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Improvement of Plant Quality with Alumina-Buffered Phosphorus Fertilizer

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BACKGROUND

We have developed and extensively tested a new type of fertilizer for supplying phosphorus (P) to plants while reducing leaching of phosphorus from production systems. The P is bound to alumina, which is inert at pH levels used for plant growth. Loading conditions during manufacture of the product can be adjusted to provide the correct desorbing concentration of P. Since the material acts as a buffer, P is only released from the fertilizer when the concentration in the growth medium is depleted by plant uptake. This allows maintenance of lower concentrations of P in the medium than with current fertilization practices. Reduced P in the growth medium not only reduces impact on the environment but also may benefit plants. Very high P fertilization reduces root growth and can make plants less tolerant to stresses such as drought (Borch et al., 1998). In this project, we tested the impact of the buffered alumina fertilizer, Al-P, on growth and quality of a number of several floricultural crops. We developed methods for using the material in ground beds, recharging to replace P used by the plants, and worked with manufacturers on commercial development of Al-P products.

MATERIALS AND METHODS

Potted poinsettia and mums were produced in greenhouses using standard commercial methods at University of Florida (UF) and Penn State University (PSU). Crops were fertigated with soluble fertilizers, in some cases substituting the P source with Al-P incorporated into the medium at different rates (0.5% to 2% w/v). Desorption concentrations of the Al-P products were in the range of 100-300 µM P, while soluble P levels were usually around 1 mM P. For crops grown at the UF, postproduction quality was evaluated. For outdoor trials at Yoder Brothers in Alva, FL, Al-P was incorporated into the top 8 inches of the sandy raised bed at a rate of 1% (1.7 lb per linear foot of ground bed, 3.5 feet wide). Beds were planted with several cvs of mums for cutting production in replicated trials. Leachate was collected weekly through drainage tiles and cutting production was assessed through dry weight, leaf area, and P content of cuttings.

RESULTS

Over many crops grown in greenhouses at PSU and the UF, Al-P incorporation into the growth medium always substantially reduced P concentrations in leachate. Plants grown with Al-P were always equal or better than controls for growth, flowering time, quality, and postproduction longevity. Generally, Al-P improved root growth and often produced a compact shoot. Al-P did not influence response to shipping or simulated consumer environments. Al-P improved quality following drought stresses (Borch et al., in press). In other trials, improved flowering of marigold and impatiens with and without drought treatments was obtained (Borch et al., 1998; Borch et al., in press; Lin et al., 1996).

Al-P in Ground Beds

Two experiments were conducted During the first experiment, we incorporated PSU-made Al-P. We obtained satisfactory performance of mum stock plants over 18 months with greatly reduced leaching of P from the beds when compared with plants

fertilized by conventional Yoder practices. After testing recharging methods in containers of various media in PSU greenhouses, we developed a method to recharge the Al-P. We successfully recharged the alumina in-situ with phosphoric acid and produced an additional crop (with several harvests) on the beds containing recharged material. Recharging resulted in only a small release of excess P from the beds. A second trial was completed in March 2002 with commercial materials from Martinswerk and Alcoa into new sand beds. Three cultivars of mum stock plants are being grown in a replicated trial in comparison with Yoder's conventional fertilization practices. Al-P has again reduced leaching in the plots, but evaluations of plant quality are not complete.

Tests of commercial materials

In recent trials, we have compared Al-P produced by two companies, Martinswerk (now owned by Albemarle) and Alcoa. Their materials have performed as well or better than the "grower control". These materials consistently reduce loss of P in leachate by 70-98%. Effects on crop quality were small, but often the plants were more compact than controls without effects on flowering.

Alcoa has developed a satisfactory product, but it has not performed as well as the Martinswerk product in most trials. Alcoa worked out most of the manufacturing issues including drying the product after loading.

We are continuing to work with both manufacturers and their products. Further R&D is necessary if the Alcoa product is to be suitable for market use. The Martinswerk product is proven effective in many trials by us and by researchers in Europe. It is ready for commercialization if suitable business partners can be found.

CONCLUSIONS

Use of Al-P rather than soluble or slow-release forms of P fertilizer reduces leaching from container production systems and ground beds used for cutting production. Al-P had no effect on postproduction quality of potted poinsettia or mums. Al-P improved flowering and drought tolerance of marigolds and impatiens. For long-term use in ground beds, recharging is a viable method to replace P on the spent Al-P, so that the material can continue to be used without replacement for several years.

IMPACT TO THE INDUSTRY

Alumina-buffered phosphorus fertilizer (Al-P) is a viable alternative to current P fertilization practices. Use of Al-P would reduce loss of phosphorus in leachate while maintaining or even improving crop quality. Plants grown with reduced phosphorus supplied by Al-P are more compact and resistant to drought stress. Overall growth and flowering are as good or better than conventionally fertilized crops. Viable commercial-scale manufacturing techniques have been developed which should allow commercialization of this product in the near future.

REFERENCES

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