Ornamental Cabbage and Kale Production

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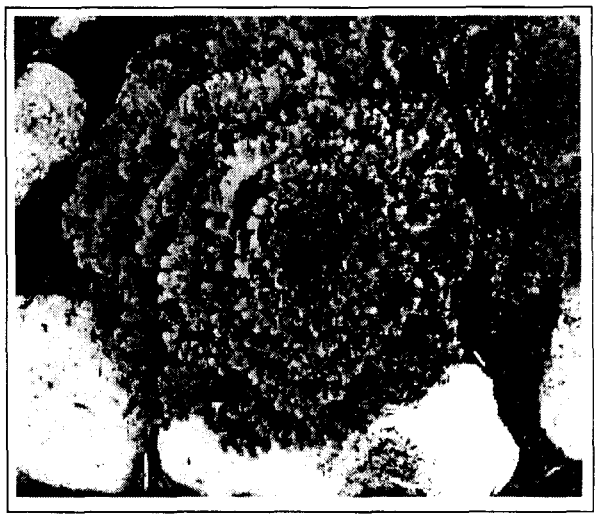
Ornamental cabbage and kale have become increasingly popular as a fall flowering crop because of their long lasting colorful foliage. They will often remain colorful until temperatures drop below 20 °F and are well suited to areas of the Southeast which have mild winters. Ornamental cabbage and kale are also an excellent complement to garden chrysanthemums and fall pansies in increasing autumn sales.



Cultivars

Ornamental cabbage and kale cultivars have red, pink, or white foliage. They are further grouped by leaf shape, with the round, smooth leaf types constituting the ornamental cabbages and the feathered or fringed types constituting the ornamental kales. Table 1 lists the characteristics of some of the most popular cultivars.

Table 1. Characteristics of ornamental cabbage and kale cultivars (Adapted from McAvoy, 1994).

Cultivar Name	Color	Growth Habit	Leaf Type
Red Peacock	Red	Tall	Feathered
White Peacock	White	Tall	Feathered
Coral Queen	Pink	Medium-Tall	Feathered
Coral Prince	White (pink center)	Medium-Tall	Feathered
Red Feather	Dark Red	Very Tall	Feathered
White Feather	White	Very Tall	Feathered
Red Pigeon	Light Red	Dwarf	Round
White Pigeon	White (pink center)	Dwarf	Round
Pink Beauty	Pink	Dwarf, early	Round
Rose Bouquet	Bright Red	Dwarf, early	Round
White Xmas	White (pink center)	Dwarf, early	Round
Red Sparrow	Red	Dwarf	Fringed
White Sparrow	White	Dwarf	Fringed
Prima Donna	Light Red	Tall	Fringed
White Lady	All White	Tall	Fringed
Red Kamome	Red	Dwarf, early	Fringed
White Kamome	All White	Dwarf, early	Fringed
Red Chidori	Dark Red	Dwarf	Fringed
White Chidori	All white	Dwarf	Fringed

Scheduling

Plants generally require between 21/2 to 3 months of growth to achieve marketable size, when produced in 6" pots. Allow an extra 2 weeks of growth for 8" pots. For northern locations, seeds should be sown in June, while for southern locations a July sowing is optimal.

Seeding and Containers

Germination takes around 10 days at 70 °F. Germination is best in the

presence of light. Seeds can be sown in plug flats, germination trays, or directly into an 806 flat. Avoid letting the plants become root bound in the container before transplanting them. Restriction of the roots will result in stunted plant growth. Transplant the seedlings into 6" or 8" pots when sufficient growth has occurred. If the plants have become too tall in the seedling flats, they should be planted deep (up to the first set of leaves).

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Spacing

The plants required adequate spacing to encourage growth and prevent foliar diseases. Use 6" centers for 4" pots, l l " to 12" centers for 6" pots, and 16" to 18" centers for 8" pots.

Substrate, Irrigation, and Nutrition

Substrate. Plants can be grown in any good quality soilless substrate that has good water holding capacity. If the plants are to be grown outdoors, a soil-based substrate or the addition of sand may help avoid toppled plants during windy weather.

Irrigation. During the summer months the plants will require adequate moisture. Using an automated watering system similar to one used on garden chrysanthemums will assist in irrigation. Ornamental cabbage and kale are not tolerant of drought stress. This will result in the stalling of plant growth and the yellowing and drop of the lower leaves.

Nutrition. Maintain a substrate solution pH between 5.8 and 6.5 for best nutrient uptake. Irrigation water alkalinity should be adjusted to a maximum of 2meq/L (lOOppm CaC03 or 120 ppm HCO3-) to avoid a general increase in pH over the growing season. If alkalinity is higher than 2 meq/L, consider using an acidic fertilizer (as long as the NO3-N to NH4-N ratio is greater than 2:1) or acid injection. Fertilize the plants with a balanced fertilizer such as 20-10-20.

For the seedling stage, fertilize at the rate of 50 to 100 ppm N on a constant liquid feed basis. After transplanting into the final container, fertilize at the rate of 150 to 250 ppm N and K. Electrical conductivity should be maintained between l.O and 2.0 mS/cm. Some recommendations suggest fertilization should be discontinued during color. Excessive fertilization will prevent good coloration, but deficient levels of plant nutrients will result in the yellowing and loss of the lower leaves. Deficiency symptoms are more likely to occur in a soilless substrate that has a lower cation exchange capacity (the ability to hold nutrients) than in a soil-based substrate. For the final three weeks of growth, a fertilizer rate of 50 ppm N and K should be sufficient to allow the plants to develop color and avoid deficiency symptoms. Extensive research on the nutritional requirements of ornamental cabbage and kale are not available, but numerous studies have been completed for vegetable cabbage. Cabbage is susceptible to **internal tipburn** which appears as a browning

of the tissue. It is caused by an inadequate supply of calcium (Ca) (Becker, 1986). Members of the cabbage family (crucifer crops) require high levels of Ca, and fertilization rates of 50 to lOO ppm Ca may be beneficial if your irrigation water is low in calcium content. **Black Petiole** is another internal disorder of cabbage which appears as an internal blackening of the cabbage head. It is thought to be a nutritional imbalance that occurs when the potassium (K) levels are low and the phosphorus (P) levels are high (Becker, 1986). **Boron (B) deficiency** has also been reported to cause a brown spotting of broccoli heads (Latin and Helms, 1990). Growers should make sure that B is part of their fertilizer mix and that Ca is not being added in excessive amounts (excessive Ca can tie up B, making it unavailable to plants). Maintain a substrate pH between 5.8 and 6.5 to enhance B availability (B availability decreases at pHs above 6.5). Foliar analysis interpretation values for cabbage are listed in Table 2 and may be useful for ornamental cabbage and kale production.

Table 2. Foliar concentrations of elements in cabbage plants (Brassica oleracea var. capitata). Values are from wrapper leaves of cabbage plants sampled near harvest when the heads had formed (adapted from D.J. Reuter and J.B. Robinson (eds.). Plant Analysis: An Interpretation Manual)

Element	Units	Adequate Range
N	%	2.5 to 4.0
P	%	0.25 to 0.5
K	%	2.0 to 4.0
Ca	%	1.5 to 3.0
Mg	%	0.2 to 0.6
Na	%	<1.0
B	ppm	20 to 60
Cu	ppm	5.2
Fe	ppm	50 to 200
Mo	ppm	0.3 to 0.5
Zn	ppm	10 to 200

Growth Regulators

Ornamental cabbage and kale are unsuitable as a warm season crop because hot summer temperatures cause excessive stem elongation. Stem elongation can also occur with crops grown for fall sales, but it may be avoided by use of the plant growth regulator (PGR) applications. (PGRs can only be applied to ornamental cabbage and kale grown as a nonfood crop.) Luczai (1992) recommended using B-Nine at 1,500 to 3,000 ppm to achieve desired height reduction. McAvoy (1994) recommended multiple applications of B-Nine at 1,500 ppm.

Research conducted at Purdue University (Whipker et al., 1994) compared B-Nine at 2,500 and 5,000 ppm; Bonzi at 15 ppm; and Sumagic at 5 ppm on two ornamental kale cultivars.

On 'Coral Prince', foliar spray applications of Sumagic and B-Nine at 2,500 and 5,000 ppm had the greatest effect on plant height, with a reduction of 16%, 18%, and 26%, respectively, compared to the control (Table 3). These treatments resulted in plants with uniform shape. At the rate used, Bonzi had little effect on reducing plant height and resulted in a more open rosette head. The PGRs had no influence on 'Coral Prince' plant diameter.

All PGR treatments reduced 'Red Kamome' shoot elongation by at least 14% compared to the untreated plants (Table 3). Although 'Red Kamome' plant diameter was reduced by B-Nine (both rates), the shoot (head) growth was very uniform. Bonzi and Sumagic applications resulted in reduced plant height, with no change in plant diameter. Plants treated with Bonzi, although marketable, had an undesirable head due to a more open rosette and looser appearance as a result of increased internode length.

The variations in cultivar response to the PGRs observed in this study is probably due to differences in vigor and growth characteristics of the two cultivars. 'Coral Prince' is an upright, aggressive cultivar that grew 26% taller than 'Red Kamome' when no PGR was applied.

Temperatures

Optimal growth occurs with plants grown in outdoor production, similar to a system used with garden chrysanthemums. Temperatures inside the greenhouse may be too hot and may be detrimental to plant growth. After the plants have achieved marketable size, they must be exposed to 3 to 5 weeks of temperatures below 55 to 60 °F to allow the plants to develop coloration.

Table 3. Chemical growth retardant effect and cost comparison on growth of ornamental kale 'Coral Prince' and 'Red Kamome' *(Adapted from Whipker et al., 1994).*

		Coral Prince		Red Kamome		Chemical
Treatment	Conc (ppm)	Ht (in)	Diam (in)	Ht (in)	Diam (in)	cost per 100 ft²
Control	-------	12.6	15.7	10.0	14.4	----------
B-Nine	2500	10.4	16.3	7.3	12.8	$0.87[x]
	5000	9.3	15.4	7.6	13.0	$1.74
Bonzi	15	11.6	16.0	8.3	14.4	$0.77
Sumagic	5	10.6	15.3	8.5	13.8	$1.52
Significance		***[y]	NS	**	**	
LSD		1.1		1.4	1.0	

[x] Cost comparison of plant growth regulators applied to ornamental kale. Chemical cost (rounded) based on the use of foliar applications of plant growth regulators using a volume of 1/2 gallon of spray per 100 ft² of bench area. Corresponding to the cost of $71 per pound of B-Nine, $103 per quart of Bonzi, or $76 per quart of Sumagic.

[y] Nonsignificant (NS) or significant at P 0.01 (**) or 0.001 (***).

The choice of PGRs to control the growth of ornamental kale should be based on the response of the cultivar and the cost of the PGR (Table 3). 'Coral Prince' was controlled for the lowest cost ($0.87 per 100 square feet of bench area) by using B-Nine at 2,500 ppm. For 'Red Kamome', the desired control of growth was obtained for the lowest cost by using Bonzi, at the cost of $0.77 per 100 square feet of bench area, at the rate of 15 ppm. Although B-Nine at 2,500 ppm also provided an inexpensive height control of 'Red Kamome', it also reduced plant diameter by about 1". Rates of B-Nine lower than the 2,500 ppm used in this study may be effective in reducing plant height of both cultivars at a more economical cost, without reducing 'Red Kamome' plant diameter. The ultimate selection of optimal PGR rates will have to be based on the differences in cultivar growth habits in order to achieve the desired growth effects.

Pests and Diseases

Insect and Related Pests. The most common insect and related pests that attack ornamental cabbage and kale are: aphids, caterpillars, flea beetles, slugs, and whiteflies. For a complete listing of pesticides labeled for each

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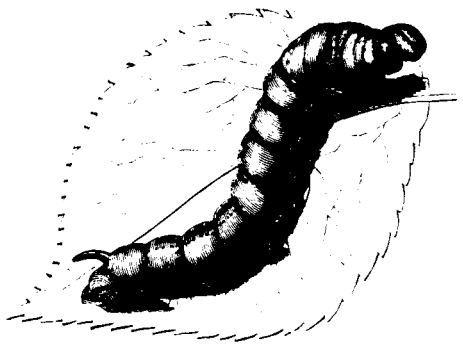
of these pests, readers should refer to "Greenhouse ornamental insect and related pest control", pages 5-18 of the October, 1995 NCCFGA Bulletin or refer to the 1996 N.C. Agricultural Chemicals Manual. Some control measures are listed below:

Aphids (many species; mainly cabbage aphid and turnip aphid): acephate (Orthene®), diazinon (Knox-Out®), endosulfan (Thiodan), horticultural oil (Sun Spray®, Ultra-Fine®), imidacloprid (Marathon®), and insecticidal soap (M-Pede®).

Caterpillars (cabbage looper *[Trichoplasia ni],* cutworms [black cutworm *(Agrotis ipsilon)* and variegated cutworm *(Peridroma saucia)* are the two most common in North Carolina], diamondback moth larvae *[Plutella xylostella],* and imported cabbage worm *[Artogeia rapae]):* acephate (Orthene®), azadirachtin (Azatin®, Margosan-O®), *Bacillus thuringiensis* (Bt) (Dipel®, Victory®), bifenthrin (Talstar®), and pyrethrins.

Flea beetles (many genera and species): acephate (Orthene®), bifenthrin (Talstar®), fluvalinate (Mavrik®), and pyrethrins.



Onion Thrips *(Thrips tabaci):* acephate (Orthene®), bifenthrin (Talstar®), fluvalinate (Mavrik®).

Slugs (many genera and species): metaldehyde (Deadline Bullets®, Snarol®).

Whiteflies (many genera and species; sweetpotato whitefly is the most difficult to control): acephate (Orthene®), azadirachtin (Azatin®, Margosan-O®), endosulfan (Thiodan),horticultural oil (Sun Spray®, Ultra-Fine®), imidacloprid (Marathon®), insecticidal soap (MPede®), and kinoprene (Enstar II®).

Diseases. There are a number of pathogens that attack ornamental cabbage and kale. The following disease descriptions are adapted from Latin and Helms, 1990.

Root Rots *(Pythium* spp. and *Phytophthora* spp.). Symptoms include: a general decay of the roots. Affected plants typically exhibit wilting, due to the destruction of the root system and the resulting inability of the root system to supply adequate amounts of water to the top growth. Control with fungicide drenches if symptoms appear (etridiazole [Truban®, Banrot®] and metalaxyl [Subdue®]).

Alternaria leaf spot *(Alternaria brassicae).* Symptoms include: round, brown lesions on infected leaves and oval or elongated lesions on stems. These lesions can enlarge to the size of a dime and are characterized by the presence of concentric rings within the dead tissue. Control with sanitation and applications of fungicides (iprodione [Chipco 26019®] and Terraguard®]).

Black leg *(Phoma lingum).* Symptoms include elongated, light brown, sunken areas with purplish margins near the soil line. Stem lesions expand and girdle the entire stem, killing the plant. Control with sanitation.

Black rot *(Xanthomonas campestris pv campestris).* Symptoms of the initial infection is the presence of small, yellow-brown, V-shaped areas at the leaf margin. As lesions enlarge, the nearby veins turn black. A cross-section of an infected stem cut near the soil surface will show a

distinct ring of decayed tissue. Control with sanitation and use disease resistant cultivars.

Club root *(Plasmodiophora brassicae).* Symptoms include stunted and wilted tops and an enlarged root system. Control with sanitation.

Downy mildew *(Peronospora parasitica).* Symptoms are the appearance of purplish, irregular spots on the leaves. During cool, wet weather, the spots will enlarge and become yellow-brown in color. A white mold on the underside of the leaves may also develop. Control with sanitation and good air flow. Apply fungicides if needed (mancozeb [Manzate®]).

Fusarium yellows *(Fusarium oxysporum conglutinans).* Symptoms include plants with a dull cast, and lower leaves that turn yellow-green in color. Control with sanitation and use disease resistant cultivars.

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Conclusions:

Clearly, lighting treatments are very beneficial for either hastening or delaying flowering of some bedding plant species. Clearly, we can control flowering precisely on some of these crops. The question arises as to how to best use this information. We are currently finishing data analysis from last year to determine the 'best' prefinishing environments for petunias, pansies, nierembergia and violas. We will be validating these treatments in commercial greenhouses this fall. Results of this work will be reported as soon as possible after that. In addition to this work, we are also studying the environmental effects on flowering of many of the new vegetatively propagated bedding plants.

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