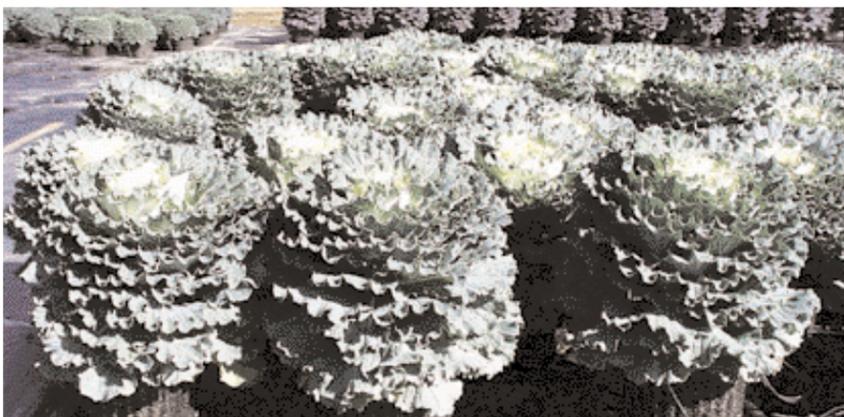


AVOIDING THE TOP PRODUCTION PROBLEMS OF ORNAMENTAL CABBAGE & KALE

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 Ornamental Pepper Production
 Avoiding Top Poinsettia Problems

By James L. Gibson,
 Brian E. Whipker,
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 Colleen Y. Warfield

Ornamental cabbage and kale can be a good spring and fall money crop, but there are a few special requirements you'll need to consider to finish off a quality crop.



Excessive stem elongation can occur if plant growth regulators are not used. (Photo courtesy of Brian Whipker.)

Ornamental cabbage and kale have become increasingly popular as fall bedding plants due to their brilliant, interesting and long lasting foliage. Ornamental cabbage and kale complement garden chrysanthemums and fall pansies exceptionally well, providing consumers with a colorful plant choice for the fall and winter landscape.

Ornamental cabbage and kale are relatively problem free crops to grow; however, growers should be aware of the more common nutritional, physiological, insect and disease-related problems encountered in the production of these crops. By watching for potential problems, understanding their causes and knowing the proper corrective actions, growers should be able to avoid most of these problems. Additional information on ornamental cabbage and kale production, as well as cultivar descriptions, can be found online by visiting NC State's Floriculture Information Center, www.floricultureinfo.com.

MAJOR NUTRITIONAL PROBLEMS

There are three primary nutritional problems that can occur with ornamental cabbage and kale: low fertilization, excessive fertilization and nitrogen (N) deficiencies. Each of these problems will be discussed separately, but the same principles of plant nutrition apply to all three.

Fertilizer recommendations for ornamental cabbage are nitrogen concentrations of 150-250 ppm applied during periods of active growth. Nitrogen rates lower than 150 ppm limit leaf expansion, resulting in an overall smaller plant. Limiting nitrogen is a strategy that has been successfully adopted by many wholesale growers who wish to produce a proportionately smaller plant in a one-gallon pot. But for growers who desire larger plants, higher rates must be used.

Nitrogen rates higher than 250 ppm can lead to luxurious uptake of N by the plant, causing leaf morphology to change. The orientation of the newly developing leaves becomes more upright, and if plants are water stressed, they will develop a "waffle-like" appearance similar to heavily fertilized New Guinea impatiens.

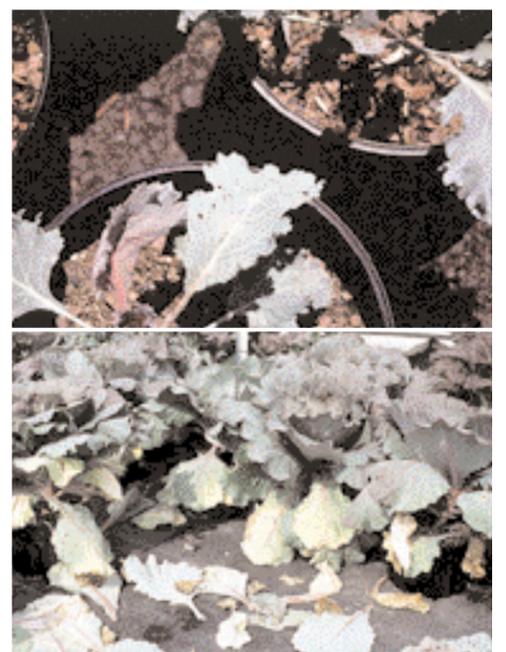
Many fertilizer recommendations suggest that fertilization of ornamental cabbage and kale should be reduced or discontinued to encourage center color development. Color development is due to the accumulation of anthocyanin in the foliage and the cessation of chlorophyll production when temperatures drop below 55° F. Because ornamental cabbage and kale are still actively growing and increasing in weight during the color initiation stage, fertilization is still required. Discontinuing fertilizer applications during this stage can result in yellowing of the lower leaves and leaf drop (nitrogen deficiency), reducing overall crop quality. Research at NC State determined that continually fertilizing ornamental cabbage and kale with 150-250 ppm N did not inhibit center color diameter and avoided lower leaf yellowing and loss.

OTHER NUTRITIONAL FACTORS

The pH of the root substrate should be maintained at 5.8-6.5. Alkalinity levels of the irrigation water should be around 2 meq/L of alkalinity (100 ppm CaCO₃ or 120 ppm HCO₃⁻) to avoid an increase in pH over the growing season. If alkalinity levels are higher, acid injection or an acidic fertilizer (as long as the NO₃-N to NH₄-N ratio is greater than 2:1) should be considered. Fertilize plants with a balanced fertilizer of calcium nitrate and potassium nitrate, with periodic applications of 20-10-20 or 21-5-20 (for phosphorus and micronutrients) and epsom salts (for magnesium and sulfur). High levels of NH₄-N+ urea in the fertilizer mix will stimulate stem elongation, resulting in the need for more PGRs to control height.

MAJOR PHYSIOLOGICAL PROBLEMS

Plant Growth Control. Warm, late-summer temperatures promote extensive plant growth, requiring the application of PGRs to maintain plant compactness. However, over application of PGRs can lead to



Top: Adult flea beetle damage on ornamental kale. (Photo courtesy of Raymond Cloyd);
 Bottom: Water stress can cause lower leaf drop. (Photo courtesy of James Gibson)



High fertilization rates will result in a "puckered" leaf appearance. (Photo courtesy of James Gibson)

stunted growth. B-Nine foliar sprays are the industry standard for controlling stretch. Rates between 2,500-5,000 ppm are common, but a small reduction in color diameter is possible with multiple applications. Sumagic foliar sprays of 8-20 ppm also provide excellent height control. In experiments at NC State, Bonzi foliar sprays up to 80 ppm were not effective. This contrasts production practices used in the Pacific Northwest where 10 ppm of Bonzi is effective. Substrate drenches of Bonzi (2-4 mg a.i./pot) or Sumagic (0.5-1 mg a.i./pot) are also effective in controlling growth. PGRs can only be applied to ornamental cabbage and kale grown as non-food crops.

Color Reversion. Color development of ornamental cabbage and kale is due to the accumulation of anthocyanin in the foliage. Anthocyanin, a pigmented flavanoid, is responsible for most of the red, pink, purple and blue colors observed in plants. The synthesis of anthocyanin in ornamental cabbage tissue is due to the cessation of chlorophyll production when temperatures drop below 55° F. Once temperatures become cool enough, the upper foliage will develop brilliant colored centers. Sometimes, the upper central leaves can undergo a color reversion if warmer temperatures return. Because temperature control is impractical with ornamental cabbage and kale production, this problem is unavoidable.

Water Stress. Ornamental cabbage and kale are not tolerant to water stress. This will cause a stalling of plant growth, lower leaf yellowing, lower leaf drop and premature bolting. The use of an automated drip irrigation system can help avoid water stress.

MAJOR INSECT PESTS

Aphids can be a problem with ornamental cabbage and kale.

Their feeding causes leaf curling or distortion. In addition, aphids secrete a clear, sticky liquid called honeydew, which serves as a growing medium for black, sooty mold fungi. Pest control materials for managing aphids include acephate (Orthene), endosulfan (Endosulfan), horticultural oil (Sunspray Ultrafine

Spray) and insecticidal soap (M-Pede/Insecticidal Soap).

Adult flea beetles chew small, circular holes or pits in leaves. They may cause plant stunting if present in large numbers. The larvae feed on plant roots. Carbaryl (Sevin), bifenthrin (Talstar) and cyfluthrin (Decathlon) may be used to manage adult flea beetle populations.

Diamondback moth larvae feed on all plant parts but generally on leaf undersides. They chew small holes on leaf undersides, giving the plant a shot-hole appearance.

Cabbage looper larvae eat irregular-shaped holes in leaves, and feed on terminal leaf growth, causing stunting. The small larvae feed on leaf undersides whereas

the older larvae feed deep within the plant canopy, tunneling through several layers of leaves.

Imported cabbageworm larvae eat irregular-shaped holes in leaves and tunnel into terminal growth, causing stunting. Damage is similar to cabbage looper feeding. Larvae usually feed on upper-leaf

surfaces near the midrib. They generally don't feed on large veins.

Pest control materials available for managing caterpillar pests include azadirachtin (Azatin/Ornazin), *Bacillus thuringiensis* (Dipel), bifenthrin (Talstar), lambda-cyhalothrin (Scimitar) and permethrin (Astro).

MAJOR DISEASE PROBLEMS

Ornamental cabbage and kale are generally free of disease problems, but there are a few bacterial and fungal pathogens that may potentially cause serious losses. Disease prevention is critical, as once a plant is infected, there are no curative measures. It is

always a good idea to have the disease properly identified. While cultural controls may be similar for most diseases, the application of chemicals, which are ineffective against the target pathogen, will not only waste money, but may result in a critical time delay in getting the problem under control.

Black Rot, caused by the bacterium *Xanthomonas campestris* pv. *campestris*, is capable of infecting plants at any stage of development. Because this pathogen can be seed-borne, it is important to plant high quality seed that has either been assayed for this pathogen and certified disease free or has been hot water treated. Do not assume the seed you are buying has been tested. If you are purchasing plugs, inquire about the seed source. Although a seedling may appear healthy, low populations of bacteria could potentially be present that will later multiply under warm, moist conditions. Seedlings from infected seeds may die quickly, serving as a source of inoculum for the remaining crop. The bacterium enters the hydathodes on the leaf margins, resulting in characteristic yellow, V-shaped lesions extending from the leaf margin inward toward the midvein. The veins within the lesion appear black in color; however, it can be difficult to see vein discoloration in darkly pigmented varieties of cabbage or kale. The infection will progress into the vascular system, and the affected leaf and petiole will wilt. Eventually, in the case of young plants, the entire plant will die. It is important to remove and destroy visually infected plants and those in the immediate area as soon as symptoms appear. Avoid overhead irrigation as the water droplets can quickly spread the bacterium from plant to plant.

Black spot is a foliar disease caused by the fungus *Alternaria brassicae*. The symptoms of this disease are circular, brown leaf spots surrounded by a border of yellow tissue. These leaf spots can take on a target-like appearance consisting of concentric rings of brown/black tissue within the larger leaf spot. The spots can range in size from small flecks up to an inch or more. When *Alternaria* attacks seedlings, girdling of the stem and damping-off may occur.

While this fungus is carried on the

seedcoat, it also survives in infected crop debris as well as alternate weed hosts. Therefore, it is important to practice good sanitation and weed control, being especially careful to remove wild crucifers. Disease development is most likely to occur during warm (80-90° F), wet weather. During these periods, one or more applications of a preventative fungicide (triflumizole [Terraguard] or copper hydroxide [Kocide]) may be necessary to reduce infection and control this disease. As with any pesticide, be sure to read and follow the directions on the product label.

Downy mildew appears as somewhat angular, yellow areas on the upper leaf surface. Turning over an affected leaf may reveal areas of purplish- or grayish-white fungal growth. These patches of fungal spores are almost always limited to the underside of the leaves. As the leaf spots enlarge, an overall yellowing of the leaf may occur. If the infection is severe enough, the leaf may eventually turn brown and die.

Sporulation occurs during cool (below 75° F), moist periods. In order for the spores to germinate and cause new infections, free water must be present on the leaves. If a susceptible host is not present, this pathogen can form persistent spores that survive in plant debris.

Spacing plants to permit good air circulation, decreasing humidity, practicing good sanitation and switching to drip irrigation will help protect plants from this disease. Fungicides (Maneb 80WP [kale only] or fosetyl-al [Aliette]) can prevent infection of healthy plants; however, fungicide resistance is becoming an increasing problem.

Pythium root rot is most likely to occur when plants are young, the temperatures are cool and the potting mix does not drain quickly enough. Young seedlings may suddenly wilt and collapse despite adequate water. Older plants may exhibit wilting and overall decline. An examination of the roots will reveal soft, reddish-brown roots with degradation of the outer root covering. Plants showing signs of wilt should be removed and destroyed. An application of a protective fungicide (mefenoxam [Subdue Maxx] or etridiazole [Truban, Banrot]) can be used to protect and slow the spread to healthy plants. GPN

names in this publication does not constitute endorsement of these products in preference to others containing the same active ingredients. The use of trade names is solely for the purpose of providing specific information and does not signify that they are approved to the exclusion of others. Mention of a product does not constitute a guarantee or warranty of the product by the author or magazine.

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Editor's Note: The use of specific trade