by Robert C. Dixon

Foliar Fertilization Improves Nutrient Use Efficiency

Studies are showing foliar fertilization is more efficient and reduces potential environmental impact

Summary: *Isotope studies have shown that the quantity of soil-applied nitrogen (N) failing to get into a crop can range from 85 percent in the worst case to 38 percent in the best. By contrast, foliar-applied N can be up to seven times more efficient than soil-applied N. Other benefits of foliar-applied N include lower application rates (higher efficiency), plus the relative ease of obtaining timely, uniform applications. A combination of soil-applied and foliar applied N is the best management practice to reduce the potential for nitrates in groundwater.*

Research has shattered the belief that only roots absorb nutrients. The use of radioactive and isotopically tagged nutrients has confirmed that plants can be fed through their leaves. Foliar N, in particular, is absorbed through other green tissue and soft woody tissue including stems, buds, blossoms, and fruit. Loss pathways for foliar-applied nutrients are few, but they are many with soil applications.

During the past several decades, increased levels of nitrate in the groundwater have occurred in many agricultural areas. Soil applications of N fertilizer, when associated with porous soils and irrigation or with shallow water tables, are linked to increases of groundwater nitrates. By contrast, foliar applications have provided a highly efficient alternative for feeding N to plants. The propensity for nitrate to move below the root zone and eventually to groundwater is being significantly reduced with foliar applied N. Slow-release N in the form of technologically advanced liquid polymethylene urea-methylene diurea is being applied with a high degree of plant safety. Applications are being made at agronomically significant rates at any time in the vegetative growth cycle.

Pathways for soil N loss

Plant roots usually occupy less than one percent of the soil volume, hence less than one percent of soil-applied N will be directly contacted by growing roots. Pathways for soil-applied N losses include:

- Mineralization
- Clay particle fixation
- Leaching
- Microbial immobilization
- Denitrification
- Volatilization

Considerable N can be lost through volatilization and denitrification. Some N is immobilized by microbial activity and clay mineral fixation.

These pathways reduce the amount of N available for plant uptake. The efficiency of this uptake can be defined by the ratio of fertilizer N in the crop to fertilizer N applied to the soil. By any measure of efficiency, uptake of soil-applied N is relatively low. Even in best case studies the crop did not recover 38 percent of the soil-applied N. In worst case scenarios, 85 percent of the soil-applied N failed to reach its intended target.

How it moves

During the growing season, most of the available N is in the nitrate form. The direction and degree of its movement is dependent on the amount of water entering the soil and the rate of its downward movement. Nitrate can move downward at a rate greater than that which is used by the crop. The depth it moves is dependent upon the amount of water entering the soil and the texture of the soil.

Studies have shown that the vertical downward movement of nitrate in a sandy soil at field moisture capacity was about 45 inches for 10 inches of water entering the soil. Downward movement was 30 inches in medium-textured soil (loam) and 20 inches in a clay soil for every 10 inches of water entering the soil. All too frequently, soil-applied nitrate nitrogen is positionally unavailable to plants. By comparison, foliar-applied N is always positionally available.

Foliar efficiency

Foliar-applied nutrients have the benefit of being 4 to 30 times more efficient and there is no risk of

groundwater contamination. Studies using labeled phosphorus (P) on apple, cherry, corn, tomato, potato, and bean crops have shown that as much as 12 to 14 percent of the total P can be supplied by multiple foliar sprays. Since P can be very immobile in the soil, foliar applications can be up to 20 times more effective than soil applications.

The benefits of foliar N sprays compared to soil applications include lower application rates and the ease of obtaining timely, uniform applications. With attention to best-use guidelines, the efficiency of foliar applied N may be optimized at nearly 95 to 100 percent. Based on the foregoing information, if the recovery of soil-applied N ranges from 15 to 62 percent, it can be concluded by the method of estimation that foliar-applied N has an efficiency of 1.3 to 1.6 times soil-applied N at the low end and 7 at the upper end. Compared to soil-applied N, on a pound-for-pound basis, foliar-applied N can be up to 7 times more efficient.

Stimulates plant

There is a direct link between foliar feeding and the activities of the enzymatic systems of the plant. The timeliness and ready availability of nutrients provided by foliar feeding stimulate enzymatic cycles to greater efficiency and quicker response. Elements have been shown to translocate as much as one foot per hour from the leaves to the roots. This rapid movement may be explained by the triggering of auxins or the stimulation of the energy mechanisms within the plant.

The "law of little bits" always appliesto foliar feeding. It is better to spray small amounts of material more frequently than it is to drench the foliage with large amounts of material. Small quantities of key elements such as N "speed up" the physiological functions of the plant.

If foliar feeding is done correctly, visual results may be seen within 48 hours.

General tips

From what we have learned, the following five points are the most important to getting best results from every application of foliar-applied N and protecting the environment:

- Make sure products used are in proper form
- Apply prior to growth stage to be affected
- Make certain coverage is thorough and complete
- Make applications when they will be most effective
- Make sure of compatibility when tank mixing with other materials
- Reduce amount of water to improve results.

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