Crop Production

Calibrachoa Response to Chemical and Organic Fertilizers

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Interest in organic fertilizers is growing in the greenhouse industry, but experience and trials are not keeping up. There is little information available on how well the new types of fertilizers provide nutrition for plants compared to traditional water-soluble chemical fertilizers. The most widely available "organic" fertilizers for application like traditional water-soluble fertilizers are fish fertilizers and Daniels fertilizers.

Many growers are familiar with fish fertilizers made from waste products of the ocean fish processing industry. The material is a thick, heavy liquid supplying plant nutrients at presumably varying levels of availability. Fish fertilizers probably supply mostly ammonium nitrogen which could be a disadvantage for some plants. Also, fish fertilizers can be a problem to store diluted because they spoil and they can be difficult to inject through some systems. In our area the Neptune's Harvest brand is the most commonly available fish fertilizer and it is OMRI-approved for organic greenhouses.

Daniels 10-4-3 is a liquid, "organically-based" fertilizer currently used with great success by many growers. The organic portion is oilseed extract. Most of the nutrients, however, are derived from inorganic salts and for this reason it cannot be certified as being organic.

Daniels Pinnacle 3-1-1 is a less well-known liquid fertilizer. It is an organic fertilizer, most nutrients are derived from oilseed extract and extra nitrogen is provided by sodium nitrate ("Chilean nitrate"). In my opinion this fertilizer is a great step forward in finding organic fertilizers that can be easily applied by growers using the systems to which they are accustomed. However, Pinnacle spoils after dilution and it does not seem to provide adequate nutrition at the labels rates with the result that growth is reduced and nutrient deficiency symptoms develop.

This objective of this project, supported by a grant from New England Floriculture, Inc., was to determine the response of calibrachoa to several different types of greenhouse fertilizers and to determine by foliar analysis their nutrient supplying ability. In the case of Daniels Pinnacle an explanation of the poor plant results was sought. Calibrachoa makes a good test plant because of its high fertility and acidic pH requirements and its tendency to respond to a variety of nutrient problems by developing leaf chlorosis (Dole, et al., 2010).

How the plants were grown

Rooted liners of calibrachoa 'Million Bells Cherry Red', taken as 2½-inch cuttings on 22 February 2010, were potted on 8 March in 4-inch pots of Fafard FOF30 organic soilless mix. On 22 March, after a two week establishment period, plants were watered as need with solutions supplying 225 ppm N in five fertilizer treatments: Plantex High Nitrate 20-2-20, Daniels 10-4-3, Daniels Pinnacle 3-1-1, Neptune's Harvest Hydrolyzed Fish Fertilizer 2-4-1, or alternating application of Daniels Pinnacle and fish fertilizer. There were 8 plants per treatment. Fertilizer treatments were applied 14 times during the course of the experiment and some plain waterings were done as needed.

On 26 April, after substantial growth was made by the plants, the experiment was ended. Shoot dry weight was determined as a measure of growth. Leaves from the terminal 2-3" of each shoots were harvested for nutrient analysis. Growth medium samples were collected to determine EC and pH.

Results

Plant growth and appearance. Plants fertilized with Plantex produced the greatest shoot dry weight and those with Daniels Pinnacle the least (Table 1). Due to the naturally irregular growth habit of the trailing calibrachoa the only treatment visually distinguishable from the others was Pinnacle which had the smallest plants. The terminal (youngest) leaves and small developing shoots of Pinnacle plants were severely chlorotic and somewhat smaller compared to similar leaves from the other treatments (Figures 1 and 2).

Figure 1. Close-up of chlorosis occurring with Pinnacle fertilizer.

Figure 2. Plantex plant (left) and Pinnacle plant (right).

Table 1. Fertilizer effects on calibrachoa dry weight and growth medium EC and pH.

Fertilizer	Shoot dry wt. (gm)	EC (mmho/cm)	pH
Plantex 20-2-20	9.8a[z]	1.57a	5.22b
Daniels 10-4-3	8.0ab	0.83bc	5.55b
Daniels Pinnacle 3-1-1	6.0c	0.62c	7.22a
Neptune's Fish Fertilizer 2-4-1	7.5bc	1.06b	5.47b
Pinnacle + Fish	8.1ab	1.21a	5.44b

[z]Means followed by different letters are statistically different at P=0.01

EC and pH. Growth medium EC (soluble salts) was significantly lower with both Daniels fertilizers compared to the other treatments (Table 1) suggesting lower fertility, but it's more likely that the organic nutrient sources in these fertilizers were not detected by the EC test. More importantly was the high pH, 7.22, found with Pinnacle. In New England a growth medium pH this high is normally seen only when the irrigation water has high alkalinity or the grower has intentionally made treatments to raise pH. For calibrachoa, a pH between 5.4 and 5.8 is considered optimum due to its susceptibility to iron deficiency. pHs in the other fertilizer treatments were about in this lower, acidic range.

Leaf analysis. Examination of Table 2 shows quite a few significant differences in nutrient content of calibrachoa due to fertilizer type. These differences might be due to the NPK analysis of the fertilizer; the presence, absence, or level of other elements in the fertilizer, or the affect of the fertilizer on pH or other nutrient process in the growth medium. Also, organic fertilizers like fish emulsion can be very complex materials with numerous sources of nutrients. The least difference in nutrient content occurred between Plantex and Daniels 10-4-3; the higher level of potassium (K) with Plantex probably is a reflection of the higher K analysis of this fertilizer. Fertilization with fish emulsion resulted in the highest N, phosphorus (P),

Table 2. Fertilizer effects on the nutrient content of calibrachoa leaves.

Fertilizer	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	B (ppm)	Fe (ppm)
Plantex 20-2-20	5.19a[z]	0.47c	4.06a	1.05b	0.79a	36c	124a
Daniels 10-4-3	5.03ab	0.46c	2.54c	1.11b	0.91a	41bc	100a
Daniels 3-1-1	3.86c	0.35c	4.28a	0.54c	0.48b	47a	80b
Neptune's Fish Fertilizer 2-4-1	5.20a	1.81a	1.61d	1.61a	0.93a	37c	77b
Pinnacle + Fish	4.57b	0.98b	3.46b	0.89b	0.76a	44ab	94a

[z]Means followed by different letters are statistically different at P=0.01

and calcium (Ca) contents and the lowest K of all the treatments. The P level resulting from fish emulsion was unusually high.

Results with Daniels Pinnacle were most interesting. Nitrogen, P, K, Ca, magnesium (Mg), and iron (Fe) were lowest and K and boron (B) were the highest of all fertilizer treatments. Alternating Pinnacle with fish emulsion fertilizer resulted in higher levels of leaf N, P, Ca, Mg, and Fe, but K and B were lower compared to Pinnacle alone.

Conclusions

Fertilization of calibrachoa with Plantex, Daniels 10-4-3, Neptune's Fish Fertilizer, and Pinnacle alternating with fish fertilizer produced plants with similar dry weights without excess soluble salts, about the same acidic pH, and no foliar symptoms of nutrient deficiency. In most cases the nutrients in the leaves (with some notable significant differences in the levels of some elements between certain treatments) met or exceeded the concentrations found in non-deficient controls in an earlier study with calibrachoa (Williams, 2004).

Plant growth was significantly reduced compared to the other treatments, growth medium pH was much higher, and severe chlorosis developed on the leaves and new branches at the stem terminals of calibrachoa fertilized with Daniels Pinnacle 3-1-1.

The concentrations of all the nutrients in the Pinnacle plants, except K and B, were lower than the other treatments, making it tempting to attribute poor growth and chlorosis to a "general" nutrient deficiency. But only B, Ca and Fe deficiency symptoms would normally occur on the terminals of the stems and in calibrachoa the deficiency symptoms of these elements is similar. It's interesting to note that when Pinnacle and fish fertilizer were alternated the dry weight was similar to the other treatments, leaf nutrient levels increased and no deficiency symptoms occurred, and pH was markedly lower.

What is the cause of the growth reduction and severe chlorosis? Boron is not the likely cause because the B concentration equaled or exceeded that in the plants treated with other fertilizers. Calcium and Fe are more likely suspects. Williams (2004) in reported that deficiency symptoms for Ca and Fe showed most quickly in her experiments. Low Ca might be the problem because the level in Pinnacle leaves was so much lower compared to the other treatments and it was close to the initial deficient level of 0.37 % reported by Williams (2004). However, normally Ca deficiency would not be expected at a pH of 7.22 (but what aspect of the Pinnacle fertilizer made the growth medium pH reach such a high level and how Ca might be involved is unknown to me). My results suggest that Fe deficiency was the most likely cause of chlorosis because high growth medium pH favors the occurrence of Fe deficiency, if left uncorrected Fe deficiency causes stunting of calibrachoa, and the Fe level in the leaves of Pinnacle plants was very close to the initial deficiency level reported of 77.5 ppm by Williams (2004).

References

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