

Revising the Fertilization Strategy for Ornamental Cabbage

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Introduction

Ornamental cabbage (*Brassica oleracea* var. *acephala* L.) is an important fall crop for the southeastern U.S. Fertilizer recommendations for ornamental kale and cabbage vary by source. American Takii (1992) suggests “giving enough pre-plant fertilizers and side-dressing is the key for better growth”, while more exact recommendations are given by Marquardt and Schlemmer (1996) who suggest fertilizing with N at 150 ppm ($\text{mg}\cdot\text{L}^{-1}$). McAvoy (1994) and Luczai (1992) recommend N at 50 to 100 ppm during the seedling stage, followed by N at 200 to 300 ppm after transplanting. The above sources suggest fertilizers should be “reduced”, “discontinued”, or “not be present in the soil” during color development in the upper-central foliage, which occurs when temperatures are 55°F (13°C) or lower. Excessive fertilization is thought to inhibit coloration development (Luczai, 1992).

Discontinuing fertilization to induce coloration may be inappropriate because these plants are still actively growing at cool temperatures. Although color development is important for sales of ornamental cabbage, discontinuing or reducing fertilization may induce nutrient deficiencies. Low fertility may promote nutrient deficiencies that result in yellowing (nitrogen deficiency), purpling (phosphorus deficiency),

and defoliation of the basal leaves (Whipker et al., 1998) (Figure 1). Nutrient deficient plants develop chlorotic or necrotic leaves, thus resulting in limited sales.

Vague fertilization recommendations leave growers balancing between excessive and deficient nutrient conditions. Establishing fertilization guidelines allow growers to monitor and manage their own fertilization program for producing top-quality ornamental cabbage. Research was conducted at NCSU to establish a fertilization strategy.

The first objective was to investigate the optimal N to K ratio for ornamental cabbage by comparing



Figure 1. Lower leaf yellowing and loss due to nitrogen deficiency.

overall growth, foliage characteristics and macronutrient leaf tissue concentration values. The second objective was to investigate the effects of discontinued fertilization on ornamental cabbage during coloration.

Materials and Methods

Experiment 1. ‘Osaka White’ ornamental cabbage plants were provided a continual liquid fertilization program based on a 4 x 1 x 4 N-P-K factorial experiment (16 fertilizer treatments) with N and K ranging from 100, 150, 200, to 250 ppm and P held constant at 10 ppm. Plants were grown under natural daylength with greenhouse day/night setpoint temperatures of 18.3/15.5°C (65/60°F) until 6 Apr. From 6 Apr. until 22 Apr., the plants were placed in a cooler set at 7.2°C (45°F) for 12 HR (19:00 to 07:00) to induce coloration and returned to the greenhouse during the day. Data were collected on total plant height, (measured from the pot rim to the top of the plant), plant diameter (measured at the widest dimension and then turned 90 degrees), and color diameter of the center foliage.

Experiment 2. ‘Osaka White’ ornamental cabbage plugs (288-cell) were transplanted into 8-inch round plastic containers on 29 Aug. 1999. A continual liquid fertilization program was initiated on 5 Sept. with three N treatments of 150, 200, to 250 ppm. For all N rates, P and K were held constant at 8.8 ppm and 166 ppm, respectively. Magnesium sulfate ($MgSO_4 \cdot 7H_2O$) was applied every 4 weeks. B-Nine foliar sprays at 2,500 ppm were applied on 13 and 30 Sept.

On 29 Aug. plant height and plant diameter were recorded, and tissue collected every two weeks until 12 Dec. The center foliage color diameter was measured (when visible) to determine if fertilization affected coloration. Shoots were harvested to determine dry weight (g).

A sub-group of plants were irrigated with tap water during the coloration stage (12 to 18 weeks

after potting); data was collected to demonstrate the effects of applying no additional fertilizer to ornamental cabbage, and was compared to plants fertilized on a continual basis.

Results and Discussion

Experiment 1. The N x K interaction was not significant, therefore the effects of the four nitrogen rates were investigated. Plants increased in height over the 13 week period, with plants fertilized with N at 200 or 250 ppm being 10% taller than with N at 150 ppm, and 30% taller than with N at 100 ppm (Figure 2). No further increase in growth was observed after week 10 for plants fertilized with N at 100 ppm, and nitrogen deficiency symptoms (purpling with a lighter green color of the lower foliage) appeared.

Coloration was first observed 12 weeks after sowing, and was measured from week 13 until termination of the experiment. All plants fertilized with N at 100 to 250 ppm had similar sized color diameters 2.0 to 2.5 inches (5.3 to 6.7 cm). N

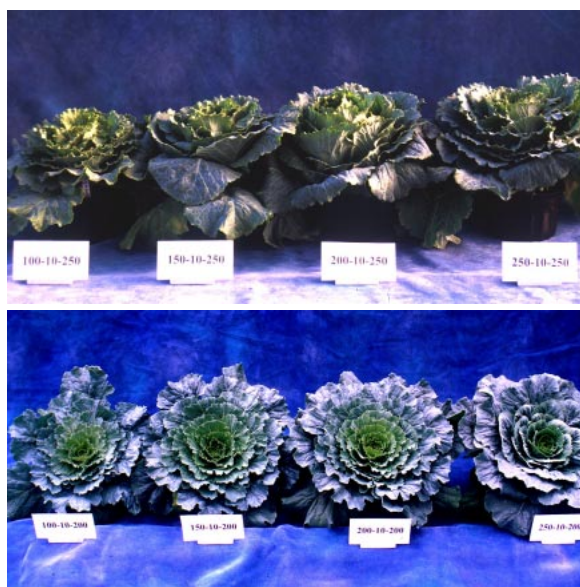


Figure 2. Plant growth was less at the lower fertility rates (left to right: 100, 150, 200, or 250 ppm N).

rates of 200 and 250 ppm did not deter coloration, which contrasts reports by Luczai (1998).

Experiment 2. There were no significant differences between the heights of plants fertilized with N at 150, 200, or 250 ppm. However, plant height increased until week 12, then became shorter. This reduction in height is due to expansion of the colored foliage which arises from a central stem causing the upper foliage to flatten and bend downward. Diameters of plants fertilized with N at 150 ppm were significantly smaller throughout the growth period than those fertilized with N at either 200 or 250 ppm (Figure 3). Growers can fertilize with N at 150 ppm to achieve smaller diameters, while retail growers should use N at 200 ppm for wider plants destined for retail markets.

Tissue Analysis. Concentrations of the mobile elements (N, P, K, and Mg) decreased as the plant aged. This decline in nutrient concentration may be attributed to the dilution effect as plants age and dry weights increase. Tissue levels of N, P and K were within the adequate range of 3.5 to 4.5%, 0.2 to 0.6%, and 3.0 to 4.0%, respectively (Whipker et al., 1998).

Magnesium was below the adequate range of 0.2 to 0.4% from weeks 12 to 18. Although Mg deficiency symptoms (interveinal chlorosis of the lower foliage) were not present, an increased rate or a more frequent $MgSO_4 \cdot 7H_2O$ application may be needed during production to provide adequate Mg tissue levels.

Calcium fertilization rates greater than 100 ppm provided sufficient calcium as tissue concentrations exceeded the adequate range of 0.5 to 1.0% (Whipker et al., 1998) for ornamental cabbage.

Coloration. Nitrogen rate had no effect on color diameter. Color diameter increased over time (Figure 4). Color diameter was first observed 11 weeks after sowing and was measured at 1.2



Figure 3. Plants fertilized with 150 ppm N were smaller in size as compared with either 200 or 250 ppm N.

inches (3 cm) on week 12. Color diameter increased to 10.4 inches (26.4 cm) by week 18.

Tap Water Comparison. Growers generally market ornamental cabbage as soon as there is a colored center. At week 14 ornamental cabbage plants were of marketable size, plant diameter had reached its maximum size and plants possessed a colored center spanning 6.7 inches (17 cm).

Plant Growth. There were no significant differences in plant height or diameter for plants fertilized on a continual basis when compared to plants irrigated with tap water for 2 weeks. When plants were irrigated with tap water for 4 or 6 weeks, height and diameters were significantly smaller, compared to plants irrigated with tap water for two weeks or continually fertilized (Figure 5). Differences in height and diameter were due to lower leaf loss and stunting of plants irrigated with tap water.

Coloration. Color diameters were similar for plants irrigated with either tap water for 2, 4, or 6 weeks when compared to plants on a continuous fertilizer program for 14 weeks (6.7 inches [17.0 cm]), 16 weeks (9 inches [22.8 cm]), and 18 weeks (9.4 inches [23.8 cm]), respectively. This contrasts recommendations by Luczai (1992) suggesting that fertilization should be discontinued to induce coloration. Results of this



Figure 4. Nitrogen rate had no effect on color diameter.

study suggest that growers should continue fertilizing plants until the market date.

Tissue Analysis. At the market date of week 14, leaf concentrations of N, P, K, and Ca were significantly different between plants that were fertilized on a continual basis when compared to plants irrigated with tap water. Plants were still actively growing and leaf tissue concentrations of N, P, K, and Ca decreased when the plants were subjected to tap water.

Discontinuing fertilization 2 weeks before sales may cause plants to become nutrient deficient since the plants are still actively developing during this period. Once plants are moved to a retail setting, nutrient deficiencies can occur because the plants are generally only irrigated with tap water.

Conclusions

Fertilizing with concentrations of N at 150 to 200 ppm and K at 150 to 200 ppm optimizes nutrient management and provides sufficient tissue concentrations of N and K. Coloration was not inhibited by concentrations of N as high as 250 ppm, therefore growers should fertilize until market date.

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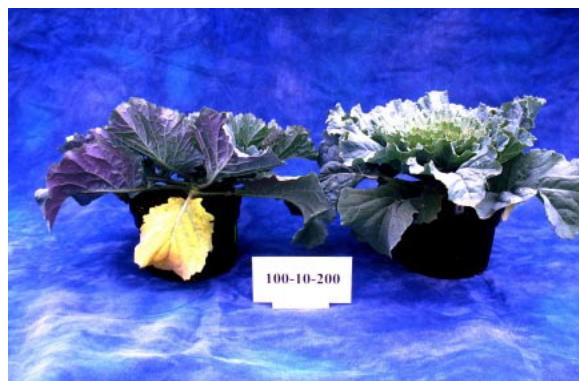


Figure 5. Deficiency symptoms (lower leaf yellowing) develop within 2 weeks after fertilizer has been discontinued (left).