

How efficient is foliar feeding?

Given that grass is a root feeder, what is the mechanism for foliar feeding? Foliar fertilization works, of course, but is it as efficient as root feeding? Is it better for quick-hit feeding? For normal fertilization, are you wasting a lot of nutrients (and money) by going the foliar route?

Dr. Richard Hull responds: Plant leaves are not designed for nutrient uptake from nutrient solutions applied to their surfaces. The leaf is engineered to absorb light and resist water loss from its surface. This latter property is not conducive to effective nutrient absorption by leaves. However, the wax impregnated cuticle and surface epicuticular wax layer are penetrated by numerous very small water lined pores.

These transcuticular pores have a diameter of less than 1 nm (a billionth of a meter) but are abundant (~ten billion per sq-cm). These pores are readily permeable to small solutes such as urea but not to large molecules such as metal chelates. The pores are lined with negative charges so they are attractive to cations (ammonium, potassium, magnesium, etc.) but tend to repel anions (nitrate, phosphate, sulfate, etc.).

Uncharged molecules can be transported readily through these pores. Nitrogen fertilizers based on urea or ammonium ions can be transported through the pores. Also, a large concentration gradient along the pores can overcome repulsion of anions by the fixed negative charges. Foliar applied solutions of negatively charged nitrate and phosphate can be absorbed readily if the ion concentration is reasonably high.

Foliar penetration of fertilizer solutions does not occur through the leaf's stomates. The inner walls of guard cells are covered with cuticular wax making their substomatal surfaces mostly impermeable to water soluble materials. The fact that stomates do not play a role in foliar absorption of nutrients is supported by the fact that foliar absorption is actually greatest at night when stomates are closed.

The rate of foliar penetration by nutrient ions does increase as the number of stom-

ates increases, but that is due to the fact that micropores in the cuticle (over the cell walls between guard cells and their neighboring cells) are more numerous and appear to be more permeable than other micropores elsewhere on the leaf surface. Unlike their brethren, these stomate micropores can even allow the passage of metal chelates and other larger (pesticide) molecules.

After having crossed the surface wax and cuticular layers of the leaf epidermal cells, nutrient uptake into the cell protoplasts is much the same as nutrient uptake by root cells.

The only real difference between the two organs is that light increases absorption of nutrients by leaf cells but has no impact on uptake by roots. Apparently some of the energy required for nutrient transport across the cell membranes of leaf cells is directly supplied by photosynthesis.

Intact leaves rarely exhibit light stimulated nutrient uptake because of the high resistance offered by the slow diffusion through cuticular micropores.

Foliar fertilization is not very efficient. Uptake by leaves is much less

than that by roots although this can vary depending on the nutrient status of the foliage, concentration of the foliar spray, age of leaves, etc. Consequently, foliar feeding would never be recommended as a general fertilization strategy.

Foliar applications do have a place for providing some micronutrients when a quick response is desired. Foliar applications of iron chelates make sense because the leaching of iron into the root zone and transport from roots to leaves takes time (several days or weeks)

A urea application to leaves will correct a nitrogen deficiency more quickly than a granular treatment even if watered into the turf. The time of response will not be very

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Control
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much more rapid but when preparing for a big event, it may be worthwhile.

Finally, foliar burning is always a potential problem following fertilizer spray applications and this should be considered when deciding if foliar feeding is desirable. Over

application of soluble fertilizer with the expectation of later absorption by roots as the solution is washed off leaves is probably not a good strategy because of the high potential for foliar burn that this approach creates.

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- **Dr. Richard Hull**, Plant Physiology, University of Rhode Island
- **Dr. Karl Danneberger**, Agronomy, The Ohio State University
- **Dr. Noel Jackson**, Plant Pathology, University of Rhode Island
- **Dr. Joe Neal**, Weed Science, North Carolina State University
- **Dr. Rick Brandenburg**, Insects, North Carolina State University

Contacting us is easy. Just call Curt Harler at 440/238-4556, fax him at 440/238-4116 or e-mail him: curt@curtharler.com.