Dialogues with Hugh: No.6: Is Foliar Fertilising Better for Orchids?

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IN recent years, foliar application of many fertilisers has become a common practice in production of agricultural and horticultural crops, and some indoor and ornamental plants. This practice is based on research in the 1950's that showed that many plants of commercial value could take up mineral nutrients through their leaves as well as their roots. Because many soluble fertiliser companies advertise the superiority of foliar fertilising, some orchid growers have become devotees of foliar fertilising.

But is the superiority of foliar fertilising of orchids a **fact**?, or a **furphy**?

Because very little research has been undertaken on the foliar fertilisation of orchids, I have heavily referenced the following text, providing web addresses when possible, so that readers might themselves follow the arguments for or against the suggested superiority of foliar fertilisation of orchids.

Evidence for foliar uptake of mineral nutrients by orchids

The uptake of many of the essential mineral nutrients by leaves, and the importance, advantages and limitations of foliar fertilising have been firmly established in agricultural and horticultural crops (Bukovac and Wittwer, 1957; Kuepper, 2003; Sait, 2010; Chalker-Scott, 2010). Poole and Sheenhan (1982) showed that *Cattleya* Trimos (*C. mossiae* X *C. trianae*) could take up radioactively labelled phosphorus (^{32}P) through its leaves, and translocate it into the pseudobulb to which the treated leaf was attached, and to pseudobulbs and leaves above and below the treated leaf within as little as 30 minutes. After 24 hours, 35% of the foliar applied ^{32}P was located in the pseudobulb to which the treated leaf was attached. While further research on foliar uptake of other mineral nutrients by orchids has probably been completed, I can not find any references to them on the web.

The studies by Poole and Sheenhan do not prove that orchids can take up all the essential mineral nutrients through their leaves. Nevertheless, we can expect orchids to have similar responses to that of the many agricultural, horticultural, and ornamental plants where foliar absorption of all mineral nutrients has been shown in numerous studies.

However, not all applied mineral nutrients are rapidly translocated from the treated leaves to other parts of the plant. Using bean as the test plant, Bukovac and Wittwer (1957) demonstrated that calcium was not exported from the treated leaf, but zinc, copper, manganese, iron, and molybdenum were slowly moved from the treated site to other parts of the plant, while sodium, potassium, phosphorus, chlorine, and sulphur were readily moved from the treated leaf to other plant parts. If orchids have similar characteristics of absorption and movement of foliar applied mineral nutrients, calcium would need to be applied to the target plant tissue to be effective.

The 'take-home' messages here seem to be:

- All orchids may have similar characteristics to other plants in the absorption and retranslation of all essential mineral nutrients from foliar sprays.
- Most of the nutrients, except calcium, are transported from the target leaf/leaves to other plant parts.

Evidence for foliar absorption through the cuticle or stomata

Many claims are made in club newsletters, and fertiliser advertising (see Anon and Orchid Focus in References) that absorption of foliar applied nutrients is prevented by the cuticle (a waxy layer on the outside of the leaf) and takes place through the stomata. In orchids, the stomata generally occur on the under surface of the leaf, but especially so in thick, fleshy-leafed genera such as the popularly grown members of the *Laeliinae*, *Vandeae* and *Oncidiinae* (Arditti, 1992). Therefore, to be effective in the more popularly grown orchids in Australia, foliar fertilising would need to be applied to the underside of leaves because that is where the stomata are located. In addition, the thick, fleshy-leaved genera so popular in Australian orchid collections are generally CAM (Crasulacean Acid Metabolism) plants that open their stomata only in the evening and close them before day-break (Avadhani, et. al., 1982). To be effective in CAM plants, foliar fertiliser sprays would need to be applied at night should absorption through open stomata be the only point of entry.

However, stomata may not be the only point of entry. The cuticle of crop plants has 'transcuticular pores' or 'microchannels' that allow absorption of foliar applied mineral nutrients (Schönherr, 2006), and there is currently no evidence I can find that orchids may be different from other plants in this respect.

The 'take-home' messages here seem to be:

- Although there is no direct evidence in orchids that foliar applied nutrients are absorbed through the stomata, or through the cuticle, or through both points of entry, absorption of foliar applied 32P did occur, and circumstantial evidence from other species suggests that absorption through 'transcuticular pores' may be a major point of entry.
- For absorption through stomata to occur in CAM plants such as the popularly grown thick, fleshy-leafed genera of the Laeliinae, Vandeae, and Oncidiinae, foliar fertiliser sprays would need to be applied to the underside of the leaf during evening hours to be effective.

Foliar uptake versus root uptake

Poole and Sheenhan (1982) applied ^{32}P as a foliar spray to the second mature leaf of Cattleya Trimos and compared the uptake through the leaf with uptake through the roots from a pot drench of ^{32}P. Within the first 2 hours of application of the ^{32}P, uptake and movement of ^{32}P to other leaves and pseudobulbs were similar for both foliar and root applications. However, over longer time frames of up to 120 hours, root uptake was 7-fold to 12-fold better than foliar uptake. Nevertheless, many statements without supporting evidence still claim that foliar uptake is much more efficient that root uptake (e.g. Sait, 2010).

The argument of whether foliar application or root application is superior may be irrelevant, because foliar sprays will dry quickly, leaving residues of the mineral nutrients on the leaves. These residual nutrients will be washed into the potting medium every time the plants are watered over-head. As a result, perhaps much of the foliar applied fertilisers will be absorbed through the roots after every watering.

Kuepper (2003), Sait (2010), and Chalker-Scott (2010, 2015) list the many conditions where foliar fertilisation is beneficial in overcoming soil conditions that limit root uptake in soil-grown agricultural plants. These conditions include: (a) isolation of the applied nutrient in dry soil; (b) very high soil pH (above 8.5) that causes iron and manganese to be locked-up and relatively unavailable; and (c) very low soil pH (below 4.5) that leads to toxicity of some elements such as aluminium and manganese. None of these conditions would be expected to occur in the

culture of epiphytic or terrestrial orchids.

The limitations of foliar fertilisation are also listed by these people, and include: (a) the low translocation of calcium and boron from the sites of uptake (leaf) to other parts of the plant; (b) the limited amounts of macronutrients that can be supplied in a foliar spray; and (c) the possibility of leaf damage caused by high concentrations of mineral nutrients in the foliar spray - all of which make foliar fertilisation less effective.

The 'take-home' messages here seem to be:

- Foliar uptake does not appear to be more efficient than or superior to root uptake of mineral nutrients in epiphytic orchids.
- Conditions where foliar fertilisation is beneficial in soil-grown agricultural, ornamental and horticultural crops may occur extremely rarely in epiphytic orchids, and should not occur in well-cultured terrestrial orchids.
- Despite the inability of foliar fertilisers to supply enough macronutrients for well-cultured orchids, foliar application of fertilisers may be beneficial in some conditions such as recovery of mature plants after major root loss from disease or severe repotting, and growth of young plants after de-flasking.

The final take home message

Is the superiority of foliar fertilising of orchids a **fact**?, or a **furphy**? It is a **fact** that orchids, like other plants, can take up many mineral nutrients through their leaves and translocate them to other above ground parts of the plant. However, I believe that the superiority often claimed for foliar fertilisation over root application for orchids is a **furphy**.

Nevertheless, there may be limited occasions, such as with deflasked seedlings or mericlones, or in the recovery of mature plants after major root loss from disease or severe repotting, when foliar fertilisation would be beneficial. As a general rule for well-cultured orchids, root absorption from a 'weekly weakly' applied pot drench of all mineral nutrients would be superior to foliar fertilisation.

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