Answers to common cranberry nutrition questions*

Oregon Cranberry School
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Nitrogen

Q. ***Why do cranberries need nitrogen?***

A. Nitrogen, in the ammonium form (NH_4^+), is used to create amino acids. Amino acids are assembled into proteins. Proteins are essential for energy capture and sugar formation via photosynthesis. Photosynthesis captures carbon for leaf growth that in turn supports berry development. Figure 1 shows the change in yield and tissue N with N application (Davenport and Demoranville data). When cranberry requirement for N is met, the tissue N increases quickly.

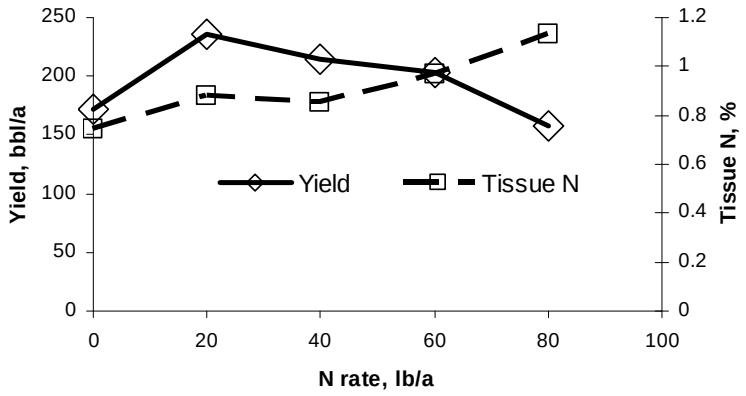

Figure 1. Fertilizer N steadily increases tissue N but only changes yield with first rate of N in this east coast example.

Q. ***Are nitrogen rates for Stevens and newer varieties the same or do the new varieties produce higher yields with less nitrogen?***

A. N requirement differs slightly for varieties. Demoranville requires 10 to 20% more N need than Stevens. Mullica Queen is similar to Stevens. Crimson Queen requires about 20% less N than Stevens. For Crimson Queen, early season N readily causes excessive vegetative growth. In addition, too much N during establishment creates excessive vegetative growth.

The higher yield from new varieties likely results from larger berries. A flowering upright supports between 1 and 2 berries. Increased leaf size allows more photosynthesis and larger berry size. Larger leaf size can require slightly more N than smaller leaf varieties.

The optimum tissue level is the same. Monitor tissue N and upright length. Adjust N rate to meet growth (upright length) and tissue N goals. New upright growth should be 2 to 3 inches and tissue N between 0.90 and 1.10%.

Q. ***What is the optimum timing for N application?***

A. Tissue analysis is the determining factor. When tissue or leaf N from samples collected in August are between 0.90 and 1.10%, a normal amount, apply:

1) about 20% of the total N amount during late hook-early bloom,

2) about 40% of the total N during fruit set, and

3) about 40% of the total amount during late fruit set to early bud development.

Q. ***Do we get any measurable amount of N from rain events?***

A. Very little, probably about a pound per acre at most. In 2006, between 1 and 2 lbs N of ammonium-N and nitrate-N were deposited at the Alsea Ranger Station. In rural Wisconsin, precipitation amounts to about 10-15 lbs N/a. However, the N in the rain is NO_3-N, not NH-N and therefore is not useful for cranberries. In addition, precipitation is present at all sites where N rate work is conducted, so any N from precipitation should not be counted as part of N application.

Q. ***After fertilizer application, how much time is needed for the N to be in the young fruit?***

A. You don't want the N to move into the fruit, you want it in the leaves so it can be used to make sugars that will cause the fruit to grow. Little current season N moves to the fruit, about 5% of the total N in the fruit is from the current year N application. Most of the N in the fruit is moved from the leaves. In field studies using ^{15}N, we found ^{15}N in the uprights 24 hours after a fertilizer N application. N uptake occurs when the soil temperature is above 55^{o} F.

Q. ***What about foliar applications*****?**

A. Nutrient supply through leaves or from a foliar application is less efficient and more expensive than supply through roots. Before applying a foliar nutrient application, carefully consider if one is needed. If your cranberries are growing well and tissue nutrient levels are adequate, foliar application of nutrients is not necessary.

Foliar N applications have their place. They are most effective when uprights are growing poorly or look pale. Foliar applications are expensive, but can cause vines to readily "green" in a short time. However, cranberry uprights cannot absorb sufficient N, P, K or many other nutrients through the leaves to meet their full requirement.

Use urea as a foliar fertilizer. It readily moves from leaf surfaces into plants including cranberries since it is non-ionic or doesn't have any ammonium-N (NH_4^+) as does

ammonium sulfate or ammonium phosphate. Urea utilization by cranberries was decreased when a spreader sticker was added to a foliar urea application. Other materials sold for foliar application are more expensive than urea, may contain other forms of N, and usually contain more nutrients than needed.

Q. ***Should I use fall applications to enhance bud set?***

A. Application of N after September 15th is not recommended or usually needed

Q. ***What about drainage and leaching, how important are they for N?***

A. Drainage is important since nutrient uptake requires the expenditure of energy. Oxygen is required for this process. When soils are saturated, air is excluded and nutrient uptake stops.

Ammonium-N (NH_4^+) does not leach appreciably (but is soluble and may leave with surface water if a significant rain event quickly follows application). The nitrate (NO_3) form of N leaches. Ammonium is microbiologically changed to nitrate. The conversion is controlled by soil pH as shown in Figure 2. As soil pH decreases, nitrate production diminishes. A month after spring ammonium application, little nitrate is produced when the soil pH is 5.5. The soil pH is usually 5.5 or below in cranberry beds, so little nitrate is produced and little, if any, N is leached.

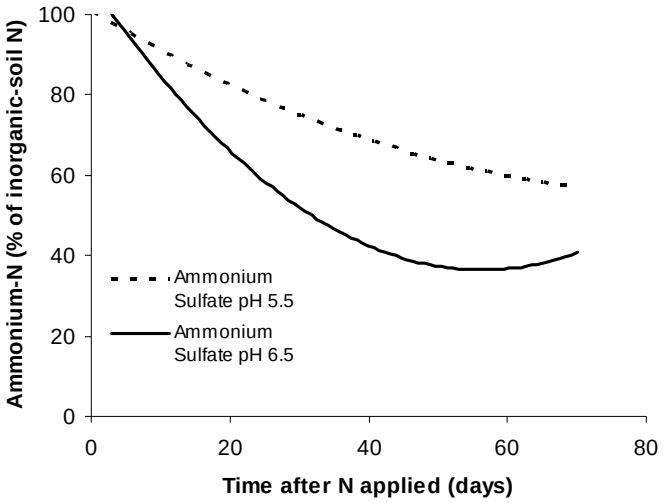

Figure 2. Soil pH dictates rate of ammonium change to nitrate from ammonium sulfate application.

Q. **What about using controlled release materials such as Nutri-sphere® (NSN), ESN®, or other products for new beds? Would any of these materials be beneficial in producing cranberries?**

A. Traditional fertilizer, such as urea, is coated with a polymer (plastic like material) or chemical to either change the rate material is available to the plant or slow microbial

changes of the fertilizer. Polymer coated urea (ESN), and NSN, urea coated with organic acid (maleic-itaconic combination) have been tested in Oregon on wheat, grass seed, and sweet corn. No yield advantage was measured from the use of these materials. In some situations, yield was reduced using a coated material or one with a nitrification inhibitor, especially materials with DCD (dicyandiamide). Super U is a product containing DCD. In contrast, a urease inhibitor, Agrotain, reduces N loss from N volatilization with topdressed urea in eastern Oregon field crops.

Before using these materials, ask yourself, "What is the problem I'm trying to solve?" Many of the perceived problems can be solved with split N application and/or irrigation with 24 hours of application. See "What about drainage and leaching" for related information.

A bit more than 10 years ago in Wisconsin, comparisons of ammonium sulfate, SCU, MEU, Milorganite and composted chicken manure were made. All treatments were adjusted to provide the same amount of N, P, & K. None of the controlled/slow release products performed as well as ammonium sulfate.

Similar results have been measured repeatedly. Split applications are more economic and many times produce higher yield than controlled release materials. Ironically, Osmocote® tends to work well in cranberry production, but is quite expensive.

Q. **How much growth should current season uprights have each year?**

A. Upright length is variable and changes with location, crop load, variety etc. However, the MA recommendation for Stevens is for $2^{1}/_{4}$ to $2^{3}/_{4}$ inches of growth before early bloom. Limited data from Wisconsin is provided in Figure 3. It shows the decrease in yield with increase in upright length. A range of length provides acceptable yield. When upright length exceeds 4 inches, yield decreases sharply or "crashes". New upright growth should be about 2 to 3 inches in length.

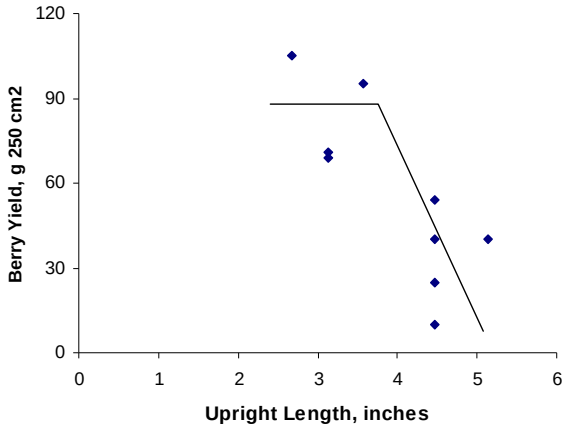

Figure 3. Cranberry yield decreases sharply as upright length increases.

Q. ***Cranberry yield was down 30 to 50% in 2010. Cranberry tissue N analysis from samples collected in August weren't high. Soil N analysis doesn't measure the unused N. What happened to the N the berries should have used?***

A. Most of the N in a cranberry plant is in the leaves. About 15 to 20 lb N/a is in fruit of a 300 bbl/a crop. If yield is reduced 30 to 50%,

5 to 10 lb of N is not used. This amount of N would make only a small change in leaf N concentration. For example, an acre of cranberries contains about 5,000 lb (dry weight) of new uprights. If 5 lb of N was not used, theoretically, tissue N would only increase 0.1% (5/5,000 x 100). Some or all the N not used in the fruit would only change the tissue test slightly.

In addition, N is stored in roots and fruit N will change slightly with N rate. A reduction in fruit set would be similar to an increase in N rate. Therefore, fruit from this year's crop might be 0.45%N rather than 0.35%N.

The N not used berry production is likely in the leaves, roots, fruit or a combination of all three. If the N is in the plant, early season N need can easily be met from this "reserve". Be very careful of early season N application as it could readily promote excessive vegetative growth.

Q. ***Another situation from 2010 is low yield and low tissue N. What happened to the N.***

A. The answer from above fits, the N is likely in the leaves and other plant parts. If N was supplied during bloom through fruit set, it would be taken into the cranberry plant. If the crop is light and the plant doesn't use the N in the berries, it can use it for growth. The plant growth uses the N, diluting it in the uprights sampled. Any tissue analysis from a woody perennial crop should be viewed with the amount of growth.

Phosphorus

Q. ***What is the role of P in cranberry plants?***

A. P is very important for plant metabolism, especially energy transfer (ATP→ADP). It plays a key role in transferring sugars from the

chloroplast into the cytoplasm where the sugar can be used for metabolism or growth or can be exported to other organs. P is a primary constituent of the genetic material of plants and animals (DNA).

Q. ***Do we have guidelines about P timing?***

B. Guidelines are used, but the research behind them is tenuous. The recommendation is not to apply P until late spring, after frost protection has stopped, and then apply in 2-3 doses. Cranberry research and extension workers from other areas recommend three applications. We also know that phosphorus in fertilizer reacts readily with iron and aluminum in soils to form insoluble compounds. These reactions occur rather quickly.

Frequent light application of P when cranberries are using nutrients is preferable to one or two large doses.

Q. ***About how much P should be applied during a year?***

A. Tissue analysis is the first step to answering this question. A phosphorus concentration of 0.10 to 0.20% is sufficient. You may not need to apply any P if you routinely applied P and tissue P is above 0.10%. In two Oregon trials, no P was added for 3 years without a reduction in yield. In Wisconsin, no P was added for 6 years without a reduction in yield. If you are not comfortable eliminating P from your nutrient program, reduce the amount applied and monitor tissue P.

Conversely, when P is needed, research shows no yield increase from added P fertilizer beyond 20 lbs P/a/yr or about 45 lbs P_2O_5/a/yr. Many growers are over-applying P by using fertilizers like 6-24-24. Materials like 16-16-16 would be preferable when P is needed.

Q. ***Are there variety differences in P requirements or timing?***

A. No differences are known and no research has been reported on this topic. For all varieties, little P is removed with cranberry harvest or pruning. For every 100 barrels of berries harvested, between 1 and 2 lb P/a is removed. Each 1000 lb/a vines removed by pruning contains ¼ to ½ lb P/a.

Q. ***Should I worry about leaching or runoff?***

A. Phosphorus does not leach and would not be any more likely to go through a sandy than a mineral or organic soil. Runoff is a concern if a significant rain event quickly followed a fertilizer application. Some data suggests that P can leach from uprights when a bed is flooded (as for harvest). The idea that P is not mobile and does not leach is supported by the data in Figure 4. Repeated topdress P application to cranberry beds increases P soil test in the surface rather than throughout the soil, resulting in stratification of nutrients. P soil tests are difficult to interpret when nutrient stratification occurs.

Figure 4. Soil test phosphorus with stand age and sampling depth from six south coastal Oregon cranberry beds in 1996. The surface sample is from three inches and entire soil was sampled to six inches

Q. ***What available fertilizers contain P?***

A. The primary P material used in blends is ammonium phosphate, probably mono-ammonium phosphate. Phosphoric acid can be used as a foliar P source, but should not be applied during flowering or on fresh fruit plantings. Rock phosphate can be used for organic beds. The material is extremely variable. Some of the rock phosphate from western US mines is almost insoluble while material from Florida supplies P about the same rate as does an old and likely now unavailable fertilizer, ordinary super phosphate.

Fertilizer	Chemical formula	Analysis	Solubility
		P_2O_5	%
Triple superphosphate	$Ca(H_2PO_4)_2$	0-46-0	87
Diammonium phosphate	$(NH_4)_2HPO_4$	18-46-0	100
Monoammonium phosphate	$NH_4H_2PO_4$	11-48-0	100
Ammonium polyphosphate (dry)	$NH_4H_2PO_4$+$(NH_4)_3HP_2O_7$	10-34-0	100
Ammonium polyphosphate (liquid)	$NH_4H_2PO_4$+$(NH_4)_3HP_2O_7$	15-62-0	100
Ordinary superphosphate	$Ca(H_2PO_4)_3$ + $CaSO_4$	0-20-0	85
Phosphoric acid	H_3PO_4		100
Rock phosphate			

Q. ***How does Avail work? Would it be beneficial to use in cranberries?***

A. Avail® is the same material as Nutri-sphere® (a combination of maleic-itaconic organic acids), but applied to P fertilizer rather than N sources. It is supposed to stop aluminum and other elements from making the P in fertilizer unavailable. Tests with other crops give mixed results. We don't know of any tests in Cranberries. Our current recommendation when P is needed is to apply in multiple applications. If Avail® performs as advertised; it could allow one application of P, a saving in labor. The added cost of the material would need to be compared to the labor cost saved from one or two applications.

Potassium

Q. ***What is the role of K in plant growth?***

A. Potassium does not have a direct role in plant metabolism. It is not involved in proteins or membranes. It is primarily used to balance charges and to move water from in plants. K is important to stomata opening and closing and in the movement of sugars.

Q. ***How much K is required annually?***

A. Tissue analysis is the first step to answering this question. A potassium concentration of 0.40 to 0.75% is sufficient. You may not need to apply any K if you routinely applied K and tissue P is above 0.40%. In two Oregon trials, no K was added for 3 years without a reduction in yield. In Wisconsin, K fertilizer application increased yield only 1 year in 4.

If you are not comfortable eliminating K from your nutrient program, reduce the amount applied and monitor tissue K. One approach is to apply a maintenance K rate or replace the amount removed. More K than N is removed in berries. A 300 bbl/a crop removes 30 to 35 lb K or 34 to 40 lb K_2O/a. From monitoring a grower bed, an annual application of 30 to 40 lb K_2O/a seems adequate to maintain soil test K between 40 and 60 ppm. This soil test range is adequate to provide sufficient K for a tissue concentration of about 0.45%.

Native or unamended sand used for bed construction will probably have between 10 and 15 ppm K. About 15 lb K_2O/a is needed to increase soil test K 1 ppm in three inches of sand.

In many crops, especially grasses, tissue K increases with K application or as soil test K increases. This relationship has not been found for cranberries. If K tissue test results are below 0.40%, an application of 60-100 lbs K_2O /a/yr is sufficient. In Wisconsin, cranberry yield was reduced from an application of 240 lbs K/a.

Q. ***Do varieties differ in K requirement?***

A. Not that we know about. However, substantial amounts of K are removed in the crop so a bed producing 300 bbl/a requires more K than a bed producing 150 bbl/a.

Q. ***What is the optimum timing for K application?***

A. Most nutrients are accumulated by plants as shown in Figure 5. Little or no accumulation occurs early in the season during Phase I. For cranberries, this time would be when soil temperature is below 55°F. Rapid uptake of most nutrients in woody perennial plants, Phase II, occurs before bloom through early fruit development. Phase III would begin as fruit ripens, beginning in late August or early September. At this time, most nutrients are in the plant. Redistribution of nutrients from leaves is greater than accumulation.

For K and most other nutrients, application during plant need or use is most efficient. For cranberries, this time is from bud break to fruit development. Sandy soil does not have the capacity to hold as much K as do the silt loam soils of the Willamette Valley. If a single dose of K is applied, some or much of the K can be leached from the root zone. Therefore, multiple applications are recommended.

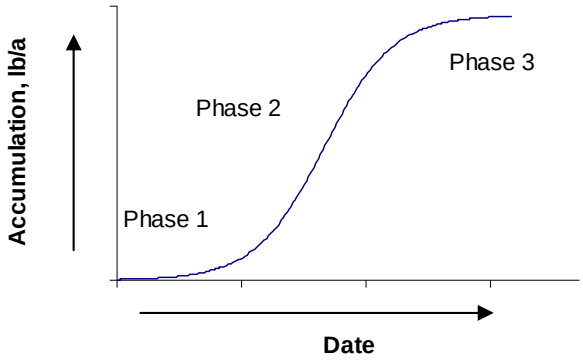

Figure 5. Nutrient accumulation

Q. ***In August, would there still be sufficient levels of K for optimal bud set? Would an August application of K be beneficial for bud set?***

A. These questions contain several topics. Let's first address the relationship of August K and but set. The need or benefit of August K application for bud set is not documented. Potassium application, in August or anytime during the growing season is made for general plant health, growth, and yield. The idea of an August K application likely comes from the idea that early growth relies on stored nutrients. When K is low in tissue or soil, an August K application insures adequate K for the plant next season, not just the buds.

The potential need for K in August is bed and year specific. The combination of marginal K tissue analysis, little early season K, a long frost season, and a large crop is a situation in which to consider an August K application. Adequate K can be supplied earlier in the growing season and cranberries will not need K in August.

The second part of the question relates to K use by the crop from an August application. Research in BC showed K uptake until mid-December so K fertilizer can be used by

cranberries if applied in August. Early August is the time suggested for the last application.

The option for an August K application is provided in the South Coastal Oregon Cranberry Nutrient Management Guide, but making the statement it is needed or beneficial for bud set or cranberry growth the following year is not documented.

Q. ***What forms of K are available? Is one better than another on sandy soils or new plantings?***

A. Three materials are commonly available: 1) potassium sulfate, 0-0-50, (K_2SO_4), 2) potassium chloride, 0-0-60, (muriate of potash, KCl), and 3) potassium-magnesium sulfate (approximate analysis 22% K_2O, 11% Mg, and 22% S). Potassium-magnesium sulfate is marketed as Sul-Po-Mag or K-Mag. Use of this material does not alleviate "crunchy" vines.

All materials supply potassium in the same form, as the ion, K^+. None are superior from the aspect of K supply. The difference in sources is solubility and the accompanying material, sulfate, chloride, or magnesium. Cranberries are sensitive to chloride, so the sulfate form is preferred.

Q. ***Will early applications of 0-0-60 vs. 0-0-50 adversely affect production?***

A. Since cranberries are sensitive to Cl, at high rates, 0-0-60 may cause some injury. No data supports early application of potassium causing better fruit set or yield.

Q. ***Should I use foliar applications of K during bloom & early fruit set?***

A. Research shows no effect of timing on yield. Research also shows no effect of different products when applied at the same rate of K.

Calcium and Magnesium

Q. ***What role does calcium play in cranberry production?***

A. Calcium is important in holding cell walls together in plants. It is also important in membrane integrity and permeability. Calcium is immobile in plants once it reaches its "final resting spot". A constant low level supply of calcium is important and is achieved by calcium moving with water in plants. Therefore, as long as plants are using water, they are accumulating calcium. Unlike most other nutrients, it is accumulated throughout the growing season.

Q. ***What does Magnesium do for cranberry production?***

A. Magnesium is essential to create and maintain chlorophyll for photosynthesis and it is involved in several enzyme systems. Mg is required, but at low levels compared to N, P, or K.

Q. ***Will I see a yield response to added Ca?***

A. Not likely. In an Oregon research project, no significant yield increase was seen by increasing calcium. One research project in the east showed increased yield with applications of Ca-B at fruit set. However, the applications of Ca & B were not separated, so we can't tell which element caused the yield increase. Boron is needed for flower development, pollen germination, and growth. Boron likely was the limiting nutrient in the trial. Not only are Ca applications not likely to increase yield, they haven't changed Ca in cranberry fruit. Cranberry tissue test results from the University of Wisconsin analytical laboratory showed very few samples below the critical value—suggesting that calcium is seldom a limiting factor. The same is true for magnesium.

Q. ***Will calcium applications during bloom increase fruit set?***

A. Not likely. See previous answer. We don't know of any research data suggesting that applications of calcium alone during bloom will increase fruit set or yield.

Q. Is gypsum an excellent form of calcium and will it lower soil pH and enhance soil drainage?

A. Gypsum ($CaSO_4$) is an excellent source of calcium for cranberries. It will **NOT** lower soil pH in cranberry beds. Gypsum will enhance soil drainage for a very specific condition of high sodium in soil. The term for this is a sodic soil. Gypsum provides Ca^{++} that will be exchanged with Na^{+} ions in the soil. This condition is not found in cranberry production, only arid and semi-arid areas such as eastern Oregon and Washington.

Q. ***Is there an optimum timing for calcium and magnesium applications?***

A. Since calcium and magnesium are taken into the plant as long as water is used, timing is not as critical compared to N or K. A low or constant amount is required throughout the season. We don't know of any research data indicating an optimum timing for Ca or Mg application for cranberry.

Q. ***What materials supply magnesium?***

A. Epsom salts ($MgSO_4 \cdot 7H_2O$) or potassium-magnesium sulfate (SulPoMag) are acceptable.

Q. ***Does soil pH affect Ca or Mg availability?***

A. Both Ca and Mg decrease as soil pH declines from 7. The availability or solubility does not change; the amount present decreases.

Q. ***How much gypsum should I apply each spring to maintain optimum levels of calcium in my tissue tests?***

A. In Oregon research, sufficient levels of calcium were seen at 25 lb/a of applied gypsum. However, sufficient levels of tissue calcium were also seen in research plots that did not receive any calcium as added gypsum, suggesting that cranberries receive adequate levels of calcium through other fertilizers or water.

Q. ***Does gypsum help relieve "Casoron Crunch"? If I apply Casoron, should I follow the application with gypsum?***

A. Gypsum does not alleviate crunchy beds. Beds are crunchy when the proportion of wood exposed is large relative to the leaf biomass. This situation or condition usually indicates an N management problem or a catastrophic event that led to leaf fall. In Oregon research, calcium has not been shown to reduce Casoron crunch.

Micronutrients

Q. ***Should I consider applying micronutrients such as zinc, manganese, copper, and boron?***

A. You should add them if a tissue test suggests they are low or dropping. Tissue test reports showing deficiencies in any of these elements are not common. Boron sometimes can be helpful during flowering to fruit set.

Q. ***Have there been any studies showing the benefits of applying the above micronutrients?***

A. Very little field research has been performed on cranberries with micronutrients. It is difficult to do and unless replicated many times as the effects are usually too small to find with the natural variability of cranberries. Some laboratory work determined the critical tissue value for these elements. The values are reflected in our current tissue test recommendations. In addition, toxicity of these elements was measured. While they may become toxic, the concentrations that affect vegetative growth are 100 fold higher than normally found in tissue tests. In New Jersey, low Cu and Zn in tissue are rare, but sometimes found.

Much of these elements are retained in the perennial portions of the vines and little is harvested with the crop. Further, soils typically contain adequate amounts of these elements. Cranberries require only a few ounces per acre of these nutrients. If your tissue tests show sufficient levels of micronutrients, adding them is not necessary.

General Questions

Q. ***Each season I see many small aborted berries at harvest time. What do I need to do to set more fruit & size these berries for harvest? Is there a problem with pollination, fertility (amount/timing), heat stress or blossom injury?***

A. While all of the above factors can affect fruit set and size, none of these likely limit fruit set and production. The loss of small berries is not a mineral nutrient inadequacy, rather a lack of carbon or photosynthesis.

   In Wisconsin, Teryl Roper's research clearly showed that most of the carbohydrates that support fruit set and growth come from leaves on the current season growth above the fruit. When photosynthesis is measured on these leaves, the data shows that on average, a cranberry upright produces enough carbon to set and grow to 2 fruit maturity.

Q. ***Why collect tissue for nutrient analysis in August/September rather than spring?***

A. Two primary reasons have been found that make taking tissue tests in the late summer logical as opposed to spring. The first is that tissue concentrations of elements (particularly N) change rapidly in the spring. That means that the date or stage of development at which the sample is taken has a large effect on the tissue concentrations found in the uprights. In the summer these elements don't change much so the date or stage of development is much less critical. The second reason is that you should think of nutrient supply as a July-to-July process rather than a May to August process. A fall tissue test tells you if your nutrient management program was effective for the year and provides areas where adjustments may have to be made for the following year. If you make this "paradigm shift" then the fall collection makes more sense than a spring sample.

Q. ***Should I irrigate after a fertilizer application?***

A. Irrigating after applying fertilizer is prudent, especially fertilizer with K (the possible exception being a foliar application of micronutrients that may be best absorbed through the leaves). About 0.10 to 0.15 of an inch of water should be sufficient to wash granules off the vines, solubilize the fertilizer and get it into the top soil layer, yet not enough to leach nutrients through the soil.

*The original document was prepared in 2000 for an Ocean Spray meeting by Teryl Roper (formerly Wisconsin extension fruit specialist and now Head of the Department of Plants, Soils and Climate at Utah State University). Additional questions were supplied by Bob Donaldson, Chair of the Oregon Cranberry Grower Association. Answers were provided to the additional questions and the document was modified by John Hart, Emeritus professor of Crop and Soil Science at Oregon State University, Joan Davenport, Professor of Soil Science at Washington State University, Prosser and Linda White, OSU Extension Service Coos County, for the 2011 Oregon Cranberry School.