

2023–2024 Florida Citrus Production Guide: Fertilizer Application Methods¹

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Granular and Controlled-Release Fertilizers

Fertilization is an important aspect of growing citrus commercially. Citrus tree growth, health, fruit production, and fruit quality are closely affected by plant nutrition. As important as it is to include all the mineral nutrients in proper balance in a fertilizer program, choosing the right method of delivery is equally important. Many fertilizer sources and formulations are available for commercial citrus production. There are also different methods of applying fertilizers. Applying the right fertilizer type, at the right rate, at the right time, at the right location (within the root zone) is very important to improving nutrient uptake efficiency. Some fertilization methods are better suited for a particular setting; therefore, it is suggested to consider all the fertilization options before deciding to invest in one program. Often a combination of delivery methods in fertilization programs works best for commercial citrus groves to ensure a tree receives all the nutrients in the right form and at the right time.

Most commonly used commercial fertilizers are water-soluble, meaning they are readily available to plants when properly applied. Soluble fertilizers are applied to the soil dry in granular form, liquid through fertigation, or foliarly. When applied in granular form to the soil, soluble fertilizers release nutrients relatively quickly, assuming the soil water content is at the appropriate level. Applying too much readily soluble fertilizer to crops at once can result in plant toxicity. In addition, heavy rainfall or irrigation can result in leaching of the nutrients. Therefore, it is suggested to split the soluble fertilizer into smaller doses.

Over many decades, the fertilizer industry has developed controlled-release fertilizers (CRFs). The Association of American Plant Food Control Officials defines CRFs as fertilizers that contain a plant nutrient in a form in which the plant uptake is delayed after application, or that provide a longer duration of nutrient availability compared with quick-release fertilizers. CRFs have become more popular in recent years. CRFs are often called slow-release fertilizers (SRFs) or timed-release fertilizers. However, the terms CRF and SRF should not be used interchangeably. The main difference between CRFs and SRFs is that in CRFs, the factors affecting the rate, pattern, and duration of release

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are well known and controllable, whereas in SRFs, they are not well controlled. CRFs were initially developed for their horticultural benefits, but they have also attracted attention in the best management practices (BMPs) and citrus greening era. CRFs have advantages in:

- inducing more growth and yield due to a continuous supply of nutrients.
- reducing rates and frequency of fertilizer applications.
- saving substantial labor and time.

CRFs are typically coated or encapsulated with inorganic or organic materials that control the rate, pattern, and duration of plant nutrient release. Soil moisture, temperature, and microbes have the greatest influence on nutrient release. CRFs have different N-P-K blends and may or may not include micronutrients. They can have different durations of release, expressed as months, which determine how long the CRF will persist.

Citrus fertilization research conducted in Florida within the past 30 years showed that tree growth and fruit yield where part or all of the fertilization program included CRF are similar or greater than growth and yield resulting from an all-conventional water-soluble N fertilization program. CRFs are more efficient, have low plant-toxicity hazard, and have less leaching and volatilization potential than conventional soluble fertilizers. The improved efficiency of fertilizer use saves energy and reduces environmental pollution.

Dry-solid fertilizer spreaders should apply materials directly over the root zone. When applying fertilizers to young trees, managers should take advantage of manual or electronic spreader adaptations that deliver fertilizer rates accurately to small tree root zones while leaving out the area between trees where roots are not present. For economical and efficient fruit production, it is essential that spreaders be calibrated to apply accurate and appropriate amounts of fertilizers.

Microirrigation is an important component of citrus production systems. For citrus trees, microirrigation is more desirable than other irrigation methods for three main reasons: water conservation, fertilizer management efficiency, and freeze protection. Microirrigation combined with fertigation (applying of small amounts of soluble fertilizer directly to the root zone through irrigation systems) provides precise timing and application of water and fertilizer nutrients in citrus production. Fertilizer can be prescription-applied in small doses and at particular times when those nutrients are needed. This capability helps

growers increase fertilizer efficiency and reduce nutrient leaching by excess rainfall or overirrigation, and it should result in reduced fertilizer rates for citrus production. The two most common nutrients applied to citrus through fertigation are nitrogen and potassium.

Florida state law requires that backflow prevention equipment be installed and maintained on irrigation systems that have fertilizer injection capability. The function of the backflow prevention device is to prevent contamination of ground or surface water by the applied chemicals. Therefore, before injecting fertilizer into any irrigation system, make sure all required backflow prevention devices are in place and working properly.

The time required for water to travel from the injection point to the farthest emitter is generally 20 to 30 minutes for most microirrigation systems. Therefore, a minimum injection time of 30 minutes is recommended. After fertigation, continue to run water for 30 minutes to completely flush the fertilizer from irrigation system lines and emitters to minimize clogging potential. Keep in mind that excessive flushing time beyond 30 minutes can leach the recently applied plant nutrients below the root zone.

Before injecting fertilizer solutions, a “jar test” should be conducted to determine compatibility of liquids and clogging potential of the solution within irrigation system components. A sample of the fertilizer solution should be mixed with irrigation water in a jar (at the same dilution rate used in the irrigation system) to determine if any precipitate or milkiness occurs within 1 to 2 hours. If cloudiness does occur, there is a chance that injection of the chemical will cause line or emitter plugging.

When urea, ammonium nitrate, calcium nitrate, or potassium nitrate is dissolved, heat is absorbed from the water and a very cold solution results. Consequently, it may not be possible to dissolve as much fertilizer as needed to achieve the desired concentration. It is often necessary to let the mixture stand for several hours and warm to a temperature that will allow all the mixture to dissolve.

- Fertilizer is precisely placed in the wetted zone area where feeder roots are extensive due to water availability.
- Increased fertilizer application frequency can improve plant nutrient-uptake efficiency and reduce leaching.
- Application cost is much lower than that of dry or foliar fertilizer application.
- Through fertigation, comparable or better yields and quality can be produced with less fertilizer.

- Microirrigation systems must be properly maintained to apply water and fertilizer uniformly.

Foliar fertilizer application is certainly not a new concept to the citrus industry. For over five decades, foliar fertilization of citrus has been recommended to correct zinc, manganese, boron, copper, and magnesium deficiencies. It is now common knowledge in agriculture that properly nourished crops may better tolerate insect pests and diseases.

Field research has shown that supplemental foliar feeding can increase yield by 10%–25% compared with conventional soil fertilization. However, foliar fertilization should not be considered a substitute for a sound soil-applied nutritional program, but a supplement to that soil program. Foliar applications are often used in situations to help trees through short but critical periods of nutrient demand, such as vegetative growth, bud differentiation, fruit set, and fruit growth. Foliar application of nutrients is of great importance when the root system is unable to keep up with crop demand or when the soil has a history of problems that inhibit normal nutrient uptake. Foliar nutrition is proven to be useful under prolonged periods of wet conditions, drought conditions, calcareous soil, cold weather, or any other condition that decreases the tree's ability to take up nutrients when there is a demand. Foliar feeding may be effectively utilized when a nutritional deficiency is diagnosed. Foliar application is absolutely the quickest method of getting the most nutrients into plants. However, if the deficiency can be observed on the tree, the crop has already lost some potential yield.

While foliar feeding has many advantages, it can burn leaves when applied at high rates under certain environmental conditions. It is therefore important to foliar feed within established guidelines. A number of plant, soil, and environmental conditions can increase the chances of causing foliar burn to foliar fertilizer application. Applications when the weather is hot (above 80°F) should be avoided. This means that during warm seasons, applications should be made in the morning or evening when the temperature is right, wind is minimal, and the stomates on citrus leaves are open, allowing leaves to efficiently exchange water and air. Highly concentrated sprays have the potential to cause leaf burn or drop.

Nutrient absorption is increased when spray coverage reaches the undersides of the leaves where the stomates are located. Favorable results from foliar feeding are most likely to occur when the total leaf area is large. Foliar applications of micronutrients, with the exception of iron, are more effective and efficient when the spring, summer, and fall

new-flush leaves are almost fully expanded. Another important factor when applying nutrients foliarly is to ensure that the pH of the spray solution is between 5.5 and 6.5. This is particularly important in areas where water quality is poor. To enhance uptake and thus the effectiveness of any foliar application, nitrogen should be added to the solution. Urea may be the most suitable nitrogen source for foliar applications due to its low salt index and high solubility in comparison with other nitrogen sources. However, the urea utilized in foliar sprays should be low in biuret content (0.2% or less) to avoid leaf burn. Be careful about possible chemical interactions among foliar fertilizers. Some materials are incompatible and should not be mixed together. They may create precipitates that tie up and make some nutrients unavailable or clog spray nozzles. Many product labels warn of such incompatibilities.

Overall, foliar nutrition is a very important and effective way of addressing diagnosed problems with specific deficiencies observed within the grove, as well as a best management strategy for supplying micronutrients, with the exception of iron. The concept that foliar sprays should be applied only after the appearance of a deficiency is not advisable because reductions in yield and quality usually precede the appearance of visual symptoms. In addition to soil-applied fertilizers, foliar sprays of nutrients should be used with the objective of maintaining citrus trees' health at an optimal level.