PLUG FERTILIZATION: FOCUS ON NITROGEN

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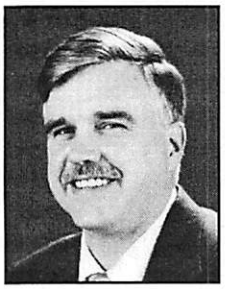

High-quality plugs are the start of every successful bedding plant crop and proper fertilization is essential for growing good plug seedlings. Low fertilizer concentrations can result in poor growth, nutrient deficiencies, and low quality plugs. On the other hand, excessive fertilization can result in nutrient toxicities, leaf edge burn, excess salinity in the growing medium, root damage, wasted fertilizer, and fertilizer runoff from greenhouses. Unfortunately, there are not a lot of good quantitative guidelines to help plug growers decide what fertilizer concentrations to apply.

A good fertilization program should focus on applying sufficient nutrients to the plants when needed, without using excess amounts of fertilizer. Because of the small volume of cells in plug flats, the growing mix does not provide much buffer capacity for fertilizer. The fertilizer in the growing mix can build up quickly if the concentration of the fertilizer solution is too high, or become depleted if too little fertilizer is applied. This makes plug fertilization more difficult than fertilization of cell packs or potted plants. Special fertilization guidelines are needed for the production of bedding plant plugs to meet the special requirements that seedlings in plug flats have.

Over the last several years, we have conducted a series of experiments at the Georgia Station in Griffin to establish quantitative guidelines for optimal fertilization procedures for bedding plant plugs. The project was a collaborative effort involving Drs. Beverly, Latimer, Mills, and us. This article gives an overview of some of our findings and focuses on the effects of nitrogen, phosphorus, and potassium fertilization on plug growth.

We have determined the effect of nitrogen, phosphorus, and potassium concentration in the fertilizer on the growth and tissue nutrient levels of impatiens, petunia, salvia, and vinca plugs. For these experiments, we used custom-made fertilizer, which allowed us to independently change the levels of N, P_2O_5, and K_2O. The nitrogen concentration in the fertilizer was varied from 14 to 225 ppm, the P_2O_5 concentration from 9 to 140 ppm, and the K_2O concentration from 24 to 370 ppm. The seedlings were fertilized once a week with the different fertilizer solutions. At the end of the experiments, we looked at the dry weight of plants to determine their growth, and the tops of the plants were analyzed for nitrogen, phosphorus, and potassium to determine how the different fertilizers affect the nutrient composition of the plants.

Surprisingly, we found that the growth of plugs of all four species is only affected by nitrogen, and not by phosphorus or potassium. There was an increase in the size of the plugs as the nitrogen concentration of the fertilizer increased from 14 to 225 ppm. In separate experiments, we have tested fertilizer solutions with up to 450 ppm nitrogen, but increasing the nitrogen concentration above 225 ppm did not have a beneficial or harmful effect on the growth of plugs. Based on these results, 225 ppm N seems to be the optimal nitrogen concentration of a plug fertilizer, if rapid growth is desired and plugs are fertilized once a week. The fertilizer concentration can be decreased if the plugs are fertilized more often. For example, if plugs are fertilized twice a week, a nitrogen concentration of 150 ppm would probably be enough to achieve maximal growth.

Increasing the nitrogen concentration in the fertilizer not only increased the growth rate of the plugs, but also the tissue nitrogen content. The tissue N content of all four species increased from 1 - 1.3% to 1.7 - 2% as the nitrogen concentration of the fertilizer increased from 14 to 225 ppm. For many greenhouse crops, 2 - 3% N in the leaves is considered to be optimal, although there are relatively large differences among species. We are currently trying to determine the optimal tissue N content for plugs of impatiens, petunia, salvia, and vinca. This will make it possibly to use tissue nutrient analysis to determine whether a particular fertilization program provides adequate nitrogen for good plant growth.

An increase in the phosphorus concentration of the fertilizer had no effect on the growth of the plants, but it did increase the phosphorus level in the plant tissue. However, even with the lowest P_2O_5 concentrations, the tissue P content of all four species was higher than 0.3%, which is the critical P-level for many species. Although it is commonly believed that high phosphorus levels are important for good root growth, we did not see any effects of phosphorus fertilization on the total weight or length of the roots. Root growth of the plugs was not affected by nitrogen or potassium fertilization either. This suggests that it is difficult to regulate the root growth of bedding plant plugs by changing the fertilizer concentration or composition.

Increasing the K_2O_5 concentration in the fertilizer affected neither the growth of the plugs, nor the potassium level in the leaf tissue of the impatiens, petunia, and vinca plugs. Only salvias showed an increase in the potassium level of the plant tissue but this effect was fairly small. The recommended minimum K level of leaves varies from 0.5 - 2.5%, depending on the species. Tissue K-levels in our experiment varied from 2.5 - 3.0% for vinca to 5 - 6% for salvia, but the K-levels of the leaves were adequate for good growth in all cases.

An increase in plant uptake of a specific nutrient without an effect on growth is commonly referred to as luxury consumption. Although this luxury consumption of certain nutrients may seem to be unproductive, that is not always the case. Plants can mobilize these nutrients at a later stage and use them as needed. Luxury consumption can help the plants to maintain a high growth rate, even if fertilizer is temporarily withheld from the plants.

Higher nitrogen levels in the plug fertilizer not only increased the growth of the plug seedlings, but also helped the plants to get established faster after they were transplanted into cell packs. Both root and shoot growth after transplant were increased with higher concentrations of nitrogen in the fertilizer during the plug stage

(up to 225 ppm). Phosphorus and potassium did not have any effect on the growth of the plants after transplant.

The results of our work show that nitrogen should be the focus of any plug fertilization program. The growth of plug seedlings is directly related to the concentration of nitrogen in the fertilizer solution. Plug growth increases when the nitrogen concentration of the fertilizer increases up to 225 ppm. A further increase has no effect on growth, but does increase the nitrogen level in the plants. This has important implications for nitrogen applications to plugs. For rapid plug growth, it is necessary to provide the plants with ample nitrogen. On the other hand, if plugs have to be held for a short period before sale, their growth can be slowed down by decreasing the nitrogen applications. In this case, it is important that nitrogen applications in the early stages of plug growth are not excessive. Plant growth cannot be slowed down by simply reducing the nitrogen applications to the plants, if the plants already have a high leaf nitrogen content. The growth rate of plants does not depend on the amount of fertilizer in the growing medium, but rather on the concentration of nitrogen in the plants. High nitrogen levels in the fertilizer allow the plugs to accumulate large amounts of nitrogen in their leaves, and the plugs can redistribute this nitrogen later on and use it when there is little or no nitrogen supplied through fertilization. This will make it difficult or impossible to reduce the tissue nitrogen content enough to slow down the growth of these plants.

To ensure that plug growth can be manipulated by changing the nitrogen concentration in the fertilizer, it is necessary to prevent the accumulation of luxury amounts of nitrogen in the plants. The objective of a good plug fertilization program should be to provide sufficient nitrogen to the plants, but not more than needed. Phosphorus and potassium fertilization of plugs can be reduced drastically. We have used very low concentrations of both nutrients without any effect on the growth of the plugs. Using fertilizers that are low in phosphorus and potassium will have no negative impact on plug growth or quality, while reducing the potential for runoff. A complete, water-soluble fertilizer containing 20-1-1 N-P-K should supply all the necessary nutrients to plug seedlings, when used at 225 ppm N and applied weekly.

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