e-GRO Nutritional Monitoring


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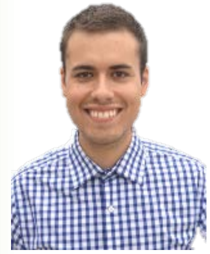
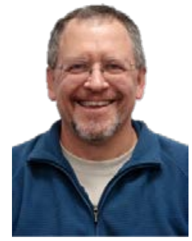

Josh Henry[2]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Nutritional Monitoring Series

Pansy

(*Viola × wittrockiana*)

Pansies require low fertility of 100 to 150 ppm N. Optimal substrate pH values for pansies range from 5.5 to 5.8. Pansies can develop both low and high substrate pH disorders. If substrate pH drifts lower than 5.5, iron (Fe) and/or manganese toxicity occurs and is observed as lower leaf black spotting. Substrate pH values above 6.2 to 6.5 inhibits Fe availability and induce interveinal chlorosis.

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Figure 1. Low substrate pH causes toxic iron (Fe) and manganese (Mn) accumulation and symptoms of black spotting on the lower leaves of pansies (*Viola × wittrockiana*). Photo by: W. Garrett Owen.

Pansy

Target Nutrition Parameters

pH Category II:
5.5 to 5.8

Fertility Category:
Low
100 to 150 ppm N

EC Category A:
1:2 Extraction:
0.4 to 0.6 mS/cm

SME:
0.9 to 1.3 mS/cm

PourThru:
1.3 to 2.0 mS/cm

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Figure 2. Low substrate pH causes toxic iron (Fe) and manganese (Mn) accumulation and symptoms of black spotting progressing into the lower leaves of pansies (*Viola* × *wittrockiana*). Photo by: W. Garrett Owen.

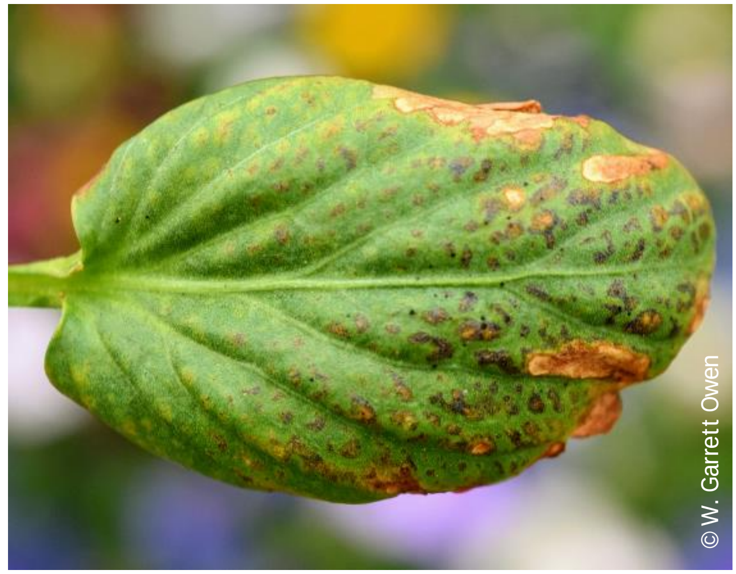

Figure 3. Lower leaf marginal necrosis occurs when toxic levels of iron (Fe) and manganese (Mn) accumulate in lower leaves of pansies (*Viola* × *wittrockiana*) induced by low substrate pH. Photo by: W. Garrett Owen.

Fertility Management of Pansy

Pansies should be grown with a substrate pH range of 5.5 to 5.8. Substrate pH influences nutrient availability and uptake, therefore use recommended 1:2 Extraction, SME, or PourThru methods to determine and monitor substrate pH and soluble salt [referred to as electrical conductivity (EC)] values. Additionally, conduct routine foliar analysis tests to monitor crop nutrient status. Tissue nutrient levels found in healthy, newly expanded leaves of pansies are listed in Table 1. Monitoring substrate pH and nutrient status will enable growers to avoid pH induced nutritional disorders.

Substrate pH below 5.5 causes increased uptake of iron (Fe) and manganese (Mn) to toxic levels which will accumulate in leaf tissue (Table 1). Plants exhibiting Fe and/or Mn toxicity exhibit purple to black spotting along lower leaf margins (Fig. 1) that progresses into the leaf (Fig. 2), developing into interveinal chlorosis (yellowing), and marginal leaf necrosis (death; Fig. 3). Less common, Fe and/or Mn toxicity can be observed as reddish-orange interveinal chlorosis of the lower leaves (Fig. 4). Corrective procedures for low substrate pH should begin within the range of 5.0 to 5.4.

High substrate pH above 6.5 can inhibit Fe uptake causing newly developed leaves to become Fe-deficient and exhibit faint marginal (Fig. 5) and interveinal chlorosis (Fig. 6). If plants become severely Fe-deficient, interveinal chlorosis intensifies and leaves become white or bleached (Fig. 7).

High substrate pH above 6.2 limits boron (B) availability and uptake, thus resulting in B deficiency (Whipker et al., 2004a). Initial symptoms of B deficiency begin on new growth, usually observed during the plug stage, with leaves and stems being distorted, clubby, thick, and strap- or spoon-like (Figs. 8A and B). Plants are often stunted with a rosette appearance, foliage is darker green, and most flowers abort, and those surviving have partially formed petals (Gibson et al., 2007). Advanced symptoms include necrosis of the primary meristem resulting in axillary (secondary) shoot growth. Corrective procedures for high substrate pH should begin within the range of 6.0 to 6.4. However, once plugs or transplants exhibit B deficiency symptoms, it will be highly difficult to reverse and recover plants using corrective procedures. In severe instances, symptomatic plugs or transplants should be discarded.

To prevent B deficiency, determine if the fertilizer or irrigation water contains adequate levels of B. Information can be found on the fertilizer analysis label and by submitting irrigation water for analysis. If supplemental B is required, add B to the fertilizer solution or apply weekly drench applications of 0.25 ppm B. For a 0.25 ppm B rate, mix 0.85 g borax (11% B) or 0.48 g Solubor (20% B) per 100 gallons of water (Whipker et al., 2004a). Excessive B can be toxic to plugs and transplants. Though rare, toxicity symptoms include spotty interveinal necrosis of older leaves, bright yellow leaf margins turning red to brown and becoming necrotic.

Additionally, excessive Ca antagonizes B availability and limits uptake of B, potassium (K), and magnesium (Mg). Therefore, limit Ca applications by avoiding calcium nitrate [$Ca(NO_3)_2$] –based fertilizers.

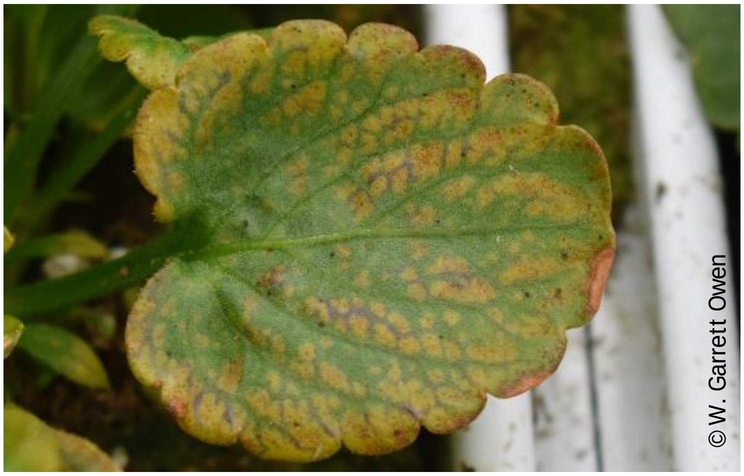

Figure 4. Low substrate pH causes toxic iron (Fe) and manganese (Mn) accumulation and symptoms of reddish-orange interveinal chlorosis of the lower leaves of pansies (*Viola* × *wittrockiana*). Photo by: W. Garrett Owen.

Figure 5. High substrate pH limits iron (Fe) availability, leading to symptoms of marginal chlorosis (yellowing) on the upper leaves of pansies (*Viola* × *wittrockiana*). Photo by: W. Garrett Owen.

Figure 6. High substrate pH limits iron (Fe) availability, leading to symptoms of interveinal chlorosis (yellowing) on the upper leaves of pansies (*Viola* × *wittrockiana*). Photo by: W. Garrett Owen.

Figure 7. As a result of high substrate pH, severely iron (Fe)-deficient pansies (*Viola* × *wittrockiana*) exhibit intensified interveinal chlorosis where recently matured leaves become white or bleached and mature leaves are also affected. Photo by: W. Garrett Owen and Brian E. Whipker.

Figure 8A. Pansies (*Viola* × *wittrockiana*) exhibiting distorted, clubby, and thick leaves and stems due to high substrate pH induced boron (B) deficiency. Photo by: W. Garrett Owen.

Figure 8B. Pansies (*Viola* × *wittrockiana*) exhibiting distorted, clubby, and thick leaves and stems due to high substrate pH induced boron (B) deficiency. Photo by: W. Garrett Owen.

Pansies are sensitive to high EC and are considered to require low fertility. During Stage 2 [radical, hypocotyl (stem), and cotyledons (seedling leaves) emergence] of plug production, provide 50 ppm N (Dole and Wilkins, 2005). At Stage 3, (true leaves develop), increase fertility and provide 100 ppm N weekly or at every two or three irrigations. At Stage 4 (toning or hardening off for transplant), increase fertility to 100 to 150 ppm N and provide as needed. From Stages 2 to 4 of plug production, maintain EC values below 1.0, 1.5, and 2.0 m mS/cm based on the PourThru method, respectively (Dole and Wilkins, 2005).

Once transplanted, continue to provide a low fertilization rate of 100 to 150 ppm N. In general, provide pansies with a fertilizer containing no more than 40% ammoniacal [ammonium + urea; (NH_3-N)] nitrogen or nitrate (NO_3-N) nitrogen should comprise >75% of the total N (Whipker et al., 2004b). During winter months when plants are grown under cooler temperatures, avoid fertilizers providing ammoniacal nitrogen because leaves may develop a blue-purple coloration similar to phosphorus (P) deficiency (Dole and Wilkins, 2005).

Routinely check substrate EC and maintain below 0.6, 1.3, or 2.0 mS/cm, based on the 1:2 Extraction, SME, or PourThru methods, respectively. When leaching is limited or crops are overfertilized or irrigated with water containing high amounts of dissolved salts, excessive EC injury can occur. Symptoms of high EC include poor plant growth and lower leaf chlorosis progressing to necrotic leaf margins (Fig. 9) (Whipker et al., 2004b). If EC levels begin to increase, switch to clear water irrigations to avoid a build-up of fertilizer salts in the substrate. If EC levels become excessive, then leach the substrate with clear irrigation water twice before providing fertility. It is best to monitor the crop to avoid excessive EC levels than to waste fertilizer by having to leach it out of the substrate.

In some instances, growers amend slow-release fertilizers into the substrate when growing in large containers or in areas of heavy rainfall where nutrients are removed from outdoor grown crops. After heavy rainfall, growers can provide 200 to 300 ppm N thereby replenishing leached nutrients (Whipker et al., 2004b). Regardless of fertility source, low EC results in stunted growth, lower leaf chlorosis (Fig. 10) or purpling caused by either P (Fig. 10) or zinc (Zn; Fig. 12) deficiencies or cold growing temperatures.

Summary

Providing pansies with a low level of fertility ranging from 100 to 150 ppm N and maintaining a substrate pH of 5.5 to 5.8 will prevent most nutritional disorders from occurring.

Literature Cited

Dole, J.M. and H.F. Wilkins. 2005. Floriculture: Principles and species. 2nd ed. Pearson Education, Inc., Upper Saddle River, NJ.

Figure 9. High soluble salts [referred to as electrical conductivity (EC)] cause poor growth of pansies (*Viola* × *wittrockiana*) and lower leaf chlorosis (yellow) progressing to necrotic (death) leaf margins. Photo by: W. Garrett Owen.

Figure 10. Low soluble salts [referred to as electrical conductivity (EC)] causes lower leaf chlorosis (yellowing) of pansies (*Viola* × *wittrockiana*). Photo by: Brian E. Whipker.

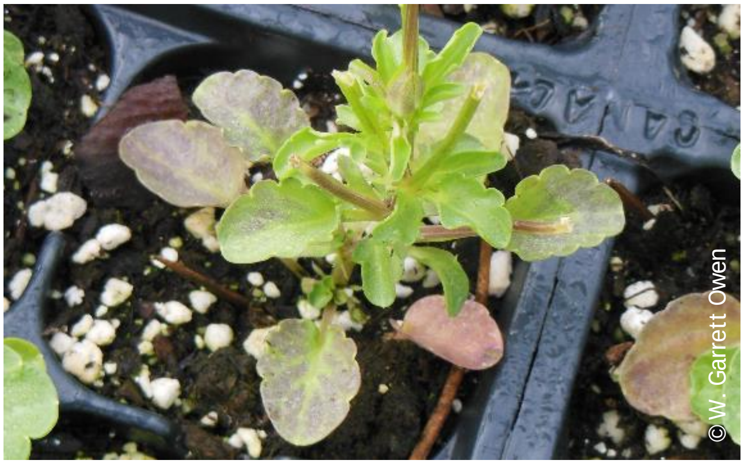

Figure 11. Lower leaf chlorosis and purpling of pansies (*Viola* × *wittrockiana*) can be a result of low soluble salts [referred to as electrical conductivity (EC)] and phosphorus (P) deficiency. Photo by: W. Garrett Owen.

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Figure 12. Lower leaf marginal leaf purpling is a symptom of zinc (Zn) deficiency in pansies (*Viola* × *wittrockiana*). Photo by: W. Garrett Owen.

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Table 1. Leaf tissue nutrient analysis for pansies (*Viola* × *wittrockiana*) grown with low substrate pH and recommended foliar nutrient concentrations for plants grown with the recommended level of fertility.

Element		**Reference Pansy** [1]	**Low pH** [2]
Nitrogen (N)	(%)	2.5 – 4.5	2.95
Phosphorus (P)		0.25 – 1.00	0.18
Potassium (K)		2.5 – 5.0	4.20
Calcium (Ca)		0.6 – 3.0	1.12
Magnesium (Mg)		0.25 – 0.75	1.43
Sulfur (S)		0.20 – 0.70	0.25
Sodium (Na)		0 – 0.5	0.75
Iron (Fe)	(ppm)	30 – 300	3,640
Manganese (Mn)		25 – 300	1,750
Zinc (Zn)		20 – 100	196
Copper (Cu)		5 – 40	4.4
Boron (B)		20 – 80	61.1

[1] Source: Whipker et al. (2014b)
[2] Values obtained from the lower leaves of mature symptomatic plants with excessively low substrate pH.

Corrective Procedures for Modifying Substrate pH and Electrical Conductivity (EC)

When the pH or substrate electrical conductivity (EC) drifts into unwanted territory, adjustments must be made. Below are the standard corrective procedures used to modify the substrate pH and EC for greenhouse grown crops in soilless substrates.

1. Low Substrate pH Correction

When Fe and Mn toxicity becomes a problem, adjust (raising) substrate pH to the recommended pH range. Corrective procedures to raise low pH levels are listed below. Switching to a basic fertilizer when the substrate pH is nearing the lower limit will help stabilize the pH. If the pH is below the recommended range, then corrective procedures will need to be implemented. Flowable lime is one option. Using a rate of 2 quarts per 100 gallons of water will typically increase the substrate pH by roughly 0.5 pH units. Two quarts can be used through an injector. Additional applications can be made if needed. Potassium bicarbonate ($KHCO_3$) can also be applied. A rate of 2 pounds per 100 gallons of water will increase the substrate pH by roughly 0.8 pH units. This treatment will also provide excessive potassium (K) and cause a spike in the substrate EC. A leaching irrigation with clear water is required the following day to restore the nutrient balance (the ratio of K:Ca:Mg) and lower the EC. As always, remember to recheck your substrate pH to determine if reapplications are needed.

pH Adjustment Recommendations

Flowable Lime

- Use 1 to 2 quarts per 100 gallons of water.
  Rinse foliage.
- Avoid damage to your injector by using rates of 2 quarts per 100 gallons of water, or less.
- Can split applications.

Hydrated Lime

- Mix 1 pound in 3 to 5 gallons of WARM water. Mix twice. Let settle. Decant liquid and apply through injector at 1:15.
- Caustic (rinse foliage ASAP and avoid skin contact)

Potassium Bicarbonate ($KHCO_3$)

- Use 2 pounds per 100 gallons of water
- Rinse foliage immediately.
- *Provides 933 ppm K.*
- Leach heavily the following day with a complete fertilizer to reduce substrate EC and restore nutrient balance.
- Rates greater than 2 pounds per 100 gallons of water can cause phytotoxicity!

2. High Substrate pH Correction

The target pH for many species is between 5.8 and 6.2. Higher pH values will result in Fe deficiency and lead to the development of interveinal chlorosis on the upper leaves. Check the substrate pH to determine if it is too high. Be careful when lowering the substrate pH, because going too low can be much more problematic and difficult to deal with.

Acid-based Fertilizer
If the substrate pH is just beginning to increase, then first consider switching to an acidic-based fertilizer. These ammoniacal-nitrogen (N) based fertilizers are naturally acidic and plant nitrogen uptake will help moderate the substrate pH over a week or two.

Acid Water Drench
Some growers use this intermediate correction if pH levels are not excessively high and a quick lower of the substrate pH is desired. Use sulfuric acid to acidify your irrigation water to a pH 4.0 to 4.5. Apply this acid water as a substrate drench providing 5 to 10% excessive leaching of the substrate. Rinse the foliage to avoid phytotoxicity. Results should be visible within 5 days. Retest the substrate pH and repeat if needed.

Iron Drench
If the levels are excessively high, then an Fe chelate application can be made to the substrate.
Below are the options.

Iron Chelate Drench (options)

- Iron-EDDHA: mix 5 ounces in 100 gallons of water
- Iron-DTPA: mix 5 ounces in 100 gallons of water
- Iron sulfate: mix 4-8 ounces in 100 gallons of water

- Apply as a substrate drench with sufficient volume to leach the pot.
- Rinse foliage immediately.
- Avoid use on iron efficient plants (geraniums).

3. Low EC Correction

If low EC problems occur, increase the fertilization rate to 300 ppm N for a few applications before returning to the recommend fertilization rate for the crop.

4. High EC Correction

Excessively high fertilization rates will result in a marginal leaf burn. Check the substrate EC to confirm your diagnosis. Values greater than 6.0 mS/cm based on the PourThru sampling method can be problematic for many plants.

Switch to Clear Water Irrigations
If the substrate EC is just beginning to increase over time, then leach with a few clear water irrigations to lower EC levels by flushing out the salts.

Clear Water Leaching
If the EC values are excessively high, leach the substrate twice with back-to-back clear water irrigations. Then allow the substrate to dry down normally before retesting the EC. If EC levels are still too high, repeat the double leach. Once the substrate EC is back within the normal range, use a balanced fertilizer at a rate of 150 to 200 ppm N.

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