

Green house cultivation of Cabbage, Broccoli, Cauliflower, and Other Brassica Crops

Introduction

The term "cole crops" refers to waxy-leaved brassicas of European origin, of the species *Brassica oleraceae*. Cabbage, broccoli and cauliflower and other brassica crops are hardy crops that are well adapted to New England. Plants maturing under cool weather conditions are of especially high quality. This diverse family has similar cultural requirements, diseases and pests.

Types and Varieties

Cabbage is the most widely grown and easily cultivated of the cole crops. Some varieties mature in as few as 60 days or as many as 120 days from transplanting. The early and mid-season varieties are generally better suited for fresh market sales where small heads of 3-4 lb are desired.

Cauliflower is more difficult to grow than other brassica crops. Common problems include failure to head properly and poor curd quality. For successful production of cauliflower, a fertile, moist soil relatively high in organic matter and nitrogen is needed. Buttoning is the premature formation of the head, when the leaves are not large enough to produce a head of marketable size. Conditions that reduce the vigor of the plant and retard vegetative growth, such as cold temperatures at transplanting and any of a number of other stresses appear to encourage buttoning. Cauliflower varieties range in maturity from 55 to 95 days.

Broccoli is not as exacting in its requirements as cauliflower, however, it must be harvested promptly to avoid flowering. The earliest spring plantings often experience buttoning. In summer months, temperatures over 85° F during the critical period when the head begins to form can result in poor head quality. In Southern New England, broccoli is best grown as a fall crop. Broccoli varieties range in maturity from 55 to 75 days.

Brussels sprouts are generally a long season crop grown for harvest in the fall. Brussels sprouts should be harvested when they are round, firm, tight and of good color.

Kale is cold-hardy and grows best as a fall crop when grown for full-size leaves, but can be succession-planted all season. Kale is also commonly grown as a component of salad mix (see [Salad Mix Section](#)). The flavor of the leaves is improved after a light frost.

Kohlrabi looks like a turnip growing on the top of the ground with sprouting leaves over the surface. It must be harvested when 1 1/2"-3" in diameter or it will become tough and stringy.

Chinese cabbage (*Brassica napa*), **mustard** (*Brassica juncea*) and **bok choy** (*Brassica rapa* var. *chinensis*), are grown as salad or braising greens or as a heading crop. They have non-waxy leaves and most are Asian in origin. See Salad Mix section for more details on production of salad mix. Crops in this group are more susceptible to damage from flea beetles, but tend to be less attractive to caterpillars than waxy cole crops. When grown as heading crops, these should be direct seeded from early May to mid-July depending on intended harvest date and location in New England. Chinese cabbage is especially sensitive to bolting in response to stress or cold. Nitrogen management for Chinese cabbage should differ slightly from other cole crops (see Soil Fertility below).

Many other brassica greens, such as mizuna, mibuna, tatsoi, komatsuna, arugula, and mustard are usually direct seeded. Some varieties are prone to premature flowering, which is enhanced by cold temperatures in the spring. Transplanting, which is less common than direct seeding, can also increase premature flowering in the spring due to increased plant stress. Plant populations vary tremendously and should be geared toward the intended harvest age and size.

Brassica Crop Varieties

Broccoli - Spring	Cabbage - Early
Belstar	Caraflex (pointed)
Castle Dome	Fast Vantage
Green Magic - DM	Red Express (red)
	Tendersweet - Y
Broccoli - Summer/Fall	Tiara
Arcadia - DM	

Brassica Crop Varieties

Diplomat - DM	Cabbage - Midseason
Gypsy - DM	Capture - Y, BR
Imperial	Early Thunder - Y, BR
Marathon - DM	Red Jewel (red) - TB
Cauliflower	Cabbage - Late Season / Storage
Amazing	Passat - Y, T
Freemont	Report - Y, TB, BR, CR
Snow Crown	SuperRed 115 (red) - Y
Skywalker	Storage #4 - Y, TB
Graffiti (purple)	Vantage Point - Y
Cheddar (yellow)	Ruby Perfection (red)
Brussels Sprouts	Cabbage - Savoy
Diablo	Alcosa - DM

Brassica Crop Varieties

Oliver	Deadon (tinged red) - Y
Nautic	Famosa - TB, DM
Cabbage - Chinese	Kohlrabi
Blues (Napa type)	Konan
Greenwich (Michihili type)	Kolibri (purple)
Jade Pagoda (Michihili type)	Kossack (giant)
Rubicon (Napa type)	
	Kale
Cabbage - PakChoi	Winterbor
Mei Qing Choi	Red Russian
Joi Choi	Lacinato

Resistant or tolerant to: BR: black rot, CR: clubroot, DM: downy mildew, TB: tipburn, Y: yellows

Soil Fertility

Apply lime according to soil test to maintain soil pH at 6.5-6.8. Maintain a high level of calcium to minimize tip burn.

The best method to apply a small amount of boron is as an additive to the fertilizer. For example, if the level of boron in the soil is low, apply 3 lb of B (15 lb Solubor, or 30 lb Borax) per acre before planting broccoli and cauliflower, and 2 lb/A for cabbage. See Tables 6 and 6a, page 14.

For **Chinese cabbage**, pepper spot can develop on the stalks of the plants as a result of excess nitrate uptake. Apply only 50 lb of actual nitrogen at planting and sidedress additional nitrogen at diminishing rates as the plant nears harvest maturity, for a total of 150 lb/A. Foliar or drip scheduled at 6 to 8 lb per week may be the most practical.

Less nitrogen fertilizer will be needed if legume sod was plowed down or if manure was applied (see Table 1, page 2 and Table 7, page 15).

If using transplants, use of a liquid starter fertilizer at planting time is beneficial, especially with cool soil conditions. Use a high phosphorus starter fertilizer mixed at a rate of 3 lb per 50 gallons of water. Apply 8 fluid ounces (1 cup) per transplant.

PLANT NUTRIENT RECOMMENDATION ACCORDING TO SOIL TEST RESULTS FOR CABBAGE, BROCCOLI, CAULIFLOWER, AND OTHER BRASSICA CROPS									
CABBAGE, BROCCOLI, CAULIFLOWER AND OTHER BRASSICA CROPS	NITROGEN (N)* LBS PER ACRE	PHOSPHORUS (P) LBS P₂O₅ PER ACRE				POTASSIUM (K) LBS K₂O PER ACRE			
		VERY LOW	LOW	OPTIMUM	ABOVE OPTIMUM	VERY LOW	LOW	OPTIMUM	ABOVE OPTIMUM
Broadcast and Incorporate	100	150	100	50	0	175	125	50	0
Side dress 4 weeks after transplant	60*	0	0	0	0	0	0	0	0
TOTAL RECOMMENDED	160	150	100	50	0	175	125	50	0
*CAULIFLOWER APPLY 30 LBS/A									

Planting

Early plantings of cabbage and other cole crops are generally made by setting out transplants grown in greenhouses or cold frames. Transplants should be 4-6 weeks old at field setting; and, for cauliflower and broccoli, transplants should be produced in greenhouses with a minimum temperature of 55° F. Excessive cold, transplant stress, inadequate fertility or other sources of stress in early stages can cause cole crops to button, or to go to seed without heading. Transplants with thick stems are likely to head prematurely or button. Midseason and late plantings can be transplanted or direct seeded. If cabbage, broccoli or cauliflower are direct seeded, 2-3 weeks should be added to the number of days to maturity.

Generally, coarse-textured soils (sands, sandy loams, etc.) are favored for early plantings because they can be worked earlier in the spring and will warm up faster. These soils are also less likely to become waterlogged under rainy spring conditions. Finer textured soils which have a greater water holding capacity can frequently be used to advantage for producing later crops.

Cabbage grown for fresh market should be planted to stand 12"-15" apart within rows and 24"-36" between rows. With most early or midseason varieties the closer spacing will give larger yields and smaller heads, which can be a more desirable size for fresh markets. Where direct seeding is used, seeding depth is 1/2"-3/4". One-half to 1 lb of seed will be required per acre (0.125-0.25 oz per 100 feet of row) depending on cultivar, seed size, and spacing. Thin seedlings to desired stand when plants are 2"-4" tall. Do not allow plants to become crowded.

Cauliflower should be planted to stand 15"-18" apart within rows and 30"-36" between rows. **Broccoli** should be spaced according to market needs. Large single heads can be achieved by a 15" to 18" spacing. Three-head bunches require 5"-6" heads with small stalks; plant double row beds with 36" between beds and 10"-12" between rows within beds. Space 6"-9" between plants, depending on cultivar. Early varieties usually require closer spacing. Southern grown plants can be purchased for transplants, but insect and disease problems often accompany them. If purchasing bare root transplants from nurseries, plant soon upon receipt. Field-grown cabbage transplants, once pulled, should not be stored for longer than 9 days at 32° F (0° C) or 5 days at 66° F (19° C) prior to planting in the field. Cauliflower and broccoli can be direct seeded to stand, with precision type planters. Raised beds of 4" are recommended. For cauliflower this will require about 4 oz seed per acre (0.0625 oz per 100 feet of row); for broccoli about 0.5 to 1 lb/acre (0.125 to 0.25 oz per 100 feet of row).

Brussels Sprouts are most commonly grown from transplants. In general, they are grown as a long season crop grown for fall harvest. Cool weather and light frosts prior to harvest increase quality. Rows are typically spaced 3' apart with 15" spacing within the row. Plants can be topped in early September to improve sprout size uniformity if harvesting entire stalks. Trimming foliage from the lower 1/2-2/3 of the plant will allow more light to reach the developing sprouts, as well as increase air circulation both of which increase sprout quality.

Kale can be successfully grown from direct seeding or from transplants. For direct seeding, sow seed at 3 to 4 lb per acre in rows spaced 16"-36" apart. Thin to 4"-5" apart in the row. Transplants are set in rows 16"-36" apart and 6"-12" apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves.

Kohlrabi may be grown for spring crops by transplants. Transplant into the field at the same time as broccoli or cabbage. Fall crops can be established by direct seeding between June 25 and July 15. Seed open-pollinated varieties at the rate of 2-3 lb per acre and thin to 6"-8" between plants in the row. Precision-seed hybrid varieties. Set transplants July 20 to August 15. Space rows 18"-24" apart.

Irrigation

The availability of water can be critical for successful production. Adequate soil water must be maintained during seedling or transplant establishment and the period of rapid vegetative growth that follows. This is extremely critical prior to head initiation for cabbage, since excessive water applied after cabbage heads have formed can result in split heads. When harvest periods of broccoli and cauliflower occur during times of high temperatures, light irrigation (0.33"-0.5") can be used to cool plants and help maintain quality.

Harvest and Storage

Cabbage. Harvest as soon as the head has reached full size for the cultivar grown. Many varieties will stand in the field for considerable periods of time after heading without serious deterioration. Harvest should not be delayed unnecessarily as plants become more susceptible to disease and to splitting.

Cauliflower. In order to produce the attractive white curd in most cauliflower varieties, it is necessary to blanch the head. When the head is 2"-3" in diameter, gather the large outer leaves loosely over the head and tie with twine or rubber bands. Tie every two to three days with different colored bands to help coordinate harvest dates. Hot, humid, rainy weather after tying

can result in a rotting curd. The head should be ready to harvest 5-15 days after tying. Harvest when head is compact, clear white and about 6" in diameter.

Broccoli is harvested when heads are dense, 3"-6" in diameter and before individual flower buds are distinguishable or yellow flowers can be seen. Cut 8"-10" of stem with the head. Broccoli should be cooled as rapidly as possible and stored under cool conditions after harvest to slow down flower development. Side heads develop rapidly following removal of the terminal head, unless the cultivar used is a nonsprouting type. Harvesting may continue for several weeks.

Brussels Sprouts should be harvested when sprouts are firm and are of the desired size for market. Sprouts can be harvested sequentially, working up the stalk as the season progresses, or entire stalks can be cut and marketed whole.

Kale and collards may be harvested by cutting off entire plants near ground level. Whole plants are then bunched, or lower leaves may be stripped from plants and either bunched or packed individually. Multiple harvests are possible. Because of their perishability, kale and collards should be held as close to 32° F as possible. At this temperature, they can be held for 10-14 days. Relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but excessive air circulation will speed transpiration and wilting.

Kohlrabi. The targeted harvest stage is when stems are full sized but before they begin to split. Many brassica crops are very sensitive to ethylene, and may yellow upon exposure to low levels of ethylene. These crops should be stored as close to 32° F as possible without freezing, at high relative humidity. Expected storage life varies widely.