

Chapter 11 Future Nutrient Management in Berry Crops - *Dr. Bielinski Santos, University of Florida or*

Let's review

Much of the information covered in the previous 10 chapters discuss the topic of nutrient management. For berry production, specifically intensive strawberry production, nutrient management usually requires the grower to understand and properly utilize fertigation techniques. This chapter will explain how berry fertilization and irrigation practices are intertwined and why it is difficult to provide growers with a “one size fits all” recommendation for fertilizing berries.

Continued below.

Fertigation

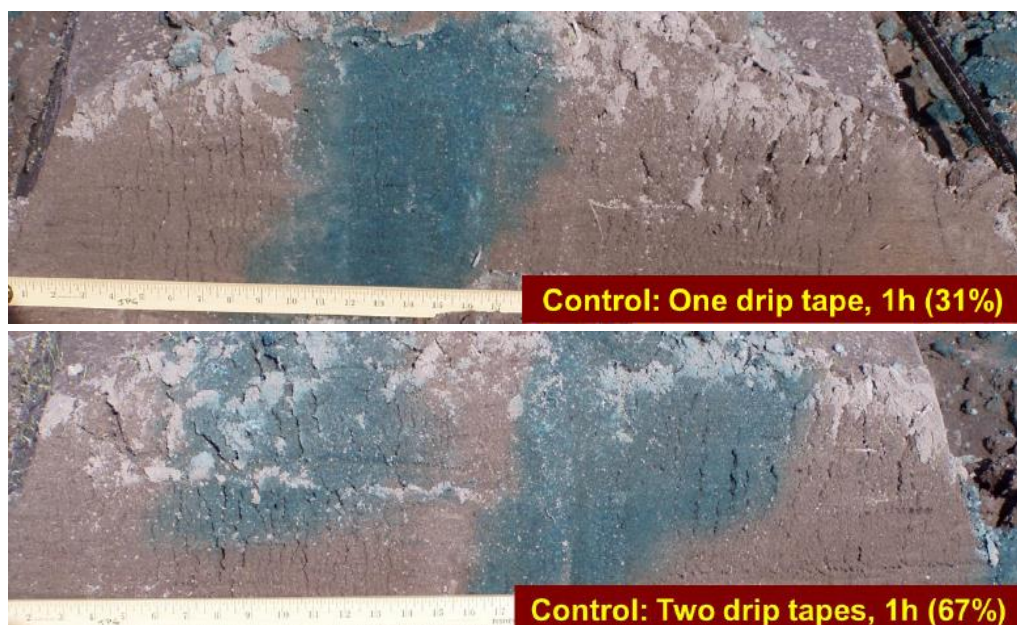
Fertigation is the process by which fertilizers are applied through the irrigation system. This practice relies on two different types of fertilizer: ready to use liquid fertilizer and hydro-soluble salts.

Custom blended liquid fertilizer is the most commonly used product in most large strawberry growing regions. It is very convenient for the grower and can be tailored to the particular need of the plant and the farm situation. The fertilizer does not precipitate out of solution so the accuracy of the dosage is greater. This fertilizer is more costly as the volume and weight of the product makes shipping and delivery more expensive.

Hydro-soluble salts are more affordable but the opportunity for error is greater as the fertilizer needs to be mixed by the farmer. These products do precipitate out of solution so during fertigation it is important that the solution be monitored.

Nutrition and irrigation principles

Nutrients only move as far as the water takes them. No fertigation program is efficient if a poor irrigation program is in place.



Photos at left illustrate water dyed water infiltrating sandy soil in a raised strawberry bed. Using one drip tape (top), only 31% of the bed was moist after 1 hour of irrigation. In the bed that had 2 irrigation tapes (bottom), 67% of the bed was moist after 1 hour of irrigation as illustrated in the lower photo.

There are four fundamental components for success with fertigation:

- 1) Do not irrigate longer than 1 hour at a time.
- 2) Use monitoring equipment.
- 3) Calibrate your soil – i.e. know your field capacity.
- 4) Keep the water in the rooting zone.

In Florida the typical soil is classified as Spodosol: an ashy gray, acidic soil with a strongly leached surface layer. Because these soils closely resemble beach sand, there is constant danger of nutrient leaching. Keeping the plants sufficiently watered and fertilized while preventing leaching requires a daily or every other day fertigation schedule. Managing this type of soil closely resembles managing a soilless media and although most strawberries

grown in the US are grown in soil, increasingly many regions of the country are using protected culture where the berries are grown in a soilless media.

The example of Florida soils illustrates the importance of knowing your own unique soil in order to grow strawberries well. This includes all of the physical and chemical properties of the soil that have been discussed in previous chapters, but also includes considerations of field capacity and the wilting point of berry crops.

Correctly determining field capacity, which is the upper limit of the plant available water in a soil, and permanent wilting point, the lower limit of plant available water, will allow growers to correctly schedule irrigation.

The available water in various soils at field capacity varies tremendously as shown in Table 29.

Table 29. *Total available water of various soils at field capacity.*

Soil Class	Available water storage capacity in acre-inches per foot depth of soil
Gravelly sandy loams	1.0 (27,000 gallons)
Sandy loams	1.35 (36,450 gal)
Gravelly loams	1.75 (47,250 gal)
Loams/silt loams	2.0 (54,000 gal)
Silty clay loams	2.5 (67,500 gal)
Organic (muck) soils	1.0 (27,000 gallons)

Water Monitoring Equipment

Water monitoring equipment varies in price and accuracy. Tensiometers are commonly used because they are easy, inexpensive and decently accurate. They are measuring the water tension in the soil in order to determine available soil moisture. One unit per location is required which can be limiting.

Time Domain Reflectometers (TDR) are more expensive but still easy to use and are very accurate. You will only need one unit for the whole farm. TDR's determine available soil moisture by measuring soil volumetric water. The farm manager could go and check all of the field readings before each irrigation cycle and determine the length of the irrigation event.

Irrigation research depends on even more sophisticated and expensive technology that is not necessary for production agriculture.

Soil vs. soilless media

Soilless media is becoming increasingly common in specialty crop production. Most soilless medium is solid substrates, but some



soilless systems like hydroponics, and aeroponics rely on liquid or mist media environments to deliver nutrients. Solid soilless media acts as a replacement for natural soil. Many of these media are naturally deficient in most nutrients but still provides root support, nutrient and water retention, gas exchange and a pest free environment. Some of these materials are of a mineral origin including perlite, vermiculite, sand, and rockwool. Others substrates are organic in origin including coconut coir, peat, pine bark, compost and coconut hulls.

Injection equipment

There are two basic types of fertilizer injection equipment; suction fertilizer injectors and constant concentration injectors.

Suction injectors like 'Venturi' TM systems are easy to use and relatively inexpensive. The drawback with suction systems are that they are consistent only if water pressure is also consistent. If water pressure changes it will change the amount of fertilizer in the line so regular monitoring is required (see drawing at end of chapter).

Constant injection systems, which can be hydraulic or electric, an example is 'Dosatron' TM, supply a constant rate of fertilizer over a broad range of water pressures – if the water pressure drops it will just take a longer amount of time to deliver the required dose, as the rate drops depending on the pressure.

Computerized consoles are the most expensive but they enable the grower to preprogram all of the fertility and the watering ahead of time. These can be worthwhile if you have a trained technician and are fertigating a number of different crops on varying schedules, but more expensive does not always mean better.

A multi tank injection point system provides soluble salt fertilizers separate tanks for all the components of a fertilizer mix. The solids are mixed into solution and stored separately so that they won't precipitate while in the mix. The acids, nitrates, phosphates etc. are stored as a concentrate liquid in their own tank and then are mixed together at the injection point.

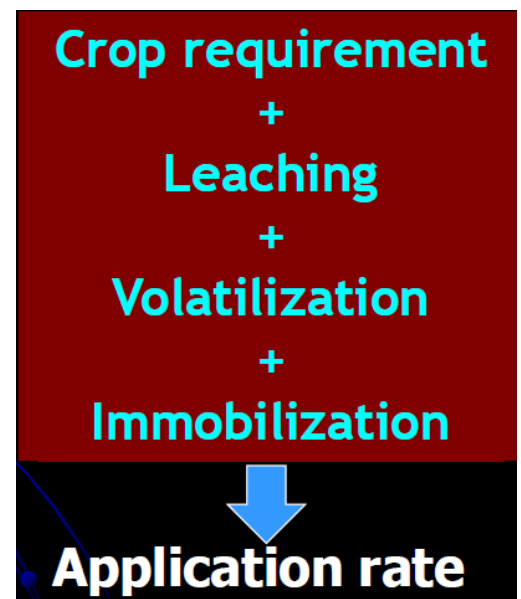
Nutrient Rate Determination

Fertilizer rates are dependent on the source of nutrients, the placement of the nutrient and the timing of application.

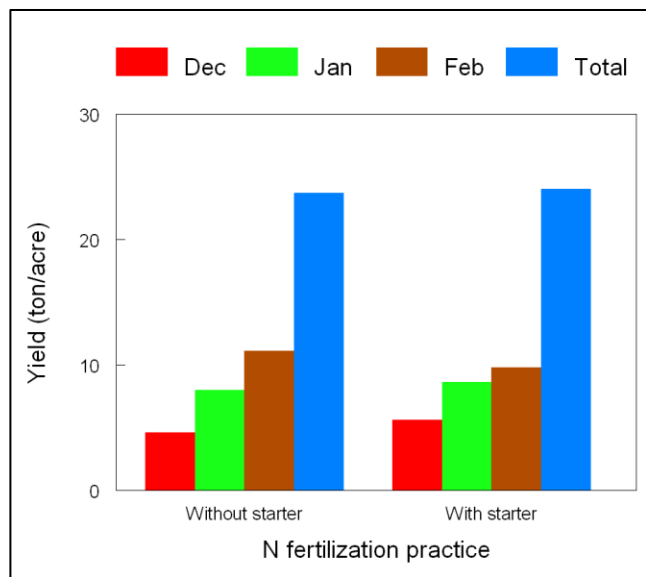
Use a soil/medium analysis to determine limiting nutrients. Crop requirement is the first consideration when determining rate, but the grower should also consider the amount of nutrients that may be lost through leaching, volatilization and immobilization so that in the end the crop will still get the necessary macro and micro nutrients.

Blanket recommendations may be used in situations where there is little supporting data in some crops as is the case for some micronutrients like Zn, Fe or Su or if a grower is starting out with a new piece of ground where little information is available.

Crop nutrient requirement varies among cultivars as rates of growth and plant architecture supplies the greatest demand for nutrients.



Preplant and early nitrogen can be applied as a granular fertilizer to the soil or media. Nitrogen and phosphorus can be applied through the drip at the beginning of the crop cycle and then nitrogen and potassium can be added



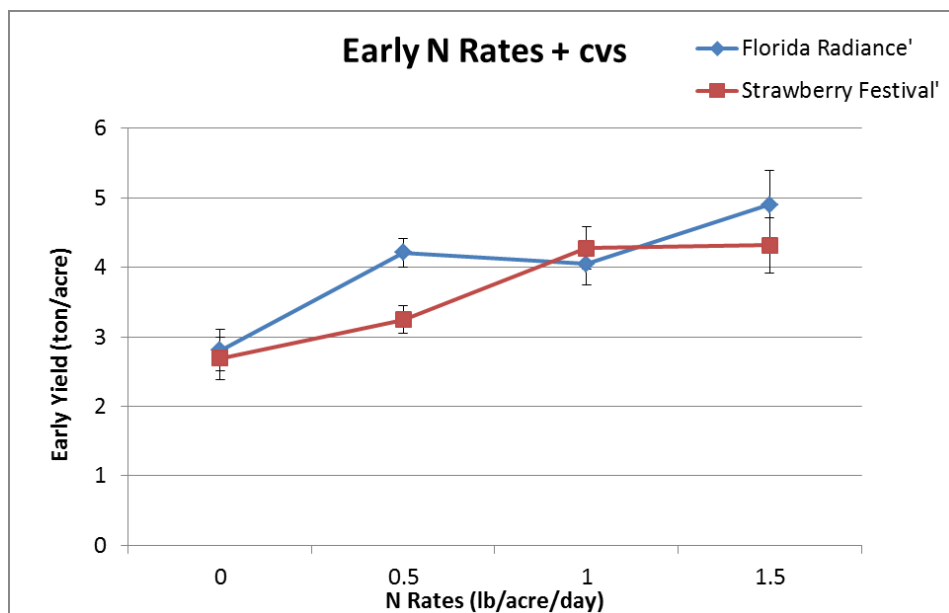
periodically through the drip as needed. Nitrogen and potassium are the most applied nutrients through the season. Nitrogen is almost entirely applied through drip in Florida strawberry production systems.

Historically 60% of Florida strawberry acreage had 20-50 lbs/acre of granular ammonium nitrate applied as a starter fertilizer. The remainder of the nitrogen was applied through the drip. Now less than 20% of the acreage follows that protocol. The reason is partially due to environmental concerns and partially because prices have forced growers to make sure the plant is utilizing all of the nutrients applied.

The fact that USDA data reveals that between 2000 and 2011 the cost of all types of nitrogen fertilizers more than doubled and in some cases tripled really helped promote the importance of understanding when N fertilizer was most utilized by the plant.

Studies showed that early N applications did not result in earlier fruit yield, and the optimum rates of N applied varied a great deal depending on the variety. It was also determined that nitrogen sources did not matter, and that plant response at the different rates varied according to cultivar. (See graph below). This work helped save growers \$17 per acre and 50 lb of nitrogen per acre.

What about nitrogen and potassium ratios during the season? Studies compared the conventional grower practice of applying fertilizer with a 1.5:1 or 1.75:1 N:K ratio from October transplanting to mid-December followed by a mid-December to March increase of potassium to a 1:1.5 or a 1:2 N:K ratio in order to improve fruit quality. The study did not reveal any differences in 3 different strawberry cultivars in terms of plant diameter, total yields and soluble solids compared to keeping



the potassium levels consistent throughout the season. However, there was a difference in cultivar response that indicates N:K ratios should vary during the season. There is a need to derive tailor made fertility programs that depend on the differences in the plant architecture.

Nitrogen sources did NOT seem to make any difference.

Practices should be designed for each specific grower and each specific cultivar type. Once the specific program has been developed, there may be no reason to change the N:K ration during the season.

The only way to determine the specific programs for each of the cultivars will be to understand and use good diagnostic tools.

Diagnostic tools

The best tools for diagnosing problems are your eyes. Visual assessment cannot be beat for catching problems, but often by the time a grower sees a problem it is too late. You want to get to the plant BEFORE the plant looks like the photo at right.

No single tool will provide a one size fits all diagnostics. You will need to several different types of diagnostic tools.



Petiole sap meters are good diagnostic tools for N specifically, but it's difficult to determine the right time to use them. High nutrient levels in the petiole may mean the petiole is simply acting as a nutrient reservoir and nitrogen is not moving through plant vascular system to the leaves.

Colormetric meters like SPAD meters measure the greenness of the leaf and helps to detect deficiencies in nitrogen, magnesium and iron.

When looking at the nutritional composition of the leaves, nothing beats a good leaf analysis – unfortunately time does not stand still while you are getting the information and the leaf analysis is just a snapshot in time. Several days can go by while waiting for the results. The results can be compared to known sufficiency ranges for strawberries. These guidelines are not written in stone, but they allow a grower to fine-tune their fertility program.

It is very important to make sure that fertigation solutions are correct from the start. Solution pH should never vary from the 6.2- 7.8 range. The soil media will impact the pH. Media may capture and retain more of the nutrients.

Electrical conductivity (EC) should not be too high. In Florida water EC is 0.7 deciseimens per meter – fertilizer solutions should not exceed 2 deciseimens per meter - that requirement will influence the kind of fertilizer needed. A grower might be better off (certainly have more choices) if they lowered the concentration of nutrients and applied fertilizer more frequently.

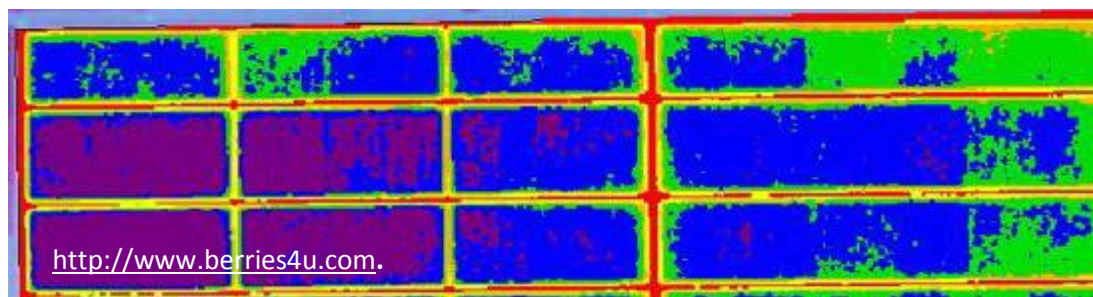
Table 30. Sufficiency ranges for petiole sap N and K concentrations for Florida strawberries, October planting.

Month of season	Petiole sap nutrient concentration (ppm)	
	NO ₃ - N	K
November, soon after planting	800 - 900	3000 - 3500
December, first harvesting	600 - 800	3000 - 3500
January, main season	600 - 800	2500 - 3000
February, main season	300 - 500	2000 - 2500
March, main season	200 - 500	1800 - 2500
April, late harvest, near end of season	200 - 500	1500 - 2000

Emerging Tools for Improving Production

Aerial infrared photographs are now used as a tool to measure crop leaf reflectance and help diagnose plant stress caused by poor nutrition and pest management. This is primarily in agronomic crops now, but vegetable crop growers are also using the technology.

The photos can point to specific areas where growers might need more nutrients – allowing you to make adjustments



as trouble arises. The areas in green in the diagram above indicate areas of poor vigor which are likely to respond to increased fertility. This type of photography combined with a better understanding of crop reflectance measurements are being used increasingly in Europe and will likely be utilized in North America in the near future.

Other innovations include nitrification inhibitors. These help slow down conversion of NH₄ to nitrate.

Other coming attractions in research programs include increased evaluations on the effects of other nutrients on growth and quality – specifically the uptake of Phosphorus in the early stages of plant growth – and the management of soilless culture – making sure that each specific soilless medium and their characteristics are understood.

Summary

Berry fertilization and irrigations are both highly intertwined and variable depending on a number of factors, which is why there is no “one size fits all” when it comes to these procedures. In order to have successful fertigation techniques, you must not irrigate longer than an hour at a time, you must use monitoring equipment, calibrate your soil, and keep the water within the rooting zone. Knowing your land and soil type are other valuable

tools to practicing efficient fertigation. While there are a number of diagnostic tools to determine problems within your crops, using your eyes and overall judgment can be a valuable tool. Aside from fertigation application techniques, having the proper pH and electric conductivity can result in a better crop yield as well as healthier plants. A combination of all of these ideas will contribute to future nutrients within berry crops.

Figure 52. Venturi injection system

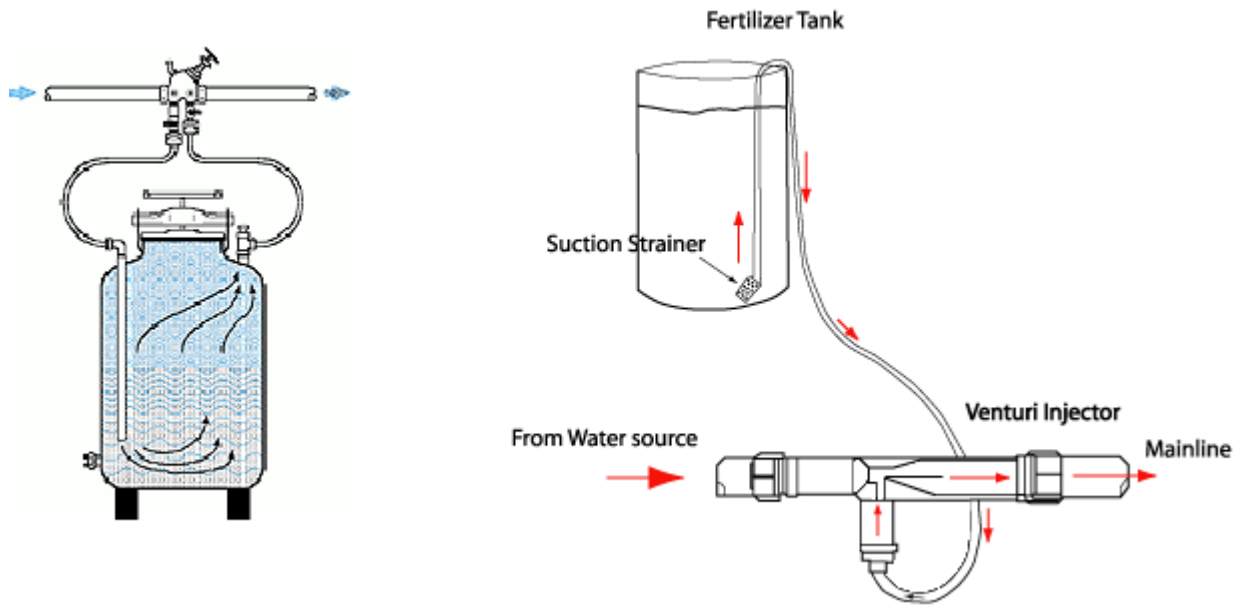


Figure 53. SPAD meter readings may be correlated with N status under certain conditions

