

## Scientific Cultivation of Broccoli (*Brassica oleracea* L. var. *italica*)

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### SUMMARY

There are numerous health benefits of broccoli. The vegetable is rich in vitamins, minerals and is a good source of Vitamin A, potassium, folic acid, iron and fiber. This article is associated with the scientific cultivation practices of broccoli.

### INTRODUCTION

The broccoli is a member of ‘*Cole Crop group*’ closely related to cabbage, cauliflower, kale and mustard. It is botanical classified as a variety of *Brassica oleracea* species, grown during cool-season for its green flowering head. The word broccoli comes from Italian word *broccolo*, which means ‘flowering crest of a cabbage’. Broccoli has large flower heads, usually green in color, arranged in a tree-like structure on branches sprouting from a thick, edible stalk. Broccoli is a high-quality vegetable for fresh use and is one of the most popular frozen vegetables. It is highly nutritious crop containing high amount of vitamins (A and C) and minerals (K, P, Ca and Fe). Moreover, it also contains thiamine, riboflavin and niacin. Broccoli is the richest source of protein among cole crops. A high intake of broccoli has been found to reduce the risk of cancer (*as it contains glucoraphanin compound*) and also prevents heart disease (Allen and Allen, 2007). India is the second largest producer of broccoli after China, while the US ranks third. It is also used as a vegetable in many other countries such as Spain, Mexico, Italy, France, United States, etc.

### Origin and Distribution

Broccoli is native to Mediterranean region. Broccoli is a cultivar of wild cabbage. Wild cabbage originated along the northern and western coasts of the Mediterranean, where it was apparently domesticated thousands of years ago.

### Family

The botanical family to which broccoli belongs is the ‘*Brassicaceae*’ (*formerly Cruciferae*), also known as the ‘Mustard family or cabbage family’.

### Major Varieties

Broccoli varieties differ mainly in the shape and size of the head, time to maturation, side shoot production and disease resistance. Likewise, other cool-season vegetables, broccoli has also ‘early and mid-season’ varieties. Early varieties mature in 50-60 days, while mid-season varieties get matured in 60-75 days of transplanting. There are three commonly grown types of broccoli i.e. Calabrese, sprouting and purple broccoli.

**Calabrese broccoli** has large (10 to 20 cm) green heads and thick stalks. It is also referred simply as ‘broccoli’ grown as cool season annual crop.

**Sprouting broccoli** has a larger number of heads with many thin stalks, which are prepared in the same way as asparagus.

**Purple cauliflower** has a head shaped like cauliflower, but consisting of tiny flower buds. It sometimes, but not always, has a purple cast to the tips of the flower buds.

The characteristics of some improved varieties are:

**Punjab broccoli:** Its leaves are smooth, wavy and dark green. The leaves as well as sprouts have slightly bluish tinge. The sprouts are compact, attractive and succulent. The main sprouts are ready for harvest in about 65 days after transplanting. Its average yield is 175 q ha<sup>-1</sup>.

**Fiesta:** It is a mid-season broccoli variety. It produces dense, well-domed heads with thick stems on stout plants. Has limited heat tolerance at maturity, but is ideal for late summer sowing for a fall/winter broccoli crop. Plant on tighter spacing for single harvest—has limited side shoot production.

**Palam Vichitra:** It is a heading broccoli which is medium-sized and bears dark green leaves with purple tinge stem. Heads are purple and compact, rich in vitamins and minerals. This variety is suitable for cultivation under low hill conditions. Its average yield potential is 225 q ha<sup>-1</sup>. Other varieties that are suitable for cultivation under low hill conditions are Palam Haritika and Palam kanchan (Singh *et al.*, 2014).

**Pusa KTS 1:** Medium-tall variety (65-70 cm), dark green waxy foliage with slightly wavy margins, heads are solid, main head size and weight about 6.0-15.4 cm and 350-450 gm. respectively, matures in 90-105 days after transplanting.

**Arcadia:** It produces uniform and purplish-green heads. Strong cold tolerance makes this variety is one of the best types of broccoli for fall and winter production. Moreover, it is resistant to head rot and downy mildew.

**Express:** It is a mid-season variety produces uniform plants with deep blue-green heads.

### Climate and Soil

Broccoli is a cool season vegetable thrives best in cool and moist climate. It is very much sensitive to very low and high temperature. Broccoli grows best when exposed to an average daily temperature between 17 and 23 °C. Temperature below optimum range delay maturity and led to small sprouts. Moreover, it cannot tolerate high temperature as it produces poor quality sprouts (Anonymous, 2012; 2013). Broccoli grows best on a well-drained, medium to heavy soil with high organic matter content. It requires moist soil for fast and proper growth. The shoots become more fibrous under dry soil. It does well in pH range of 5.0 to 6.5.

### Agronomic Practices

#### Land preparation

Prepare the land to a fine tilth by disc ploughing followed by one or two harrowing. Incorporate well decomposed FYM @ 20 t ha<sup>-1</sup> at the time of land preparation (Anonymous, 2012). Broccoli can be sown on ridges or on flat bed. Prefer sowing on ridges in case of heavy soils. Application of organic manure or vermicomposting improves plant growth, productivity and improves water holding capacity of field soil. The sterilization of soil by drenching, nursery beds with formalin @ 1:49, about 15-20 days before seed sowing is beneficial for preventing the attack of the fungal diseases. After drenching, seed beds should be covered with polythene for a week. Then beds are again dug and left open for 5-6 days to avoid injurious effect of formalin on seeds. The standard procedure for raising nursery should be followed. The beds should be covered with a proper mulching material before watering. Apply water with a water cane over the grass mulch during initial stage i.e. 15-20 days of sowing, while during later stage watering should be done through furrows. The mulch should be removed as soon the emergence of seed sprouts. The beds should be provided with roof for shading against hot sunshine and rains.

#### Planting Season

The best time for sowing seed in nursery is mid-August to mid-September. Seedlings are ready to transplant in field after month of sowing in nursery. In order to avoid bolting and buttoning, it is advisable to sow the nursery at right time.

#### Spacing

A spacing of 45 × 45 cm between row to row as well as plant to plant should be followed for the successful cultivation of broccoli. However, planting distance vary according to the variety, climate and soil.

#### Seed Rate

A seed rate of 600-650 g is sufficient for the cultivation of broccoli in one hectare area.

### Nutrient Management

Manure and fertilizer requirements in broccoli depend upon fertility status of the soil. So, a soil test is the most accurate guide to fertilizer requirements. Good management practices are essential, if optimum fertilizer responses are to be realized in the production of cole crops. Because of the influence of soil type, climatic conditions and other cultural practices, crop responses from fertilizer may not always be accurately predicted. Soil test results help determine the nutrients needed and the rate of application. Optimum fertilization is intended to produce top quality and yields in keeping with maximum returns. Apply 20 tonnes well rotten FYM during field preparation. Apart from application of manure, apply 100 kg N, 75 kg P<sub>2</sub>O<sub>5</sub> and 50 kg K<sub>2</sub>O per hectare. The half dose of N and full doses of P and K should be applied before transplanting. The remaining half dose of N should be top dressed in two equal splits viz. after one month of transplanting and at the time head formation. For acid soils low in Ca and Mg, application of 'dolomite' as lime should be followed

### Intercultural Operations

Shallow frequent hoeing should be done in broccoli field by '*khurpi* or hoe' to kill young weeds and provide soil mulch. Since, it is a shallow-rooted crop, hoeing should not be done beyond the depth of 5 – 6 cm to avoid injuries to the roots. Weeding should be started as soon as plants are set in the field. Four to five weeks after transplanting, plants should be slightly earthen up in the field. For chemical weed control, Stomp 30 EC (Pendimethalin) 2.5 liter ha<sup>-1</sup> can be applied one day before transplanting of seedlings under moist soil conditions.

### Water Management

Broccoli needs sufficient moisture in the soil for uniform and continuous growth of plants. First irrigation should be given just after transplanting. First irrigation should be light to avoid the loss of freshly transplanted seedlings. Subsequent irrigation can be given at an interval of 7-8 days during summer and 10-15 days during winter depending upon soil type and weather. There should be sufficient moisture in soil at the time of head formation. The dry conditions adversely affect the quality and yield of shoots by being more fibrous. On the other hand, water logging condition depresses plant growth.

### Physiological Disorders

**Whiptail:** The lamina of the newly-formed leaves become leathery, irregular and consisting of only mid-rib. It is caused due to molybdenum deficiency in plants.

**Control:** Soil application of molybdenum @ 1-1.5 kg ha<sup>-1</sup> before transplanting reduces the occurrence of disorder. Foliar spray with 0.01% Ammonium molybdate solution helps to check this disorder.

**Browning Head:** Firstly, there is appearance of water-soaked areas on bud clusters which later on turns pinkish or rusty-brown resulting in rotting. Browning head is a result of boron deficiency in plants.

**Control:** Soil application of borax or sodium borate @ 20 kg ha<sup>-1</sup> prevents the disorder. Foliar spray of 0.25-0.5% borax solution is very much for effective especially when the deficiency is acute.

### Plant Protection

The important pests and diseases of broccoli crop are given below:

#### Major Insect-pests

**Aphids** (*Brevicoryne brassicae*): The aphids are generally observed on lower surface of the leaves. The Yellowish green nymphs and adults suck cell sap and devitalize plants. Affected plant parts become discolored, malformed and weakened.

**Control:** Spraying of Monocrotophos (0.05%) or Malathion (0.1%) at 10-15 days interval control aphid population effectively. To prevent recurrence of the pest granular insecticides like Phorate @ 1.0 kg a.i./ha should be applied to soil.

**Cabbage Diamondback Moth** (*Plutella xylostella*): It is one of the most serious pests of cole crops including broccoli. The green or brownish coloured caterpillars feed the inner leaves by making holes, rendering transparent cuticular patches. Severely affected leaves are completely skeletonized.

**Control:** Spraying of neem based formulations @ 4 ml or Bt product like Delfin 3G @ 1 g per of water gave good control on pest or spraying crop with Malathion (0.1%) or Profenofos (0.25-0.5 kg a.i./ha) gives excellent control of the larvae.

### Major Diseases

**Black Rot (*Xanthomonas campestris*):** It is the most serious disease affecting broccoli. This bacterial disease is common in areas with warm and humid climate. The typical symptoms of black rot are caused by local infection that results when bacteria enter leaves through natural openings of leaf margins. The infected tissue turns pale green-yellow and then turns brown and dies. Affected areas are usually wedge or V-shaped. These areas enlarge as the disease progresses and severely affected leaves may drop off. The veins in infected leaves, stems and roots sometimes become black. The heads of the infected plants remains small and its quality is reduced making it unfit for marketing

**Control:** Seed treatment with Agrimycin-100 (100 ppm) or Streptocycline (100 ppm) is effective in controlling disease. Planting should be done on raised beds to facilitate drainage. Cultivation in the fields where crucifers have been continuously grown during last 2 years should be avoided. Plants should be thoroughly inspected for black rot symptoms and the affected plants should be removed and destroyed.

### Harvesting and Yield

As soon as sprouts are of marketable size i.e. 10–15 cm stems should be harvested with a sharp knife. The bud cluster should be green and compact. If harvesting is delayed, bud cluster becomes loose. The sprouts or head should be picked up regularly to ensure quality. Moreover, sprouts should be marketed as soon as possible because they cannot be stored for a long time. Sprouts are ready to harvest again after 10-12 days. An average yield of 100 – 150 q ha<sup>-1</sup> from multi-cuts can be obtained depending upon variety.

### Post Harvesting

After harvesting, its heads should be immediately sorted, graded, packed in baskets and sent to markets. A high rate of respiration results in deterioration of its quality. They should be cooled at 400C and then packed with ice in crates and stored in refrigeration. They can be stored well for 7–10 days at 400C. Broccoli can also be preserved in glass jars after lactic acid fermentation.

### REFERENCES

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