e-GRO Nutritional Monitoring



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Nutritional Monitoring Series

Ornamental Cabbage and Kale

(Brassica oleracea var. acephala)

American Floral Endowment
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Ornamental cabbage and kale are excellent plants for fall color. Plants require medium levels of fertilization, growing optimally with 150 to 200 ppm N. The target substrate pH values are between 5.8 and 6.2. The most common nutritional disorder of ornamental cabbage and kale is providing insufficient fertility, which results in lower leaf chlorosis (yellowing) and drop. In addition, like all members of the cabbage family, they are unforgiving if drought stressed and if wilted may exhibit stalled growth.

Figure 1. Low soluble salts [referred to as electrical conductivity (EC)] results in lower leaf yellowing (chlorosis) of green leafed cultivars [right] or reddening of red leafed cultivars [left] of ornamental cabbage and kale. Photo: Brian E. Whipker.

Target Nutrition Parameters

pH Category III:
5.8 to 6.2

Fertility Category:
Medium
150 to 200 ppm N

EC Category B:
1:2 Extraction:
0.6 to 0.9 mS/cm

SME:
1.3 to 2.0 mS/cm

PourThru:
2.0 to 3.0 mS/cm

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Figure 2. If the electrical conductivity (EC) is too low early in the production cycle, plant growth will be limited or even stunted. Carefully monitor the plant growth to avoid excessively low fertility which will result in lower leaf discoloration and leaf drop. Photo: Brian E. Whipker.

Figure 3. Excessively low soluble salts [referred to as electrical conductivity (EC)] ultimately results in lower leaf loss of ornamental cabbage and kale. Photo: Brian E. Whipker.

Fertility Management of Ornamental Cabbage and Kale

Ornamental cabbage and kale require medium levels of fertility. Growers should maintain fertilization at 150 to 200 ppm N during periods of normal growth. Low soluble salts [referred to as electrical conductivity (EC)] results in lower leaf yellowing (chlorosis) of green leafed cultivars or reddening of red leafed cultivars (Fig. 1). If the EC is too low early in the production cycle, plant growth will be limited or even stunted (Fig. 2). For growing plants in smaller sized pots, growers often use half the recommended fertility rate. They then carefully monitor the plant growth to avoid excessively low fertility which will result in lower leaf discoloration and leaf drop (Fig. 3).

For finishing, earlier recommendations suggested stopping fertilization to enhance coloration of plants. Coloration is a function of temperature, and color development is enhanced by temperatures in the 50 to 55 °F (10 to 13 °C) range. While the vibrancy of color development will be hindered by excessive fertilization, adequate fertilization rates still need to be provided to maintain overall plant quality. Research by Jamie Gibson during his M.S. program at NC State University (Dr. Gibson is currently with Syngenta) found that plant growth continues during coloration. These newly developing leaves have a high demand for nutrients as they grow. If fertilization is curtailed, this will result in the plant moving (translocating) the mobile elements [nitrogen (N), phosphorus (P), and potassium (K)] from the lower leaves to the new growth. This results in the development of nutrient deficiency symptoms of lower leaf yellowing or reddening, and ultimately leaf loss. To avoid lower leaf loss, it is common near coloration time to lower the fertility to around 100 ppm N and monitor the plants for signs of deficiencies – making adjustments as needed. Additional details about fertilizer strategies for ornamental cabbage and kale can be found in e-GRO Alert 3.45 Ornamental Cabbage and Kale: Avoiding Lower Leaf Loss (Whipker, 2014).

Another fertility strategy used by ornamental cabbage and kale growers for outdoor produced crops, is to provide a half rate of slow release fertilizer. This helps maintain a baseline level of fertility in the pots even if there are periods of heavy rain (i.e,,: tropical storms delivering 2+ inches of rain). The remaining fertilizer needs are provided by liquid fertilizer applications and can be adjusted over time as required.

Also note that drought stress will result in lower leaf chlorosis and leaf loss (Fig. 4). Ornamental cabbage and kale plants do not perform well when wilted and may not fully recover.

On the opposite end of the spectrum is excessive EC. High EC can lead to marginal chlorosis or browning (necrosis) of the lower and/or upper leaves (Fig. 5). Leaf margin chlorosis on the younger leaves will result in a cupping of the leaves as they continue to grow. If the EC increases beyond optimal levels, apply a few irrigations with clear water to lower it. If the EC is excessively high, apply two clear water irrigations to leach excess salts (but this more drastic step results in wasting your fertilizer investment and can be avoided by monitoring the EC and taking action before it becomes excessive).

Figure 4. Drought stress of ornamental cabbage and kale will also result in lower leaf yellowing and leaf loss. Symptoms can mimic a low electrical conductivity (EC) situation. Photo: Brian E. Whipker.

Substrate pH should be maintained between 5.8 and 6.2. Lower or higher values beyond this range commonly lead to low or high pH induced nutritional disorders. High pH inhibits iron (Fe) uptake, causing interveinal chlorosis of the upper foliage (Fig. 6).

On many species, low substrate pH results in excessive uptake of Fe and manganese (Mn), which leads to toxicity symptom development. Toxicity of Fe and Mn exhibits symptoms of a lower leaf purplish coloration with black spotting. This has not been observed with ornamental cabbage and kale by the authors in greenhouse production.

Figure 5. High soluble salts [referred to as electrical conductivity (EC)] due to an over-application of fertilizer can lead to marginal leaf browning and death (necrosis). Symptoms are typically observed after the plants were drought stressed. Photo: Brian E. Whipker.

Figure 6. High substrate pH leads to interveinal yellowing (chlorosis) on the upper foliage. Photo: Brian E. Whipker.

Summary
Maintaining moderate fertility at 150 to 200 ppm N and a pH of 5.8 to 6.2 will enable you to grow healthy ornamental cabbage and kale while preventing high pH induced nutritional disorders.

Literature Cited

Gibson, J.L., D.S. Pitchay, A.L. Williams-Rhodes, B.E. Whipker, P.V. Nelson, and J.M. Dole. 2007. Nutrient deficiencies in bedding plants: A pictorial guide for identification and correction. Ball Publishing, Inc., West Chicago, IL.

Whipker, B.E. 2014. Ornamental cabbage and kale: avoiding lower leaf loss. e-GRO Alert 3-45, p. 5.

Table 1. Recommended range of leaf tissue analysis for ornamental cabbage and kale (*Brassica oleracea var. acephala*).

Element	Recommended Range [1]
Nitrogen (%)	3.50 – 4.50
Phosphorus (%)	0.20 – 0.60
Potassium (%)	3.00 – 4.00
Calcium (%)	0.50 – 1.00
Magnesium (%)	0.20 – 0.40
Sulfur (%)	0.25 – 1.00
Iron (ppm)	50 – 300
Manganese (ppm)	59.7 – 77.5
Zinc (ppm)	20 – 75
Copper (ppm)	3 – 10
Boron (ppm)	20 – 40
Molybdenum (ppm)	Not reported

[1] Source: Gibson et al. (2007)

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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