GROWERTALKS

Features

8/31/2017

Phosphorus Deficiency on Upper Leaves

Josh Henry & Brian Whipker

This article is the fourth in a 12-issue series highlighting research from North Carolina State University (NCSU). We would like to thank the Fred C. Gloeckner Foundation for support of this research project.

At NC State, we've been researching several aspects of low phosphorus (P) nutrition. Much of this work has been to determine optimal P rates for floriculture production. However, when working with nutrient restriction, it's important to recognize and understand deficiency symptoms. In this article, we'll discuss our research on reproductive stage P deficiency symptoms, which occur on the upper foliage.

As we discussed in our last article ("Using Low Phosphorus Fertility to Enhance Red Foliage Coloration"), P deficiency often results in a red or purple coloration on the lower leaves. In addition, there are some less common symptoms, such as chlorosis with olive green or necrotic spotting. Regardless of the symptom, P deficiencies usually have one thing in common: symptoms develop on the lower leaves because P is a mobile element. This means that P gets translocated from the lower leaves (a source) and moves to the young developing tissues (a sink). As P is depleted in the lower leaves, symptoms begin to develop there.

But what happens when a plant is experiencing a P deficiency and the symptoms develop on the upper leaves first? This question originated from an issue with a chrysanthemum grower whose crop developed symptoms of necrosis on the upper leaves, just below the flowers. The central and lower foliage appeared healthy, but a tissue sample confirmed that these symptoms were due to a P deficiency. It turned out that the affected chrysanthemums had been grown to the point of flowering with sufficient levels of P, but were then moved outside, switched to a low P fertilizer and exposed to several leaching rain events.

Increasing P

We attempted to induce upper leaf P deficiency symptoms by replicating these conditions of sufficient P fertility early on, but no P after flower initiation. We experimented first with ornamental peppers (Capsicum annuum) and later refined the methods with chrysanthemums (Chrysanthemum morifolium).

Figure 1. Upper leaf chlorosis and leaf abscission just below the developing fruit on Tango Red Ornamental Peppers.

In our first experiment, Tango Red Ornamental Peppers were grown in the greenhouse with initial rates of 2.5, 5, 10 and 20 ppm elemental P (not phosphate [P2O5]). After six weeks, the plants began flowering and half of the plants from each treatment were switched to 0 ppm P. Peppers initially grown with 2.5 to 5 ppm P quickly developed the typical P deficiency symptoms on the lower leaves. Three weeks after the switch, we observed chlorosis and leaf abscission of the upper leaves on plants initially grown with 10 ppm P (Figure 1).

After two more weeks, similar upper leaf symptoms developed on plants initially grown with 20 ppm P. By the end of the experiment, several plants grown with restricted P had lost most of their foliage. This experiment found that upper leaf symptomology readily occurs on plants, but only when P is limited during the later stages of development when the flowers or fruit are developing.

Figure 2.Marginal chlorosis and necrosis on the upper leaves of Little Rock Chrysanthemums.

To refine this initial study, we conducted a similar experiment with Swifty Yellow, Little Rock and Crystal Misty Purple Chrysanthemums using initial rates of 10, 15 and 20 ppm P switched to 0 ppm P after flower bud development. In this experiment, Swifty Yellow and Little Rock developed symptoms of chlorosis, marginal necrosis and olive green spotting on the upper leaves (Figure 2).

On the other hand, Crystal Misty Purple developed upper leaf symptoms of purpling, marginal necrosis and olive green spotting (Figure 3). The reason Crystal Misty Purple developed symptoms of purpling while the other cultivars didn’t may simply have to do with the plants innate ability to synthesize anthocyanins or other red pigments.

Finding the cause

So we had successfully induced these unusual symptoms on two different plant species, but we needed to know what was causing them. After symptoms developed, the plants were divided into four parts to analyze P levels throughout the plant. These parts were the lower, middle and upper leaves and stems, and the flowers. Our goal was to determine P movement in the plant by comparing P levels in plants grown with continuous or restricted P fertilization.

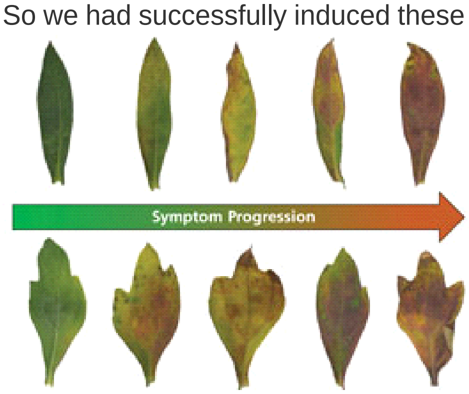

Figure 3. Symptom progression of Crystal Misty Purple Chrysanthemum leaves includes chlorosis, necrosis, olive green spotting and purpling.

We saw that P concentrations in plants grown with continuous P fertilization were lowest in the lower leaves and stems, and increased moving up the plant (Figure 4). This illustrates how plants' reproductive tissues have a higher P requirement than the leaves and stems, and that the lower leaves specifically have the lowest P requirement. On the contrary, P concentrations in restricted P plants were equally low in all vegetative tissues and were again highest in the flowers (Figure 4). Although every tissue type had lower P concentrations when grown with restricted P, it was the upper leaves that experienced the greatest loss.

The tissue analysis indicated that these upper leaf P deficiency symptoms were due to a bypass of translocated P moving from source to sink. P was still being translocated from the lower leaves, but there were two competing sinks: the flowers and the upper foliage. Each of these tissues was expanding and maturing just as the external P supply was restricted. Normally, P would move from the lower leaves to the upper leaves, supplying the upper leaves with the P they need to remain green and healthy.

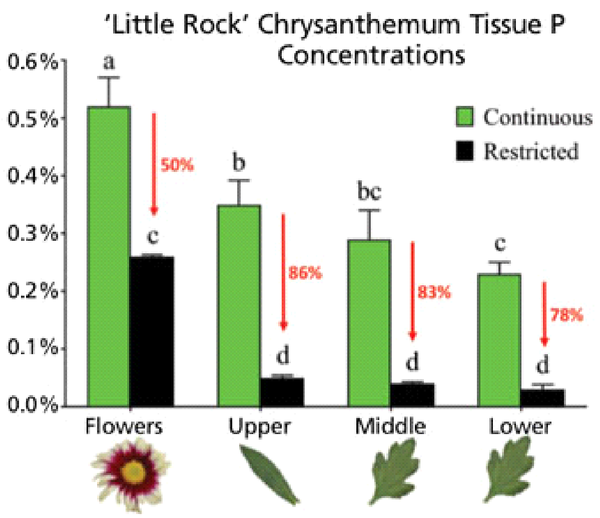

Figure 4. Little Rock Chrysanthemum tissue P concentrations in the flowers and upper, middle and lower vegetation. Different letters indicate significant differences among all tissue types.

In this situation, the limited supply of P had to be allocated to either the upper leaves or the flowers. Reproduction took precedence over sustaining the plant's vegetative growth and development. This explains why a healthy plant experiencing P-deficient conditions during reproduction will develop P deficiency symptoms on the upper foliage.

To avoid reproductive stage P deficiency in your crops, it's important to supply at least ~5 to 10 ppm P throughout the entire production cycle. Floriculture crops grown in soilless substrates have a very low P holding capacity and healthy, mature plants may develop irreversible symptoms in as little as two to three weeks without P. It's also important to note that heavily flowering or fruiting species, such as ornamental peppers, typically have a high P requirement and you should err on the side of caution by supplying at least 10 ppm P.

If deficiency symptoms are observed, you may wish to supply a high P drench with ~20 ppm P (e.g., 20-10-20 mixed at 100 ppm N or 15-5-15 mixed at 200 ppm N). By taking these steps, and closely monitoring your crops, you can successfully implement a low P fertilization regiment while avoiding symptoms of a reproductive stage P deficiency. **GT**

Josh Henry is a Ph.D. student in floriculture and Brian Whipker is a Professor of Floriculture and Extension Specialist at NC State University.