

THE CHINESE CABBAGE

1. DESCRIPTION OF PLANT



Chinese cabbage (*Brassica oleracea* L. var. *capitata* L.) is a hardy biennial grown as an annual. It has broad, thick, tender leaves and heavy midribs. There are several varieties of Chinese cabbage, some are loose head and some are tight headed. Plants grow from 15 to 18 inches tall.

The common names of the plant are Chinese cabbage, white cabbage, flowering cabbage, celery cabbage, pakchoy, Michihli, and Napa cabbage. It originated from China. Although, they are members of the cabbage family, these cabbages are more delicately flavored than most coles.

2. ORIGIN AND MAJOR TYPES

Chinese cabbage is also known as pechay Baguio or wongbok. Together with cabbage and broccoli, it belongs to a group of cultivated varieties of the species *B. oleracea*, called "cole crops". It is grown for its leaves, which are a good source of vitamin C and calcium, but are low in fat and calories. In 2006, Chinese cabbage contributed around P1.08B to the local economy. The popular variety type in the Cordillera Administrative Region is the barrel-type while in the southern Philippines the michihili type is preferred.

3. PRODUCTION TRENDS

Production in 2006 was 37,171 tons, up by 0.30% from the output of the previous year (2005) at 37,062 tons. The major producer of Chinese cabbage is the Cordillera Administrative Region.

4. VARIETIES

1. China Express -It has a maturity period of 55 - 60 days. Its shape is large barrelled and weighs 1.5 - 2.5 kgs, light green in color. It has multiple disease

resistance and tolerant to bacterial soft rot. It is compact and wrapped and has a good shipping quality.

2. Hybrid Green Cool (Takii) - It has a maturity period of 60 - 65 days. Its shape is barreled and weighs 2 kgs, bright green in color. It is highly tolerant to certain races of club root, strongly tolerant to bacterial soft rot and viral diseases. It is very vigorous and dependable year round. It grows best in the highlands.

3. Hybrid Michihili Jade Pagoda (Sakata) - It has a maturity period of 65 - 70 days. Its shape is tall cylindrical and weighs 1 - 1.5 kgs, green in color. It is resistant to insect pests and diseases. It is very vigorous and widely adaptable

4. Hybrid Tropical Delight - It has a maturity period of 50 - 55 days. Its shape is oval and weighs 1 - 1.5 kgs, light green in color. It is resistant to insect pests and diseases. It is high yielding and grows well under hot lowland condition.

5. Hybrid CR Summer (Nong Woo Bio) - It has a maturity period of 65 days. Its shape is oval and weighs 2 kgs, green in color. It is tolerant to club root and resistant top downy mildew. It has a good shape.

6. Hybrid Yellow Queen - It has a maturity period of 70 days. Its shape is oval and weighs 2 kgs, yellow in color. It is resistant to downy mildew. It has a good taste.

7. Hybrid New Autumn King Seminis - - It has a maturity period of 70 - 75 days. Its shape is barrelled and weighs 2.5 kgs, outer leaves are green in color while inner leaves are yellowish. It is tolerant to cold temperature. It has excellent heading ability and compact leaves.

8. TaiboNozomi Hybrid - Its shape is barreled and weighs 2.5 - 3 kgs, deep green in color. It is highly tolerant to soft rot and virus. It keeps its high quality even under long distance shipping.

5. CULTIVATION

Climatic and Soil Requirements

Chinese cabbage thrives best during the cooler periods of the growing season. Although the optimal temperature range of Chinese cabbage development is between 13 and 15 °C, certain cultivars tolerate the higher temperatures of midseason providing there is ample soil moisture. Other cultivars which mature during midseason may

readily bolt. Late-growing Chinese cabbage can withstand light frosts in the fall, although alternate freezing and thawing may damage leaf tissue.

Chinese cabbage is best grown in full sun in cool regions and in partial shade in warm regions. First thing that you must keep in mind before growing this vegetable in your garden or greenhouse is the climate. Chinese cabbage doesn't tolerate hot weather so if you want to get good results from production then you should start its cultivation before extreme hot weather. Cool temperature seems to be the best for the production of cabbage. It grows well when it exposes to direct sun light however it can tolerate shade as well.

Plant Chinese cabbage in well-worked, well-drained but moisture retentive soil rich in organic matter.

Culture and Management



before the planting.

A. Land Preparation. The land should be clean cultivated eight weeks before planting and the ground must be ploughed deeply, immediately before planting, with a disk harrow or other suitable implement to a depth of 450 to 600 mm. The soil should be fumigated two weeks before planting time if necessary, to control nematodes. Consider before planting the pH level of the soil; it should be 6.5-7. Start using fertilizer in the garden one week

- B. Planting and spacing.** Chinese cabbage or wombokis grown through direct seeding. In direct seeding, plant 2 to 3 seeds per hill. When these have germinated, thin out the poor growers but leave one robust plant per hill. Sometimes when many seedlings are growing well in a hill, transplant the excess in other plots or use them to replace dead ones, after which cultural management practices should be applied. After sowing, cover the seeds with fine topsoil or if possible, use ashes as this would act as deterrent from the attack of insects/pests especially ants. Water the bed daily but not excessively to minimize the incidence of damping off and to insure high rate of germination.
- C. Spacing.** Space the seedlings at about 30 to 50 cm between hills and rows' wider spacing may be necessary for "bigger head" Chinese varieties.

D. **Irrigation.** The availability of water can be critical to successful production. Steady, even growth of Chinese cabbage plants is necessary for high quality and yields. Irrigation may also be used to cool plants during periods of high temperature. Fertilizer could be applied through an irrigation system. Chinese cabbage requires a regular water supply of 25mm every 5 to 7 days. The most critical moisture period is during head development. Irrigation at the wrong time can cause problems.

E. **Fertilization.** Chinese cabbage is a crop that should have an uninterrupted growth. Any delay in growth will encourage the plants to prematurely form a small head that is of no value. In order to avoid this, the soil should be high in organic matter so that it will hold a lot of moisture. It must also be very fertile.



For best development Chinese cabbage must have a large amount of available nitrogen. This is best supplied by making at least three side-dressings. Make the first application after the plants have been in the field about 3 weeks and then two more applications 2 weeks apart. Each application should be one tablespoon per plant. Make the application on top of the ground about 3 inches from the plant. A circle around each plant is a good method if only a few plants are grown in the home garden.



If nitrogen fertilizer is not available, place fresh chicken manure into the soil around each plant 3 weeks after setting out the plants.

F. **Weed Control.** Hoeing of the weeds may be necessary at early stage of weeds growth before the plants shade the spaces in between plants. These crops grow rapidly and are spaced closer that weeds normally not a problem.

G. **Care.** Keep plants cool when the weather warms; do not let Chinese cabbage sit in direct sun for more than 8 hours each day.

6. CROP PROTECTION

Pest Management

1. **Caterpillar Pests** Cabbage worm (*Pieris rapae*), cabbage looper (*Trichoplusia ni*), diamondback moth (*Plutella maculipennis*) and Purple-backed cabbageworm (*Evergestis pallidata*). High levels of feeding damage will cause severe defoliation, resulting in stunted plants. Cauliflower can also become unmarketable if the heads are stained with insect excrement.

The adult of the Imported Cabbageworm is a white butterfly, easily seen going from plant to plant laying eggs during the summer. The eggs hatch into velvety-green larvae with one thin yellow stripe down the center of its back. The cabbageworm larvae do not loop when they walk. They are generally the most prevalent of the caterpillars found on Cole crops.

The cabbage looper gets its name from the way it forms a loop as it walks. It is a smooth green larvae with two white stripes along the back and two along the sides. The cabbage looper is capable of causing the most damage to Cole crops. Adult moths migrate into the region during the summer. Cabbage looper tends to be more problematic during the late summer.

The Diamondback Moth is much smaller than the previous insects. Three to six generations of 1.1 cm yellow-green larvae may develop each year. The larvae squirm actively when disturbed and produce many small holes on the host plant. This pest can bore into the heads of Chinese cabbage. Adult moths migrate in throughout the growing season. There is therefore often an overlap in generations, and all stages may be present at one time.

The Purple-backed cabbageworm is not as commonly seen as the others but will cause serious damage in high numbers. The larvae are purple on the back and pale yellow along the sides. There are one to two generations per year.

Management

- a. There are many natural enemies that will help control these pests in fields. Ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big eyed bugs, and lacewing larvae will all attack the caterpillars.
- b. There are also some commercially available parasitic wasps that sting and parasitize eggs and larvae of caterpillars; these include *Trichogramma* spp., *Copidosoma* spp., *Apanteles* spp., *Diadegma* spp., and *Hyposoter* spp.
- c. Cultural controls include pheromone emitters to disrupt mating.
- d. Evening overhead sprinkler irrigation.

- e. Placement of floating row covers over young crops to exclude egg-laying females.
- f. If using chemical controls, scout plants frequently and treat when the threshold level has been reached. For cauliflower, the threshold guidelines are 20-30% before heading and 5-10% after heading.

2. Cutworms (*Agrotisipsilon*). Cutworms are grayish, fleshy caterpillars up to 5 cm long, which curl up when disturbed. Plants may be chewed off above or below ground level and may be damaged higher up by climbing cutworms. Most of the cutworm damage is to newly set plants in the field, but they are often found attacking seedlings in plant bed and greenhouses. Late infestation of variegated cutworm occasionally occurs.

Management

- a. Prepare the soil two weeks before planting to cultivate in cover crops and destroy weeds.
- b. Check plants frequently and treat when damage is first observed.

3. Cabbage Maggot or Cabbage fly (*Delia redicum*). The cabbage maggot or adults fly close to the ground near brassica plants and lay elliptical white eggs on the stems of crops or in nearby crevices in the soil. The adult is a two-winged, ash grey fly, with black stripes on the mid section. It is half the size of a housefly, but has longer legs. Eggs hatch in three to seven days. Larvae are white, legless maggots that enter the roots and feed by rasping the plant tissue with a pair of hook like mouthparts and tunnelling into the roots. Feeding damage by the cabbage maggot causes roots to be misshapen and allows the entry of decay organisms and other species of maggots, resulting in stunted or dead young plants. Maggots mature in three to four weeks and pupate. The pupae are 6 mm long, oval, hard shelled and dark brown. Adult flies emerge in two to three weeks. The presence of adult flies can be determined by looking for eggs which are laid at the base of plants. Generally, there are two to three generations a year.

Management

- a. Natural enemies for the cabbage maggot include ground beetle, rove beetle, spiders, harvestmen or daddy longlegs and ants.
- b. Cultural controls include covering young plants with floating row cover to prevent the flies from depositing eggs after plant

emergence, and intercropping clovers or other legumes to prevent the flies from finding open ground near a brassica stem.

- c. When using chemical controls, scout plants frequently and treat when damage is first observed.

3. Flea beetles (*Phyllotreta* spp.). Flea beetles are small shiny black beetles, about 2 mm in length. They are very active early in the growing season, especially during periods of dry sunny weather. Flea beetles can seriously damage seedlings and transplants, and to a lesser extent larger plants, by chewing small pinholes through the leaves. There is one generation per year. The larvae live in the soil and feed on roots.

Management

- a. Biological control options for flea beetle include using a braconid wasp that will parasitize and kill adult flea beetles, and using nematodes that attack the larvae.
 - b. Trap crops such radishes or collards can be used.
 - c. Living mulches or polycultures are other possibilities.
 - d. Covering young seedlings with floating row cover to prevent the insects from attacking the plants is another option.
 - e. Using white or yellow sticky traps every 4.5 - 9 m.
 - f. Making sure to destroy plant debris.
 - g. If using chemical controls, scout plants frequently and treat when the threshold has been reached. One flea beetle per plant (up to the sixth leaf stage) is the threshold number. After the 6 leaf stage, feeding will not interfere with plant growth.
- 4. Aphids (*Brevicoryne brassicae*).** The cabbage aphid is a major pest of Cole crops worldwide. Aphids are small, soft bodied, slow moving insects. A colony consists of winged and wingless adults and various sizes of nymphs. Aphids may be black, yellow or pink, but mostly are various shades of green. They are often found in large colonies on the under surface of leaves; however, aphids will feed on heads, flower stalks as well as leaves, resulting in unmarketable produce. Aphids feed by piercing plants and sucking out plant sap, resulting in distorted plant parts and a slowing of plant growth. The plants may be covered by a sticky substance, called honey dew, which is excreted by the aphids.

Management

- a. There are many natural enemies that will feed on aphids, thus helping to reduce the populations of this pest in the field. Natural enemies that produce larvae which will feed on aphids include syrphid flies, lacewings and the predaceous midge. Adults and larvae of minute pirate bugs, big eyed bugs, lady beetles, soldier beetles and parasitic wasps like *Diaeretiellarapae* will also consume aphids.
 - b. Cultural controls include using high pressure sprinkler irrigation to knock the insects off of plants, as well as using living mulch such as clover inter-planted with the crop.
 - c. If using chemical controls, check plants frequently and treat when damage is first observed.
5. **Slugs and Snails.** Slugs exist in various sizes up to 10 cm. They eat holes in the leaves and leave a trail of mucus, which makes plants unsightly. The control of slug populations has been a continuing problem in the Cole crop industry.

Management

- a. Slugs prefer areas which are cool, moist and high in organic matter. Sod crops, weedy fence lines and hedgerows fulfil these conditions.
 - b. Cultural practices aimed at controlling slugs should begin at least one year before the susceptible crop is put in. If possible, sod crops should not be followed by Cole crops.
 - c. A cultivated strip around the crop has been shown to reduce the number of slugs migrating from weedy field borders. If urea (4 kg/ha) is sprayed on this cultivated strip, slug movement may be further impeded. The salt irritates the slugs as they move over it. Repeated applications are necessary as rainfall washes it into the soil.
6. **Clubroot (*Plasmodiophora brassicae* Wor.).** Clubroot is a soil borne disease which affects cauliflower. Early infections are difficult to detect as symptoms begin underground. Symptoms include small to large swellings and other malformations of the roots. As a result of these swellings, water and nutrient flow are restricted within the plant, which causes the above ground parts to wilt, turn color and look stunted. Wilting is most common on warm sunny days; plants may show little wilting early in the morning or late at night.

The clubroot fungus enters the plant through the many fine hairs on the roots. The extent of the disease is affected by many factors. Moist, cool soils usually

produce more diseased plants than dry, warm soil. The disease also thrives best in acid soils; that is when the pH is below 7. Once land becomes infested with this disease, it will remain so for several years. When clubbed plants rot and break down, the fungus spores are released into the soil, where they may live for 10-20 years, ready to infect any Cole crop subsequently planted. Since the fungus spores are in the soil, movement of the soil by any means (boots, tools, wheels or wind and water, etc.) also spread the disease.

Management

- a. Isolate (if possible) or avoid the use of infested fields for brassica crops for about seven years. The disease affects only the brassica crops so any other crop may be planted as long as brassica type weeds are not present.
 - b. Do not apply clubroot infested manure on land to be used to grow brassicas. Cattle fed infected plant material can pass the fungus spores in manure, therefore it is best to put contaminated manure back on the field that contained the infected roots, thus preventing the spread of the disease to other fields.
 - c. Rotate crops and fields as a preventative measure before club root occurs. Allow at least three years between growing susceptible crops.
 - d. Clean and disinfect all equipment used on infested land before using on a non-contaminated field.
 - e. Control susceptible weeds whenever possible.
 - f. Apply lime to raise the pH of the soil to at least 7.2. Clubroot seems to thrive best in moist, acid soils, therefore wet, poorly drained land should be avoided or drainage improved.
 - g. Use clubroot free transplants.
7. **Black Rot (*Xanthomonas campestris*)**. Black rot can live in the soil for one year without another Cole crop present. Humid, rainy conditions favor the disease, which is usually spread by splashing rain or irrigation water. Black rot lesions first appear at margins of leaves. The tissue turns yellow and the lesion progresses toward the center of the leaf, usually in a v-shaped area with the base of the v toward the midrib. The veins become dark and discoloration frequently extends to the main stem and proceeds upward and downward.

Management

- a. Use clean, certified seed, or seed which has been hot water treated. 2.

- b. Practice a 4 year crop rotation.
- c. Destroy brassica weeds and thoroughly incorporate plant debris.
- d. Good air and water drainage is critical in controlling this disease, along with avoiding water on the crop in the afternoon and evenings.

8. **Damping -off (*Rhizoctonia*) and Wirestem (*Pythium*).** Pre-emergence damping off occurs when seeds are attacked and decay, as well as when plants germinate, but fail to emerge. Post-emergence damping off occurs when the stem of 2 to 5 cm tall plants are attacked. A water soaked area completely encircles the stem near the soil line and the seedling wilts and topples over.

Wire stem results from an extension of the damping off process, but new infections may occur on plants 10-15 cm tall. The stem above and below the soil line darkens, and the outer cortex tissue decays and sloughs off in sharply defined area encircling the stem. The stem is thin and wiry at the lesion but remains erect. The plant may survive, but will perform poorly.

Management

- a. Sterilized soil or soil that has not previously had brassicas for several years should be used.
 - b. Seeds should be hot water treated and also treated with a suitable fungicide.
 - c. Plant density should permit adequate light and air penetration.
 - d. Factors such as deep planting, reduced seed vigor and excessively cold, hot, moist or saline soils that delay seed emergence should be avoided.
 - e. Field rotation with non-brassica crops should be practiced for at least three years.
 - f. Avoid mounding of soil onto lower leaves when cultivating.
9. **Bacterial soft rot.** Leaves turn yellow (chlorotic) beginning at margins and spreading inwards. Veins within area turn black. Infection enters main stem turning the inside black. Plants either die or are dwarfed when young, become defoliated if more mature.

Management. Plant resistant varieties and rotate crops from year to year.

7. HARVESTING

Cut whole heads at soil level when they are compact and firm and before seed stalks form usually 50 to 80 after sowing. Complete the harvest before the arrival

of freezing weather. If the first fall frost arrives before heads form, Chinese cabbage can still be harvested for greens.

8. POST HARVEST

Storing and preserving. Chinese cabbage will keep in the vegetable compartment of the refrigerator for about 4 weeks. Chinese cabbage can be blanched and frozen for 3 to 4 months.

Toxic effects. Pak choi contains glucosinolates. These compounds have been reported to prevent cancer in small doses, but are toxic to humans in large doses. In 2009, an elderly woman who had been consuming 1 to 1.5 kg of raw Pak choi per day developed hypothyroidism, resulting in myxedema coma.^[5] There are other milder symptoms from over-consumption of Pak choi, such as nausea, dizziness and indigestion in people with weaker digestive systems. Sometimes this is caused by not thoroughly cooking.

9. COST OF PRODUCTION AND ROI FOR A ONE-HECTARE LAND

COSTING - CHINESE CABBAGE						
Planting Area- 1,000 sq. meters						
Seedling (3,000 @ .75 / piece)						2,250.00
Inputs:						
Fertilizer						13,000.00
Lime		meter				1,750.00
Pesticide (Insecticide & Fungicide)						2,300.00
Sub-Total:						19,300.00
Labor: 150 per day (free chow)						
Tillage			2	mandays	150	600.00
Digging			2	mandays	150	600.00
Planting			4	mandays	150	600.00
Spraying			1	manday	150	450.00
Hilling Up			4	mandays	150	600.00
Irrigation						600.00
Harvest (2x)						3,000.00
Sub-Total:						6,450.00
Administrative Cost (per month)						2,700.00
Land Rental 12.00 Php / sq. Meters						4,000.00
Packaging Materials						2,000.00
Transportation						1,500.00
Overhead & Contingency (10%)						3,595.00
Sub-Total						13,795.00
Grand Total						39,545.00
Cost per Kilo (Php 39,545.00/2,500 kilos projected harvest)						Php 15.81 / kilo
Mark Up (50%)						Php 23.71 / kilo

10. REFERENCES

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