
Fertilizer Use in Cranberry Production

An Information Fact Sheet

Fertilizers are essential for producing an adequate food supply for the world population. It is estimated that in North America crop yields would drop 30 to 50% without the use of fertilizer. In nature, as in agriculture, plants take up critical nutrients to grow and produce fruit. In nature the death and decomposition of the plant on site replenishes the nutrients to the ground. In agricultural practice the crop and its nutrient content is removed from the field and sent to the consumer. For millennia man has sustained the viability of productive fields by supplementing this loss with fertilizer.

Fertilizers are organic or inorganic compounds containing the mineral nutrients needed to support plant growth. They are applied to cranberry bogs through the soil or via a foliar application using the irrigation system. There are 16 elements that are considered essential to plant growth. Three of these elements, carbon, hydrogen, and oxygen make up the most abundant elements in plant tissue. In the process of photosynthesis plants use carbon dioxide from the air along with water to make carbohydrates that ultimately form the building blocks of plant life. The supply of carbon, oxygen, and hydrogen from carbon dioxide and water remains relatively constant in a cranberry bog and therefore these elements are generally not limiting to cranberry growth.

Essential Elements to Plant Life

The remaining 13 essential elements are classified as being either macronutrients or micronutrients. Macronutrients are nitrogen, phosphorous, potassium, sulfur, calcium, and magnesium and it is these nutrients that are most often found in fertilizers applied to a cranberry bog or in the home garden. The remainder of the essential elements are classified as micronutrients. The distinction in “macro” and “micro” is not in the importance to the plant, rather in quantity required for optimum plant health. Therefore, the concentrations of the micronutrients required are very small though they are no less important than the macronutrients for maintaining plant health. While it is carbon, hydrogen, and oxygen that will ultimately form the hydrocarbon building blocks in photosynthesis, all essential elements are required for the process to occur. The photosynthetic process, which produces pure oxygen gas as a byproduct, is the central process in plant life, producing structure as well as the energy the plant needs to function.



Every bog in production, like all plant life requires all of the essential elements and unless the elements are in perfect balance, one element will become the factor limiting plant growth and function. As an example, if a cranberry bog has too little phosphorous, adding other nutrients in large quantities will not have a growth effect. The 'law of the minimum' dictates that the element that is lacking, in this case phosphorus, would control growth and only the addition of that limiting element will give a plant response.

Cranberry Nutrition

Cranberries are adapted to the relative lack of fertility in their native sandy soils. These soils are low in organic matter in the root zone and have relatively little clay, the two soil components that can hold nutrients available to the plants. Though the plant is adapted to low soil fertility, fertilizers are essential because nutrients are taken from the bog through the harvest of fruit. Nitrogen (N), phosphorous (P), and potassium (K) are the three elements most often added to the bog, since these are the elements removed in the largest quantities when the crop is harvested. Despite the necessity for N-P-K fertilizer in cranberry cultivation, fertilizer use is low in comparison to that in traditional agronomic crops such as corn or soybeans.

Cranberries grow best in soils with low pH and are naturally adapted to the acidic soils of the area. Optimal soil pH for cranberry cultivation is around 4.5. Newly planted beds may be closer to neutral (higher pH) due to the large sand component in the soil. As the bog is fertilized with ammonium N, the cranberry vines will acidify the soil as they take up the fertilizer. Occasionally growers will apply sulfur to the bog to lower pH, but this practice is not very common since sulfur applications can damage the vines under some conditions.

Phosphorous Use

Much attention has been given to the use of phosphorous in cranberry fertilization. Like the other 13 essential mineral nutrients phosphorous is required for healthy plant growth. Though found in low levels in cranberry tissue, phosphorous is necessary in root development, several metabolic energy transforming processes, and is a fundamental building block of the plant cell membrane and DNA.

The correct application of phosphorus is critical because as a nutrient it often represents the limiting factor in the growth not only of the cranberry crop but also of many algae and other freshwater aquatic plants. Often, nitrogen is abundant in surface water bodies but phosphorus is limiting. When additional phosphorus reaches the water, aquatic plant growth accelerates. These aquatic plants consume both oxygen and carbon dioxide from the water. An increased number of these plants can lead to reduced oxygen levels and potentially, fish kills. In the acid cranberry soils, P is tightly bound to iron and aluminum and generally does not leach or run off. However, when bogs are flooded, the soil becomes saturated and depleted of oxygen, causing a chemical change in the soil iron. This change releases the bound P into solution. When the flood is released, some of that dissolved P may leave the bog. For this reason, growers must balance the need to use P to produce the crop, to use flooding for various management tasks, and to preserve of water quality. The industry has supported extensive studies have been conducted by the UMass Cranberry Station to optimize phosphorous application for both the bog and the environment. Growers use tissue testing to monitor for P deficiencies and limit maintenance dose of P. Currently soil testing is less useful for P monitoring but research is ongoing to define a better soil testing method to further refine P use. Ultimately growers strive to balance production with environmental protection since clean surface and ground water are vital to cranberry production as well as to society in general.

Nitrogen Use

Cranberries are fairly unique in how they take up nitrogen. Unlike almost all other crops, cranberries preferentially use the ammonium form of N over the nitrate form. In fact, there is some evidence that cranberries can also use organic N forms through their association with specialized soil microbes. What this means is that growers apply N as organic or ammonium forms rather than as nitrate. Nitrate is the N form with the most potential for contaminating

ground water by leaching. Because cranberry growers do not use the nitrate N form, water quality is protected. In neutral pH soils, ammonium could become converted to nitrate by soil microbes and then leach into the groundwater. However, at acid pHs, the soil microbes that mediate that conversion are suppressed and the N remains as ammonium until the cranberry plants take it up. Ammonium is applied as fertilizer ammonium, as urea, or as organic fertilizers that breakdown to release ammonium. Organic forms include fish fertilizer, a product made from fish remains. Chemically it works the same as traditional fertilizer with the advantage of being organic but the disadvantage of a slight odor and increased cost.

Cranberry plant demand for nitrogen is highest during three stages of the lifecycle critical to cranberry development -- early growth, fruit set and bud set. Early growth is when the plant grows vegetatively through vining and root growth and produces a flush of new leaves. Fruit set is when the flower becomes pollinated and fruit begin to form. Soon after fruit set comes bud set when nitrogen is needed for both fruit development and production of the next year's flower bud. Typically cranberry bogs will receive ammonium throughout the growing season through applications timed to coincide with these growth stages.

The amount of nitrogen applied is determined by cranberry variety, soil conditions, and past practices on the bog. Soil characteristics can dramatically alter the amount of nitrogen needed for a good crop. Sandy soils are low in organic matter and typically need greater amounts of applied ammonium than peat or muck soils. However, if soil pH is well above the ideal 4.5, much of the intrinsic nitrogen in heavily organic soils is converted to nitrate which, again, is largely unavailable to the cranberry plant. This is generally not an issue in Massachusetts where cranberry soils are not highly organic. Aside from pH, soil temperature is important to determining fertilizer need. Microbes in the soil work to convert organic N to ammonium N and these microbes become



Fertilizing By Helicopter

more active as soil temperatures rise. Consequently, warmer soils have reduced nitrogen needs and in warm springs, growers reduce early season N applications. To tally the final amount of N to apply growers may use a "Cranberry Nitrogen Balance Sheet". Here, growers will start with the amount of N they have previously used (or a baseline recommendation of 25-30 lbs/acre), then subtracting or adding to the balance depending on results of tissue tests, amount of crop the previous year, expected crop in the current year and other factors such as insect damage or frost that might impact growth or crop potential. This credit/debit system will allow the grower to effectively quantify needed nitrogen.

Much research has been conducted regarding N use in cranberries. UMass in collaboration with other land-grant universities has published a handbook that guides cranberry growers to optimize nitrogen use. Environmental protection is a reason for growers to apply only the needed amount

of N. The fact that too much N can reduce crop is also a powerful incentive to moderate N fertilizer use.

Total Maximum Daily Loads

A Total Maximum Daily Load (TMDL) is a watershed or basin-wide budget for the influx of any given nutrient or pollutant. The TMDL is a Clean Water Act mandated planning document that sets an “allowable budget” and is determined by scientific study. The TMDL quantifies the maximum amount of any substance that can be carried by a waterbody without exceeding the water quality standards for that waterbody’s specified use, be it aquaculture, drinking water, recreation etc.

The Federal Clean Water Act provided states the right to establish their own TMDLs. In Massachusetts this is done by the Department of Environmental Protection. The DEP does scientific surveys to assess what nutrient loading can be carried by any given waterbody. From this, industries, such as cranberry cultivation, aim to establish Best Management Practices (BMPs) to reduce their share of nutrient loading into the environment. Currently the UMass Cranberry Station is working in conjunction with the DEP to evaluate cranberry impacts and to develop BMPs to assure that cranberry cultivation has minimal impact on water quality.

When and How is Fertilizer Applied?

Fertilizer is applied throughout the growing season. Timing of fertilizer applications is based on plant growth and fruiting. Generally fertilization takes place between April and August. The goal in timing these applications is to fertilize when the plant can use nutrients for fruiting rather than vegetative growth. In addition, fertilization is timed to coincide to when the plant is capable of absorbing nutrients, thus mitigating nutrient runoff. Fertilizer can be applied by helicopter, by ground rig, through chemigation, or by a manual spreader if being done to only a small part of the bog.

Applying Fertilizer Safely

Each year growers must decide how much fertilizer to apply. Apply too little and the vines won’t be as healthy resulting in poor, unsustainable yields. Applying too much costs additional time and money for the business and can result in minerals leaving the bog for the natural environment and vegetative growth instead of good crop production. With the aid of the applied research done by the UMass Cranberry Station and a desire for continued environmental stewardship growers are better equipped to make the best decisions for their bogs and for the environment. Farmers have been called the first conservationists because they do so much to protect the scenic beauty and ecological function of the local habitat. Cranberry growers strive to remain rightly proud of this distinction.

For More Information

For more information on cranberry nutrient requirements consult the following publications available from the UMass Cranberry Station, One State Bog Road, East Wareham, MA:

- *Nitrogen for Bearing Cranberries in North America*
Oregon State University
- *Phosphorous for Bearing Cranberries in North America*
University of Wisconsin