot growth the following year will require 50 lb N/a.

Line 6 (credit)—N will move from old growth to new growth early next season. Only 5 to 10 percent of the N in new growth comes from current-season fertilizer. The remaining 90 percent (45 lb) comes from the soil and from old tissue. Enter this amount as a credit.

Line 7—The ending balance is the result of adding all credits and subtracting all debits from the beginning balance.

Line 8—The ending balance is 40 lb/a less than the starting balance. This amount of N needs to be supplied from fertilizer or soil organic matter.

Cranberry Nitrogen Balance Sheet

● Item	Credit	Debit	Balance
1. <i>Beginning balance</i>			185
2. <i>Removal of fruit / leaves</i>		25-30	155
3. <i>New root growth</i>		50	105
4. <i>N from soil for root growth</i>	45		150
5. <i>New shoot growth</i>		50	100
6. <i>N moving from old growth</i>	45		145
7. <i>Ending balance</i>			145
8. <i>Fertilizer N need</i>			-40
●			

Although high rates of N were not associated with high yield, they were associated with high levels of N in leaf tissue. This association may explain why vegetative growth increased at the expense of yield as N rate increased. High N rates also were associated with a decline in fruit quality. At high N rates, fruit rot increased and fruit color (Total Anthocyanin Content, or TAcy) declined.

When deciding how much N to apply to a cranberry bed, consider several factors, including soil type, climate, past response of the bed to fertilization, N status of the plants, and cultural practices such as pruning, sanding, and herbicide application.

These topics are discussed below.

The role of soil characteristics

Standard soil tests for available N are of little value in cranberry production. Instead, we gain useful information from knowing the soil type (peat, muck, sanded peat, or sand), percent organic matter (percent OM), and soil pH.

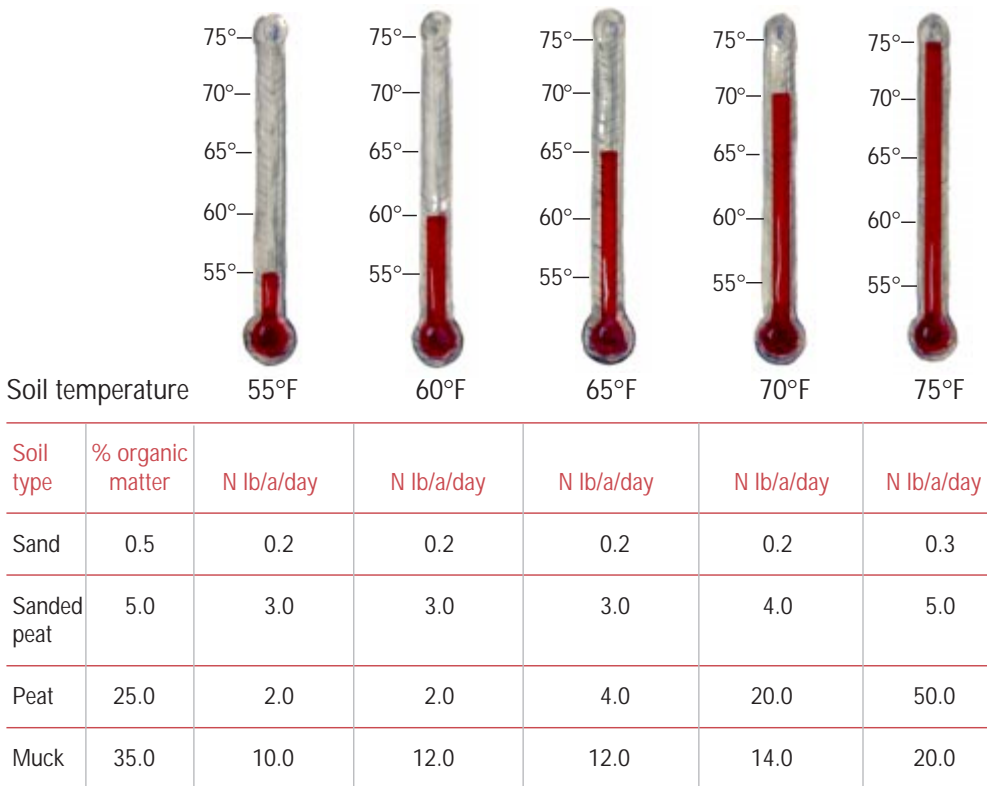
Soil organic matter has the potential to provide ammonium-N to cranberry plants through the process of mineralization (Figure 1). The amount of N provided depends primarily on the amount of organic matter, level of decomposition, and soil temperature.

Within a given production region, beds with little organic matter need more N fertilizer than those on peat or muck soils. However, in soils containing more than 10 percent highly decomposed organic matter (black, mucky soils), much of the plant-available N is rapidly converted to nitrate-N. Even in less decomposed organic soils, significant amounts of ammonium-N are converted to nitrate-N if soil pH is above 4.5. As noted on page 1, cranberries do not use nitrate-N.

Soil temperature is important because microbial activity and the production of available N increase in warm soil. Figure 9 shows the average daily accumulation of N as related to soil type and soil temperature. These values can be used as guidelines for nitrogen management. If the temperature is unusually warm, reduce fertilizer nitrogen applications to compensate for increased soil N availability.

Soil pH also influences N transformations. When soil pH is above a certain level (5.5 in sand or mineral soil or 4.5 in soil with more than 10 percent organic matter), microbial transformation of organic N to plant-available forms might occur faster than shown in Figure 9. However, research has shown that as soil pH increases, an increasing proportion of the plant-available N is nitrate, which is not used by cranberries.

Figure 9.—The influence of soil organic matter content and temperature on production of available N in cranberry beds.



Setting your target N rate

For cranberry producers with limited experience, we suggest selecting a rate from Figure 8 as your initial target rate. If your growing area is not listed, choose an area with a similar climate. Your target N rate should be between 20 and 60 lb/a N.

Based on plant needs, research information, and knowledge of a bed's soil conditions, setting a more precise target N rate is possible. When doing so, take into account the following:

- The plants' previous response to fertilizer
- The previous crop yield
- Results of tissue tests taken the previous August or September

If the previous crop was heavy and tissue test N results were below normal, you may need to increase the N rate. Conversely, a light crop and/or tissue tests above 1.1 percent N indicate the need for a reduction in N rate. For N tissue standards and more information, see "Plant evaluation" on this page or obtain a copy of *Cranberry Tissue Testing for Producing Beds in North America* (see "Extension publications," page 17).

Adjusting your target N rate

Always evaluate the target rate and change it if necessary. However, changes should not be large or abrupt.

As the season progresses, adjustment might be

Table 2.—Evaluation of crop N status from tissue concentration and amount of upright growth.

	Tissue N (%)	Upright growth (inches)
Below normal	below 0.90	less than 2
Normal	0.90 to 1.10	2 to 3
Above normal	above 1.10	more than 3

necessary based on observations of plant growth, crop development, and unusual weather events. Over the years, refine the rate as the bed matures, weather conditions vary, and management practices influence N availability or need. For example, surface sanding generally reduces the nitrogen need by 5 lb/a the season after sanding.

Management practices vary from region to region. Refer to local guidelines regarding management effects on N requirements.

Plant evaluation

Visual monitoring of cranberry plants during the season is essential. Observation of leaf color and upright length can be particularly valuable in adjusting the N rate during the season.

Greenness indicates the amount of chlorophyll present. Chlorophyll is important for photosynthesis and carbohydrate production. See the box on page 12 for more information about assessing leaf color.

Upright length prior to bloom is correlated with yield. The new leaves above the flowers/fruit are the source of carbohydrates that

will make up about 85 percent of berry dry mass. Field research has shown that from hook stage until early bloom, the upright lengths shown in Figure 6 (page 7) were associated with the greatest yield. The samples were a mix of vegetative and flowering uprights.

Consideration of upright length is important when evaluating tissue sample results. The interaction of the two factors can be valuable in determining fertilizer N need. Categories of tissue N concentration (in samples taken from mid-August to mid-September) and length of new upright growth are shown in Table 2.

Normal tissue N and upright growth—If tissue N concentration and upright growth are normal and yield is average or better for the variety and region, your N fertilizer program is meeting crop needs. Review your program to determine whether you can make adjustments or savings.

Below-normal tissue N and upright growth—If tissue N concentration and upright growth are low and yield is below average for the variety and region, adjust your N fertilizer program.

Leaf color as an indicator of N status

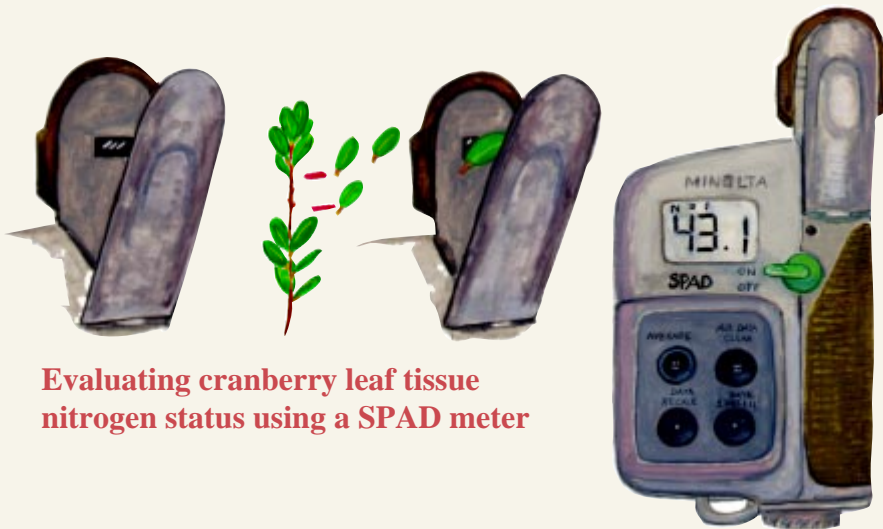
Healthy cranberry leaves are a bright, deep green. Pale or yellow leaves might indicate the need for more N, particularly if growth is inadequate.

Greenness is easy to observe. However, since not all people perceive color the same way, color evaluation can be problematic. For objective measurement, a SPAD chlorophyll meter can be used to evaluate chlorophyll content based on light transmittance. Unfortunately, the current cost of a SPAD meter, approximately \$1,200, makes this device too expensive for many growers. Hopefully the technology will decrease in cost and be affordable by growers in the near future.

Measurements can be made on old or new leaves during June and July, but in August should be made only on new leaves. Standard SPAD values are shown in the table below. Lower values might indicate the need for additional N fertilizer. Never use leaf color alone, whether assessed visually or with a SPAD meter, to assess N need. Although low N is a common cause of pale leaves, other nutrient deficiencies, herbicide injury, or root-feeding insect damage can cause leaf discoloration.

Standard SPAD values for various cranberry varieties and developmental stages.

Variety	Roughneck to hook		Bloom to fruit set	Preharvest
	Old	New	Old or new	New
'Early Black'	40	25	35	35
'Howes'	45	30	40	40
'Stevens'	40	30	35	40
'Ben Lear'	40	25	35	40



Evaluating cranberry leaf tissue nitrogen status using a SPAD meter

You might need to increase the rate of N applied or adjust the timing of application. Refer to the sections on N application rate and timing for specific information.

Below-normal tissue N and above-normal upright growth—If tissue N concentration is below normal and upright growth is above normal, you might have applied fertilizer too early in the growing season. The plant produced above-normal upright growth, which diluted the concentration of N. Refer to the section on N application timing for specific information.

Above-normal tissue N and below-normal upright growth—If tissue N concentration is above normal and upright growth is below normal, growth was limited by some factor other than N. Review the tissue concentration and supply of other nutrients. Also examine your irrigation schedule, soil drainage, herbicide application, and other factors that might limit growth.

Above-normal tissue N and upright growth—If tissue N concentration and upright growth are above normal, N was supplied in excess of crop needs. Reduce your N application rate. Specific information is contained in the sections on N rate and timing.

Table 3.—Factors indicating a need to adjust the N fertilizer rate.

Use more N if:	Use less N if:
The bed is mostly sand. (Add extra N in small increments.)	The planting was sanded.
The soil contains more than 3 percent clay.	The bed is on a deep peat base.
Tissue test N is less than 0.75 percent.	Tissue test N is greater than 1.1 percent.
Plants show low vigor (stunting).	Plants show high vigor (rank or lanky growth).
The previous crop was heavy.	The previous crop was light.
Vines show general yellowing.	There was frost or hail damage.

Experimenting with N rates

If you are planning changes in fertilizer management, experimental strips in your beds can provide valuable comparisons. Various strips can be untreated, given one fewer N application than normal, or used to try new fertilizer types, rates, or timing. For ease of management, each strip can be a section between two sprinkler lines. As with all fertilizer practices, it's important to keep records of treatments and results.

Decision-making checklist

As for all perennial crops, many factors influence the required level of N application for cranberries. Adjust your N rate each year depending on observations, plant response, and outside influences. Table 3 lists factors that indicate a need for more or less N fertilization.

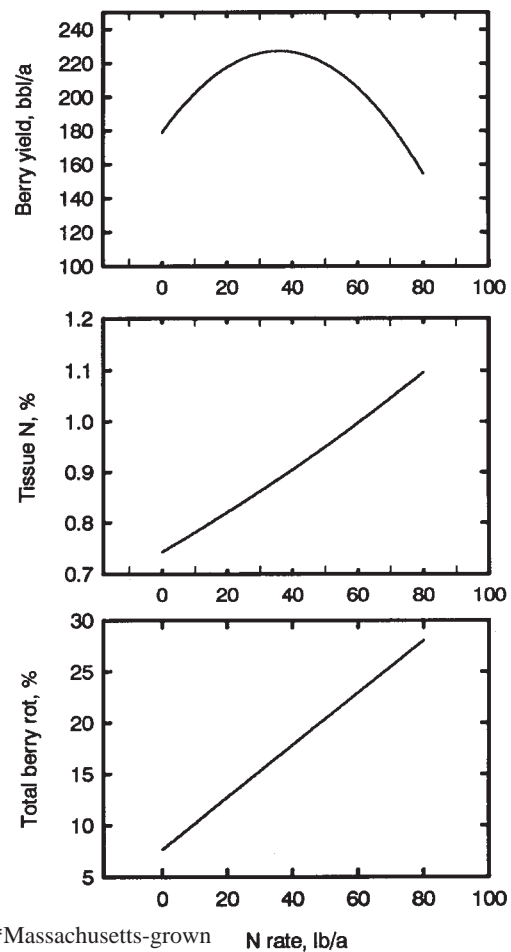
Excess applied N

The addition of N to cranberries increases yield until applied N exceeds the plant's demand. At higher N rates, yield fails to increase or actually declines. In addition, excessive N rates have been associated with decreased crop quality in numerous fertilizer studies.

The results from a study of 'Stevens' in Massachusetts are illustrated in Figure 10. A decline in yield, especially at the 80 lb N/a rate, is apparent. In addition, fruit rot increased significantly with high N rates. In other studies, high N rates also have been associated with poor fruit coloring (TAcy) at harvest.

See the box on page 14 titled "Fruiting and vegetative response to nitrogen" for more information on cranberry response to nitrogen application.

Figure 10.—Yield, tissue N, and rot of cranberries with various N fertilizer rates.*



*Massachusetts-grown 'Stevens'

Fruiting and vegetative response to nitrogen*

Cranberry plants have two types of reproduction: sexual reproduction (fruit) and asexual reproduction (vines). One of the challenges of growing cranberries is to maximize fruit production without overproducing vines.

Cranberry varieties have different yield abilities. Growers often ask, “Do high-yielding varieties require more N than other varieties in order to produce high yields?” and “Do high-yielding varieties reach a point where additional N shifts growth away from fruit production to excessive vine production?”

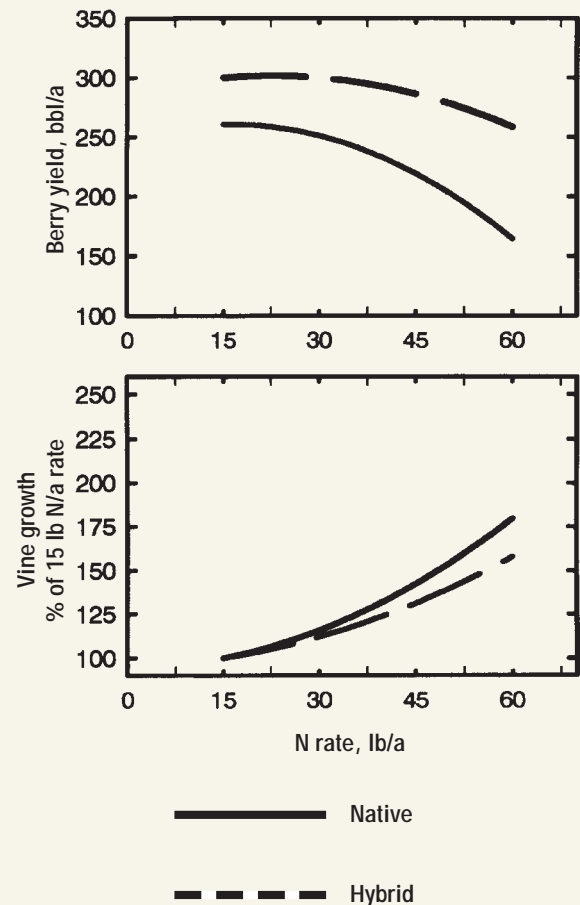
To answer these questions, 10 cranberry varieties were examined to determine how they allocate resources to fruits and vines in response to nitrogen fertilizer. The fertilizer rates used were 15, 30, and 60 lb N/a. The hybrids were ‘Crowley,’ ‘Franklin,’ ‘Number 35,’ ‘Pilgrim,’ ‘Stevens,’ and ‘Wilcox’; and the native selections were ‘Ben Lear,’ ‘Cropper,’ ‘Early Black,’ and ‘Howes.’

Varieties differed in how they divided resources between fruit and vine production. In all native selections, the high N rate led to greatly reduced fruit production and excessive vine production. Yield decreased less at high N rates for the hybrids than for the native selections. This study suggests that fruit yield, yield stability, and vine production vary genetically, and that hybrids have higher tolerance of high nitrogen levels than do native varieties.

The apparently higher tolerance of high N environments by the hybrids ‘Stevens,’ ‘Franklin,’ and ‘Pilgrim,’ as compared to ‘Crowley,’

likely is due to the different environments at the selection locations. ‘Crowley’ was the only Pacific Northwest hybrid in this study. The others were selected in New Jersey before sanding became common. Thus, these selections were made on high N soils, possibly resulting in increased production stability in high N environments.

The effect of N fertilizer on yield and vine growth of hybrid and native selections



*Results from Davenport and Vorsa, 1999. *Journal of the American Society for Horticultural Science* 124(1):90–93.

Sources of N

Ammonium and nitrate forms of N are plant-available. However, cranberry plants are ammonium users and do not use nitrate-N. Thus, fertilizer sources recommended for cranberries are those that contain either ammonium-N, urea, or organic N. The latter two are converted to ammonium-N in the soil. Table 4 lists common commercial N fertilizer sources for cranberries.

Slow-release and organic fertilizers are best suited for sandy mineral beds that do not supply or retain ample N. Organic N must be

transformed to ammonium-N before being taken up by the cranberry plant. This process can take more than a year. Thus, if you use organic fertilizers such as fish waste you may need to apply other sources of N the first year to provide immediately available N. Organic sources can be used early in the season to supply a low level of N, but often need to be supplemented with conventional granular fertilizers during periods of peak demand.

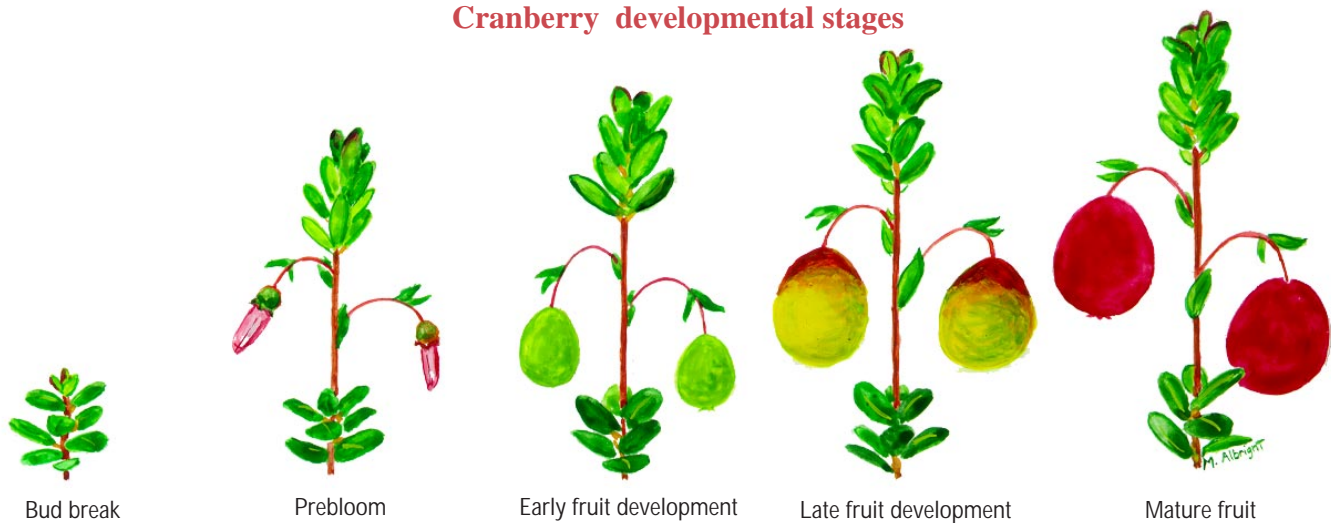
In general, granular fertilizers are the most common product used in cranberries. Products containing uniform particle

size will be distributed evenly by boom, cyclone spreaders, and aircraft. Blended products with uneven particle size might separate, leading to uneven distribution of nutrients. Liquid fertilizers, used either as a foliar feed or soil feed, can be effective for midseason applications (at the bloom and fruit set stages). However, because the demand for nutrients is high at this time, it is difficult to supply enough nutrients with foliar applications without damaging plants. Use foliar fertilizers as an N supplement rather than an entire fertilizer program.

Table 4.—Suggested granular fertilizer sources for cranberry production.

Name	Analysis	Percent N	Notes
Ammonium sulfate	21-0-0	21	Also supplies S.
Urea	46-0-0	46	High analysis; can be used as a liquid.
Monoammonium phosphate	11-52-0	11	Also contains P.
Diammonium phosphate	18-20-0	18	Also contains P.

Cranberry developmental stages



For more information

Articles from *Cranberries* magazine and the scientific literature

- Dana, M.N. 1968. Nitrogen fertilization and cranberries. Parts I & II. *Cranberries* 32(11):10–11 and 33(1):10–11, 15.
- Davenport, J. 1993. Nitrogen: Its role and function in cranberry plants. *Cranberries* 57(8):14–15.
- Davenport, J. 1994. Nitrogen: How fertilizer rates and timing influence cranberry yield and fruit quality. *Cranberries* 58(2):13–17.
- Davenport, J.R. 1996. The effect of nitrogen fertilizer rates and timing on cranberry yield and fruit quality. *J. Amer. Soc. Hort. Sci.* 121(6):1089–1094.
- Davenport, J. and J. Provost. 1994. Cranberry tissue nutrient levels as impacted by three levels of nitrogen fertilizer and their relationships to fruit yield and quality. *J. Plant Nutr.* 17:1625–1634.
- Davenport, J. and N. Vorsa. 1999. Cultivar fruiting and vegetative response to nitrogen fertilizer in cranberry. *J. Am. Soc. Hort. Sci.* 124(1):90–94.
- DeMoranville, C.J. 1992. Cranberry nutrients, phenology, and N–P–K fertilization. Doctoral dissertation. Univ. of Massachusetts, Amherst, MA.
- Eck, P. 1976. Relationship of nitrogen nutrition of ‘Early Black’ cranberry to vegetative growth, fruit yield and quality. *J. Amer. Soc. Hort. Sci.* 101:375–377.
- Finn, Rosen, and Luby. 1990. Nitrogen form and solution pH effects on root anatomy of cranberry. *HortSci.* 25:1419–1421.
- Greidanus, Peterson, Schrader, and Dana. 1972. Essentiality of ammonium for cranberry nutrition. *J. Amer. Soc. Hort. Sci.* 97:272–277.
- Leschyson and Eaton. 1971. Effects of urea and nitrate nitrogen on growth and composition of cranberry vines. *J. Amer. Soc. Hort. Sci.* 96:597–599.
- Provost and Davenport. 1994. The chlorophyll meter as a tool for monitoring cranberry nitrogen levels. *Cranberries* 58(3):23–25, 27.
- Rosen, C.J., D.L. Allan, and J.J. Luby. 1990. Nitrogen form and solution pH influence growth and nutrition of two *Vaccinium* clones. *J. Amer. Soc. Hort. Sci.* 115:83–89.
- Somogyi, Childers, and Eck. 1963. Influence of nitrogen source and soil organic matter on the cranberry (*Vaccinium macrocarpon* Ait.). *Proc. Amer. Soc. Hort. Sci.* 84:280–288.
- Stieber and Peterson. 1987. Contribution of endogenous nitrogen toward continuing growth in cranberry vine. *HortSci.* 22:463–464.

Books

- Brady, N.C. and R.R. Weil. *The Nature and Property of Soils*, 12th edition (Prentice-Hall, Inc., 1999).
- Havlin, J.L., J.D. Beaton, S.L. Tisdale, and W.L. Nelson. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management*, 6th edition (Prentice-Hall, Inc., 1999).

Extension publications

Check with the publishing university for current prices, additional publications, and ordering information. (See box at right.)

Bundy, L.G. *Soil and Applied Nitrogen*, Bulletin A2519 (University of Wisconsin, Madison, 1999).

Davenport, J., C. DeMoranville, J. Hart, K. Patten, L. Peterson, T. Planer, A. Poole, T. Roper, and J. Smith. *Cranberry Tissue Testing for Producing Beds in North America*, Publication EM 8610 (Oregon State University, Corvallis, 1995).

DeMoranville, C.J. "Nutrition," in: H. Sandler, C. DeMoranville, and D. Cannon, eds. *Cranberry Chart Book, Management Guide for Massachusetts*. UMass Cranberry Experiment Station and UMass Extension Publication (University of Massachusetts, Amherst, 2000)

DeMoranville, C. "Cranberry nutrition and fertilizers," in H.A. Sandler, ed. *Cranberry Production: A Guide for Massachusetts*. UMass Extension Publication SP-127 (University of Massachusetts, Amherst, 1997, second printing 1998). pp. 81–85.

Schulte, E.E. and L.M. Walsh. *Management of Wisconsin Soils*, Bulletin A3588 (University of Wisconsin, Madison, 1993).

Sources of listed Extension publications

To obtain copies of the Extension publications listed on this page, contact the publishing university as shown below. These sources also have additional publications on cranberry production.

Publications also are available from other university Extension offices and Experiment Stations.

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Summary

Nitrogen is the most abundant mineral element in dry cranberry tissue. Nevertheless, before applying N fertilizer, you must consider the amount of N to apply, timing, source, and application method.

Amount to apply

The application rate of N for cranberry production typically is between 20 and 60 lb/a. Before adjusting your N fertilizer rate, review last season's tissue N concentration, growth of new uprights, yield, fertilizer applications, and other management practices that might affect vigor, such as resanding and pruning.

Timing of N application

The supply of N to cranberries must be regulated so that carbohydrates and other plant resources are used to produce fruit rather than

excessive vegetative growth. Cranberry plants utilize N during three periods: early growth, fruit set, and bud set. These developmental stages span the entire growing season, so N must be available to the plant throughout the season.

Peak N use by an individual fruit occurs when the seeds and first flesh form. Plants flower and set fruit for several weeks, and N demand is high throughout this period. N use by cranberry plants drops substantially after fruit set. Supply most of the N during the fruit set developmental stage.

Sources of N

Cranberries use the ammonium (NH_4^+) form of N. If using a manufactured N fertilizer, choose one with N in the form of ammonium or urea. Fish waste and other organic N sources also supply N in the ammonium form.