

SPECIALTY CROPS:

Chinese Cabbage and Related Oriental Crops

COMMERCIAL VEGETABLE PRODUCTION

THE UNIVERSITY OF GEORGIA COLLEGE OF AGRICULTURAL
& ENVIRONMENTAL SCIENCES ■ COOPERATIVE EXTENSION SERVICE

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CHINESE CABBAGE

Chinese cabbage is a member of the Cruciferae family, which also includes cabbage, broccoli, cauliflower and mustard. In fact, Chinese cabbage is more closely related to mustard than to cabbage. Though seemingly new to Southern diets, Chinese cabbage has been cultivated in North America for more than a century and in China for almost 1,500 years. Today, it is grown for sale primarily in California, New Jersey, Hawaii and Florida.

The flavor of Chinese cabbage is somewhat milder than cabbage when cooked or eaten raw and has been traditionally used in soups, egg rolls, stir-fry and pickling. It can adequately substitute for cabbage in many Western dishes.

Chinese cabbage is an annual that grows 10 to 20 inches tall. Two types are available: a leafy type (*Brassica rapa*, Chinensis group) and a heading type (*Brassica rapa*, Pekinensis group). Both types probably originated in China. The heading types are most often envisioned when one mentions Chinese cabbage; however, the leafy types are more often called bok choy or pak choy by people remotely familiar with these Chinese vegetables.

The head of a Chinese cabbage is not round like a regular cabbage head, but tall like a romaine lettuce head with a broad central midrib. The heading types are known by many names, for example the Chinese call it pai tsai ("white vegetable") and the Japanese call it hakusai.

The cylindrical head of Chinese cabbage is firm, but not as firm as cabbage at maturity. The outer foliage and wrapper leaves are characteristically pale green, whereas the inner leaves are blanched to a creamy white color.

Two head shapes predominate in Chinese cabbage. The wong bok or napa (Figure 1) types produce a barrel-shaped head, typically short and broad, about 8 to 10 inches in length and 6 to 8 inches in diameter. Napa types tend to bolt slowly, weigh 3 to 9 pounds, and have some tolerance to downy mildew, wilt, bacterial soft rot and tip burn. The napa type will mature in 50 to 80 days, grows well in both the spring and fall, and stores longer than michihli types. Varieties represented in this category are Che-foo, Wong Bok, Spring Giant, Tokyo Giant, Tropical Pride, Tropical Delight, Early Top, Tip Top, China King, Winter Giant, Oriental King, Blues, Takii 50 days and Winter Knight.

Table 1. Quick Guide to Chinese Cabbage Names and Types

English	Botanical Name	Type	Japanese	Chinese	Filipino
Chinese cabbage	<i>Brassica rapa</i> Pekinensis Group	Heading (short, broad)	napa hakusai	pai-tsai won bok	pechay tsina
		Heading (long, tapering)		chihli	
	<i>Brassica rapa</i> Chinensis group	Leafy	chongee	pei tsai pak choi	petsay
	<i>Brassica rapa</i> Chinensis group var. para chinensis	Flowering		choi sum paak tsoi sum	



Figure 1. Wong bok or napa type Chinese heading cabbage (Photo courtesy of Takii Seed)

The michihli types (Figure 2) have long tapering heads often 15 to 20 inches in length and 3 to 5 inches in diameter. This group has an erect, upright growing habit, weighs 2 to 5 pounds, matures in 72 to 80 days and has some tolerance to bolting and bacterial speck. Among the varieties having this form are Chihli, Michihli, Market Pride, Shantung, Green Rocket, Monument and Shaho Tsai. The michihli is a new, improved strain of chihli.



Figure 2. Michihli type Chinese heading cabbage (Photo courtesy of Takii Seed)

Chinese cabbage cultivars differ in plant and head size, time of maturity, disease tolerances and certain head and foliage characteristics. There are no recommended varieties specifically for Georgia; however, preliminary trials indicate Chinese cabbage can be grown in both the spring and fall with seed from a variety of sources. Most seed companies offer at least one Chinese cabbage, but experienced growers should check with their buyers to assure market acceptance of a particular variety. Based on experience, choose the cultivars most suitable for your production operations and clientele.

Plant Characteristics

Chinese cabbage is a hardy, shallow-rooted (18 to 24 inches), cool-season crop with an optimal temperature range of 55° to 70°. It can tolerate higher temperatures if there is ample soil moisture.

Late-growing Chinese cabbage can withstand light frosts in the fall; however, alternate freezing and thawing may damage leaf tissue. Growth in these cabbages is quite fast, and within two to three weeks after head formation they are ready for harvest.

Chinese cabbage seems to do best as a fall crop. It is not especially successful as a spring crop because hot weather tends to make it go to seed.

Soil Requirements

A soil of good structure, fertility and water-holding capacity will produce a satisfactory crop of Chinese cabbage. Watch sandy or porous soils carefully to monitor nutrient and water status of the crop. Chinese cabbage grows on soils with pHs of 5.5 to 7.6, although the ideal pH for growth is near neutral (7.0).

Prepare a planting bed similar to cabbage culture: Bury previous crop debris to a minimum of 10 inches, smooth with a tine harrow (avoid disking as severe soil compaction can occur), prepare a bed to be seeded, pre-water bed thoroughly to provide adequate moisture for good germination, plant seed, and water properly until good seedling establishment occurs.

Fertilization

According to *Knott's Handbook for Vegetable Growers*, Chinese cabbage will produce adequately with the following program: 110 pounds nitrogen, 150 pounds potassium. Higher nitrogen application rates may be necessary on sandy soils. Best results are obtained when about one-fourth of the nitrogen is broadcast before planting. The remainder is supplied by sidedressings 10 days apart following thinning or within one month of transplanting. This insures an ample supply of nitrogen during plant development.

Research has shown that Chinese cabbage uses the majority of its nitrogen requirement during and shortly after head formation. Excessive application of

nitrogen may increase disease susceptibility and delay maturity. Avoid excessive nitrogen fertilization near maturity because heads of larger size but lesser density may result.

Expect satisfactory growth of Chinese cabbage when the phosphorus and potassium levels in the soil are sufficient to support the production of cabbage.

Chinese cabbage may exhibit tipburn similar to the tipburn observed in lettuce and cabbage. Brown and black necrotic areas on the leaf margins of the foliage are the obvious symptoms. Tipburn in lettuce is likely due to plant water status and the uptake of calcium and/or boron in the plant. Some cultivars that appear to possess tolerance to tipburn are available.

Planting

Chinese cabbage seed will remain viable for three years if stored properly. Direct seeding in the field can begin as early as mid-February (South Georgia) if you can afford to lose some plantings to possible cold-induced bolting. Seeding in mid-April may also predispose Chinese cabbage to bolting due to the long day conditions it may encounter. Fall plantings will generally result in better success and mid-August will be the earliest suggested planting date. If planted during dry, summer conditions, provide a moist seedbed and additional water to establish the plants and seed 75 to 85 days before frost.

A continuous supply of fall Chinese cabbage through the season is achieved by successive planting every 10 to 14 days, allowing ample time for plant development before the anticipated date of the first frost. To safeguard against total crop failure, plant more than one cultivar at a time.

Plant seeds $\frac{1}{4}$ to $\frac{1}{2}$ inch deep. One to 2 pounds of seed are required per acre for a field spacing of 10 to 18 inches between the plants and 18 to 36 inches between the rows. Use the closer row spacings for the narrow upright michihli types and the wider spacings for the larger, spreading wong bok types. The wider spacings will also result in larger individual plants, which may be a requirement of the home gardener. To accomplish this spacing, some larger growers may use precision seeders to reduce labor and seed costs. If thinning is required, the thinned plants can be used as transplants, though Chinese cabbage transplanted in this manner may not succeed.

In the Philippines, transplants are grown in a seedbed prior to field establishment, and in Canada transplants are greenhouse grown. In both instances transplants are set out within a month after seeding and under favorable conditions to ensure plant growth is not halted. Bolting may result if plant growth is halted. Generally, the seedlings are handled in a manner similar to cabbage transplants, and

maybe hand or mechanically set in the field. The key to transplant success is to provide adequate soil moisture before and after transplanting. Avoid disturbing the roots and shocking the seedlings as little as possible.

Irrigation

Ample and uniform soil moisture for plant development is essential for the successful production of Chinese cabbage. Because rainfall is unpredictable, monitor soil moisture levels closely and be prepared to irrigate when necessary. Moist soil conditions will lower field soil temperature, giving additional benefits during late summer, early fall conditions. Overhead irrigate in the morning so plants will dry before evening. Long periods of wet foliage will increase foliar disease problems.

Weed Control

Weed control is one of the most serious concerns to Chinese cabbage growers. Develop a cost-effective weed control program before establishing a planting.

From the standpoint of weed control, consider several factors before venturing into Chinese cabbage production. Use land that does not have a history of troublesome weeds or weeds that will be resistant to chemical control methods. Avoid land with a history of weeds that can be expected to germinate in middle to late growing season. Avoid land with an infestation of perennial weeds such as common Bermuda grass and Johnson grass.

Identify the weed since the total weed control strategy depends on weed species and the degree of weed infestation. A good approach is to know the weed history of the field and if possible draw a weed map showing areas with the infestation of different weed species. By having a weed map, control strategies can be more effective.

Crop rotation is also important to maintain land free from troublesome weeds. During the process of rotation, avoid lands treated with herbicides to which Chinese cabbage are sensitive or have the potential to be sensitive. Many of the herbicides used for weed control in agronomic crops (peanuts, soybeans, corn, cotton, grain sorghum) have not been thoroughly tested for Chinese cabbage sensitivity. The residual soil life, particularly of the newer compounds, has not been fully established. Keep a record of the herbicides used on fields to be planted to Chinese cabbage and check the herbicide labels for crop rotation guidelines. The following are herbicides with the potential to cause severe injury or stand loss to Chinese cabbage if sufficient rotation time is not allowed:

Herbicide	Waiting Period*
Atrazine	one year
Bladex	one year
Classic	one year (possibly more)
Cotoran/Lanex	two years
Karmex/Direx	one year to 18 months
Lexone/Sencor	six months
Lorox, Linex	six months
Milogard	one year
Princep	one year
Scepter	one year (possibly more)
Surflan	six months**

* Rotation time after application required to prevent injury to Chinese cabbage.

** Buildup of Surflan with continuous yearly usage may result in injury even after a six month waiting period.

Methods of Weed Control

Hand weeding is the safest and least damaging to the crop; however, only growers with small acreage and abundant labor can depend on this approach.

1. **Mechanical:** Mechanical control is very effective during early growth; however, once plants begin to size up cultivation is not practical. Tractor wheels and cultivars easily damage crops. Also, mechanical cultivation requires supplementary hand weeding for removing weeds in the rows.
2. **Herbicides:** Herbicide control is limited to materials recommended by the University of Georgia Cooperative Extension Service (see Circular 695, *Chemical Weed Control in Vegetables*).
3. **Stale seedbed:** Stale seedbed control is a method of chemical control that is used to destroy weeds that emerge before crop emergence or transplanting. A contact herbicide is applied prior to seeding or transplanting to kill weeds that have germinated during the seven to 10 day period after a pre-plant incorporate herbicide was applied.
4. **Fumigation:** Fumigation for weed control is expensive and dangerous. In general, registered fumigants are restricted use chemicals and must be handled carefully by a certified applicator. Once the fumigant is injected, the soil is covered with a non-perforated, airtight material such as plastic or a tarp. All edges are then sealed with soil. The cover remains in place for three days. After the cover is removed, the soil is allowed to aerate for several days before the Chinese cabbage is planted. A properly applied fumigant penetrates the soil and kills most existing viable seeds. Apply all fumigants in full compliance with label recommendations and precautions.

Physiological Problems

If Chinese cabbage is grown under long days (15-hour days for a month = late spring/summer), it will

produce a seedstalk in a process called bolting. Spring plantings tend to bolt more frequently than fall plantings. When plants of Chinese cabbage bolt, undesirable head size and quality result. Studies have shown that the bolting response in Chinese cabbage is under genetic control. Therefore, certain cultivars may bolt more readily than others. When planting in the spring, use a variety that is described as “early” and “slow-bolting.” These varieties tolerate surprisingly warm weather and still head nicely.

Chinese cabbage is sensitive not only to photoperiod for flowering but also to temperature. Research indicates that frost or extreme cold early during seedling growth induces bolting. This is important in spring plantings. Short days and warm temperatures keep the plant in the vegetative phase.

Finally, factors that cause a check in plant growth, such as nutrient deficiencies or water stress, may also induce bolting.

The other major physiological problem in Chinese cabbage is pepper spot. Experts are not certain if it is caused by a virus, high concentrations of carbon dioxide within the head of the cabbage or something else.

The symptoms appear as small, dark, circular spots on the white midribs of the leaves. The appearance is much like someone has sprinkled pepper on the plant. No cure is known, but the symptoms are aggravated by storage. While unsightly at times, pepper spot affected Chinese cabbage is often marketable if the symptoms are not overly abundant or if market demand is high and supply is short (Figure 3).

Diseases

A number of crucifer diseases have been reported on Chinese cabbage. Disease incidence will depend on locality, weather, irrigation practices and other factors.

Some Chinese cabbages are susceptible to turnip mosaic and turnip yellow mosaic virus; however, information on the availability of resistant cultivars is

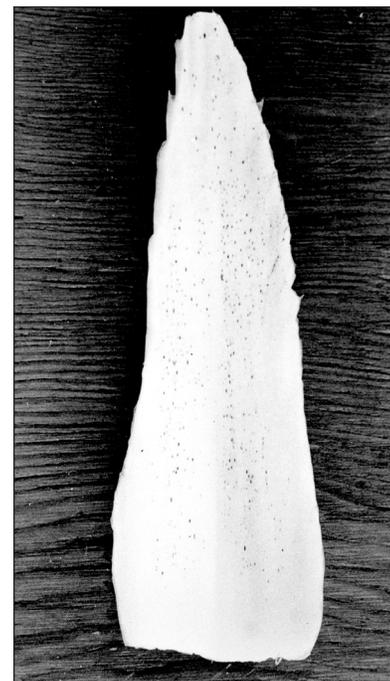


Figure 3. Pepper spot on napa leaf midrib (Photo courtesy of D. Maynard, University of Florida)

lacking. Young plants with turnip mosaic virus are stunted, mottled, and may never reach harvest maturity. Aphids transmit the virus, but insecticides cannot protect fields from migrating aphids carrying the virus.

Downy (*Peronospora parasitica*) and powdery (*Erysiphe polygoni*) mildews can attack Chinese cabbage at any stage of development. On mature plants an infection deep within the head may render it unfit for sale. Secondary infections by bacterial soft rots (*Erwinia carotovora* or species of *Pseudomonas*) may further complicate cabbage quality.

Leaf spots (*Alternaria brassicae* and related species), blackleg (*Phoma lingam*) and white rot (*Sclerotinia sclerotiorum*) may also affect production in certain years.

Insects

Insects that feed on the cole crops may also damage Chinese cabbage. Insects that may be major problems are: diamond-backed moth caterpillar, cabbage looper, beet armyworm, corn earworm, aphids, vegetable weevil, seedcorn maggot and flea beetles.

The more minor insect pests include: thrips, stinkbugs, tarnished plant bug imported and cross-striped cabbage worms.

Nematode Control

Nematodes can reduce yields, stunt plants, retard plant growth and otherwise render Chinese cabbage unmarketable. Certain nematicides are registered for use on direct-seeded and transplanted heading type Chinese cabbage only.

Harvesting

Chinese cabbage is harvested by hand when the heads are fully developed, firm and free of discoloration, pests and disease injury. Cut plants at the base and remove the outer leaves. Do not remove outer leaves if the heads are to be stored if these leaves are disease-free. These outer leaves are removed after storage is complete. If long-term storage is desired, handle with care to avoid bruising, cuts and abrasions, which lead to accelerated deterioration.

Plants exposed to a light frost are marketable, but do not market heads that have been exposed to a hard freeze. Temperatures below 50°F will slow fall Chinese cabbage growth, but such crops hold well in the field for later pickings.

Chinese cabbage is typically sold in either a 15½ inch wirebound crate (50 to 53 lbs.) or a 1⅞ bushel wirebound crate (40 to 45 lbs.). Check with your buyer for other preferences.

Storage

The wong bok types of Chinese cabbage store for longer than two months when held at 0°F and a high

relative humidity (95 to 100 percent). When held for three to four months at 0°F considerable losses can occur. Storage life is shorter when held at higher temperatures.

Concentrations of ethylene gas are detrimental to Chinese cabbage storage because high levels of ethylene gas cause leaf abscission. Other studies indicate a 1 percent oxygen atmosphere during storage can extend the storage life of Chinese cabbage.

Establish the appropriate storage conditions quickly following harvest to assure maximum storage length. When placed in cold storage, pack the heads loosely in crates to allow for proper ventilation around the heads. Store heads of certain cultivars in an upright position to safeguard them against becoming misshapen.

Marketing

According to information released by the USDA, the best Georgia market prices should occur for products harvested from October through December. There is a market preference for wong bok or michihli types depending on ethnic origin, so know your market.

BOK CHOY

Although the genus and species for bok choy (Figure 4) is *Brassica rapa L.*, it is sometimes called *Brassica chinensis* because it belongs to the *Chinensis* group (Table 1). Some call it Chinese mustard, but it should not be confused with the broader leafed Chinese mustard called kai choy



Figure 4. Bok choy, a leafy type Chinese cabbage (Photo courtesy of Takii Seed)

(*Brassica juncea*), which will be discussed later. Other names for bok choy are: celery mustard, PEI tsai (Mandarin) pak choy (Cantonese), chongee (Japanese) and Japanese white celery mustard.

Bok choy is a non-heading form of Chinese cabbage requiring 40-60 days to maturity depending on the season. The most familiar form of this vegetable has thick white leaf stalks (petioles) and smooth, glossy, dark green, almost round leaf blades. There are not as many bok choy varieties available as there are on the heading types. Some of the varieties include: Canton Pak Choi, Pak-Choy Green, Pak-Choy White, Green Boy, Lei Choi, Hung Chin, Shanghai Pak Choi and Joi Choi.



Figure 5. Choi sum, a flowering relative of bok choy (Photo courtesy of Takii Seed)

Closely related to bok choy is a flowering type that is called choi sum (Figure 5). “Sum” in Cantonese means “flower stalk.” These varieties have petioles and leaves that tend to be less massive than the bok choy types proper. Chinese Tsai Shim and Tsoi-Sim are green varieties of the flowering bok choy. A purple variety of the flowering bok choy is Hon Tsai Tai. It has dark green deeply cut (serrated) leaves with purple-red veins.

Flowering bok choy has small flowers borne on top of erect flower stalks varying in color from yellow to purple depending on variety. Whole plants are harvested in about 40 days (when summer planted) and should be taken when two or three flowers have opened.

Planting

Bok choy is a cool-weather vegetable. Plant in March for a spring crop or the middle of August for a fall crop. Spring plantings are susceptible to bolting.

Sow seed ¼ to ½ inch deep about 6 inches apart in rows 18 inches apart. When the plants are about 4 inches high, thin to stand about 6 inches apart.

Fertilization

Fertilize according to the recommendations listed for Chinese cabbage above; bok choy does best with frequent light fertilization rather than occasional heavy fertilization. Sidedress lightly about every two weeks. Like all cabbages, bok choy should be encouraged to grow briskly, and the best way to accomplish this is with sufficient moisture.

Harvest

Bok choy matures fairly quickly; in about eight weeks. Follow the instructions delineated above for Chinese cabbage harvest and storage.

The home gardener can leaf-crop the outside leaves of bok choy as in Swiss chard, letting the rest of the plant continue to grow. The practice of cropping the outside leaves is only recommended for fall plantings, however, because the spring season is too short. Leaf-cropping practices are not acceptable in commercial production.

CHINESE MUSTARD

The true Chinese mustard (Figure 6) is called kai choy (*Brassica juncea*). Other names for kai choy are Chieh tsai (Mandarin), gai choy (Cantonese), takana (Japanese) and oriental mustard. Popular varieties are: Paa Sum Kaai Tsoi (a wrapped heart mustard), Takana (a red and green leaved Japanese variety), Miike Giant (a giant size mustard) and Serifon.



Figure 6. Kai choy, the true Chinese mustard (Photo courtesy of Takii Seed)

Chinese mustards are generally sown in August through early autumn for fall harvest. They have some frost tolerance. Seed or thin plants to a final spacing of 4 inches between plants and 18 inches between rows. Follow cultural and fertilizer recommendations.

FLOWERING CABBAGE

Flowering cabbage (*Brassica oleracea*) is usually grown as an ornamental, appearing in Southern landscapes from January through April, and is known for its spectacular range of colors. However, flowering cabbage is edible and is beginning to show up in supermarket specialty vegetable sections and also as a salad bar decoration.

A cool-weather vegetable, flowering cabbage is only planted as a fall crop because spring crops do not develop the color. Flowering cabbage will produce its various colors when subjected to cold temperatures.

The popularity of these cabbages makes them readily available from garden shops as transplants in the fall. The expense of this method of purchase is prohibitive for the commercial grower, however. Flowering cabbages transplant easily; therefore, the grower may grow his own transplants or contract them out.

Locate seed beds on new ground or where cabbage or collards have not been grown in the past several years. One-fourth to ½ pound of seed will produce enough plants to transplant one acre if plant beds are carefully managed. Plant seed ½ inch deep in rows 6 inches apart. Fertilize plant beds with ¼ to ⅓ pound of complete fertilizer per square yard of plant bed.

Avoid nitrogen sidedressing, if possible; nitrogen causes rapid, tender growth. If nitrogen is leached and plants become yellow and stunted, apply 1 pound of nitrate of soda to each 25 square yards of the bed.

Maintain adequate moisture through supplemental irrigation as needed. Irrigation is essential on fall cabbage seed beds to ensure a stand.

Fall flowering cabbage can be grown in South Georgia by planting seed beds in August and transplanting in September or October. In North Georgia, set the fall crops in early August. It is very difficult to get a good stand of plants during August because of the hot and normally dry weather. It may be necessary to irrigate seed beds lightly several times a day during emergence and until plants have become well established. Avoid excessive water during later weeks of plant growth to prevent disease and plants that are too tender.

Culture

Unlike other Chinese cabbages, grow the ornamental flowering cabbages like common cabbages. The best pH is 6.0 to 6.5. In general 1,000 to 1,200 pounds of 6-12-12 or 5-10-15 per acre will be adequate on fer-

tile soils in rotation with highly fertilized crops. On poorer soils, this crop can use 1,700 to 2,000 pounds per acre where adequate irrigation is applied. In addition to the complete fertilizer, 30 to 45 pounds of nitrogen per acre will be needed as sidedressing. Add 1 pound of actual boron (use a slow releasing type, such as Borate 65 or borosilicate) to the amount of fertilizer to be applied per acre in the initial application.

Fertilizer can be broadcast, mixed in the row or applied in bands. Use the broadcast method when a heavy rate is applied initially. Banding about one-third and applying the balance in two equal sidedress applications makes more efficient use of fertilizer. Irrigate immediately after transplanting to insure a good stand in the field.

Harvest

Pick flowering cabbage anytime after they have formed loose heads (possibly as early as 55 days). Flowering cabbage does not have good keeping qualities even when stored as suggested above.

CHINESE BROCCOLI

Chinese broccoli (*Brassica alboglabra*) is one of the oldest of the brassicas, which was eaten in ancient Greece over 2,000 years ago. It is also sometimes called Chinese kale, though it is prepared like broccoli, not like kale.

Chinese broccoli looks like regular broccoli, but the stems are long in proportion to the flowers and the heads are much smaller than those of common broccoli. The larger, less numerous flowers are yellow like regular broccoli.

Culture

As with other cool-season brassicas, plant Chinese broccoli either in early spring or mid-August. It will take about 14 days to germinate. Sow the seed in place ½ inch deep, 1 inch apart, in rows 12 inches apart. Thin seedlings to stand 6 inches apart when they are 3 to 4 inches tall. Chinese broccoli is not a heavy feeder.

Harvest

Like regular broccoli, Chinese broccoli flavor is best just before the flowers open. The central heads will never approach the size of commercial broccoli; however, harvest the secondary shots for an extended harvest.

The commercial success of any vegetable such as the Chinese cabbages, mustards or broccolis will be completely dependent on the marketing strategies of the grower. Before production even begins, know where, when and which varieties to market. These crops can constitute a specialty niche that can be maintained by the production of a quality product.

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ATTENTION!

Pesticide Precautions

1. Observe all directions, restrictions and precautions on pesticide labels. It is dangerous, wasteful and illegal to do otherwise.
2. Store all pesticides in original containers with labels intact and behind locked doors. KEEP PESTICIDES OUT OF THE REACH OF CHILDREN.
3. Use pesticides at correct label dosage and intervals to avoid illegal residues or injury to plants and animals.
4. Apply pesticides carefully to avoid drift or contamination of non-target areas.
5. Surplus pesticides and containers should be disposed of in accordance with label instructions so that contamination of water and other hazards will not result.
6. Follow directions on the pesticide label regarding restrictions as required by state or federal laws and regulations.

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Horticulture 2

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