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Do You Have Suicidal Geraniums?

Possible reasons your geraniums are killing themselves and basic solutions

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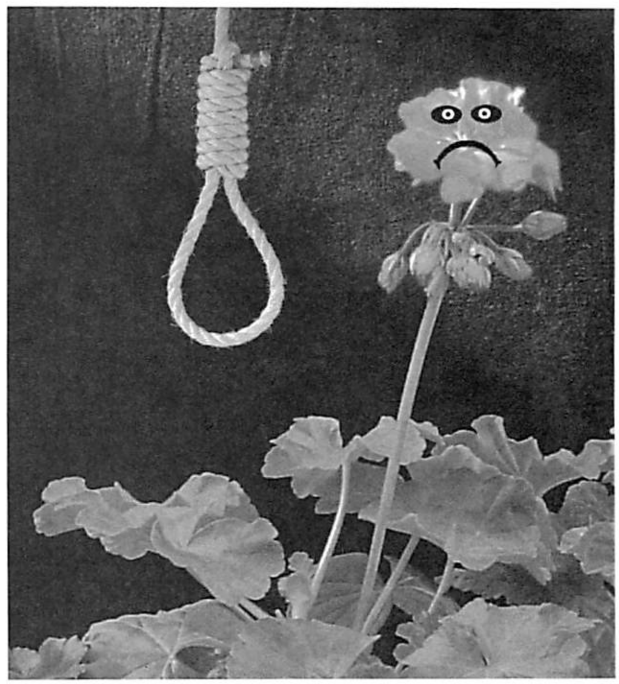
One of the largest cultural problems facing ornamental plant growers is control of root substrate pH. A common axiom proclaimed at trade meetings is that proper control of substrate pH can prevent more than half of all nutritional problems. There are customary rises and declines in pH during crop production. Rises most often stem from alkalinity in irrigation water while declines result from use of acidic fertilizers in combination with pure irrigation water (mostly devoid of alkalinity) as well as from insufficient limestone in the substrate. These shifts in pH are usually gradual and can be detected in time and successfully corrected. Remedies can include a shift in fertilizer type to achieve the proper acidity or basicity level or application of acids or bases such as ferrous sulfate and flowable limestone.



On some occasions geraniums exhibit quite a different decline in substrate pH that involves a very large and sudden pH decline (SPD). Crops growing at a substrate pH of 6 or higher suddenly cause substrate pH to shift downward one to two units within 7 to 14 days with values as low as 3.8 have been experienced. In organic based soilless media the pH has a large effect over nutrient availability and at low pH crops are often devastated from problems of iron and manganese toxicities (Fig. 1) and calcium and magnesium deficiencies. Prolonged exposure to low pH can also suppresses lateral root formation and can lead to death of root tips, reducing nutrient uptake. Other crops reported to be affected by low pH include gerbera, New Guinea impatiens, pansies, marigold (Fig. 2), dahlia, fuchsia, tomato, pepper, cosmos, nasturtiums, pentas,

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and zinnia. These represent a significant proportion of the 2005 wholesale value of floricultural crops, e.g., $214 million for geranium, $166 million for pansy, and $81 million for New Guinea impatiens. Many of the remaining crops belong to the bedding plant group that is valued at $2.6 billion, half of the total value of floricultural crops (USDA, 2005). A distinguishing feature of SPD is its sporadic occurrence. Within a greenhouse firm one geranium crop might be affected and the subsequent is not. Within a geographic area a crop in one firm is affected but not in a second firm, even though all crops appear to be grown in similar materials. Symptoms of this disorder have been inconsistently reported and include; marginal necrosis, chlorotic and/or necrotic spotting of older leaves, upward and/or downward cupping of the leaves, distortion of the leaves, large purplish black spots, light-brown or orange pigmentation, bronzing, and bronze stipple on older leaves and leaves of all ages (Fig. 3). Most of these symptoms are most likely the result of Fe and/Mn toxicity, but in some cases tissue analysis does not confirm these hypothesis. Symptoms also seem to be highly influenced by genetic variability amongst the geranium species.

Clearly, a signal is received in the plant that triggers an acidification process by the roots. The one documented process that could explain the SPD are the proton efflux pumps. These pumps are on the surface of the root and expel hydrogen ions (acid) into the soil, thereby acidifying it. Although these pumps naturally operate during nutrient uptake, they can be stimulated to abnormally high levels by three situations. These include: 1) when the plant takes up ammonium-nitrogen preferentially to nitrate-nitrogen due to the type of fertilizer applied or environmental stresses of water, adverse temperature, or light intensity; 2) when more positively-charged nutrients (ammonium, potassium, calcium, and magnesium) are taken up than negatively-charged nutrients (nitrate, phosphate, and sulfate); 3) when iron, phosphorus, or zinc are in short supply. Situation 2 could result from the pattern of fertilizer application. In a system of infrequent application, preferred nutrients run into short supply during the late part of the fertilization cycle, thus forcing plant uptake of nutrients not ordinarily selected. Low iron stress can stimulate the proton efflux pump to 100 times the normal rate involved in nutrient uptake. Phosphorus stress is a strong possibility because growers have relied heavily on alkaline fertilizers in an attempt to prevent pH decline, particularly in geranium. Phosphate is low or absent in these alkaline fertilizers, i.e., 13-2-13, 15-0-15, 14-0-14.

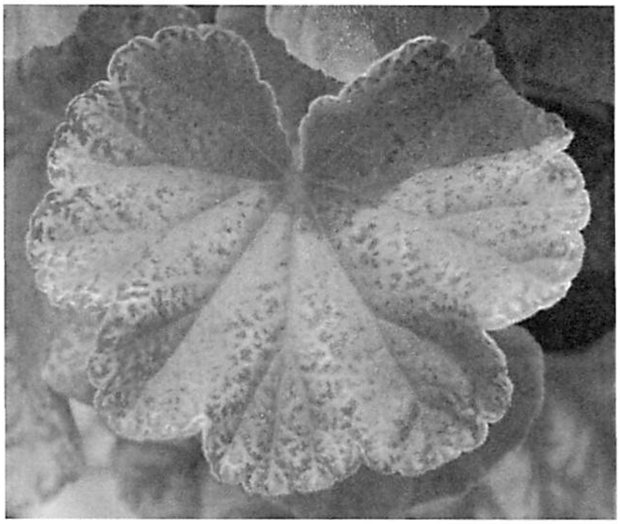

Fig. 1. Purplish bronze coloration on older geraniums leaves indicative of micronutrient toxicity resulting from low pH.

Currently, at North Carolina State University there is a project in place aiming to determine the cause of SPD in geranium. The project began with a survey of many growers and companies to establish

Table 1. Effect of day and night temperatures on final substrate pH of geraniums 9 weeks after transplanting.

Day temperature	Night temperature	Substrate pH	Dry weight (g)
65	57	6.2	22.4
72	65	5.6	23.5
80	72	4.6	25.4

any trends with the occurrence of SPD. The surveys did not yield any new cultural information, but did determine some susceptible and tolerant types and series. Seed geraniums seem to be the most susceptible, followed by zonal geraniums with ivy geraniums being the most tolerant. The series that tend to be more susceptible include; Pinnacle by Dumman, Designer by Ball, Patriot by Oglevee, and Maverick and Orbit by Goldsmith. When growing these cultivars, it is important to maintain the pH to ensure it is within the acceptable range. The tolerant series include; Fantasia by Ball, Elegance by Oglevee, and Rocky Mountain by Fischer, with all other series being intermediate or unknown.

The research at NCSU began by testing some basic hypotheses dealing with phosphorus and iron deficiencies of geraniums. In hydroponics, 25 day old rooted cuttings drove solution pH from 5.8 to below 4 within four days with both nutrient stresses. The effect of phosphorus was the most severe with solution pH reaching 3.7. Plants grown without phosphorus were also less than half the size of control and minus iron plants. Control plants receiving complete nutrients acidified the solution to pH 4.5, indicating that geranium is naturally an acidifying plant. A second hydroponic study showed that under phosphorus stress geranium will suppress nitrate (NO_3-) uptake. This causes a shift in root uptake from negative anions to positive cations, which leads to increased soil acidification.

Another set of experiments were designed to test the effects of water and temperature stresses. It has been shown in other plant species that these stresses suppress the uptake of nitrate which could lead to acidification of the substrate. The water stress study had three treatments (Wet, Medium, and Dry). Geranium plants receiving the dry treatment had a dry weight that was half of plants receiving both medium and wet treatments with no effect on substrate pH. These results indicate water stress may not play a role in SPD. Temperature experiments were performed in growth chambers and as day/night temperature increased from 65/57° F to 80/72° F substrate pH decreased from 6.2 to 4.8 over a nine week period (Table 1 & Fig. 4).

These results indicate phosphorus stress and high temperature may be important factors in the cause of SPD. They may also be part of an interaction where an unknown factor sets the stage for these stresses to activate SPD. In order to prevent or control SPD, substrate pH must be constantly monitored. Recommended pH range for both ivy and zonal geraniums in soilless substrate is 6.0 to 6.6. Andrews and Hammer at Purdue University found optimal growth occurred at 6.4 to 6.5. pH should be checked every week and maintained within this recommended range. If pH drops below this recommended range corrective action must be taken in order to prevent micronutrient toxicity. Three recommended methods used to increase substrate pH are alkaline fertilizers, flowable lime at 1 to 2 quarts per 100 gallons, or potassium bicarbonate at 2 pounds per 100 gallons. Plants should be rinsed off after application of flowable lime or potassium bicarbonate to remove foliar residues and prevent burn. One day after application of potassium bicarbonate the soil should be leached with water containing fertilizer to remove excess potassium

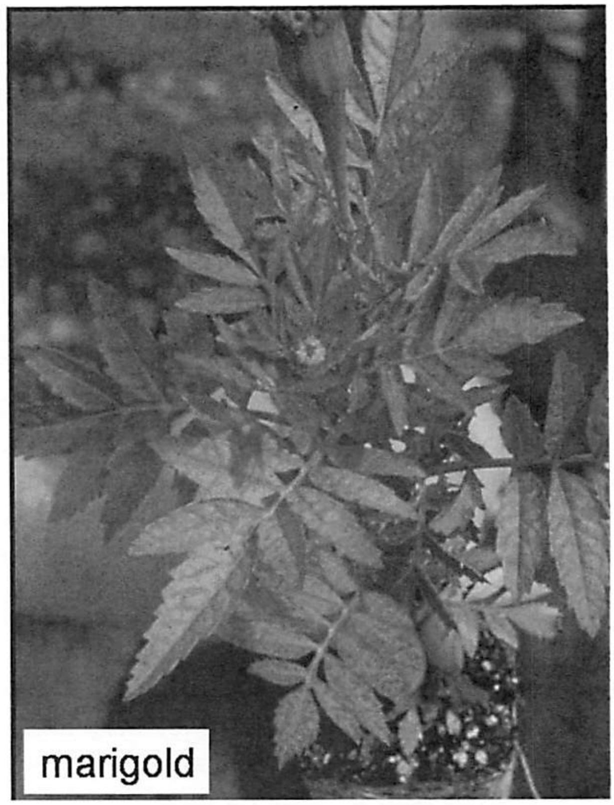

Fig. 2. Bronzing of lower leaves of marigold grown at low pH.

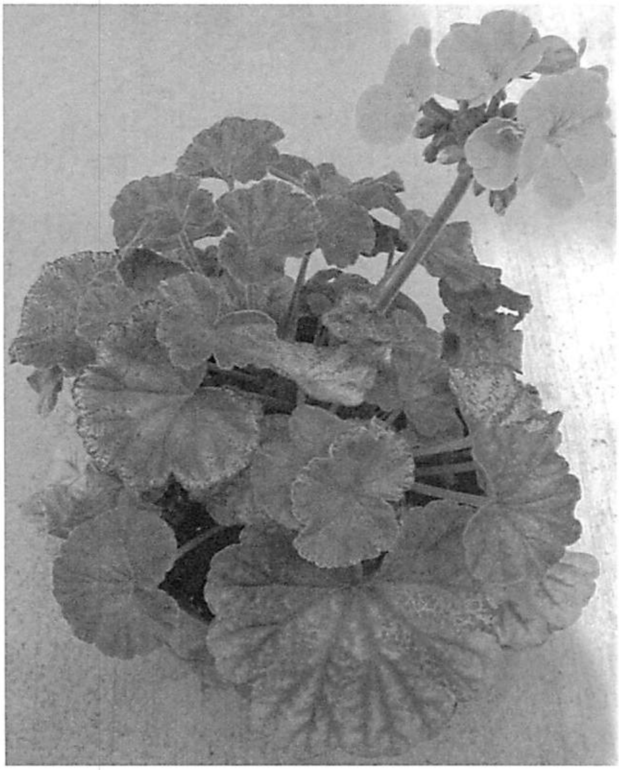

Fig. 3. Late stage of micronutrient toxicity showing the progression of bronzing, chlorosis, and necrosis from the base of the plant upward.

Fig. 4 . Purple bronze discoloration of older geranium leaves caused by low pH caused by high temperature.

and reestablish the proper nutrient balance. Allow 3 days reaction time and recheck the substrate pH to determine if a second application is necessary.

The cause SPD will continue to be investigated with much anticipation on to the cause. If SPD is a problem in your greenhouse you should follow these guidelines to minimize losses:

- Maintain substrate pH between 6.0 to 6.6
- Check pH weekly
- Use alkaline fertilizers and supplement phosphorus if it is low or absent
- Avoid excessively high temperatures
- Use flowable lime at 1 to 2 quarts per 100 gallons or potassium bicarbonate at 2 pounds per 100 gallons if pH is below the target range

2007 Poinsettia Open House

December 6 from 9 am to 2 pm
(Grower Day)
and
December 9 from 1 to 5 pm
(Consumer and Grower Day)

J.C. Raulston Arboretum
Raleigh, NC