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Improvement of Plant Quality with Alumina-Buffered Phosphorus Fertilizer

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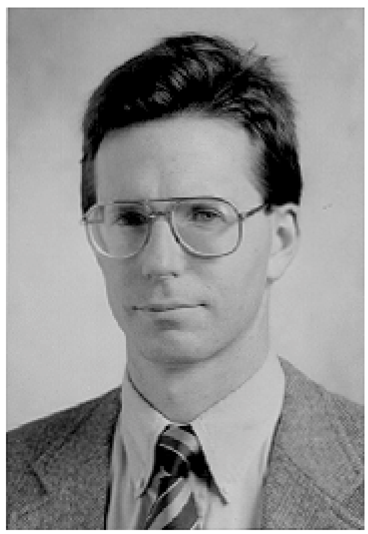
BACKGROUND

We have developed a novel alumina-buffered P fertilizer (Al-P) which allows controlled, slow release of P into the potting medium throughout the life of the plant. As the plant takes up P, more P is released from the fertilizer. Thus, adequate, but not excessive, P is always available to provide optimum nutrition for the growing plant.

Preliminary research indicated that plants grown under P levels, which were lower than those generally recommended, had increased tolerance to drought stress. This may result from increased root branching and proliferation. We have shown that this occurs under low P fertilization. Low P may also affect other aspects of plant development which affect water use efficiency and drought tolerance. In these experiments, we evaluated the water use efficiency of bedding plants grown with Al-P fertilizer.



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MATERIALS AND METHODS

Marigolds were grown with a conventional P fertilization (fertigation, 1mM P) or Al-P desorbing at sufficient (20 µM) or deficient (5 µM) P concentrations. Plant growth was assessed under optimally irrigated and drought stressed plants. Transpiration was measured during a period of withholding water. Root structure was evaluated in an experiment where the plants were grown in calcined clay rather than peat-based planting mix.

RESULTS

Compared to control plants., sufficient phosphorus fertilization (20 µM Al-P) produced plants with more flowers and a reduced leaf area. Photosynthetic CO_2 assimilation from whole shoots was nearly twice as high in phosphorus-sufficient plants as in controls. This could have been due to decreased internal canopy shading. In phosphorus-sufficient plants, smaller leaf area resulted in reduced transpiration. Moreover, the relative water content of the pot (a measure of how much water the plant had removed from the pot) was significantly lower at wilting. The improved water acquisition with sufficient Al-P could be explained by increased root proliferation. Sufficient Al-P plants had longer main roots and less densely distributed lateral roots. Plants grown with sufficient P supplied by Al-P developed more flowers and buds in the postproduction environment than P-deficient or conventionally-grown plants.

CONCLUSIONS

Optimizing phosphorus nutrition with Al-P fertilizer improved drought tolerance by reducing transpiration and increasing water use efficiency. Lower P increased root development, which improved the ability of the plant to acquire water from all areas of the container. Lower P levels, as demonstrated here in the "sufficient-P" treatment, resulted in slightly smaller leaves, which made the plants appear more compact and which lost less water. Photosynthesis rate, and therefore productivity and timing, are unaffected. In fact, photosynthesis rates of whole shoots expressed on a leaf area basis were actually higher. Plants grown with sufficient P supplied by alumina were higher in quality than plants produced with conventional methods. Also, they were more drought tolerant and had better post-production performance even when optimally irrigated.

IMPACT TO THE INDUSTRY

Reducing the level of P in floriculture crop production systems has several benefits.

(1) For growers, the reduction of P leaching from containers, which improves their ability to comply with environmental regulations.

(2) For growers and retailers, the improved resistance to drought stress. This is particularly important for bedding plants and other plants marketed with small root volumes relative to shoot size. These plants rarely receive ideal care during retail display. Customers are likely to reject wilted plants and will be unhappy with the performance of plants which have been severely wilted. Plants grown with Al-P are more forgiving of lapses in care in a retail setting and are more likely to perform satisfactorily for customers.

(3) For retailers, the improvement in post-production performance will improve customer satisfaction.