BEGINNER'S SERIES

# Orchid Culture — 8 — Fertilizing

STEPHEN R. BATCHELOR

SOLUBLE SALTS are at once a bane and a blessing in orchid culture. They can be present in dangerously high concentrations in water supplies and potting media, and yet they are what constitute conventional fertilizers. Since opposite charges attract, negative and positive ions in solution come together to form a salt when the water is removed (by evaporation). Salt deposits can be a nuisance on leaves, a peril near roots. Conversely, when water is added to a fertilizer's soluble salts, they dissolve into their component, negative and positive nutrient ions.

*All Photography: Stephen R. Bachelor* **Salt deposits** from a hard water supply form on a Cattleya leaf.

While of some nutritional value, water supplies with a high ion content can cause the orchidist difficulty. Dr. O. Wesley Davidson, in his discussion entitled, "Quality of Water and Orchid Culture" in the *Handbook on Pests and Diseases* (Davidson, 1978, page 39) defines water quality in terms of electrical conductance, a measure of total soluble salt content. Salts form readily on surfaces with the evaporation of waters high in soluble salts. "Hard" waters, waters high in calcium and magnesium, leave a whitish residue, particularly on leaves (see illustration). Likewise, waters high in soluble iron leave orange-colored deposits. In these instances, care should be taken to avoid wetting the leaves; misting or syringing should be excluded.

In the repetitive process of drying, potting media can accumulate salts. Using a water supply with a high ion content can lead to salty media. Heavy and frequent fertilizing can have the same effect. Areas of salt accumulation usually have a lighter, crusty look. Clay pots tend to build up tremendous salts on their inner surfaces, because their porosity encourages water to evaporate, leaving the salts behind. Roots coming into contact with these regions high in salts will encounter the overwhelming osmotic draw described in the last article of this series (**Orchid Culture — 7 — Nutrition,** September 1981 BULLETIN, pages 1087-1091), and are likely to turn black, at least at the tips. "Leaching", or flushing with water, is often recommended to retard this build-up of hazardous salts. Quantities of water help dissolve existing salt residues, but in cases of heavy accumulation repotting with fresh media may be necessary. Clay pots require soaking and a vigorous cleaning to remove residues before sterilization and re-use.

Fertilizers differ according to their formula, a three-figure designation indicating, from first to last, the percentage of "total nitrogen (N)", "available phosphoric acid ($P_2O_5$)" and "soluble potash ($K_2O$)". These are the terms used to express the content of those three essential elements a plant is least likely to obtain on its own in quantities sufficient for good growth and flowering (see previous article of this series). Consider the "Guaranteed Analysis", required on all fertilizer labels, for an "Orchid Special" 30-10-10 water-soluble fertilizer, the type recommended for cattleyas in bark mixes. Total nitrogen is 30% of the fertilizer, as indicated by the first figure of the formula, and is listed in three forms: nitrate nitrogen ($NO_3$~), the form most readily absorbed by plants, is a fraction over 3%; ammoniacal nitrogen ($NH_4^+$), next in terms of availability, is slightly over 2%; and urea nitrogen [$CO(NH_2)_2$], least immediately available of the three, composes nearly 25% of the total 30% figure. Available phosphoric acid is 10% of the fertilizer, as is soluble potash. But in what form are nitrogen, phosphorus and potassium provided?

Listed below on a 30-10-10 fertilizer label are the "primary plant nutrient sources". Synthetic urea, first on the list, is considered an "organic", or complex, slower-release source of nitrogen. It is simplified through the influence of water and microorganisms into $NO_3$'. Ammonium phosphate ($NH_4H_2PO_4$) is the next fertilizer ingredient listed, and is a source of nitrogen and phosphorus for plants, dissolving into $NH_4^+$ and $H_2PO_4$" ions in water. The third and last ingredient of a typical 30-10-10 water-soluble fertilizer is potassium nitrate ($KNO_3$), a soluble salt offering, as is evident, potassium and nitrogen in readily available form.

Composed of soluble ingredients, water-soluble fertilizers do just that — they dissolve in water and are then applied. More conventional "dry" fertilizers used around the yard are never recommended for orchids. If applied without water as a dressing on a porous, relatively unabsorbent bark mix, a granular fertilizer would in all likelihood create conditions of devastating osmotic turmoil, resulting in the "burning" of roots and tissue. Any fertilizers, granular, slow-release pellets or otherwise, which are not applied with copious amounts of water, should be considered risky in terms of epiphytic orchid culture for this reason.

Of the water-soluble fertilizers, there are offered on the market an array of formulas: 30-10-10, 20-20-20, 10-30-20, and others. The 30-10-10 formula, high in nitrogen, as mentioned earlier is used with woody mixes, essentially to provide enough nitrogen for both the orchids and the decay organisms in the mix (see discussion in **Orchid Culture — 7 — Nutrition).** The nitrogen is typically provided in both available (simple) and unavailable (complex) form. An orchid will absorb what it can of the readily soluble $NO_3$", while the microorganisms present in the mix can simplify the more complex urea compounds.

Fertilizers with an even ratio of nutrients, such as the 20-20-20 formula, are recommended for orchids growing in media not particularly woody in nature, such as tree-fern or osmunda. Nitrogen is not needed in superabundance when there are not countless extra mouths to feed! Nitrogen, phosphorus and potassium, as previously discussed, are all vital in some way to the growth process. To provide nitrogen to build new tissue, for example, without the phosphorous needed to convert and supply the energy necessary to do so, is of little use, possibly even counterproductive. The same applies with potassium, though it is more readily translocated from existing tissue to regions of greatest demand in plants.

Fertilizers proportionally high in the last two figures of the formula, such as a 10-30-20 "Blossom Booster", as it has been called, are purported to encourage flowering. However, since all three elements are involved in growth, any one of the three can be the limiting factor in terms of growth when provided in the least amount, leading to the accumulation of food reserves needed for flowering. In the case of a 10-

30-20 fertilizer, nitrogen would be the limiting factor. Under these circumstances, what an orchid would do with the extra phosphorus and potassium, I cannot say. All these formulas aside, the best guarantee for satisfactory flowering: is a healthy orchid, one not limited, or overfed, with any one essential element. Once these nutrients are adequately provided, light and temperature deserve far greater concern when it comes to flowering (see Orchid Culture — 5 — Light and Temperature, in the June 1981 BULLETIN, pages 640-646). My recommendation to those beginning in orchids is to stick to the basic, and sufficient, 30-10-10 (3-1-1 ratio) or 20-20-20 (1-1-1 ratio) water-soluble fertilizers, using only one or the other depending on the media used. (For a contrary point of view, see Wilcock, 1973).

So-called "organic" fertilizers, such as fish emulsion with a 5-5-1 analysis, contain nutrients in complex, organic form at low concentrations. These organic compounds, again, have to be reduced to the simple, inorganic ions before they can be absorbed by plants. Purchasing a smelly material low in nutrients in complex, unavailable form, when for a similar price one can buy nearly twice as much of an "inorganic" fertilizer, high in both available and unavailable nutrients, does not make economic — or biological — sense, in my opinion.

## HOW M UCH AND W HEN TO F ERTILIZE

Orchids are comparatively slow-growing plants. But like most plants, they are composed of more than 90% water. For these reasons, orchids do not require high amounts of fertilizer. Not to be disregarded, however, are the fungi within woody media which are fast-growing and demanding, particularly of nitrogen.

It is only logical that orchids have a greater demand for nutrients when in active growth. Conversely, during periods of little growth, less fertilizer and water are needed. Micronutrients present in the water supply and the media are almost always sufficient for orchids, even when actively growing. The macronutrients calcium and magnesium are also usually available in adequate quantities in the water supply. In contrast, nitrogen, phosphorus and potassium are in low supply, though in fairly high demand. Therefore these elements are regularly supplemented in orchid culture.

Whether you are using a 20-20-20 water-soluble fertilizer for orchids in tree-fern or osmunda, or a 30-10-10 formula for orchids in a bark mix, the safe approach is to apply in low concentrations. It is frequently suggested that the orchid hobbyist use at most half the recommended dosage on the fertilizer package. Dr. O. Wesley Davidson, the Question Box Editor, routinely recommends 1/2 teaspoon of 30-10-10 fertilizer per gallon of water for orchids growing in bark. The coarse, porous media required by orchids retain but little of the fertilizer supplied, so residual fertility is minimal, especially in bark mixes full of hungry fungi! Because of this, fertilizing should be frequent, perhaps as often as every other watering for orchids actively growing or in a fresh bark mix. Alternating light feeding with a good watering will help flush or leach any residual salts. When not in growth, fertilizing may be cut back to as little as once a month, or eliminated altogether for orchids in a partially decayed medium such as osmunda, which is not woody and has residual fertility.

Orchids recently repotted in a fresh bark mix have a double nutritional handicap compared to those well-established in an older medium. The disruption and inevitable (partial) damage caused to roots in the process of repotting must reduce their nutrient-absorbing capabilities to some extent. Having lost the "intimate association" they had with the previous substrate, orchid roots are then forced into a rather inhospitable (at least initially) new medium. Fresh bark is not only competitive for water, being quite dry, but the microbial population which blossoms with this new, undecomposed food source makes it competitive for nitrogen as well. This is the time when nitrogen especially may be most scarce, though in high demand. In my experience, nitrogen deficiency symptoms (particularly the yellowing of leaves) readily appear during this newly-repotted stage,

unless a periodic fertilizing program with a high-nitrogen fertilizer is begun immediately. With time, new roots penetrating the medium will enhance nutrient absorption, and a "seasoned" medium is better able to retain water and nutrients, some of which may eventually become available to the plant.

## How to fertilize

Naturally, watering and fertilizing are similar activities with orchids, since both involve the application of abundant water. As with watering, a fertilizer solution should be given when an orchid can use it. Temperatures should be moderate at the time of application. If they are too low or too high, the roots will not be able to properly absorb the nutrients. You may have sensed in the literature and at orchid meetings that there is an ongoing debate as to whether the medium should be wet at the time of fertilizer application. My feeling is that if you use the low concentrations of fertilizer recommended here and elsewhere, there will be little risk of soluble salt injury in substituting "fertilizer water" when watering is called for. If anything, fertilizing then will enhance retention. The important point is that orchids, and all plants, need water present to absorb nutrients. This is assured, with a minimal chance of salt damage, in using a weak nutrient solution of water-soluble fertilizer.

If you have a small collection, preparing a fertilizer solution in a two-gallon water-bucket and then applying is easy enough. Particularly at first do not trust your judgment; use a measuring spoon in mixing! For more expansive collections, proportioners are frequently used, and are certainly more realistic. These can be quite elaborate and expensive — or quite simple and cheap (though still effective). Simple proportioners involve an attachment to the faucet and hose, and a siphon dipped into a container of concentrated fertilizer solution. Many proportioners mix at a ratio of 1:15, so if you have a gallon container for the concentrate, and you want 1/2 teaspoon of fertilizer per gallon of water, set up an equation: 1/15 = 1/2/X. With a little arithmetic, X, the amount of fertilizer you will add to a gallon of water to make the concentrate, is 15/2 or 7 1/2 teaspoons. Fertilizer and proportioner packages also provide instructions.

## NUTRIENT IMBALANCES IN ORCHIDS

"The nutrient content of potting or support materials used, supplemented by the nutrient furnished by water supplies, is apparently adequate to preclude the occurrence of all but nitrogen and phosphorus deficiencies in these relatively slow-growing plants." (Davidson, 1978, page 48) Nitrogen deficiency in orchids, as just mentioned, can cause a yellowing of leaves, starting with the oldest and shifting to younger leaves if the deficiency persists (see illustration). New growths forming without adequate nitrogen will mature much reduced in size. Phosphorus deficiency in orchids is far less common, but can be induced when nitrogen is supplied in abundance while phosphorus is not. In this case, the nitrogen will encourage growth, resulting in a demand for the phosphorus which is not there in comparable amounts. Leaves are reported to become darker green, even to take on a reddish cast, without adequate phosphorus. Growth ultimately is substantially reduced (see Davidson, 1961).

On the other hand, excesses of nutrients do occur with orchids, most frequently because of overfertilizing. Short of extreme, overfertilizing favors vegetative growth, since nitrogen, phosphorus and potassium promote growth at the expense of the food reserves necessary for flowering. Rather than applying yet more fertilizer in the form of a "Blossom Booster", the more appropriate choice would be to reduce the rate and concentration of fertilizer, or to withhold it altogether. Even higher amounts of fertilizer will cause the blackening of roots where salts accumulate and the die-back (necrosis) of the tips of the newest leaves. At this extreme, growth will

be limited because of the impairment of the roots' ability to absorb. In this case, further fertilizing should be stopped and water given in copious amounts to reduce the salt residue. Repotting is also likely to be in order.

A recently repotted paph seedling manifests a possible nitrogen deficiency in the form of yellowing leaves.

## OTHER FACTORS IN FERTILIZING

Besides nitrogen and phosphorus deficiencies, symptoms of other deficiencies have been observed in orchids. Leaf-tip necrosis (see illustration, page 646 of the June 1981 BULLETIN) is a troublesome phenomenon with many orchids. There are many possible causes, including the excess salts from overfertilizing, just discussed. Poole and Sheehan in an article entitled, "Leaf-tip Die-back of Cattleya — What's the Real Cause?" attribute this problem to a calcium deficiency and put forth the following hypothesis: "An active root system is necessary to absorb calcium ions from the medium and the greatest need for calcium is during the period of rapid leaf elongation prior to maturation. The roots become ineffective at absorbing these ions when high temperature conditions surround the roots (perhaps greater than 75°F or 24°C). Frequent watering supplies additional calcium but more importantly maintains a cooler medium, thereby improving calcium absorption by the roots." (Poole and Sheehan, 1973, page 228)

This hypothesis points out that other factors must be considered in orchid nutrition beyond whether the essential elements are available. What good is the presence of nutrients if they cannot be absorbed by the plant? "The fact that absorption of root-cells is dependent upon respiration suggests that temperature may have a marked effect on the process, a suggestion which has been confirmed experimentally." (Meyer, *et al,* 1973, page 304) High temperatures not only adversely affect the upper portions of orchids, but the functioning of their roots as well. In addition, without proper aeration a root is unable to respire the energy necessary to absorb the nutrients. Even with adequate energy, roots surrounded by a solution extremely high in soluble salts may have difficulty absorbing. An orchid with dead or crippled roots cannot make use of any fertilizer (or water) it is given!

**Decay organisms** have reduced the organic components of this bark mix into humus. Orchid roots cannot absorb nutrients, much less survive, under these low-oxygen conditions. Repotting is a necessity!

## CONCLUSIONS

Providing orchids with sufficient nutrients to grow and flower is by no means an up-hill battle. Nutrients are available from sources other than fertilizers, particularly existing water supplies and organic media. Competing for nutrients, nevertheless, are fungi present in the media. Their needs, as well as an orchid's, can easily be met with the frequent but light application of water-soluble fertilizers containing the elements most in demand — nitrogen, phosphorus and potassium — in a ratio suitable for the media involved. Conditions within the potting media strongly influence an orchid's ability to absorb available nutrients and water. The substrate as a factor in orchid health will be further considered in the next article of this series. — *84 Sherman Street, Cambridge, Massachusetts 02740.*

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