Controlled-Release Fertilizers in the Production of Container-Grown Floriculture Crops

Claudio Pasian, PhD
Floriculture Extension Specialist
Department of Horticulture and Crop Science
Columbus, OH 43210

In order for plant roots to absorb nutrients, the nutrients must be dissolved in the water surrounding the roots. The question is, “How quickly does a fertilizer release these nutrients to the water surrounding the roots?”

Fertilizers differ in the rate at which their nutrients dissolve into water in the root zone. Water-soluble fertilizers (WSFs) dissolve more or less instantly; therefore, the nutrients they contain are available for uptake immediately after application (unless they are held by the solid phase of the rooting medium). Other fertilizers are manufactured to release nutrients more slowly. These so-called slow-release fertilizers are typically coated with a resin or other substance that temporarily traps the nutrients within the fertilizer prill. The proper use of water-soluble and slow-release fertilizers is essential to achieving crop yield and quality, environmental stewardship and profit goals.

Greenhouse and nursery production systems are intensively managed requiring high amounts of fertilizer for appropriate quality growth. Nutrients are generally applied in the form of WSFs. However, because WSFs can be easily leached, there is the potential of high nutrient losses. Phosphates and nitrates are prone to leaching in greater quantities because they do not readily bind to negatively charged colloids. As a consequence, they may appear in runoff. This problem may be compounded by the fact that most greenhouse and nursery growers do not capture or recycle leachate during production.

Slow-release fertilizers (SRFs) are designed to release nutrients slowly over time. Within the SRF category, we have the so-called controlled-release fertilizers (CRFs), which are fertilizers encapsulated inside a coat that slowly releases nutrients over time. This slow release increases the probability that nutrients will be taken up by the roots. This results in fewer losses (i.e., greater nutrient-use efficiency) and reduced pollution potential. The present fact sheet covers only CRFs.

Controlled-Release Fertilizer Design

Controlled-release fertilizers are also called coated or encapsulated fertilizers because the release is controlled by a polymer coating that contains a water-soluble fertilizer. The first coatings were made of sulfur urea. Due to cracks or uneven thickness of the coating, these materials produced irregular results. Today’s coatings are made of resins allowing for better control of nutrient release. These modern coatings are made of acrylic resins, polyethylene, waxes and sulfur. The two main families of common resins in use are the alkyd-type resins (e.g., Osmocote) and polyurethane-like coatings (e.g., Polyon, Plantacote and Multicote). The release of nutrients from the prills (the small spheres made of coated fertilizer) is controlled mainly by the thickness of the coating and the temperature.

How Controlled-Release Fertilizers Work

A semipermeable coating surrounds a water-soluble fertilizer (Figure 1). Water penetrates the coating and dissolves the fertilizer inside the prill increasing the osmotic pressure, which in turn increases the size of the coat’s micropores. The fertilizer solution then exits the prill through the coating pores into the substrate. In addition
to temperature, the release will depend on the type and thickness of the coating, the salt composition, and the salt concentration differential between the inside and outside of the prill. However, the two most important factors are coating thickness and temperature.

![Diagram of CRF prill](image)

**Figure 1.** Representation of a CRF prill absorbing water and then releasing the fertilizer solution. The rate of release will depend, among other things, on the salt differential between the interior and exterior of the prill. Initially, the concentration of salts inside the prill is very high (represented by the word “salts” inside the brackets). Outside the prill, the salt concentration is lower. Such salts’ gradient favors the release of nutrient from the prill’s micropores.

### Current Use of and Barriers to further Adoption of Controlled-Release Fertilizers

CRFs are not widely used in containerized greenhouse floriculture production except for stock plants, poinsettias, hanging baskets and garden mums. Even in these few exceptions, CRFs are used as a supplement to water-soluble fertilizers. One reason for limited use of CRFs in floriculture production could be the inadequate knowledge regarding their use for herbaceous plant production. Other reasons include fear for possible plant damage due to salt accumulation when applied at higher rates. Some growers may also fear the loss of control over their fertigation program and thus feel they are unable to employ techniques such as “toning” crops to meet production goals. Toning is the alteration of fertigation practices at the end of the production cycle to improve post-production quality after plants leave the greenhouse.

At The Ohio State University, we have grown numerous bedding and container floriculture crops and some herbs with a single (initial) application of controlled-release fertilizers (Figure 2). In most cases, CRF-produced plants were equal—if not higher—in quality to plants grown with water-soluble fertilizers.

### Why Use Controlled-Release Fertilizers?

CRF use has three main advantages. First, it may simplify nutrient management relative to repeated applications of WSFs. Second, CRF use can increase nutrient use efficiency. Third, CRF use can enhance crop performance.

CRFs supply nutrients for a relatively long period of time and, for some greenhouse crops, for the entire production cycle. After applying fertilizer prills to the mix before planting, no water-soluble fertilizer equipment is needed and irrigation is done with tap water only. Fewer nutrients are lost in the leachates because

![Salvia plants grown in 4.5-inch diameter plastic containers](image)

**Figure 2.** Salvia plants grown in 4.5-inch diameter plastic containers using a 20–10–20 water-soluble fertilizer at an application rate of 150 ppm N (left), or a 16–9–12 controlled-release fertilizer of 5–6 month longevity (center), or 8–9 month longevity (right) at a rate of 5 grams (0.18 oz) per container. Marketable plants were produced with all three fertilizers. *(Photo by C. Pasian)*
nutrients are slowly released throughout the season and remain present in the substrate at the time when the plants have developed roots to absorb them. CRFs have the potential of increasing fertilizer efficiency (nutrient absorbed/nutrient applied) and reducing nutrient losses into the environment.

There is evidence that some plants grown with CRFs perform better in the landscape than plants grown with water-soluble fertilizer. This effect carries over to the landscape assuming that not a lot of time has passed between when the plant is ready to sell and the time it is planted in the landscape.

**Fertilizer Longevity**

Longevity of a CRF refers to the time it takes for all nutrients to leave the prills at a given temperature. This temperature is usually 70°F (some companies may use 82°F). The thickness of the coating determines the longevity. The thicker the coating, the slower the prills release nutrients.

Always check the fertilizer bag for the temperature that was used to determine longevity. If the temperature of the substrate where the prills are located is higher than that specified on the bag, the release will be faster than specified. At lower temperatures, it will be slower. The most common longevities are: 3–4 months, 5–6 months, 8–9 months and 12–14 months. In summary, increased longevities are the results of thicker coatings.

Growers should be aware that adjusting the CRF rates of application is necessary when using different longevities. In order to achieve maximum plant growth, CRFs of extended longevities require higher application rates.

At low application rates, greater longevity CRFs (e.g., 8–9 month or 12–14 month) release insufficient nutrients to meet the demands of rapidly growing crops early in the season. At higher application rates, release by shorter longevity CRFs (e.g., 3–4 month) may result in excessively high salt levels (high electrical conductivity [EC]) and poor growth. At low fertilizer application rates, the faster release rate (shorter longevities) CRFs can produce larger plants. At higher application rates, slower release CRFs (longer longevities) can outperform the faster release CRFs (Figure 3).

**Prill Cracking**

The coating material of the prill can have cracks if the CRF is mishandled and damaged. Through these cracks, the fertilizer can be released very fast, defeating the purpose of using a CRF. The bags with CRF should be handled gently. Care should also be taken when mixers and pot fillers are used to avoid prill breakage by the growing mix handling equipment.

---

**Figure 3.** Shoot dry weight of *Impatiens wallerana* plants (common impatiens) as a function of a 15–9–12 controlled-release fertilizer concentration of four different longevities: 3–4, 5–6, 8–9 and 12–14 months. Note how the maximum shoot dry weight (peak) of each fertilizer curve moves slightly toward higher concentrations (toward the right) with increasing longevities. After G.A. Andiru, C.C. Pasian, J. M. Frantz and P. Jourdan (2013). “Longevity of Controlled-Release Fertilizer Influences the Growth of Bedding Impatiens.”
Application Methods

Growers can apply CRFs to container-grown plants in different ways: (1) top-dresses; (2) dibble planting; (3) incorporated into the media; and (4) layered. When top-dressed, the prills are deposited on the top of the substrate in the container. For a large number of containers, a dispenser is essential to do an efficient job (faster and fewer loss of prills). Dibble planting consists of making a hole in the substrate and adding a pre-measured amount of CRF before planting the plug or liner in the container.

Uniformity of Prill Distribution

In order to achieve the appropriate dose, the right amount of prills (number or weight) should reach each container. This can be difficult to achieve when small containers are used (cell packs or plug trays). For these containers, it is recommended to use CRFs with prills of smaller diameter that facilitate uniform distribution in the substrate. An alternative for small containers is to apply both CRFs and water-soluble fertilizers.

Irrigation

**Do not over irrigate when using CRFs!** Excess watering can lead to leaching of nutrients. It is better to irrigate often with small volumes than only once for a long period of time. Efficient irrigation can be achieved by programmable timers, computerized irrigation, sensors or a combination of these.

CRFs and Substrate pH and EC

Research has shown that with CRFs there is less substrate pH drift than with WSFs. As a consequence, growers who use acidic fertilizers to compensate for high alkalinity levels in the irrigation water need to adjust the amount of acid added. On the other hand, the effect of CRFs on substrate EC is small and results in lower substrate EC levels. Growers who monitor substrate EC of their crops should keep in mind that they will measure lower (but still acceptable EC levels) than when WSFs are used.

Storage

All fertilizers should be stored indoors on a concrete pad with a curb that will contain spills or leaks. CRFs should be stored in a dry environment, especially if the plastic bags have been opened. It is also important to minimize the movement of these bags and when necessary, they should be handled with care to avoid cracking the prills. Cracks in the prills will release nutrients faster than specified in the label. When CRFs are blended into the growing mixes before use, these mixes should not be stored. The mixes should be used as soon as possible to avoid water absorption by the prills and possible nutrient losses before planting.

How to Start Using CRFs

Growers who have limited experience with CRFs should start small. Selecting a crop or a portion of a crop, and becoming familiar with the new cultural practice would be a good way to start. After that, slowly expanding to more crops/areas would be prudent. Always start with the lowest rate listed on the label for a given crop and container size. If more fertility is needed, apply WSF. Keeping records of what was done and when it was done will help growers master the use of CRFs.

Always read the label and consult your fertilizer sales representative or your Extension educator if you have any doubts.

**Disclaimer:** This publication may contain fertilizer recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the applicator’s responsibility to read and follow all current label directions for the specific fertilizer being used. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The author and Ohio State University Extension assume no liability resulting from the use of these recommendations.