Department of Horticultural Science

Horticulture Information Leaflet 507
New 12/98

Success with Ornamental Cabbage and Kale

Brian E. Whipker[1], James L. Gibson[2], Raymond A. Cloyd[3], C. Ray Campbell[4], and Ron Jones[5]

Ornamental cabbage and kale have become increasingly popular as fall crops because they have colorful, long lasting foliage. They will often remain colorful until temperatures drop to 15 to 20 ^{0}F and are well suited to areas of the Southern US which have mild winters. Ornamental cabbage and kale are also excellent complements to garden chrysanthemums and fall pansies, and will help increase overall sales.

Cultivars

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

Scheduling

Plants generally require between 2 to 2.5 months to achieve marketable size in 6" pots when grown from seed. An extra 2 weeks of growth should be allowed for an 8" mum pan. For Northern U.S., seeds should be sown in June, while for Southern U.S. locations a late July sowing is optimal. It is common for southern growers to purchase plugs (typically 288s or 350s) from northern plug producers. This avoids heat stress on the plug seedlings and ensures a high quality plant. Mid- to late August is the typical time that North Carolina growers receive their shipment of plugs. A typical production schedule for North Carolina is listed in **Table 2**.

Seeding and Containers

Germination takes around 3 to 5 days at 70 ^{0}F in the light. Seeds can be sown in plug flats, germination trays, or directly into an 806 flat. The plants should not be allowed to become root bound in the container before transplanting, as 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 can be planted deep (up to the first set of leaves) on the final pot.

Spacing

Plants require adequate spacing to encourage growth and prevent foliar diseases. Use 6" centers for 4" pots, 11" to 12" centers for 6" pots, and 16" to 18" centers for 8" mum pans.

[1] Floriculture Extension Specialist, Dept. of Horticultural Science, Box 7609, NC State Univ., Raleigh, NC 27695-7609
[2] Graduate student, Dept. of Horticultural Science, NC State Univ.
[3] Entomologist, Entomology Department, Purdue University, West Lafayette, IN 47907-1158
[4] Agronomist, NCDA Agronomic Div., 4300 Reedy Creek Road, Raleigh, NC 27607-6465
[5] Ornamental Plant Pathologist, Dept. of Plant Pathology, Box 7616, NC State University, Raleigh, NC 27695-7616

North Carolina Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES

Table 1. Characteristics of ornamental cabbage and kale cultivars.		
Cultivar	**Source**	**Cultivar Description**
Cabbage		
Color-up Pink	P	• Similar to Osaka Pink • Blush or light pink center • Upright growth habit with columnar type of appearance • Does not furl out like Osaka Pink • Possesses downward leaf orientation for older growth • Plant growth regulator appears to affect plant diameter and not height • Agressive grower • Venation is a more distinct white that Osaka Pink • Green foliage
Color-up Red	P	• Identical to Pigeon Red and similar to Rose Bouquet • Light fuchsia to light pink center • Leaf margin is wavy in appearance • Waviness of leaf margin is between Pigeon Red and Rose Bouquet • Green foliage
Color-up White	P	• Identical to Pigeon White's cream white center with blush interior. Cream-white color at mature stage. • Upright growth habit with columnar type appearance • Wavy leaf margin • Green foliage
Osaka Pink	B, G, N	• Upright growth habit • Center's color goes from a pale fuchsia to a deeper fuchsia color towards the center • Similar to Color-up Pink • Green foliage
Osaka Red	B, G, N	• Upright form of growth • Most intense color of the red cabbages • Magenta center • Leaf orientation similar to the wrapper leaves of cabbage • Unfurling of leaves is slow • Wavy leaf margins • Darker foliage than Tokyo Red
Osaka White	B, G, N	• Semi-feathered foliage with frizzy leaf margin • Rapid color expansion once coloration has been initiated • Pale green foliage with milky white coloration • Minor tinge of blush in center during early stage of coloration • Mounded form • Green foliage
Pigeon Red	B	• Identical to Color-up Red • Deep pink to light fuchsia center • Venation is a distinct white • Margins less wavy than Rose Bouquet • Plant growth regulator response, color, and growth identical to Color-up Red • Green foliage
Pigeon White	B	• Identical to Color-up White • Upright type of growth • Milky to cream-white with blush tinge from outer area of coloration towards the center. Cream-white color at mature stage. • Green foliage with wavy leaf margin
Rose Bouquet	B	• Similar to Pigeon Red and Color-up Red, although more curl on the outer edges of the margin • Deeper pigment that Color-up Red or Pigeon Red • Deep pink to magenta center • Color of green foliage is equal to Pigeon Red
Tokyo Pink	G, N	• Pale pink cabbage-like head formed, but not as defined as Tokyo Red • Blue-green foliage • Medium leaf expansion • Very rounded leaves
Tokyo Red	G, N	• Cabbage head formation well developed • Blue-green foliage • Upright growth habit • Venation is a more distinct red in center
Tokyo White	G, N	• Smaller head formation than Tokyo Red • Very rounded leaves with pale green color • Retains older, lower leaves as nitrogen deficiency symptoms develop
Seed sources: B = Ball, G = Gloeckner, N = Novartis, P = Parks		

Table 1. Continued.		
Cultivar	**Source**	**Cultivar Description**
Kale		
Chidori Red	B, G	• Only fringed kale with purple foliage • Similar fringed foliage as Osaka Red cabbage • Very curly • Best coloration of the red kales with a deep magenta center • Mounded shape • Not a very aggressive grower
Chidori White	B	• Foliage color equal to Sparrow White • Blue-green foliage • Cream white center • Best coloration of the white kales
Coral Prince	B	• Feathered kale • Similar, but somewhat identical to Snow Prince • Cream white color with blush accents in the center. All white color at mature stage. • Tall growth habit
Coral Queen	B, G	• Feathered kale • Purple foliage with a medium magenta center • Foliage color is equal to Flamigo Plumes and Osaka Red • Tall growth habit
Flamingo Plumes	G	• Large growth habit • Notched leaf margins • Deep magenta pigmentation on purplish foliage • Open, textured center diffuses color
Frizzy Red	P	• Curly red kale • Not grown in the NCSU trial
Frizzy White	P	• Last of the white curly kales to color up • Lightest shade of green foliage, almost olive colored • Creamy white center • Plant growth regulator applications delayed coloration
Kamone Red	B	• Curly red kale • Not grown in the NCSU trial
Kamone White	B	• Dark green foliage • Milky white, semi-creamy center • Appeared to have the most "open" center • One of the best curly white kales
Nagoya Red	B, G, N, P	• Tight coloration • Deep fuchsia center • Dark green foliage
Nagoya Rose	B, G, N, P	• Dark green foliage similar to Nagoya Red • Light fushsia coloration in center • Small, mounding growth habit • More open plant diameter than Nagoya Red
Nagoya White	B, G, N, P	• Lighter foliage color than Sparrow White or Chidori White • White center has a sizeable diameter • Showing small layer of leaf margin burn
Peacock Red	B, G, N, P	• Feathered red kale • Not grown in the NCSU trial
Peacock White	B, G, N, P	• Deeply grooved leaves • Pronounced textured center diffuses pigment • Greater foliage texture than Snow Prince or Coral Prince • Tall habit • Faint blush accent in milky white center. Milky-white center at mature stage. • Pale green foliage
Snow Prince	G	• Feathered foliage • Moderate blush accent in milky white center • A deeper tinge of blush than Color-up White cabbage • Similar, but somewhat identical to Coral Prince
Sparrow Red	B	• Diameter of color and center of color identical to Nagoya Red • Tight, mounding growth habit, but with limited coloration • Affected by plant growth regulators • Purple accents in foliage
Sparrow White	B	• Slightly smaller than Chidori White and similar to Kamone White • Semi-creamy white center with bluish-green foliage • Mound habit • Least aggressive growth habit of all the curly, white kales • Most responsive of the white kales to plant growth regulators

Table 2. Typical North Carolina ornamental cabbage and kale production schedule for an 8" mum pan.	
Time	Cultural Practice
Week 0	Sow seeds into plug flats and grow out
	Fertilize at the rate of 50 to 100 ppm N and K after seedlings emerge
Week 3-4	Transplant plugs into 8” mum pan
	Fertilize at the rate of 150 to 250 ppm N and K
	Apply insecticides as needed
Week 5-6	Apply plant growth regulator(s)
	Apply preventive fungicide drench
Week 10-11	Induce coloration by exposing plants to 2 to 3 weeks of night temperatures 55 to 60 ^{0}F
	Decrease fertilizer rate to 50 ppm N and K

Root Substrate, Irrigation and Nutrition

Root Substrate (Medium): Plants can be grown in a good quality soilless substrate, which has good water holding capacity. If the plants are to be grown outdoors in pots, a soil based substrate or the addition of sand may help avoid toppled plants during windy weather.

Irrigation: During the summer months plants will require adequate moisture. Use of an automated watering system similar to one used on garden chrysanthemums is recommended. Ornamental cabbage and kale are not tolerant of water stress, which results in the stalling of plant growth, yellowing, and dropping of lower leaves.

Nutrition: Maintain the root substrate pH between 5.8 and 6.5. Irrigation water alkalinity levels should be around 2 meq/L of alkalinity (100 ppm $CaCO_3$ or 120 ppm HCO_3^-) to avoid a general increase in pH over the growing season. If alkalinity levels are higher, consider using acid injection or an acidic fertilizer (as long as the NO_3-N to NH_4-N ratio is greater than 2:1). Fertilize the plants with a balanced fertilizer of calcium nitrate ($Ca(NO_3)_2$) and potassium nitrate (KNO_3), with periodic applications of 20-10-20 or 21-5-20 (for phosphorus and micronutrients) and $MgSO_4 \cdot 7H_3O$ (for magnesium and sulfur). High levels of NH_4-N + urea in a fertilizer mix will stimulate stem elongation, resulting in the need for higher plant growth regulator rates to control plant growth. For the seedling stage, fertilize at the rate of 50 to 100 ppm of N with a constant liquid feed. After transplanting into the final container, fertilize with a balanced fertilizer at the rate of 150 to 250 ppm N and K. Electrical conductivity (EC) should be maintained between 1.0 and 2.5 mS/cm during periods of active growth. Excessive fertilization will prevent good coloration, but deficient levels of fertility will result in yellowing (nitrogen deficiency), purpling (phosphorus deficiency), or defoliation of the basal leaves. Some recommendations suggest fertilization should be discontinued during color development. Deficiency symptoms are more likely to occur in a soilless substrate, which has a low cation exchange capacity (the ability to hold nutrients). Based on a preliminary investigation, foliar deficiency symptoms were present when root substrate EC readings were <0.30 mS/cm (SME extract). Therefore, for the final three weeks of growth, a fertilizer rate of 50 ppm N and K should be sufficient while allowing the plants to develop color and avoid deficiency symptoms.

Extensive research on the nutritional requirements of ornamental cabbage and kale have not been done, 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). This would suggest that members of the cabbage family (crucifer crops) require high levels of Ca, and fertilization rates of 50 to 100 ppm Ca may be

Table 3. Foliar concentrations of elements in ornamental cabbage and kale plants. All values are from the most recently matured leaves.

Element	Units	Adequate Range
N	%	3.5 to 4.5
P	%	0.2 to 0.6
K	%	3.0 to 4.0
Ca	%	0.5 to 1.0
Mg	%	0.2 to 0.4
Na	%	<1.0
S*	%	0.2 to 1.0
B	ppm	20 to 40
Cu	ppm	3 to 10
Fe	ppm	50 to 300
Mo	ppm	0.1 to 2.0
Zn	ppm	20 to 75

Source: C. Campbell, NCDA - Agronomic Division.

**The N:S ratio should be between 10 and 15. Ratios above 18 are considered high and indicate a need for sulfur.*

beneficial. Black Petiole is another internal disorder of cabbage, which appears as an internal blackening of the cabbage head. This may be due to a nutritional imbalance 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. (High Ca levels have an antagonistic relationship with B, thus limiting B availability.) Maintaining pH levels between 5.8 and 6.5 will also enhance B availability (B availability decreases at pHs above 6.5). Foliar analysis interpretation values used by the NCDA Plant Analysis Lab for ornamental cabbage and kale are listed in **Table 3**.

Growth Regulators

Ornamental cabbage and kale are unsuitable as warm season crops because hot summer temperatures cause excessive stem elongation. Stem elongation can also occur with crops grown for fall sales, but may be avoided by use of plant growth regulator applications. Plant growth regulators can only be applied to ornamental cabbage and kale grown as non-food crops. The lower recommended rates are suitable for growers who desire a larger plant for retail sales. Higher rates are suitable for wholesale growers who require smaller diameter plants for shipping. B-Nine foliar sprays at 2,500 to 5,000 ppm are recommended for height control. If using the lower rate, multiple B-Nine applications may be required. Sumagic foliar sprays of 2 to 8 ppm may also be used. Bonzi foliar sprays are not effective.

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 detrimental to plant growth. Once plants achieve marketable size, they must be exposed to night temperatures between 45 to 50 ^{0}F for 2 to 3 weeks to allow the plants to develop full color. Night temperatures between 45 to 50 ^{0}F usually occur in late September to October in North Carolina. Many growers market plants when they have partial coloration. Enough partial coloration usually occurs after a few nights exposure to 45 to 50 ^{0}F.

Insects and Diseases

A number of insects and diseases can attack ornamental cabbage and kale. A descriptive listing of insect and disease pests and management strategies are listed in **Table 4** and **Table 5**, repectively. (*Mention of chemical trade names does not constitute an endorsement. Omission of any registered chemical does not imply criticism.)*

Costs of Production

Profitable production of ornamental cabbage and kale is dependent upon the knowledge and control of production costs. A grower who understands production costs will be better prepared to make decisions on the optimal number of plants to produce and to help establish prices. The costs presented here should be useful to current growers who wish to compare their own

Table 4. Common insect pests of ornamental cabbage and kale.	
Insect	**Management Strategies**
Aphids	
Aphids use their piercing-sucking mouthparts to remove plant juices. They may also inject toxins into plants. Aphids secrete a clear, sticky liquid called honeydew. Honeydew serves as a medium for black sooty mold fungi, which can reduce photosynthesis and crop marketability. Aphids are generally located on leaf undersides. They are usually wingless, but they can be winged under high populations. Aphids can increase in large numbers within a short period of time due to their ability to give birth to live young.	• **Cultural:** Inspect plants regularly for the presence of live aphids, old cast-skins, and/or honeydew. Remove all leaf debris and weeds from the area. • **Chemical:** Acephate (Orthene), Bifenthrin (Talstar), Chlorpyrifos (Duraguard), Diazinon (Knox-Out), Endosulfan (Endosulfan), Horticultural oil (Sunspray Ultrafine Spray), and Insecticidal soap (M-Pede/Insecticidal Soap). • **Biological:** Predators such as ladybird beetles and lacewings. Apply early, before aphid populations are high. Consult biological control supplier catalogs for availability of natural enemies.
Caterpillars	
Diamondback moth larvae feed on all plant parts, but prefer the undersides of older leaves. They chew small holes on leaf undersides, giving the plant a shot-hole appearance. Larvae feeding on the growing points of small plants can cause stunting. Large populations can cause considerable damage to small plants.	• **Cultural:** Inspect plants regularly for the presence of larvae and/or larvae damage. Use yellow sticky cards to monitor adult (moth) activity. Remove leaf debris and weeds from the area. This removes potential overwintering sites. • **Chemical:** Azadirachtin (Azatin), *Bacillus thuringiensis aizawai* (Xentari), *Bacillus thuringiensis kurastaki* (Dipel), Bifenthrin (Talstar), Lambda-cyhalothrin (Topcide), and Permethrin (Astro). • **Biological:** Parasitic wasps such as *Trichogramma* can be used against cabbage looper and imported cabbbageworm. Consult biological control supplier catalogs for availability of natural enemies.
Cabbage looper larvae eat irregular holes in leaves, and feed on leaves in the head region causing stunted growth. Small larvae feed primarily on the undersides of leaves. Older larvae feed deeper within the plant canopy, burrowing through several layers of leaves. This means that control should be implemented when larvae are small. These caterpillars move with a characteristic "looping" motion.	
Imported cabbageworm larvae eat large irregular holes in leaves and burrow into heads causing stunted growth. Damage is similar to cabbage looper. Larvae usually feed on upper leaf surfaces near the midrib. They generally don't feed on large veins. Extensive feeding can kill small plants. Older larvae can burrow into the center of plants.	
Flea Beetles	
Flea beetle adults chew small, circular holes or pits in leaves. Flea beetles may cause plant stunting if they are present in large numbers. They can be particularly serious on small plants. Larvae are located in plant medium. Flea beetle adults come in various sizes and colors, but they all have enlarged hind legs that allow them to jump considerable distances when disturbed.	• **Cultural:** Remove all leaf debris and weeds from around the area. This may help to reduce flea beetle populations. Avoid placing plants near other crucifers (i.e. cauliflower and broccoli). • **Chemical:** Azadirachtin (Azatin), Bifenthrin (Talstar), Carbaryl (Sevin), Chlorpyrifos (Duraguard), Cyfluthrin (Decathlon), and Lambda-cyhalothrin (Topcide).
Whiteflies	
Whiteflies remove plant fluids with their piercing-sucking mouthparts. Their feeding can cause plant stunting and leaf distortion. Whiteflies are generally located on the undersides of leaves. Whiteflies produce a clear, sticky liquid called honeydew. Honeydew serves as a medium for growth of black sooty mold fungi, which can reduce photosynthesis and crop marketability.	• **Cultural:** Inspect plants regularly, look at leaf undersides for the presence of young whitefly stages. Use yellow sticky cards to monitor for whitefly adults. Remove leaves heavily infested with whitefly young. Dispose of leaves in plastic bags. Remove all leaf debris and weeds from the area. • **Chemical:** Acephate (Orthene), Bifenthrin (Talstar), Endosulfan (Endosulfan), Fluvalinate (Mavrik), Imidacloprid (Marathon), and Insecticidal soap (M-Pede/Insecticidal Soap). • **Biological:** Parasitic wasps such as *Encarsia formosa*. Predators such as lacewings. Apply early, before whitefly populations reach high numbers. Consult biological control supplier catalogs for availability of natural enemies.

Table 5. Common diseases of ornamental cabbage and kale.	
Disease	**Management Strategies**
Alternaria Leaf Spot (*Alternaria* spp.)	
This fungus causes small, round, brown lesions on infected leaves and oval or elongated lesions on stems. These lesions may enlarge to the size of a dime. They are characterized by the presence of concentric rings within dead tissue.	• **Cultural:** Inspect plants regularly for the presence of disease symptoms. Minimize leaf wetness for prolonged periods. Remove plant debris from the area. Keep plants on schedule with transplanting and fertilizer applications. Sell plants promptly. • **Chemical:** Chlorothalonil (Daconil 2787), Iprodione (Chipco 26017), and Mancozeb (Protect T/O).
Black Rot (*Xanthomonas campestris* pv. *campestris*)	
The initial infection of this bacteria is the presence of small, yellow to light brown patches at the margins of leaves. Later, black veins develop within the yellow areas. Affected areas dry out, leaving a triangular-shaped lesion on the leaf margin. Older infected leaves can drop from plants. Cross-sections of infected stems cut near the medium surface will show distinct rings of black tissue.	• **Cultural:** Use disease free seed. Remove infected plant debris and weeds from the area. Minimize leaf wetness for extended periods.
Club Root (*Plasmodiophora brassicae*)	
This soil borne fungus causes a club shaped swollen gall on the roots. This disease occurs in fields with a history of crucifer production and should not occur in greenhouse production with soilless medium.	• **Cultural:** Use clean growing medium.
Downy Mildew (*Peronospora parasitica)*	
Downy mildew is a water mold fungus that causes purplish irregular spots on leaves. These spots later enlarge and turn a light brown to yellow. A grayish-white fluffy growth can develop on leaf undersides early in the morning. Severe leaf and/or stem infections can stunt plants. This disease is favored by cool, wet weather conditions, and high humidity. It is also favored by long periods of leaf wetness.	• **Cultural:** Inpect plants regularly for the presence of disease symptoms. Remove infected plant parts. Maintain good air flow. Avoid crowding plants together. Avoid splashing water. Minimize leaf wetness for extended periods. • **Chemical:** Mancozeb (Protect T/O) can be used as a protectant.
Fusarium Yellows (*Fusarium oxysporum conglutinans*)	
This fungus causes plants to have a dull cast. Lower leaves turn yellow-green in color. Symptoms may appear on one-side of the leaf and/or plant. Entire plants can wilt and die. This is a soil borne pathogen that occurs in fields where cabbage and other crucifers have been grown. It should not occur in greenhouse production with soilless medium.	• **Cultural:** Use clean growing medium.
Rhizoctonia Stem Rot (*Rhizoctonia solani)*	
This fungus, which is also called wire stem, causes a brown, dry, sunken stem rot at the soil line that results in a general root destruction. As a result, roots are unable to take-up water and/or nutrients. Roots, which are normally light-brown in color, turn a dark-brown to black. If the disease starts on older plants, the stem may not be completely killed. Such plants can be stunted and/or wilted. Leaf yellowing may also occur.	• **Cultural:** Start with clean medium. Avoid splashing water. Discard infected plants. • **Chemical:** Iprodione (Chipco 26019), PCNB (Terraclor), Thiophanate-methyl (Cleary's 3336), and Triflumizole (Terraguard).
Root Rots (*Pythium* and *Phytophthora*)	
These soil-borne fungi attack the root system causing plant wilting, stunting, and leaf yellowing. Roots cannot supply adequate amounts of water and nutrients to top growth. Phytophthora is much less likely to occur than Pythium.	• **Cultural:** Avoid overwatering plants and use a well-drained medium. Don't let plants sit in water. Use clean soilless medium. • **Chemical:** Etridiazole (Truban), Etridiazole + Thiophanate-methyl (Banrot), and Mefenoxum (Subdue Maxx).
** If you are unsure of a problem, consult your Cooperative Extension center and/or call a diagnostic laboratory.*	

production expenses and for potential growers in determining whether to begin growing ornamental cabbage and kale. The data were collected from 2 North Carolina growers who specialize in producing high quality ornamental cabbage and kale plants. Each grower produced >3,000 pots and developed market outlets which demand a high quality crop and are willing to pay a higher price for quality. Costs are calculated for the 1998 growing year.

Costs: variable versus fixed. Costs can be categorized as either variable or fixed. Variable costs, also called direct costs, are costs that are incurred directly by growing the crop. Variable costs items are the basic inputs required to grow a crop, such as pots, plants, root substrate, or chemicals. These costs are easy to allocate to a specific crop because you know the materials used to produce the crop and production practices you followed. The direct costs are $0.83 per pot (**Table 6**).

Table 6. Example costs for producing ornamental cabbage and kale.

Item		Costs per pot
Variable Costs		
	Plug	$0.0500
	Pot/Soil	$0.4640
	Fertilizer	$0.0825
	Chemicals	$0.0555
	Labor	$0.1547
	Interest on Variable Expenses	$0.0240
TOTAL VARIABLE COSTS		$0.831
Fixed Costs		
	Equipment / Interest / Repairs	$0.0343
	Full time labor	$0.0167
	Utilities / Taxes / Misc Costs	$0.0720
TOTAL FIXED COSTS		$0.1230
TOTAL PRODUCTION COSTS		$0.9537
	3% Shrink	$0.0295
TOTAL COSTS		$0.983
	Delivery Costs (Labor and Expenses)	$0.225
TOTAL COSTS (Delivered)		$1.208
Revenue		
	Wholesale Price	$2.25
TOTAL NET PROFIT PER POT (WHOLESALE)		
	Non-delivered	$1.267
	Delivered	$1.042

Fixed costs, also called overhead or indirect costs, are incurred whether or not a crop is produced. They include items like management salaries, depreciation, insurance, interest, repairs, and taxes. Fixed costs represent general operation expenses present in every greenhouse facility. These costs are usually the hardest to determine and to equitably allocate to each crop grown. In general, for greenhouse operations, fixed costs are allocated to a crop on a cost-per-square-foot-per-week basis. Because ornamental cabbage and kale are grown outdoors, fixed costs were allocated to the crop on a percentage basis, based on: 1) the actual use of a piece of equipment or 2) as a percentage of sales. The remaining percentage not allocated to the crop would then be allocated to the other crops produced like garden mums, bedding plants, or poinsettias.

Fixed costs are only $0.12 per pot (**Table 6**). The depreciation expense is fairly low and can be attributed to this firm's reliance on used equipment and because ornamental cabbage and kale's share of the overall expenses are low because it represents 0.1% of the operations total sales. Firms which purchase new machinery and equipment

will have a higher depreciation expense. The overhead operation expenses represent the total miscellaneous operating expenses of the firm. The costs included in this budget are generalized and costs will vary greatly among firms.

Shrink. Even under the best production practices, a certain percentage of the crop will not be marketable due to poor growth, insects, disease, or damage. The cost of inputs for these non-marketable plants have to be accounted for by the operation. This is done by adjusting the production cost by a shrink factor. In this case, a 3% shrink was calculated which involved dividing the total production costs by 0.97 to get the total production costs (including shrink). Total production costs will increase for growers who have a higher percent of shrink.

Total production costs per pot, including a 3% shrink, and costs for marketing the crop was $1.21 (**Table 6**).

Profitability. By adding the total variable costs and total fixed costs together, this provides the total costs of producing ornamental cabbage and kale. The profitability of the crop is directly related to the price received. The profitability per pot of a delivered ornamental cabbage and kale was $1.04 (a 46% profit margin). This high return is due in part because the 2 growers specialize in producing high quality ornamental cabbage and kale plants and they have developed market outlets which demand a high quality crop and their customers are willing to pay a higher wholesale price for quality.

Using the method outlined will enable ornamental cabbage and kale growers the ability to compare the profitability of their crops for their own operation. Of course costs will vary among greenhouses according to their amount of capitalization in equipment and structures and the grower's ability to purchase inputs at lower costs. Therefore, each manager will need to calculate their own specific production costs in order to determine profitability.

For Further Reading:

American Takii, Inc. 1992. Cultural information on flowering kale. p. 4.

Becker, R.F. 1986. Nonpathogenic disorders of cabbage. Cornell Ext. Service.

Gill, S., T. Blessington, and E. Dutky. 1993. TPM for ornamental cabbage and kale. Greenhouse Grower. 11(6):24-26.

Latin R. and K. Helms. 1990. Identification and Control of Crucifer Diseases, BP-22, Purdue University Coop. Ext. Service.

Luczai, R. T. 1992. Flowering cabbage and kale: ideal for use in late fall landscapes. PPGA News. 23(4):2-3.

Marquardt, B. 1998. Feathers, fringes, and waves. GrowerTalks 62(1):56, 58.

McAvoy, R.J. 1994. Cultural tips for ornamental cabbage and kale. Conn. Greenhouse Nwsltr, No. 180, June/ July. p. 13-15.

Nau, J. 1998. Brassica (ornamental cabbage and kale). In: Vic Ball (ed.), Ball Red Book, 16th ed. Ball Publishing, W. Chicago, IL p. 401-403.

Whipker, B.E., R.T. Eddy, and P.A. Hammer. 1994. Chemical growth-retardant height control of ornamental kale. HortScience 29:329.