

## Broccoli

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Broccoli *Brassica oleracea* var. **italic** was introduced in the industry and to Filipino taste buds in the 20th century. Broccoli belongs to the family that includes cabbage, pechay, and cauliflower. Broccoli is of the *Brassica oleracea* species. It is often called a brassica or cruciferous vegetable from the Brassicaceae or Cruciferae family.

Broccoli is one of the most expensive vegetables in the Philippines. It is boiled, steamed or stir fried. It is fairly high in Vitamin A, and a good source of Vitamin C, calcium, iron, thiamine, riboflavin and niacin.

The word broccoli means 'little sprouts' in Italian. It is part of the cabbage family of vegetables which also includes cauliflower, cabbages, Brussel sprouts, turnips and many of the Asian greens.

The broccoli's flowerettes are green compared to the cauliflower's white flowerets. Broccoli is the highest-valued vegetable in the Cordillera. This is mainly because broccoli has been reported to help in fighting cancer. Approximately 283 hectares of the Cordillera is being used for growing this vegetable.

Broccoli production grew by 16.0 percent from 1.2 thousand metric tons in January-June 2004 to 1.4 thousand metric tons in January-June 2005. Benguet province the major producer of broccoli shifted from asparagus to broccoli. During the first semester of 2005, Benguet was the top producer of broccoli with an output of 1.2 thousand metric tons which accounted for 87.4 percent of the national production. Bukidnon followed with a share of 9.1 percent or 125 metric tons.

### Varieties

1. 'Hybrid Gypsy' Sakata - It matures at 60 - 65 days. It is high domem, the head is bluish green in color, the bead size is fine and the compactnes is excellent. It is tolerant to downy mildew and black rot. It has large and heavy curds with large stem and few branches.
2. 'Hybrid Green Magic' Sakata - It matures at 65 days. It is semi-domed, the head is bluish green in color, the bead size is fine and the compactness is excellent. It is tolerant to downy mildew and block rot. It is a new variety bred for long distance markets.
3. 'Hybrid Gree Pride' Tokita - It matures at 63-73 days. It is domed, the head is dark green in color, the bead size is fine and the compactness is excellent. It is tolerant to rot. It is a heavy yielder with excellent green color retention adaptable to rainy and cold season.
4. 'Hybrid Marathon' Sakata - It matures at 60 days. It is high domed, the head is bluish green in color, the bead size is fine and the compactness is excellent. It is resistant to downy mildew. It is the best choice for uniformity during cold weather production. It has a large head and is the standard variety for long distance shipping.
5. 'Hybrid Top Green' Condor - It matures at 45 - 50 days. It is flat domed, the head is bluish green in color, the bead size is medium and the compactness is excellent. It is

tolerant to downy mildew and block rot. It is a tropical variety that grows well under hot tropical lowland condition.

6. 'Hybrid Green Pia' Nong Woo Bio -- It matures at 80 - 95 days. It is domed, the head is blue green in color, the bead size is large and the compactness is very solid. It is tolerant to downy mildew and block rot. It has an excellent quality head such as compact yield.
7. 'Hybrid Sonata' Nong Woo Bio - It matures at 75 - 80 days. It is medium domed, the head is dark blue green in color, the bead size is large and the compactness is solid. It is suitable for warm season cropping. It is a wide adapted variety and has a good holding ability.
8. 'Blue Genuis' Hybrid - It matures at 45 days. The head is dark green in color and the compactness is excellent. Its average weight is 0.8 kg. It is highly disease resistant and is covered with white tender powder.
9. 'Green Country' Hybrid - It matures at 85 - 90 days. It is high domed, the head is deep green in color, and the bead size is small fine. It has improved uniformity and size in cold production. It is very good in crown cut packing and processing.
10. 'Green King' - It matures at 85 days. The head is blue green in color, the bead size is large and the compactness is excellent. It is tolerant to downy mildew. It is a heavy yielder, heat tolerant and can be planted in lowland areas of the Philippines.
11. 'King Dom'e Hybrid - It matures at 85 - 90 days. It is high domed, the head is deep green in color, the bead size is small fine and the compactness is solid. It has an excellent post harvest quality after cutting. It has a very popular crown cut market and is widely adapted for cooler condition.
12. 'Legacy' Hybrid - It matures at 75 - 100 days. It is high domed, the head is deep green in color and smooth with fine beads, and the compactness is solid.
13. 'Tender Green' - It matures at 55 - 60 days. The head is dark green and the compactness is solid. The average weight is 0.6 kg and it is good for consumer market and freezing.

### **Climatic Requirement**

Broccoli will tolerate frosts of 20°F (6.5°C) and likes daytime temperatures around 50-70°F (10-20°C) and certainly no higher than 80°F (26°C), or it will bolt to seed. The minimum and maximum growing temperature is 00C and 290C, however, the optimum growing temperature range is between 15 and 220C. Optimum germination temperature is 290C. High temperatures (greater than 270C) delay maturity and increase vegetative growth and cool temperatures (1.5 -100C) hasten maturity and may induce 'bolting'.

### **Soil Requirement**

Broccoli requires soils that can provide continuous water throughout the season. Well drained, sandy loam soils are suited to early varieties, whereas loamy and clay loam soils are suited to late ones because they are somewhat tolerant of poor drainage. Well drained soils can be rotated closely since club root is easier to control.

### **Culture and Management**

- A. **Seedling Production.** About 280 g of seeds per hectare is required. Prepare 1-m wide seedbed at any desired length. Pulverize the soil and incorporate 1 kg fully decomposed chicken manure or compost and 300 g carbonized rice hull/M<sup>2</sup>. Wet the seedbeds and

make shallow lines across the beds, 7-10 cm apart. Sow the seeds thinly and cover lightly with soil. Mulch with rice hull, chopped rice straw, or cogon, and water regularly. Provide partial shade during the dry season and rain shelter or clear plastic roofing during the wet season.

In case of diamondback moth and cutworm infestation, spray with hot pepper solution (100 g macerated hot pepper/16 L water) plus 1 tbsp soap, or apply pesticides at recommended rates. Harden the seedlings at one week before transplanting by exposing fully to sunlight and watering only when the plants show signs of temporary wilting. Transplant the seedlings at three weeks after emergence.

- B. **Land Preparation.** Prepare the land thoroughly by plowing and harrowing several times. In low and mid elevation areas, make deep furrows 0.5 m wide. In high elevations, prepare beds 0.75-1.0 m wide. Apply 1kg fully decomposed chicken manure and 300 g carbonized rice hull/m<sup>2</sup>. Incorporate thoroughly with the soil. For single row planting, make holes 0.3 m between hills, and for double row planting, 0.3 m between hills and 0.4 m between rows. Wet the holes, apply 10 g 14-14-14 in each hole, and then cover lightly with soil.
- C. **Transplanting.** Water the seedbeds and gently uproot the seedlings. Transplant in rows 0.5-0.75 m apart and 0.3-0.5 m between plants. Apply basal fertilizer at 10 g 14-14-14/hill. Irrigate before and after transplanting. Mulch with rice straw, rice hull or plastic to prevent weed growth and conserve soil moisture. It is best also to intercrop with bunching onion, bulb onion, garlic, kutsai, tomato, marigold, and other crops to minimize insect pests. Areas with low irrigation capacity should plant broccoli in seedbeds with the width of sixty to one hundred twenty cm. As for areas with ample irrigation facilities, broccoli may be planted in a sunken bed to ensure that the crop is receiving enough moisture.
- D. **Fertilization.** Side-dress with urea (46-0-0) at the rate of 5-10 g/plant 2-3 weeks after transplanting with 10 g/hill of 2:1 mixture of 46-0-0 and 0-0-60. Fertilize only after weeding. Tea manure may be applied weekly as source of micronutrients. To prepare, soak 3/4 sack cow/ horse manure in a plastic drum filled with 189.25 L water for seven days. Fermented plant juice may also be used every two weeks to boost plant vigor. To prepare, mix equal parts of chopped actively growing plant parts and molasses or brown sugar. After one week of fermentation, extract the juice and apply as foliar fertilizer at 1 tbsp/ 3.785 L water.
- Broccoli does well when manure is applied, however it is best not to use manure from animals that have been fed turnips or rutabagas. Excessive use of manure may contribute to tip burn, hollow stem, internal browning, head rot and other problems.
- E. **Liming.** Lime should be applied to maintain the soil pH in the range of 6.5 to 7.0, unless club root control is required (pH of 7.2). If soil pH is below 6.2, apply lime six weeks before planting.
- F. **Mulching.** Mulching with rice straw, rice hull, or mulching film is recommended to suppress weed growth and conserve soil moisture.

- G. **Weeding.** Perennial weeds should be controlled prior to planting. Herbicides recommended for use on Cole crops will not provide complete control of weeds; therefore it is important to grow Cole crops on soil where the weed seed population is low. The weed seed bank in the soil can be reduced by crop rotation. Care must be taken to avoid fields where residual herbicides from previous years persist in the soil as crop injury may occur.
- H. **Irrigation.** During the dry season, irrigate before transplanting. Repeat every 7-10 days (furrow irrigation) or 2-3 times/week (sprinkler irrigation). Mulching helps minimize irrigation frequency. The availability of water is critical to successful broccoli production. Irrigation may also be used to cool plants during periods of high temperature. Fertilizer could be applied through an irrigation system. Irrigation at the wrong time can cause problems such as head rot. Broccoli crops require a regular water supply of 25 mm every 5 to 7 days during the growing season. Shortage of water is detrimental for head development.

## I. Disease and Insect Management

1. **Clubroot (*Plasmodiophora brassicae* Wor.)** Clubroot is a soil borne disease which affects broccoli. 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.** There are seven things that can be done to reduce the occurrence of this disease.

- 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
- 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.
  - g. Use clubroot free transplants.
2. **Grey Leaf Spot (*Alternaria brassicae*) and Black Leaf Spot (and *A. brassicola*).** Grey leaf spot causes small and light brown or grey lesions. Black leaf spot causes larger and darker lesions. These diseases are seed and soil borne. Small black spots (1 to 2 mm in diameter) appear on leaves, later turning into a tan color with target-like concentric rings. When the spots dry out, the tissue falls from leaves, resulting in a 'shot-hole' appearance. Cool temperatures, rain and high humidity favor the development of this disease. Spots usually are most conspicuous on the outer, older leaves. The disease causes small brown sunken lesions and decay of broccoli heads, under very wet conditions. The spots enlarge in storage to sunken, black areas. *Alternaria* is a secondary fungus; it usually invades the plant after it has been injured by other pests or management practices.

#### **Management**

- a. Use clean, certified seed or a hot water seed treatment if certified seed is not available.
  - b. Practice long rotations between Cole crops
  - c. Avoid over head irrigation.
  - d. Make sure to incorporate plant debris.
  - e. 5. Good air circulation is needed in the field, as well as in storage. Keep storage temperature at 00C and relative humidity at 92 % to 95%.
3. **Downey Mildew (*Peronospora parasitica*).** Once infected, the plant shows white, fuzzy masses in patches on the underside of leaves, stems and heads. The tops of leaves turn purple, then later turn yellow or brown. Internally, the broccoli heads may show brown and black streaks on the main stalk and branches leading to the florets. Infection is favored by wet, cool weather, especially during prolonged periods of leaf wetness, such as during dew or fog.

#### **Management**

- a. Good air and water drainage is critical in controlling this disease, along with voiding water on the crop in the afternoon and evenings.
  - b. Crop rotation with non brassica plants and incorporating plant debris will also aid in controlling this disease.
4. **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. In seedbeds, only 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. 3. Plant density should permit adequate light and air penetration.
  - c. Factors such as deep planting, reduced seed vigor and excessively cold, hot, moist or saline soils that delay seed emergence should be avoided.
  - d. Deficiencies of calcium, potassium and nitrogen or excessive nitrogen may promote disease.
  - e. A field rotation with non-brassica crops should be practiced for at least three years.
  - f. Avoid mounding of soil onto lower leaves when cultivating.
5. **Blackleg (*Phoma lingam*)**. This disease can be seed borne. Early signs of blackleg appear as small spots on leaves of young plants. On stems the spots are more linear and often surrounded by purplish borders. Stem lesions at the soil line usually extend to the root system causing dark cankers. The fibrous root system may be destroyed although new roots sent out above the lesion may keep the plant alive. Many plants wilt abruptly and die.

### Management

- a. Use clean, certified seed, or seed which has been hot water treated.
  - 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.
6. **Black Rot (*Xanthomonas campestris*)**. It is caused by a bacterium and 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 discolouration 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.
  - 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.
7. **Broccoli Head Rot (*Pseudomonas marginalis*)**. Symptoms appear after periods of rain when heads remain wet for several days. The bacteria are splashed up from the soil to the head. When heads are colonized by the bacteria some areas appear water soaked (because a biosurfactant is released by the bacteria) in contrast to unaffected areas where the waxy surface of the florets cause water to form in beads. Small black lesions may develop in these water soaked florets. During long periods of wetness, decay spreads rapidly, resulting in a sunken area on the head. Head rot develops most rapidly at high temperatures (28°C). Frost injury and infection by Downy mildew may also bring rise to this disease.

## Management

- a. Avoid high levels of nitrogen and avoid applying pesticides during head formation.
  - b. Use resistant cultivars whenever possible.
  - c. Wider plant spacing's to increase air movement through the crop.
8. **Cabbage Maggot (*Delia radicum*)**. 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 tunneling 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.
9. **Caterpillar Pests-Cabbage worm (*Pieris rapae*), cabbage looper (*Trichoplusia ni*), diamondback moth (*Plutella xylostella*) and Purple-backed cabbageworm (*Evergestis pallidata*).** High levels of feeding damage will cause severe defoliation, resulting in stunted plants. Broccoli 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 broccoli. 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 broccoli, the threshold guidelines are 20-30% before heading and 5-10% after heading.



10. **Cutworms (*Agrotis ipsilon*)**. 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.
11. **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 undersurface 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 *Diaeretiella rapae* 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 interplanted with the crop.
  - c. If using chemical controls, check plants frequently and treat when damage is first observed.
12. **Thrips (*Thrips tabaci*)**. Thrips are slender, yellow-brown insects about 1 mm long. They feed by puncturing the leaves and sucking up the exuding sap. This causes the appearance of dark warts or blisters on the leaves. They also feed on curds, damaging them and making them unmarketable. Populations increase quickly when the air temperature is over 21 0C.

#### **Management**

- a. Destroy refuse and control weeds
- b. If using chemical controls, check plants frequently and treat when damage is first observed.

13. **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 as Chinese type cabbages, 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.
14. **Tarnished Plant Bug.** Adult tarnished plant bugs are light brown to reddish brown in color and about 5-6 mm in length. They occur throughout the season and are very active and quick moving. They feed on cauliflower curds causing brown blemishes or streaks which reduce the marketability of the head.

#### **Management**

- a. Keep plantings and adjacent areas weed free.
  - b. Avoid planting next to legumes.
  - c. Check plants frequently and treat when damage is first observed.
15. **Slugs.** 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 fulfill 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.
- J. **Physiological Disorders.** Broccoli crops show various non-parasitic disorders which cause tissues to die off. In some cases, these deviations have been shown to depend mainly on heritable characters; whereas in other cases external factors had a least marked effect.
1. **Blindness** . Plants do not form heads, but produce many shoots at ground level. This may be caused by insects or damage to the growing point early in the plants life.
  2. **Leafy Heads.** Small leaves develop and protrude through the head during high temperatures, drastic fluctuations in day and night temperatures or improper nitrogen balance.
  3. **Broccoli buttoning.** Buttoning is the premature formation of a head 2.5 to 10 cm in diameter. Buttoning can occur anytime between seeding and almost mature plant, but usually occurs shortly after transplanting into the field. Generally foliar growth slows after buttoning resulting in too few nutrients to nourish the curd to marketable size. Losses are usually most severe in the early planted crop during cold, wet seasons, when vegetative growth is affected by: too much hardening of greenhouse plants, too little hardening of greenhouse plants, low soil nitrogen, low soil moisture, continued cold weather (4 to 10 0C for day or more) and others like disease, insects, micronutrient deficiency, etc.
  4. **Lack of heads in Broccoli** . During periods of extremely warm weather (days over 30 0C and nights of 25 0C) broccoli can remain vegetative (does not head) since they do not receive enough cold for head formation. This can cause a problem in scheduling the marketing of even volumes of crop.
  5. **Hollow stem in Broccoli.** Symptoms are internal only. This condition starts with gaps that develop in the tissues, and gradually they enlarge to create a hollow stem, sometimes from the bottom of the stalk into the head. Ordinarily, there is no discoloration of the surface of these openings at harvest, but both discoloration and tissue breakdown may develop soon after harvest. Avoid excessive nitrogen after head initiation. Dense plantings will maintain even growth rates and decrease the occurrence of hollow stem.
- K. **Harvesting and Handling.** Harvest broccoli heads when bud clusters are tightly closed and the entire head is tight and firm. Heads that are loose or have individual flower clusters with yellow petals should not be picked.

The terminal heads mature first. By removing the main terminal head the growth of the lateral heads (auxiliary buds) lower on the main stem will be promoted and production of smaller heads that can be harvested will commence. Since the lateral heads develop unevenly, they cannot all be harvested at one time; lateral heads must be harvested twice a week.

Broccoli heads are usually harvested with about 15 cm of the stem attached. After they have been cut off, part of the foliage is removed from the harvested shoots. The heads are from 5 to 25 cm in diameter and weigh from 100 to 800 g each. Side shoots are from 5 to 10 cm in diameter and weigh from 100 to 500 g each. Broccoli intended for fresh consumption is often sold in bunches weighing about 450 to 600 g.

Broccoli heads mature at different times, resulting in two or three cuts needed to harvest a field. Broccoli is harvested by hand. Rapidly removing field heat from broccoli is very important as the quality of harvested heads declines rapidly at warm temperatures. If field heat is not removed immediately, broccoli will turn yellow and wilt after a few days in storage.

- L. **Storage and Conditioning** . Broccoli is highly perishable and should be cooled immediately following harvest. In addition to icing, hydro cooling and forced-air cooling can also be used, but good temperature management must be maintained following cooling. If held at 0°C and near 100% relative humidity, broccoli can be stored for 3 to 4 weeks. Exposure to ethylene (from apples, other ethylene producing fruit or engine exhaust) will accelerate the yellowing of flower buds and reduce storage life and should be avoided.

Controlled atmosphere (CA) storage atmospheres of 1-2% oxygen with 5-10% carbon dioxide at temperatures of 0-5°C will benefit broccoli and can double storage life, specially when held above optimum temperatures.

Crushed ice or slurry ice is usually added to packed cartons to keep produce fresh during shipping, especially when adequate refrigeration is not available.

## References

- AAFC. Crop Profile for Cabbage and Broccoli in Canada. April 2005.  
[http://www.agr.gc.ca/env/pest/index\\_e.php?s1=pub&page=cab-broc-chou](http://www.agr.gc.ca/env/pest/index_e.php?s1=pub&page=cab-broc-chou)
- Atlantic Provinces Agricultural Services Coordinating Committee. Cole Crops Vegetable Crops Production Guide for the Atlantic Provinces. Publication No. 1400. April, 1997.
- ATTRA Publication. Cole Crops and Other Brassicas: Organic Production. 2006.  
[www.attra.ncat.org/attra-pub/PDF/cole.pdf](http://www.attra.ncat.org/attra-pub/PDF/cole.pdf)
- ATTRA Publication. Organic Allium Production. 1999. [www.attra.org/attra-pub/allium.html](http://www.attra.org/attra-pub/allium.html)
- BBC Radio 4. Gardeners' Question Time - Factsheets. August 2001.  
[www.bbc.co.uk/radio4/gqt/fsheets/12\\_08\\_01/fsheetsq8.shtml](http://www.bbc.co.uk/radio4/gqt/fsheets/12_08_01/fsheetsq8.shtml)
- Broccoli & Cauliflower Production Guide Info Bulletin No. 148/1999  
Reproduced By: Department of Agriculture Region IV-B MiMaRoPa

Clemson Extension. Broccoli. April 2004.  
<http://hgic.clemson.edu/factsheets/HGIC1301.htm>

Howard, Ronald, J. Allan Garland and W. Lloyd Seaman. Diseases and Pests of Vegetable Crops in Canada. 1994.

Innvista.com. Crop Rotation. [www.innvista.com/health/foods/rotation.htm](http://www.innvista.com/health/foods/rotation.htm)

Johnny's Selected Seeds. 2005 Seed Catalogue. 2005. Page 9.

Kansas State University. Cabbage, broccoli and cauliflower. November 1994.  
[www.oznet.ksu.edu/library/hort2/mf602.pdf](http://www.oznet.ksu.edu/library/hort2/mf602.pdf)

Manitoba Government. Cabbage, Cauliflower, Brussels Sprouts, Broccoli Production.

Michigan State University Extension Bulletin E-1668: Disorders of Cole Crops. January 1983.

North Carolina State University Cooperative Extension Service: Vegetable Crop Irrigation. August 1997. [www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html](http://www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html)

North Carolina State University. Broccoli Production. January 2001. [www.ces.ncsu.edu](http://www.ces.ncsu.edu/factsheets/crop_rotations_for_increased_productivity.pdf) NDSU  
Factsheet. Crop Rotations for Increased Productivity. January 1998.  
[www.ag.ndsu.edu/pubs/plantsci/crops/eb48-1.htm](http://www.ag.ndsu.edu/pubs/plantsci/crops/eb48-1.htm)

Ohio State University Factsheet. Growing broccoli and cauliflower in the home garden.  
<http://ohioline.osu.edu/hyg-fact/1000/1605.html>

OMAFRA Factsheet: Horticultural Crops-Vegetables. August 2005.  
[www.omafra.gov.on.ca/english/environment/hort/veg.htm](http://www.omafra.gov.on.ca/english/environment/hort/veg.htm)

OMAFRA Fact sheet. Fertilizing Cole Crops: broccoli, Brussels sprouts, cabbage, cauliflower, horseradish, kale, kohlrabi. September 2003.  
[www.omafra.gov.on.ca/english/crops/facts/pub363/fertilizing\\_colecrop.htm](http://www.omafra.gov.on.ca/english/crops/facts/pub363/fertilizing_colecrop.htm)

OMAFRA Fact sheet: Fungal Diseases of Cruciferous Crops. April 1985.  
[www.omafra.gov.on.ca/english/crops/facts/85-043.htm](http://www.omafra.gov.on.ca/english/crops/facts/85-043.htm)

OMAFRA Fact sheet: Bacterial Diseases of Cruciferous Crops. January 1997.  
[www.omafra.gov.on.ca/english/crops/facts/86-046.htm](http://www.omafra.gov.on.ca/english/crops/facts/86-046.htm)

OMAFRA. Vegetable Production Recommendations 2006-2007. Publication 363. OMAFRA  
Factsheet. Production and Handling of Broccoli. July 1998.  
[www.omafra.gov.on.ca/english/crops/facts/88-126.htm](http://www.omafra.gov.on.ca/english/crops/facts/88-126.htm)

Oklahoma Cooperative Extension Service. Cole Crop Production (Broccoli, Cabbage, and Cauliflower).

Oregon State University. Broccoli. August 2004.  
<http://oregonstate.edu/Dept/NWREC/broc-pr.html>

Pennsylvania State University. Agricultural Alternatives: Broccoli Production.2000.  
<http://agalternates.aers.psu.edu/crops/broccoli/broccoli.pdf>.

Sydney Postharvest Laboratory & Food Science Australia. Optimal Fresh: Broccoli. 2001.  
[www.postharvest.com.au/Broccoli.pdf](http://www.postharvest.com.au/Broccoli.pdf)

UC Davis Postharvest Technology Research and Information Centre. Broccoli: Recommendations for Maintaining Postharvest Quality. December 2005.  
<http://postharvest.ucdavis.edu/Produce/ProduceFacts/Veg/broccoli.shtm>

University of Georgia. Broccoli. <http://www.uga.edu/vegetable/broccoli.html>  
 USA Gardener. How to Grow Broccoli.  
[http://www.usagardener.com/how\\_to\\_grow\\_vegetables/how\\_to\\_grow\\_broccoli.php](http://www.usagardener.com/how_to_grow_vegetables/how_to_grow_broccoli.php)

## Cost and Return Analysis Per Hectare

### ITEMS AMOUNT (P)

#### I. VARIABLE COSTS

**P 60,780**

##### A. Labor (P150/MD)

Plowing	1,500
Harrowing	1,000
Bedding	1,500
Manure application	1,500
Seedling preparation (15 MD)	2,250
Mulching (10 MD)	1,500
Transplanting (10 MD)	1,500
Fertilization (3x) (6 MD)	900
Spraying	4,500
Weeding	300
Irrigation	3,000
Harvesting (10 MD)	1,500
Miscellaneous (20 MD)	3,000

**Sub-total 23,950**

##### B. Materials

Seeds	1,000.
Animal manure (10 t)	10,000

##### Fertilizers

14-14-14 (5 bags)	1,750
46-0-0 ( 6 bags)	2,280
0-0-60 (3 bags)	1,800
Chemical sprays	10,000
Fuel & Oil	5,000
Miscellaneous	5,000

**Sub-total 36,830**

#### II. FIXED COSTS 18,063

Land rental	5,000
Depreciation	
5 pcs. Scythe (2 yrs)	63
5 pcs. Hoe ( 3 yrs)	125
3 pcs. Shovel (3 yrs)	75
2 knapsack sprayers (5 yrs)	800
Interest on Loans at 20% int. p.a.	12,000
<b>TOTAL COSTS</b>	<b>78,843</b>
<b>GROSS INCOME:</b>	
<b>Broccoli</b>	<b>300,000-600,000</b>
<b>NET INCOME</b>	

**Broccoli 221,157-521,157**

a. With marketable yield of 15-20 t/ha at P20-30/kg

Pictures

Varieties



**GREEN COMET**  
**EARLY**  
**PURPLE**  
**SPROUTING**  
**BROCCOLI**



**LATE WHITE SPROUTING BROCCOLI**

<http://www.pinoybisnes.com/agri-business/broccoli-and-cauliflower-production-guide/#ixzz27LvODUJB>

s eggs of the large butterfly

Caterpillar of the small white butterfly

Diseases



**Aphid**







**CLUBBING OF THE BROCCOLI ROOTS**

<http://www.pinoybisnes.com/agri-business/broccoli-and-cauliflower-production-guide/#ixzz27LvODUJB>



Initial infections are caused by fungal spores which infect the young phoma leaf lesions.

### **Culture and Management Practices**



**Seedlings ready for transplanting**





**Transplated seedling**



**Seedling starting to flower**



<http://www.pinoybisnes.com/agri-business/broccoli-and-cauliflower-production-guide/#ixzz27LvODUJB>



**FFS of Broccoli**



**Mulching**

