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Managing micronutrients in hydroponic culture

Managing micronutrients in hydroponic production systems with recirculating nutrient solutions requires a different approach than managing them compared to containerize crops.

For container-grown ornamental plants, managing micronutrients can be a challenge for producers. We generally classify annual and perennial bedding plant, potted plant, and cut flower species into different groups, depending on their micronutrient requirement.

First, there is the "general" group that doesn't require too much special treatment during production, and the average amount of micronutrients available to them is sufficient to grow a high-quality crop.

Figure 1. Hydroponically grown food crops vary in their micronutrient requirements. For example, rosemary requires lower concentrations of micronutrients than other crops.

Next, we have those groups of plants that do require special attention: 1) micronutrient efficient crops and 2) micronutrient inefficient crops. The micronutrient-efficient group requires less-than-average amounts of micronutrients, while the micronutrient-inefficient group requires more-than-average amounts of micronutrients.

Producers of herbaceous annuals and perennials and woody plants typically manage micronutrients in containerized crop production by managing the root-zone pH. For those species classified in the "general" group, no special accommodations are made; a standard substrate pH of 5.8 to 6.2 is fine for these species.

Alternatively, the root-zone pH is typically increased into the range of 6.0 to 6.4 for micronutrient-efficient plants (also called the “geranium group” or “marigold group”), while the pH for micronutrient inefficient plants are usually lowered to 5.6 to 6.0. By adjusting the pH of the root-zone, we alter the availability of micronutrients, not the actual concentration or amount. The availability of micronutrients decreases as pH increases, whereas availability increases as pH decreases. While adjusting pH to make micronutrients more or less available in container-grown crops in soilless substrates, hydroponic crops require a different approach.

For food crops grown hydroponically, the variety in micronutrients requirements is going to be the same as substrate-based systems, with some species requiring more or less micronutrients than the average crop. For example, basil is a crop that generally requires more iron than other herbs and chlorosis can be problematic when it is deficient, while rosemary should be provided with lower amounts of micronutrients. However, it is more difficult to use pH to control micronutrient availability. Rather, instead of using a low pH to make more micronutrients available or a high pH to restrict them, it is more effective to regulate the actual concentrations of micronutrients in your solution. However, for plants grown hydroponically and especially in recirculating water culture systems such as nutrient-film technique (NFT) and deep-flow technique (DFT), the relationship between pH and micronutrients is a little different. The micronutrients are much more available to plants from the nutrient solution. Therefore, producers need to manage the concentration of these elements in the nutrient solution.

Fertilizer concentrations are commonly measured using the electrical conductivity (EC) of nutrient solution in hydroponic production systems. The EC doesn’t measure the amount of individual mineral nutrients; rather it reflects the total concentration of all nutrients. As the name implies, micronutrients are required in such small quantities that the amount commonly present in nutrients solutions has a negligible effect on EC; as a result, EC values represent primary and secondary macronutrients, those elements in greater quantity in the nutrient solution. Additionally, the speed at which nutrients are taken up varies- some are taken up rapidly while others are taken up slowly, and micronutrients are not exception. Some micronutrients such as manganese are taken up very quickly, whereas boron is taken up slowly. Therefore, you’ll want to measure the concentrations of micronutrients in nutrient solutions and/or plant tissue to better manage them during production. Over time, you will have a better understanding of the dynamics of micronutrients in your solutions. The nutrients added to your nutrient solution throughout production may contain different concentrations of micronutrients than the initial or original nutrient solution. Accommodating specific, individual micronutrient concentrations will only be possible for those producers who are mixing their own fertilizer. For those using a one or two-bag fertilizer, the proportions of micronutrients are fixed; for these fertilizers, watching for concentrations that are out of balance (i.e. deficient or toxic concentrations) will be especially important.

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