Department of Horticultural Science

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Success with Ornamental Vegetables as Floricultural Crops

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Ornamental cabbage and kale have been the traditional ornamental vegetables for providing colorful and attractive foliage during the fall and winter months. Recently leafy vegetables, in particular oriental mustards, have become popular for landscape plantings during the cool season. Leafy vegetables which have been popular in salads and stir-fry dishes are now being adopted by curators of botanical gardens and landscape contractors as specimen plants, border plants, and in mass plantings. Planted with pansies and garden mums, these vegetables offer a change of texture and foliar color. The shades of green and purple provided by these vegetables help to increase the color in cool season gardens during October through March. Ornamental vegetables also produce brilliant yellow flowers in early spring that provide additional color.

The increased interest in heirloom plants have added to the appeal of these vegetables including red mustard 'Red Giant', potherb mustard 'Early Mizuna' mustard-spinach type plants like flat pak choi or 'Tatsoi', and kales like 'Red Bor', 'Red Russian', and 'Lacinato'. Swiss Chard is another ornamental vegetable that provides colorful stems and robust foliage during the winter and warmer periods. Many greenhouse growers are now adding ornamental vegetables to their annual production cycle since they are easy to produce. The cultural requirements of mustards, kales, and Swiss chard are discussed together and specific requirements are covered in **Table 1**.

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Selected Cultivars

Red mustard or India mustard (*Brassica juncea* var. *rugosa*) produces large leaves with thick petioles. The cultivar 'Red Giant' has large, bronzed leaf blades that become more intense in color as the plant matures. The leaf blades taper down to the main growing point that is thick and fleshy. The midribs are bright white and as the plant reaches full maturity, the leaves change from a rusty red to a reddish black color. The color of the leaves also changes from a dull to a shiny appearance. The application of plant growth regulators enhances the color intensity. The plants rapid growth enables growers to market the plants 6 to 8 weeks after sowing. The roots are fibrous and the irrigation requirements increase as the root mass develops in the pot.

Red mustard can achieve a height of three feet as long as winters remain warm and wet. Temperatures below 15°F can

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Table 1. Growing requirements for ornamental vegetables.			
Crop	Pot Sizes / Spacing	Fertility	Plant Growth Regulator Foliar Sprays
Ornamental Mustards 'Red Giant' 'Early Mizuna'	4.5-inch pots on 10-inch centers 8-inch and gallon pots on 17-inch centers	200 ppm N constant feed	2,500 ppm B-Nine, multiple applications; 5,000 ppm B-Nine, single application
Ornamental Cabbage and Kale	4.5-inch pots on 10-inch centers 8-inch and gallon pots on 17-inch centers	200 ppm N constant feed	2,500 ppm B-Nine, multiple applications; 5,000 ppm B-Nine, single application; 2 to 8 ppm Sumagic, single application
Swiss Chard 'Bright Lights'	4.5-inch pots on 10-inch centers 8-inch and gallon pots on 17-inch centers	200 ppm N constant feed	2,500 ppm B-Nine, multiple applications
Forage Kales 'Lacinato' 'Red Bor' 'Red Russian'	4.5-inch pots on 10-inch centers 8-inch and gallon pots on 17-inch centers	200 ppm N constant feed	2,500 ppm B-Nine, multiple applications; 5,000 ppm B-Nine, single application
Mustard-Spinach Type Vegetables 'Tatsoi'	4.5-inch pots on 10-inch centers 8-inch and gallon pots on 12-inch centers	100 ppm N constant feed	None required

damage the unprotected outer leaves and cause them to shrivel. The interior leaves of this biennial can survive low temperatures, but the entire plant may be reduced to only 5 to 6 leaves. To limit cold injury, the plants should be planted under trees or wind protected areas. The tall mounding growth habit makes 'Red Giant' an attractive specimen plant or background texture plant.

Potherb Mustard 'Early Mizuna' (*Brassica rapa* var. *nipposinica*) can be used as a specimen item in the landscape as well as a groundcover. 'Early Mizuna' has a mounded form and can reach 2 feet in the garden. The feathery-textured leaves are yellow-green and deeply notched. Plants may possess up to 180 leaves and all petioles are attached to a thick, tan stem. Plants may survive light frosts, but are killed by sub-freezing weather. After a vernalization period has occurred, the plants produce several elongated stalks, which contain the reproductive structures. 'Early Mizuna' is very attractive in bloom with a profusion of bright yellow flowers covering the plant.

Mustard-spinach type crops like pak-choi are also popular Asian vegetables. The variety 'Tatsoi' (*Brassica rapa* var. *rosularis*) produces firm, broad, fleshy dark-green leaves that are flat and shiny. The leaves have white petioles that attach to a central growing point forming a rosette. The low growing habit (up to 8" tall) of 'Tatsoi' makes the plants attractive in borders or in mass plantings. 'Tatsoi' does not survive temperatures below 25°F and bolts rapidly as temperatures begin to increase in the spring. 'Tatsoi', with its small compact form, can be grown tightly on benches or on ground beds like mums.

Forage kales (*Brassica oleracea acephala*) were originally were used as a source of fodder for cattle. 'Lacinato', 'Red Bor', and 'Red Russian' are three of the varieties used by botanical gardens today as ornamentals. 'Lacinato' grows to a height of 2 feet and has thick and crinkled dark blue-green foliage. 'Red Bor' achieves a height of 3 feet and possesses dark purple ruffled leaves. 'Red Russian' is an interesting variety that grows to 3 feet. As the cooler weather sets in, its foliage

changes from a blue-green to a purple-red color.

Swiss Chard (*Beta vulgaris*) is a relative of the beet, but unlike the beet, it is grown only for its colorful leaves and stalk. The plants generally grow 1 to 1 1/2 feet tall. The cultivar 'Bright Lights' was a 1998 All-America Selections Winner. This variety is a favorite among gardeners because of its multiple colored stems and robust and crumpled foliage.

Ornamental cabbage and kale (*Brassica oleracea L.* var. *acephala*) are also popular plants used in the fall landscape. Another name used to identify this crop is flowering cabbage and kale, but this label is inappropriate, because the plants are grown primarily for their colorful fall foliage and not the yellow flowers that appear in the spring. For more information about ornamental cabbage and kale see the Horticultural Information Leaflet # 507: Success with Ornamental Cabbage and Kale.

Cultural Information

These plants, with their rapid growth rates, generally require 6 to 8 weeks of growth from seeding to achieve marketable size in 8" mum pans or 1 gallon containers. Due to their rapid growth rate, ornamental vegetables can be of wholesale shipping size by 6 weeks, and retailers can market the crop at 8 weeks. See **Table 2** for a sample production schedule.

Germination and Plug Culture. Seed can be sown in plug flats, germination trays or into a 606 or an 804 flat. Seeds can also be sown in the final containers and then thinned when the seedlings begin to produce true leaves. Southern growers commonly purchase plugs (typically 288s or 384s) from northern plug producers.

Germination takes 3 to 5 days at 70°F with the seeds covered lightly with germination substrate. If growers decide to sow these leafy vegetables themselves, the germination substrate needs to remain cool and moist. An application of B-Nine at 2,500 ppm two weeks after sowing can be applied to control plant height in the plug tray. The plants should not be allowed to become root bound in the germination container before transplanting, as restriction of the roots can result in stunted plant growth.

Seedlings should be transplanted into larger pots containing a substrate with excellent water holding capacity. Normally, growers will transplant the plugs into 6-, 7-, or 8-inch pots when the root ball is fully developed and the first true leaves are twice as large as the cotyledons. If plants become too tall in the seedling flats, they can be planted slightly deeper, up to the first set of leaves. These vegetables are heavy feeders and competition for nutrients should be avoided, so one seedling should be transplanted per finished pot. Swiss chard is the exception, avoid small celled containers and plant 3 to 4 plugs per 8-inch pot for a robust, colorful display.

Table 2. Typical North Carolina ornamental mustard 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
Weeks 3-5	Transplant the plugs into 8" mum pan
	Fertilize at the rate of 150 to 250 ppm N and K
	Apply preventive fungicide drench
	Apply insecticides as needed
Weeks 6-8	Respace plants if needed
	Acclimate plants to cooler temperatures if greenhouse grown
	Decrease fertilizer to 100 ppm N and K

Spacing. Due to their robust foliage, plants should be adequately spaced in order to maximize airflow to prevent foliar diseases and allow for uniform growth around the pot. If plants are being grown in greenhouses, extra care should be taken during watering, spraying, and shifting plants because the foliage may be fragile due to the lack of cool temperature acclimation. Use 6-inch centers for 4.5-inch pots, 11- to 12-inch centers for 6-inch pots, and 16- to 18-inch centers for 1-gallon containers and 8-inch mum pans.

Irrigation. Plants can be grown in a soilless substrate with good water holding capacity. If the plants are to be grown outdoors in pots, a soil-based substrate or the addition of sand may keep plants from being knocked over during windy weather. During the late summer months, when the plants are establishing themselves in pots, an adequate supply of water should be provided to the substrate. Use of an automated watering system similar to one used on garden chrysanthemums is recommended. Ornamental vegetables are not tolerant of water stress, which results in the stalling of growth, yellowing, and dropping of lower leaves. Premature bolting can occur if moisture levels become low in the growing substrate and extensive wilting takes place.

Fertilization. Maintain the root substrate pH between 5.8 and 6.5. Irrigation water alkalinity levels should be below 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 epsom salts [$MgSO_4 \cdot 7H_2O$] (for magnesium and sulfur). High levels of NH_4-N and/or urea in a fertilizer mix will stimulate stem elongation, resulting in the need for higher plant growth regulator rates to control plant growth. The percentage of ammoniacal nitrogen and urea should be less than 20% of the total nitrogen supply to avoid stretchy 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 (saturated paste extraction method) 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. Deficiency symptoms are more likely to occur in a soilless substrate, which has a low cation exchange capacity (the ability to hold nutrients), than in a soil-based substrate. Therefore, for the final two weeks of growth, a fertilization rate of 100 ppm N and K should be sufficient while allowing the plants to develop color and avoid deficiency symptoms.

Temperature. Outdoor production of ornamental vegetables is highly recommended, as cool night temperatures in the late summer and early fall strengthen the foliage and may enhance foliage color. When ornamental vegetables are grown in greenhouses, night temperatures should be held at 55 to 60°F during the final 4 weeks of production. Cooler temperatures will help avoid the leaves from becoming too soft and fragile and will allow the plant to harden and become acclimated to cooler outdoor temperatures. The exception is ornamental cabbage and kale, which requires night temperatures of 45 to 50°F for significant color development.

Growth Regulators. Plant growth regulators (PGRs) can only be applied to ornamental vegetables grown as non-food crops. PGRs can be used to avoid stretching and achieve desired wholesale and retail plant heights and diameters. Based on PGR studies conducted at NCSU,

Table 3. Common insect pests of ornamental vegetables.	
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 4. Common diseases of ornamental vegetables.	
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 substrate 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 substrate.	• **Cultural:** Use clean growing substrate.
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:** Inspect 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 substrate.
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 substrate. • **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.*	

multiple foliar applications of B-Nine at 2,500 to 5,000 ppm should be used to control plant height and diameter of 'Red Giant', 'Early Mizuna', the forage kales, and ornamental cabbage and kales (**Table 1**). Multiple foliar applications of B-Nine at 2,500 ppm are appropriate for Swiss chard. Mustard-spinach is naturally compact and does not require PGRs. Lower PGR rates produce plants that are more robust and suitable for retail sales. Higher rates result in more compact plants suitable for wholesale shipping. Sumagic foliar sprays at 2 to 8 ppm were also found to be suitable for ornamental cabbage and kale in trials at NCSU, but Sumagic trials have not been conducted on the other vegetables. Besides controlling internode stretch and leaf expansion, PGRs also produce darker foliage color on most ornamental vegetables and intensify the bronze appearance of 'Red Giant'. Ornamental vegetables treated with PGRs should never be sold as edible crops.

Insects and Diseases. A number of insects and diseases can attack ornamental vegetables. A descriptive listing of insect and disease pests and management strategies are in **Table 3** and **Table 4**. *(Mention of chemical trade names does not constitute an endorsement. Omission of any registered chemical does not imply criticism.)*

The varying textures and foliar colors make ornamental vegetables an exciting, new addition to the fall garden. When the garden mums begin to fade and the pansies start their winter hibernation, mustards, kales, and chard can withstand the chilly air, and maintain color throughout the winter months. The landscaping industry is always searching for attractive additions to their fall planting list. Growers should consider adding them to their fall production regime.

For Further Reading:

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Knott, J. and J.R. Deanon. 1967. Vegetable Production is Southeast Asia. Univ. of the Philippines. pp. 366.

Stephens, J.M. 1988. Mustard, p. 72. In: J.M. Stephens. Manual of Minor Vegetables. Univ. of Florida Coop. Ext. Serv., SP-40.

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Recommendations for the use of chemicals are included in this publication as a convenience to the reader. The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by the North Carolina Cooperative Extension Service nor discrimination against similar products or services not mentioned. Individuals who use chemicals are responsible for ensuring that the intended use complies with current regulations and conforms to the product label. Be sure to obtain current information about usage and examine a current product label before applying any chemical. For assistance, contact an agent of the North Carolina Cooperative Extension Service in your county.