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Garden Mums:
Upper leaf yellowing and necrosis

When phosphorus is limited during flowering, mums translocate it from the nearest leaf sink, resulting in upper leaf yellowing and necrosis.

Click blue text for YouTube video: Phosphorus Deficiency

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Recently investigated a situation affecting garden mums that occurred at two greenhouse operations. The problem was out of the ordinary and I wanted to share insights into new aspects of phosphorus nutrition.

With the first operation, one cultivar had upper leaf necrosis and yellowing (Fig. 1). These were grown outside, and the symptoms were advanced. Inspecting the lower foliage revealed they were still dark green, which helped discount the possibility that we were

Figure 1. Upper leaf yellowing and necrosis can occur with late season phosphorus deficiencies. Instead of translocating phosphorus from the lowest leaves, plants utilize the resources which are closest to the reproductive flowers.

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Figure 2. Non-symptomatic plant (left) of the same cultivar grown inside versus outdoor grown plants (right). Tissue values were 0.18% for the plant on the left, while levels were 0.11% P for the right plant.

looking at a bacterial infection. The grower and I discussed other options, such as spray phytotoxicity and drought stress. Neither of these really seemed probable. Then the grower mentioned that the plants were grown without phosphorus.

It reminded me of another situation from a few years back with ornamental peppers in which the upper foliage just under the fruit developed necrosis. That turned out to be a phosphorus deficiency. So I obtained a tissue sample from the affected cultivar (Conella Yellow) grown outside with symptoms and one from the same cultivar grown inside not exhibiting symptoms (the inside plants were not subject to leaching summer rains) (Fig. 2).

So what did the tissue analysis test reveal? The tissue value was 0.11% P for the plants exhibiting symptoms and 0.18% for same cultivar indoors which was symptomless. The recommended range for P is between 0.25 to 1.0%. The other nutritional parameters were near normal. This provided a

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strong confirmation that the problem was indeed due to the lack of phosphorus, but I would of have really liked to of have seen the initial symptoms to be more confident in the diagnosis.

A problem at a second greenhouse 2 weeks later provided the missing information. Outdoor grown garden mums had symptoms of upper leaf necrosis (just below the flowers). Lower leaf necrosis was also lacking, which again directed the diagnosis away from a bacterial infection (Fig. 3).

With severe conditions, the flowers were also necrotic (Fig. 7). With these advanced symptoms it was difficult to determine the cause of the problem. (Necrotic leaves offer very few clues of the progression of the problem other than they are dead.)

Luckily an aid with the diagnosis occurred with a second crop which was being grown indoors as a method of inducing heat delay in order to expand the blooming period. With the slight delay of flowering, that offered a peek into an earlier stage of the problem. Plants had dull green leaves (both on the lower leaves and up-

Figure 3. Leaf necrosis primarily occurred on the upper foliage. Bacterial leaf spot problems typically begin on the bottom leaves and work up the plant.

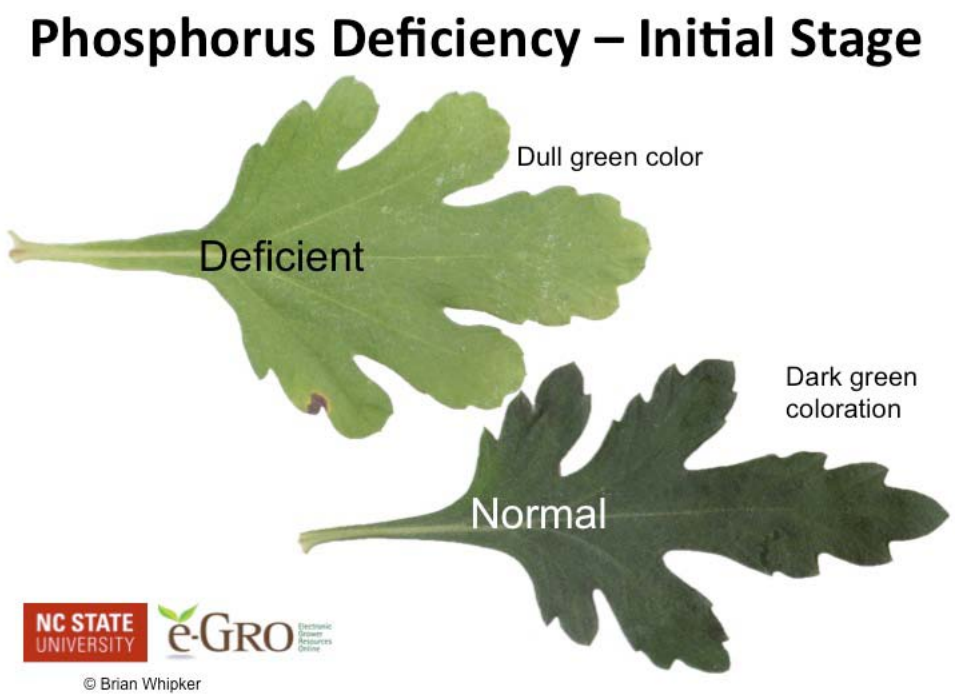


Figure 4. Close up of the dull green leaf color of a phosphorus deficient plant. Normal dark leaf in lower right.

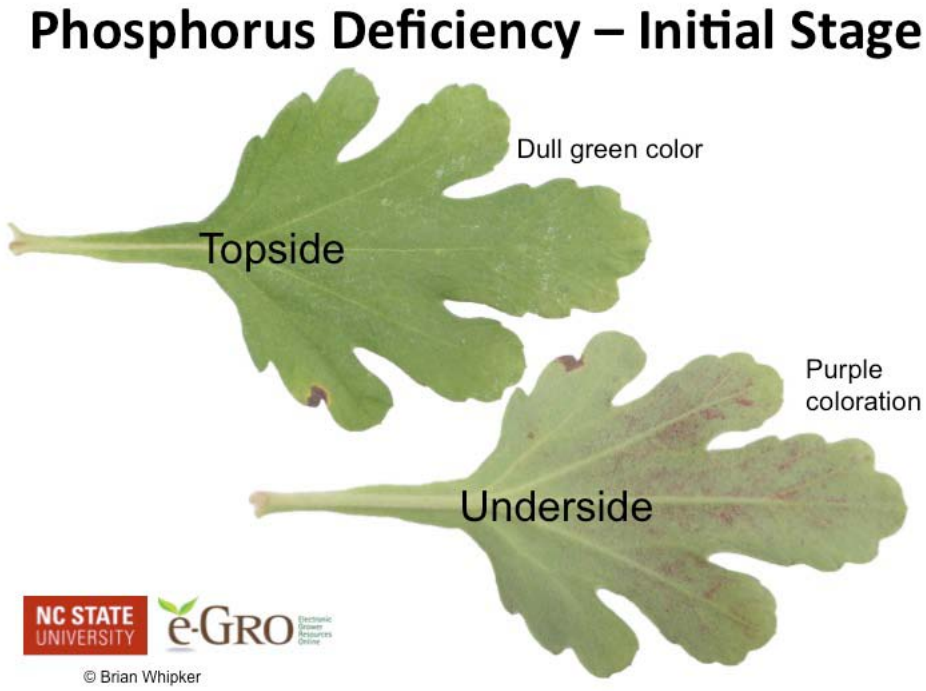


Figure 5. At the beginning stage of phosphorus deficiency, the leaves have a dull green coloration. The underside of the leaf may have a purple discoloration (lower right leaf).

Management

Phosphorus is an essential element and still needs to be provided to garden mums. Slow release fertilizer containing a low amount of phosphorus is most likely the most economical option available to garden mum growers. It can also be accomplished by utilizing low P fertilizers such as 13-2-13 Cal-Mag (what we primarily use in my research at NC State). Another method is with periodic phosphorous applications (such as potassium phosphate if you mix your own fertilizer). Finally, monthly applications of 20-10-20 (which when applied at 200 ppm N, provides 44 ppm P) can be made. The target amount of phosphorus in a SME substrate test is between 5 and 10 ppm. Higher substrate values will encourage elongated growth. Excess levels also readily leach and can lead to environmental contamination.

per) (Figs. 4&5), yellowing, olive colored leaf spots, and then necrosis (Fig. 6). With severe deficiencies, flower death can occur. (Fig. 7).

In this case, phosphorus was supplied at a low level during the production season.

The lab analysis confirmed the tissue samples were phosphorus deficient. The tissue contained 0.07% P for both cultivars tested (Helen Maroon and Mabel White).

Conclusions

In an earlier e-GRO Alert (3.54), we discussed how visual symptoms of phosphorus deficiency vary. The normal symptom everyone associates with limited phosphorus is lower leaf purpling (Fig. 8). The purple coloration is the result of an increase in anthocyanin production. It commonly occurs under cold, wet growing conditions or when there is root rot inhibiting phosphorus uptake.

The second set of symp-

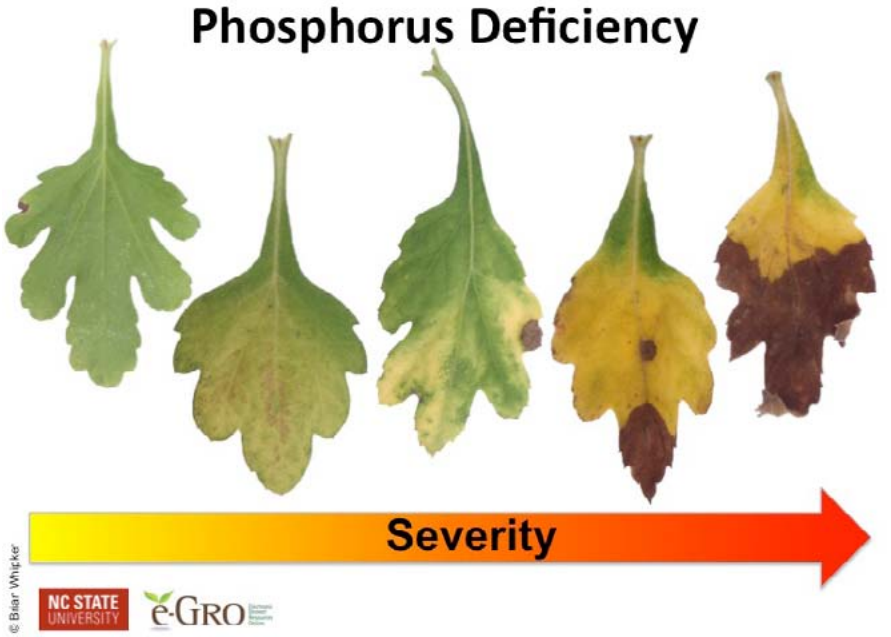


Figure 6. Progression of leaf symptoms due to limited phosphorus in garden mums.

toms initially start on the lower leaves as a dull green coloration, which advance to an overall yellowing with olive green spots, and finally necrosis (Fig. 6). Early in the season these symptoms begin on the lower leaves because phosphorus is a mobile element. When limited, the plant reallocates phosphorus from the lower leaves to the uppers leaves, hence the deficient symptoms appear on the older foliage.

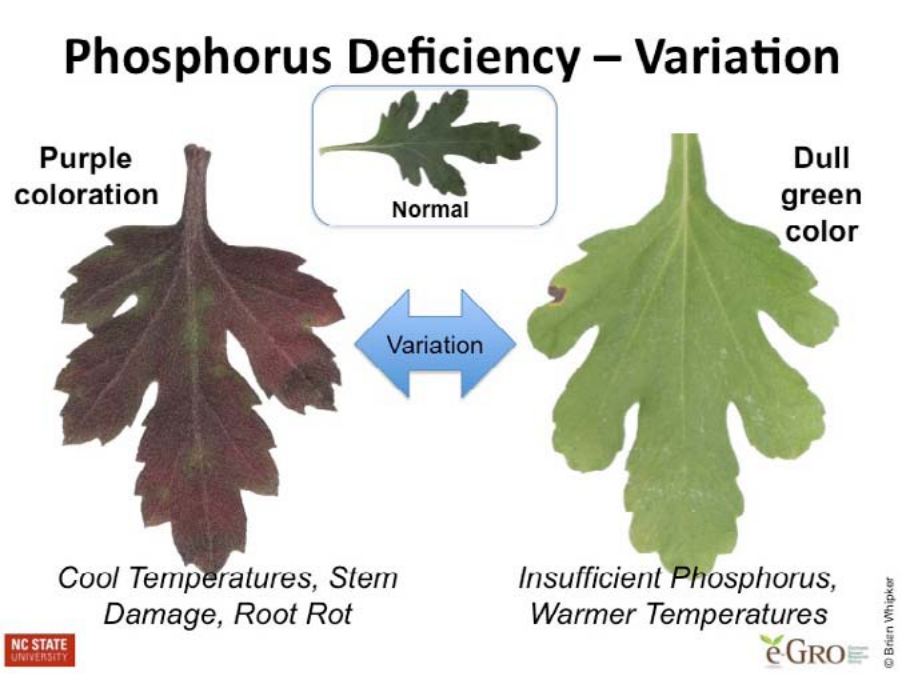
A variation of these symptoms can occur when the plants are in the reproductive (flowering or fruiting) stage of development. The primary goal of a plant is to reproduce the next generation (seed). If phosphorus is limited at this stage of development, plants opt for the easiest available supply, the leaves just below the flowers or fruit. This is what occurred with the ornamental pepper sample a few years ago when phosphorus was limited. (I have also observed upper leaf symptoms occurring with late season magnesium deficiencies in poinsettias and pot mums.) So as in the case of these two growers, I was initially confused by what I observed and where the symptoms appeared. It is important to note this variation when you diagnose problems too.

Figure 7. With severe phosphorus deficiencies, flower death can also occur.

Figure 8. Purple vs Dull Green Leaf Coloration

Phosphorus deficiency symptoms take on two distinctive variations. The most common is a purple coloration of the lower leaves. This typically occurs during cool growing conditions, overly wet substrates, root rot, or when phosphorus levels are low.

The other set of symptoms which occur more commonly during warm growing conditions begin as a dull coloration of the lower leaves, followed by increasing amounts of yellow leaf coloration, olive green leaf spots, and finally necrosis.



Economic Impact

Phosphorus deficiency is not usually considered to be an element that results in major plant losses. With the emphasis of providing little or no phosphorus to plants to control growth, negative economic impacts are occurring more frequently.

In these two cases highlighted, the value of the affected plants estimated by the growers was over $340,000. With corrective phosphorus applications and the covering of the necrotic foliage with open blooms, many of those plants were still sold.

Unfortunately not all the plants could be salvaged. The amount of direct losses estimated by the growers for the unmarketable plants was over $130,000. The extra labor cost for removal of dead leaves is not included in the estimate and would increase the amount even higher.