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Managing Fall Pansy Fertilization

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Monitoring and management of pansy fertilization requires a balancing of the plants needs. Growers must be aware and manage the root substrate pH, electrical conductivity (EC), and provide adequate, but not excessive, levels of all the essential elements for pansies. Optimal pH and EC levels for both the saturated media extract and the PourThru method are listed in Table 1. Table 1 also contains optimal nutrient levels based on the saturated paste extraction method. Differences are listed for plant age and growing conditions. Conducting root substrate testing either in-house or through a commercial lab will help insure that your fertility program is on target. Ideally, testing should be conducted every 2 weeks and plotted in order to detect trends before any deficiency or toxicity symptoms appear. Tips on conducting PourThru Monitoring are available from the NC State University Website at: *pourthruinfo.com*.

pH. The pH of your root substrate (medium) dramatically influences nutrient availability to plants for either a soil-based substrate or an organic soilless substrate. Therefore, it is important to maintain the root substrate pH within a range which provides "adequate" availability of all essential elements. A substrate pH above 5.8 for pansies grown in a soilless root substrate can result in boron (see Boron) or iron deficiencies (Figure 1). In addition, the incidence of black root rot caused by the fungus *Thielaviopsis basicola* also increases at substrate pHs >5.8. A very low pH below 4.8 can result in micronutrient toxicities.

Nutrient availability and subsequent plant growth can be adversely affected by high substrate and irrigation water pH. However, the major factor regulating pH rise in substrate

Keys to Success:

1. ***Maintain the substrate pH between 5.4 and 5.8.***
2. ***Provide a complete, balanced fertilizer at the rate of 125 ppm N under low leaching conditions.***
3. ***Use an acidic, low P fertilizer.***
4. ***Provide additional B if needed.***

Fig. 1. The young growth develops interveinal chlorosis (yellowing) when the pH is above 6.2.

Fig. 2. Excess fertilizer applications and growing the crop on the dry side can lead to a marginal necrosis.

solutions is the degree of alkalinity of the irrigation water. If the irrigation water contains a high concentration of carbonates and bicarbonates, the substrate solution pH will rise to undesirable levels during plant production. Test your water to determine your alkalinity level. Take corrective actions like injecting acid to neutralize alkalinity if required. The optimal pH varies by the root substrate used. The range for a soilless root substrate is 5.4 to 5.8 and for a soil-based substrate is 5.6 to 6.0 (Table 1).

Listed below are rapid corrective measures to use to adjust the root substrate pH in pots already containing plants. The materials listed may burn the foliage. Apply only to the root substrate. Rinse the plant's leaves if any solution comes in contact. Some plants may be sensitive, so test a small area or a few plants before treating a large area. Adjustment of pH is rapid, but effects are not long lasting. Recheck the pH in a week and reapply if necessary.

1. To Lower pH: (select one)

Option 1: Dissolve 1 to 2.5 pounds of iron sulfate [$FeSO_4 \cdot 7H_2O$] in 100 gallons of water. Apply to the root substrate and rinse the foliage after application. Iron sulfate may increase the root substrate EC level and may release toxic levels of minor elements from the root substrate's exchange sites.

Option 2: Add sulfuric acid to clear irrigation water until the pH is around 4.5. Apply to the root substrate as a drench. Rinse off foliage. Retest substrate pH and reapply if needed until the pH is within the desired range.

2. To Raise pH: (select one)

Option 1: Apply flowable limestone products as a substrate drench. Start with a rate of 1 to 2 quarts per 100 gallons of water. Lightly mist off any solution from the foliage after applying.

Option 2: Mix 2 pounds of potassium bicarbonate in 100 gallons of water. Apply as a substrate drench with at least 30% leaching. Lightly mist off any solution from the foliage after applying. This treatment supplies 933 ppm K, but does not supply Ca or Mg, which could be low when the substrate pH is acidic. Therefore to restore nutrient balance, apply a complete, basic-type fertilizer using moderate leaching one day after the potassium bicarbonate application.

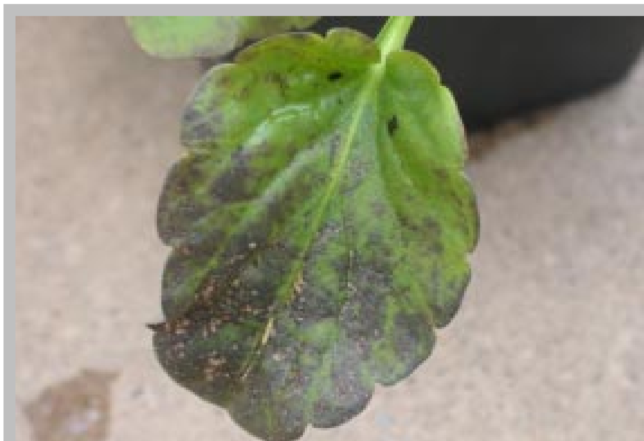

Fig. 3. Phosphorus deficiency can result when plants are held without fertilizer and the lower leaves turn purple.

Option 3: In a plastic bucket, mix 1 pound of hydrated lime with 3 to 5 gallons of warm water. Allow the mixture to settle and pour off the clear solution into another plastic bucket. Apply the clear solution with a fertilizer injector set at 1:100 or 1:128. Hydrated lime is corrosive, avoid contact with skin and metal. Hydrated lime may displace ammonium from the root exchange sites of the root substrate into the soil solution causing root injury. Avoid using hydrated lime if high levels of ammonium fertilizer are present in the root substrate. Lightly mist off any solution from the foliage after applying.

Electrical Conductivity (EC). Soluble salts refer to the total dissolved salts in the root substrate (medium) at any given time and is measured in terms of electrical conductivity (EC). Nitrogen and potassium are the main fertilizer materials contributing to the EC concentration of the root substrate. In some areas, high sodium in the irrigation water can also contribute to the EC.

Excess salts accumulate when leaching during irrigation is insufficient, too much fertilizer is applied, or the irrigation water contains a high amount of dissolved elements. Excessively high EC readings are associated with poor plant growth. Plant symptoms often begin on the lower leaves as leaf chlorosis and progress to necrotic leaf tip margins (Figure 2). If the root substrate is allowed to dry down, plants may also exhibit wilting symptoms because of dieback of the root tips, which further inhibit water and fertilizer uptake. High EC has also been linked with the increased incidence of *Pythium* root rot.

At the opposite end of the spectrum, when the EC content of the root substrate is too low, plant growth is stunted from lack of fertilizer. Symptoms of low EC typically are lower leaf yellowing (nitrogen deficiency) or lower leaf purpling (phosphorus deficiency).

Maintain EC levels between 0.75 to 1.5 mS/cm to promote good growth (Table 1). See notes under nitrogen for fertilization tips during periods of excessive leaching due to hurricanes.

Nitrogen (N). Plants with N deficiency exhibit slow growth, stunting, lack of lateral shoot growth, or with advanced conditions lower leaves initially turn greenish-purple to yellow (chlorosis). Leaf abscission occurs after prolonged deficiency conditions. Excess levels of N will result in a darker green color, reduced plant growth, and delayed flowering.

A fertilization rate of 125 ppm N on a constant liquid fertilization or 175 to 200 ppm N constant liquid fertilization with excessive leaching (outdoor production) is recommended. Table 1 lists specific fertilization recommendations based on growth stage and fertilization practices.

Some growers find the addition of slow release fertilizer in larger pots or tubs to be beneficial, especially in the South where heavy rainfall during hurricanes remove all the nutrients. Another common practice used after a hurricane is to immediately fertilize pansies with around 200 to 300 ppm N which helps restore the nutrient charge, even though the substrate is already thoroughly saturated from the rain. This avoids having the plants stall due to the lack of fertilizer.

Phosphorus (P). Most substrate mixes have a preplant P charge. This should provide ample levels of P to the plants. Because pansies prefer acidic conditions, most growers are using acidic fertilizers like 20-10-20. Remember that 20-10-20 applied at the rate of 200 ppm N will supply 44 ppm of P – more than what is required! In fact, P applications should be limited in order to keep the plants compact. No more than 5 to 10 ppm P should be applied (Table 1).

P deficiencies can occur and are first expressed as stunting with the leaves turning darker green, followed by the lower leaves becoming reddish-purple (Figure 3). The reddish-purple coloration can be caused by lack of P, root rot, wet substrates, and cool temperatures. So if you see the lower leaves turning purple, the first step is to check the roots.

Potassium (K). A fertilization rate of 104 ppm K constant liquid fertilization or 145 to 166 ppm K constant liquid fertilization with excessive leaching (outdoor production) will provide ample K (Table 1). Potassium fertilization rates >200 ppm can have an antagonistic effect on Ca or Mg uptake by the plant. Supplying the plants with a K : Ca : Mg ratio (ppm) of 4 : 2 : 1 will limit any antagonisms.

Deficiency symptoms first develop on the medium to older leaves as a darker green color, which progress to marginal leaf necrosis (browning), and plants develop short compact internodes with few lateral shoots. K deficiency is rarely observed.

Calcium (Ca). A fertilization rate of 50 to 100 ppm Ca constant liquid fertilization will provide ample Ca (Table 1). For many locations, there is ample Ca in the irrigation water. For many areas of the Southeast and Northeast, Ca additions are required. This is especially important if you are using a fertilizer that does not contain Ca, like 20-10-20.
Deficiency symptoms are initially expressed as stunted plant growth, and death (blackening) of terminal buds and roots. Young leaves are strap-like with necrotic spots, that develops to complete necrosis over time.

While providing some Ca to pansies is good, avoid adding too much. Boron deficiency induced by excess Ca applications, specifically with the use of calcium nitrate ($Ca(NO_3)_2 \cdot 4H_2O$), can easily occur.

Magnesium (Mg). A fertilization rate of 25 to 50 ppm Mg constant liquid fertilization will provide ample Mg (Table 1). Many areas have ample Mg in their irrigation water, but this is not always the case in the Southeast and Northeast where Mg additions are required. This is especially important if you are using a fertilizer that does not contain Mg, like 20-10-20.

Initially deficiency symptoms develop as an interveinal chlorosis (yellowing) of older, lower leaves. Upward curl of the leaves is possible. With advanced conditions, the leaves rapidly turn chlorotic to necrotic (dead, brown tissue).

Table 1. Optimal fertilization and substrate nutrient levels for pansies.

Item	Units	Optimal range[a] Seedlings	Optimal range[a] Finishing	Comments
pH		5.4 to 5.8	5.4 to 5.8	*Rotate between acid-residue and basic-residue fertilizers to help maintain pH levels between 5.4 and 5.8. *Too low of a pH can induce Mg deficiency. *Too high of a pH can induce B and Fe deficiencies, and lead to an increased incidence of *Thielaviopsis basicola*.
EC	mS/cm	0.25 to 0.5 -or- 0.375 to 0.75	0.75 to 1.5 -or- 1.12 to 2.25	(Based on the SME method) (Based on the PourThru method)
N	ppm	Until the 1st true leaves, 50 ppm N every 3 to 5 days 1st true leaves to plug transplant, 100 ppm N every 3 to 5 days	125 ppm constant liquid fertilization without leaching -or- 175 to 200 ppm constant liquid fertilization if leaching is excessive (outdoor production) -or- 225 to 275 ppm with weekly fertilization under minimum leaching	*Nitrate-nitrogen should comprise >75% of the total N, with the remainder being ammoniacal-N or urea-N.
P	ppm	Limit P applications to avoid stretching.	Provide limited amounts of P to avoid stretch (5 to 10 ppm)	*Do not preplant incorporate P into the root substrate to avoid stretch.
K	ppm	Until the 1st true leaves, 41 ppm K every 3 to 5 days 1st true leaves to plug transplant, 83 ppm K every 3 to 5 days	104 ppm constant liquid fertilization without leaching -or- 145 to 166 ppm constant liquid fertilization if leaching is excessive (outdoor production) -or- 187 to 228 ppm with weekly fertilization under minimum leaching	
Ca	ppm	25 to 50	50 to 100	
Mg	ppm	12.5 to 25	25 to 50	*Mg deficiencies can be encountered if: 1) the pH is too low or 2) if K or Ca levels are too high with respect to Mg levels.

[a]Ranges based on the saturated paste extract method. Fertilization levels would be 25% to 50% lower with a subirrigation or reduced leaching irrigation program in order to achieve similar substrate nutrient levels as with a 20% leaching program.

If your fertilizer does not contain adequate levels of Mg, another option is monthly applications of magnesium sulfate (Epsom Salts) ($MgSO_4{\cdot}7H_2O$). Apply at the rate of 1 to 2 pounds per 100 gallons of water. Do not mix with other fertilizers to avoid possible precipitates.

Boron (B). Boron deficiency can be a serious problem with pansies. Symptoms are initially expressed on the new leaves and stems, with the young growth being thick texture strap-like (Figure 4). With advanced conditions, death of the growing point can occur, thus resulting in axillary shoot growth. It is important to prevent B deficiency before symptoms appear because growing point death or distorted leaves can not be reversed. If deficiency symptoms are severe, it is rarely economical to try to reverse the damage. It is more economical to dispose of the crop and start over.

Excessive levels of Ca can have an antagonistic effect on B availability and growing the crop at substrate pHs above 6.2 can tie up B. Make sure your fertilizer or irrigation water contains ample levels of B. Limit excessive Ca applications by avoiding calcium nitrate based fertilizers. Maintain the pH within the acceptable range of 5.4 to 5.8 to assure B is readily available to the plant. Some growers are supplying a weekly B drench application to the plants for the first three to four weeks of the crop as a preventative measure. 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.

Which Fertilizer to Use?

Based on the nutritional needs of pansies, there are a number of fertilization strategies that would work. If your system is working, don't change it. But if you want to change, there are four factors to consider when selecting a pansy fertilizer.

1. Pansies prefer a lower pH, so is the fertilizer acidic?
2. Most acidic fertilizers are high in ammoniacal-nitrogen and phosphorus. Height control of pansies during the summer is difficult enough without supplying too heavy of a dose of either of these. Does the fertilizer have less than 30% ammoniacal-nitrogen and a low amount of P?
3. Does the mix supply all of the essential elements? Is there enough Ca and Mg supplied by your irrigation water or does it need to come from the fertilizer?
4. Where are the microelements?

Based on these criteria, no single fertilizer fulfills all those requirements. All of the special pansy blends are excellent fertilizers, but they are basic. This can cause the pH to increase, even though pansies prefer an acidic pH. What to do? Rotate fertilizers! Use the Pansy Fertilizers (15-2-20, 15-3-30, or 13-2-13) to provide adequate levels of Ca, Mg, and micros, but have low amounts of P and ammoniacal-nitrogen. Then use a fertilizer like 21-5-20 which is acidic and has a low amount of P. Monitor the pH to make sure it stays within the acceptable range of 5.4 to 5.8. This type of a fertilization program will keep your pansies on track.

Fig. 4. Boron deficiency is the most significant nutritional problem of pansies. Symptoms of distorted new growth is typical and occurs more frequently on blue cultivars (Photo A). Rarely do plants grow out of boron deficiency. Another typical symptom of boron deficiency is if new growth occurs, it comes from the base of the plant and not the growing point (Initial symptoms in Photo B and new growth 1 week later in Photo C).