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59. Understanding plant nutrition: correcting low media-pH. Fisher, P. and Argo, B. Greenhouse Grower 27(4):36-39. 2009.

Understanding Plant Nutrition:
Correcting Low Media-pH

In the second article of this 12-part series, Argo and Fisher pour over the details to systematically identify and correct common nutritional problems found in greenhouses and nurseries.

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IRON/MANGANESE toxicity is a common problem when media-pH drops below the ideal level in certain crops, including geraniums, marigolds, lisianthus, and pentas. As media-pH decreases (meaning the pH becomes more acidic), iron and manganese become more soluble, resulting in higher concentrations in the soil solution.

For each drop in media-pH by one unit, for example from pH 6.0 to 5.0, solubility of inorganic iron in the growing medium (and availability of this iron for uptake by plants) increases by a factor of 1,000.

Geraniums, marigolds and certain other species are very "iron-efficient" at taking up the soluble iron and manganese into their tissue. These species evolved to grow in calcareous (low-iron, high-pH) soils and "harvest" extra iron by exuding acid or chelating agents from their roots into the soil, growing extra root hairs and other processes.

When we place those plants into an iron-rich greenhouse media and fertilizer regime, they can't turn off those iron-accumulating processes and take up so much iron that they accumulate excess micronutrients in their leaves. That results in toxicity symptoms. In contrast, some other crops such as petunia and calibrachoa, which are not iron-efficient, can grow very well at pH levels between 5.0 and 6.0.

Once plants show toxicity symptoms of necrotic spots and marginal burn (**Figure 1**), the affected leaves do not completely heal. The only options become shipping lower-quality plants, taking additional time to produce healthy new growth that will cover the older damaged foliage or throwing them away.

It is therefore usually the combination of growing iron-efficient plants in a media-pH below 6.0 that results in iron/manganese toxicity. For these crops, it is important to take steps to prevent low pH, regularly test media-pH and take rapid actions to raise pH when pH drops below 6.0 or toxicity symptoms are observed.

Prevent Low Media-pH From Occurring

For iron-efficient species, including geranium, marigold and lisianthus, the

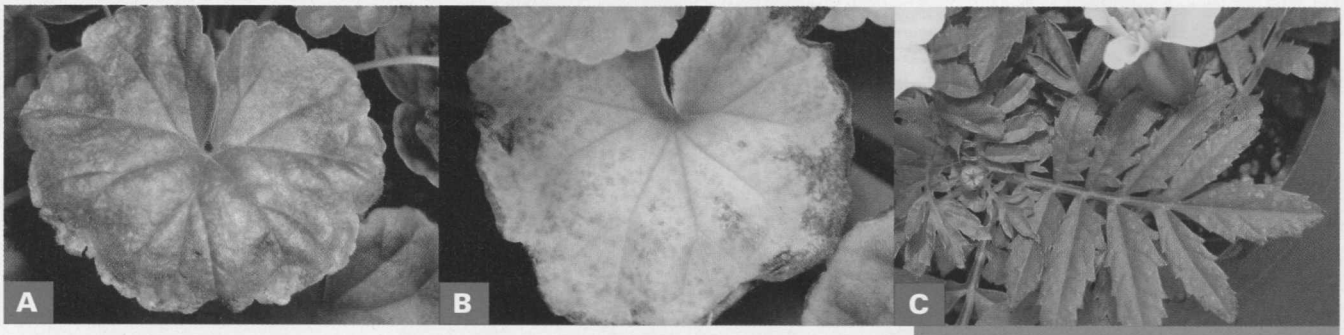

Figure 1. Iron/manganese toxicity symptoms. (A, B) In geranium, older leaves are affected first, starting as chlorotic (yellow) spots scattered around the leaf and on the leaf margin. These chlorotic spots turn necrotic (brown and dead), and an overall chlorosis and necrosis develops. (C) In marigold, micronutrient toxicity usually appears as a bronzing, or as speckled necrotic spots that progress into an overall chlorosis and necrosis. Photographs by Brandon Smith, University of New Hampshire (UNH).

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target media-pH is 6.0 to 6.6. This target pH-range is higher than most crops. A more general range is 5.6 to 6.2.

There are a balance of factors that raise or lower media-pH. Don't rely on the growing mix to maintain pH at target levels, even if initial pH is correct, because pH can easily drift up and down depending on your water quality and fertilizer choice. Factors that can drop media-pH below the target range include:

- Insufficient pre-plant lime, or the wrong lime type (either too slow-acting or very fast-acting without a residual effect).
- A fertilizer high in ammoniacal nitrogen (more than 25 percent of all nitrogen is in the ammonium form) used on a continual basis, especially when combined with low-water alkalinity (60 ppm $CaCO_3$ or below).
- Over-acidification of irrigation water (100-120 ppm alkalinity is the usual target when acidifying a high-alkalinity water).
- Certain plant species, especially geranium, can interact with the media to reduce pH.

Word To The Wise

There are many causes of necrotic spots and chlorosis in geraniums and marigolds other than low media-pH, for example damage from pests and diseases. Be sure to take a soil test and check that media-pH is indeed low before applying a basic drench. Plants are already under stress when media-pH is out of range, and you should expect recovery in plant health to take several weeks – even after media-pH is back in range. The earlier you correct low media-pH, the better your chances of a saleable crop.

We have seen phytotoxicity occur on roots after applying potassium bicarbonate above 2 pounds/100 gallons, and also on foliage when we did not wash the leaves immediately afterward. Leaf spotting with lime residue can also occur after flowable lime applications (**Figure 2**). It is up to you to balance the risk of phytotoxicity against the damage caused by low media-pH. As with any chemical

application, it is advisable to run a test application on a small number of plants to check for phytotoxicity before applying to the entire crop.

Steps To Rapidly Correct Low pH

When growing geraniums and other iron-accumulating crops, and after you have tested that the media-pH is between 5.8 and 6.0, we recommend the following:

- If acidifying water, make sure to stop acidification.
- Change to a basic fertilizer at 150 ppm N or a lower fertilizer rate, regardless of alkalinity.

If the media-pH has fallen below 5.8 and the crop is showing micronutrient toxicity symptoms, then more drastic measures are needed to raise the media-pH to a safe level (above 6.0). We recommend the following:

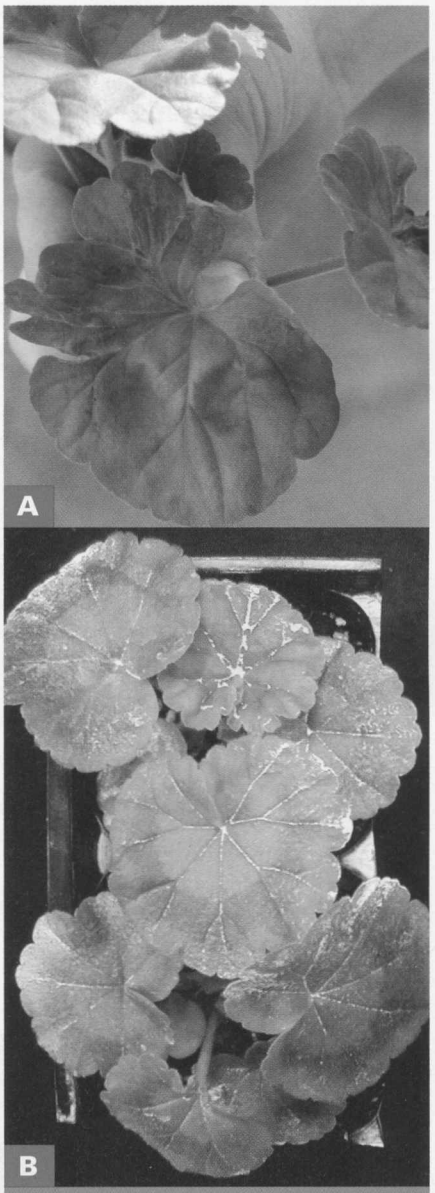

Figure 2. Phytotoxicity when foliage was not immediately rinsed after an application of (A) potassium bicarbonate at 4 pounds/100 gallons and (B) flowable lime at 4 quarts/100 gallons. Photographs by Linda Bilodeau and Brandon Smith, UNH.

- Apply flowable lime at 1:100 or potassium bicarbonate at 2 pounds/100 gallon applied in the morning (to slow drying on foliage) with high volume (ideally through a hose and breaker, leaching out half a soil volume of solution).
- Flowable lime needs constant application in the stock tank, or settling will occur. Consider diluting flowable lime in the stock tank.

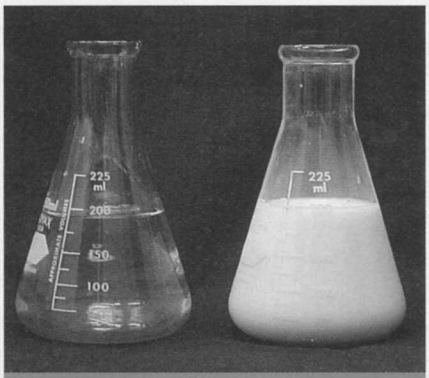

Figure 3. Comparison of potassium bicarbonate (left) and flowable lime solutions. Photograph by Linda Bilodeau, UNH.

- Wash foliage with water immediately after application to remove residue, and clean irrigation equipment if using flowable lime.
- Potassium bicarbonate at 2 pounds/100 gallons provides 933 ppm potassium, and increases media electrical conductivity (EC). For this reason, if applying potassium bicarbonate we recommend leaching the media heavily with a basic-reaction (high nitrate) fertilizer solution that contains calcium and magnesium (such as 13-2-13 or 14-0-14) one day after application in order to remove the high levels of potassium and to restore the nutrient balance.
- Check media-pH again after 3 days.
- Reapply flowable lime or potassium bicarbonate if pH remains below 6.0 after 3 days.

The main criteria to choose between potassium bicarbonate and flowable lime are availability and ease of application. **Figure 3** shows the difference in solutions: potassium bicarbonate is clear and dissolves completely, whereas flowable lime is a milky suspension. Potassium bicarbonate is available from fertilizer or industrial chemical suppliers and can be applied to flood floors, through low-volume drippers, and into hard-to-reach corners. Purchase technical grade potassium bicarbonate to avoid contaminants.

In other situations, use flowable lime, which is available through most greenhouse/nursery suppliers (usually as Limestone-F). Flowable lime tends to have a longer-lasting effect on raising pH and is also a better choice if your media already has a high EC.

Conclusion

Flowable lime and potassium bicarbonate are effective materials for quickly raising low media-pH. It is preferable, however, to avoid stressing plants with low media-pH in the first place. **GG**

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