Nitrogen foliar feeding has advantages

Strategies will differ, depending on what growers want to accomplish

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Photos by Guihong Bi

The top row of hydrangeas had a fall foliar application of urea, which increases spring growth compared to the untreated plants on the bottom row.

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Nitrogen availability affects plant growth and development and is intimately linked to the quality of nursery plants.

In nursery production, nitrogen is commonly applied to soils and container media as controlled-release and/or liquid fertilizers. However, research has shown that combining foliar nitrogen fertilization with a soil-based fertility program improves crop quality.

Foliar fertilization means applying nutrients to plant leaves or needles. Using foliar nitrogen fertilization during nursery production can correct nitrogen deficiencies, decrease the amount of total nitrogen necessary (saving nurseries money) and minimize nitrogen runoff.

Fertilization practices are unique to each nursery. There is no single strategy to fit every grower's situation. But supplementing a traditional nitrogen-fertility program with foliar applications gives growers more management options. Timing of foliar applications will depend on the specific goals of production, and the benefits that are desired.

Which N formulation is best?

Leaves can absorb inorganic and organic nitrogen sources. Small pores within leaf cuticles can take up urea, ammonium and nitrate.

These pores are lined with negatively charged molecules. Therefore, uptake of cations (such as ammonium) is faster than anions (such as nitrate). Uptake of small, uncharged molecules, like urea, is fast.

Urea is commonly used for foliar fertilization because of its uncharged, high solubility and it's rapidly and efficiently absorbed by leaves.

Once urea is absorbed, it's changed into ammonia and carbon dioxide by a chemical called urease, found in the leaves of many plants. Actively growing tissues contain more urease activity than senescing (dying) tissues.

Foliar urea absorption is affected by external factors such as temperature and moisture. High leaf surface moisture followed by drying during urea application can cause nitrogen losses from ammonia volatilization.

Application effectiveness can be decreased by runoff from leaf surfaces, rain and overhead irrigation, and rapid drying of spray solutions on leaves. Avoid application during times of high moisture or high temperatures, and consider adding a silicon-based surfactant to the spray.

How much you can apply depends on how much the foliage can tolerate without exhibiting urea toxicity. Sensitivity to urea varies with species and leaf age.

Foliar urea applications in early spring to bare-root apple nursery stock at concentrations greater than 0.5 percent can damage young leaves. However, concentrations of 4-5 percent can be applied to the

same apple cultivar in fall before leaf senescence.

Fall applications

Theoretically, foliar nitrogen uptake can occur any time when leaves are present. In nursery production, foliar nitrogen fertilization is most effective in spring and fall.

When you decide to apply depends on what benefits you desire.

Foliar urea application after terminal bud set in autumn can increase the amount of stored nitrogen in nursery plants. This increases plant growth the following year.

Foliage absorbs the majority of urea from foliar applications in autumn — even during leaf senescence — and these nutrients are transported to storage tissues.

With bare-root nursery trees, 50-80 percent of the absorption occurs within 48 hours and up to 80-90 percent of the nitrogen absorbed is moved into storage. This is much more rapid and efficient than nitrogen received via soil fertilization.

The effectiveness of foliar urea applications in fall depends on the background nitrogen status of the plant. An inverse relationship exists between plant nitrogen status and the likelihood of response to foliar urea applications.

Plants containing a high amount of nitrogen will show a smaller response to foliar applications of urea than plants containing less nitrogen. This is partially a result of plants with low nitrogen status being more efficient in absorbing and translocating nitrogen from foliar urea applications than those with higher nitrogen status.

Advantages of fall foliar nitrogen

1. Compared to spring foliar fertilization applications, foliar nitrogen fertilization in autumn can use higher urea concentrations. This is because the foliage is less sensitive to ammonium toxicity late in the growing season.

Foliar urea sprays at concentrations up to 10 percent have been reported in the literature, but 3 percent urea sprays (25 pounds of urea in 100 gallons of water) prove to be safe for most species.

2. Combining foliar nitrogen fertilization in autumn with reduced rates of soil nitrogen during the growing season can reduce the total nitrogen inputs and the amount of nitrogen runoff during production.

Fall foliar urea applications improved spring growth and flowering for the two hydrangeas on the right, compared to the two untreated hydrangeas on the left. Plants that receive foliar urea in the fall are less dependent on spring nitrogen applications.

Where do plants get nitrogen?

Most plants use two main sources of nitrogen.

Stored nitrogen. This is nitrogen that has accumulated in the plant during the previous year. Depending on the plant species, this nitrogen is stored in roots, stems, and/or leaves.

The amount available for growth depends on growing conditions during the previous year. Factors that influence nitrogen storage include nitrogen availability and losses of roots, stems (possibly due to handling, cold storage, pruning, and transplanting, etc., or environmental factors such as temperature or moisture).

Nitrogen uptake. This is nitrogen taken up by roots or leaves during the current growing season. The rate of nitrogen uptake depends on nitrogen availability in soil and media and the physiological capacity of roots and leaves to acquire nitrogen.

Factors that influence the capacity of roots to take up nitrogen include temperature, moisture, soil texture and the plant developmental stage. Factors that influence the capacity of leaves to absorb nitrogen include plant species, plant age, leaf age, temperature and humidity.

Leaves of some species have physical and chemical characteristics that allow them to absorb nitrogen better than others.

Reduced rates of soil nitrogen can also lessen excessive vegetative growth, resulting in fewer problems from container blow over, handling and pruning. Reduced nitrogen in the growing medium during the growing season can also increase root growth relative to shoot growth and result in increased transplant success the following season.

3. Fall foliar nitrogen fertilization can reduce plant dependence on soil nitrogen the following spring. In many growing regions, fertilizers applied in spring are inefficiently taken up due to low temperatures and high rainfall.

4. Combining foliar nitrogen fertilization in fall with defoliants can increase stored nitrogen and improve plant quality compared to use of defoliants alone. In the Pacific Northwest, controlled defoliation of bare-root, deciduous nursery stock must occur before the rainy season. Natural defoliation occurs later than desired for efficient harvesting.

Application of chemical defoliants often decreases the amount of nutrients (including nitrogen) mobilized from leaves into storage, resulting in poor regrowth performance (stem dieback, delayed or no bud break and reduced growth) the following growing season.

Research at Oregon State University showed that applying 3 percent urea after terminal bud set, before or in conjunction with chemical defoliant, not only promotes earlier defoliation but also increases nitrogen reserves and improves plant quality. Many nurseries have adopted and benefited from this practice.

5. Foliar nitrogen fertilization in fall can improve plant nitrogen status in bare-root production when a lack of available water in the topsoil limits nutrient uptake. In many regions, lack of available water in the topsoil is commonly associated with a decline in nutrient availability. Under these conditions, soil application of nitrogen is less effective than foliar applications.

Spring applications

Spring foliar nitrogen fertilization can improve plant nitrogen status, but the amount of nitrogen

absorbed following foliar urea application is limited by leaf area and may not be as effectively absorbed as with fall applications.

Plants with slowly expanding leaves will be less effective at absorbing foliar urea than plants with rapidly expanding leaves. Another factor limiting the effectiveness of foliar nitrogen fertilizer in spring is the sensitivity of foliage to ammonium toxicity.

Early-spring foliage is tender and more susceptible to phytotoxicity. Limited leaf area and the low concentrations of urea applied mean several foliar urea sprays would be required in spring to meet total nitrogen requirements. In many situations this strategy may not be cost-effective.

But there are advantages to spring foliar nitrogen fertilization.

1. Early-spring foliar nitrogen fertilization can be used as a supplement for plants with low amounts of stored nitrogen. Foliar nitrogen fertilization in early spring is more efficient than soil applications of nitrogen since root uptake activity is low and the potential for nitrogen losses from leaching is high.

2. Foliar nitrogen fertilization after transplanting can be used as a nitrogen supplement for plants with damaged root systems. Spring transplanting can often damage roots and decrease a plant's ability to take up nutrients from the soil or growing media until new roots have developed.

Foliar nitrogen uptake may help satisfy the nitrogen demands early in the season and correct transient nitrogen deficiency during the period between the exhaustion of stored nitrogen and significant uptake of nitrogen by the roots.

When do nursery crops need nitrogen?

We have investigated the nitrogen supply/demand relationship of bare-root and container-grown nursery plants. In both deciduous and evergreen species, spring growth is primarily supported by remobilization of stored nitrogen and there is limited nitrogen uptake by roots in early spring.

This dependence of early-spring growth on the amount of nitrogen stored in the plant makes stored nitrogen an important criterion for determining nursery plant quality. It also suggests that high nitrogen availability in the soil or growing medium in the early spring is not necessary for good plant growth.

As the season progresses, root uptake of nitrogen plays an increasingly important role in satisfying the nitrogen demands for growth. Nitrogen is rapidly taken up from the soil or growing medium and used for new growth during late spring and early summer.

Later in the growing season, nitrogen demand by plants can still be high. However the nitrogen taken up during this time is mostly put into storage.

When plants depend on stored nitrogen varies with species. The timing of transplanting may also affect the stored nitrogen/nitrogen update relationship.

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