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ORIGINAL PAPER



## Broccoli: an Anticarcinogenic

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India is endowed with a wide range of tropical, sub-tropical and temperate vegetable crops. But still there are some vegetables which are lesser known or rare to most of our growers and consumers. Our farmers can earn a lot of profit by growing these rare or unusual high value vegetables nearby big cities and towns as they attract very high prices in cosmopolitan markets, star hotels and places of tourist's interest. Chinese cabbage, broccoli, red cabbage and brussel's sprouts, etc. has opened up new opportunities for vegetable growers of our country.

Broccoli (*Brassica oleracea var. italica* L.) is a native of eastern Mediterranean region, derived from ancient forms of *Brassica oleracea*. In recent years broccoli cultivation has gained momentum in India, because of its high nutritive values and popularity among tourist. Broccoli is a rich source of vitamins, minerals, proteins, etc. It has about 130 times more Vitamin 'A' content than cauliflower and 22 times more than cabbage. Besides, it is a rich source of sulphoraphane a compound associated with anticarcinogenic properties consequently reduces the risk of cancer. The curd of broccoli contains following nutrients per 100 g of edible portion; moisture 89.9 g, carbohydrates 5.5g, fat 0.2g, protein 3.3g, vitamin A 3500 IU, thiamine 0.05 mg, riboflavin 0.12 mg, phosphorous 79 mg, calcium 80 mg, iron 0.8 mg, ascorbic acid 137 mg and calories 37 g.

In India, its cultivation is negligible but now it is becoming increasingly popular in hotels in Delhi, Bombay, Calcutta, Chennai, and Bangalore. It is mostly cultivated in the areas of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Nilgiri hills and northern plains of India.

## **VARIETIES**

Broccoli is of 2 types i.e. heading and purple or green sprouting. The varieties of broccoli differ in days to maturity and are early, medium and late according to their response to time of planting. Palam Haritika (a green sprouting broccoli having delayed maturity and average yield potential of 175-225 q/ha), Palam Samridhi (a compact, green head, free from yellow eyes and bracts, average head weight is 300-400 g with average yield of 150-200 q/ha), Palam Vichitra (a high yielding heading broccoli with compact purple colour head and average yield of 200-225 q/ha), Palam Kanchan (a heading broccoli with large yellowish green heads with an average yield potential of 250-275 q/ha), Ganesh (curds are dark green, compact, dome shaped, attractive with negligible hollowness, tolerant to downy mildew and bacterial blight with an average yield of 65 q/ha), Pusa Broccoli KTS 1 (compact curd, light green with small buds weighing 250-400 g, first picking in 85-95 days after transplanting and average yield of 125 q/ha) are some good varieties of broccoli.

## **CLIMATE**

Broccoli is a cool season crop resistant to mild frost. It is very sensitive to high temperature which causes the heads to be distorted, making it a high risk crop. Moderately uniform cool temperature is best for growth of broccoli. The temperature of 20-25°C is optimum for its proper growth, while 15-20°C for heading stage.

## **SOIL**

Broccoli can be grown on almost all type of soil but deep loamy soil is best suited. A well drained soil of 5.5-6.5 pH with better water retaining capacity gives better yield. Stagnation of water causes injury to the root system of plant. The land should be prepared by one deep ploughing followed by 2-3 harrowing and planking should be done to make the soil friable and leveled.

## **SEED RATE**

The seed rate of broccoli depends on variety, spacing and the real value of the seed. However, 400-500 g seed is sufficient to supply seedlings for one hectare.

## **NURSERY RAISING**

The sowing of seed is done in August-September. Raised nursery beds (15 cm high) and 1.0 m wide is prepared for raising seedlings. Before sowing, seeds should be treated with carbendazim @ 1g + mancozeb @ 2g/kg of seed to get rid of fungal diseases. The seeds are sown in well prepared beds in lines 2-3 cm deep spaced 5 cm apart. After sowing, the seeds should cover with fine soil and mulched with gunny bags to facilitate early and uniform germination. Immediately after sowing, light irrigation is done.

## **TRANSPLANTING**

The seedlings are ready for transplanting after 30-40 days of sowing. Old seedlings result into poor growth of plant and development of small size heads. The seedlings are

transplanted 45 cm apart within and 50 cm between the rows. The gap filling should be done after a week of transplanting.

### **MANURE AND FERTILIZERS**

About 10-15 tonnes of well rotten farmyard manure, 100 kg/ha nitrogen, 80 kg/ha of phosphorous and 60 kg/g of potassium are recommended. Organic manure, full dose of P, K and one third dose of N is applied during land preparation. The remaining dose of N should be given in two split doses. The first is applied 30 days after transplanting, whereas second at curd initiation stage.

Micronutrient requirement of broccoli is fairly high. Molybdenum and Boron may be supplied by soil application or foliar sprays.

### **IRRIGATION**

The crop grows well under high moisture conditions. The dry conditions during early growth and head development stage adversely affect the yield. Therefore, frequent irrigation at 7-8 days interval is given depends upon weather conditions.

### **INTERCULTURAL OPERATIONS**

The crop should be kept weed free. Two hand weeding with shallow hoeing helps in controlling weeds effectively. Hoeing is done for breaking the surface crust to facilitate better aeration and water absorption. In broccoli, practice of earthing up at the time of weeding and hoeing is beneficial. Pre-planting sprays of 2 kg/ha of Basalin followed by 1 or 2 hoeings can also check the emergence of weeds.

### **HARVESTING**

The crop is ready for harvest from December-March. The heads having 10-15 cm stems should be harvested with a sharp knife when its bud clusters are green, compact and attained proper size. The leaves are removed from the cut-stem and head. Delayed harvesting cause opening of buds and loosening of head making it unfit for market purposes. Yield of broccoli mainly depends upon varieties, maturity period and method of harvest. Single harvest of main heads generally gives lesser yield.

### **YIELD**

The average yield of broccoli is 5-10 tonnes/ha.

### **POST-HARVEST MANAGEMENT**

After harvesting, its head 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 4.4<sup>0</sup>c and then packed with ice in crates and stored in refrigerators. They can be stored well for 7-10 days at 4<sup>0</sup>c. Broccoli can also be preserved in glass jars after lactic acid fermentation.

## DISEASE MANAGEMENT

The important disease of broccoli and their control measures are given below:

### Damping off

The disease is incited by the species *Pythium*, *Phytophthora*, *Fusarium*, *Phoma* and *Rhizoctonia*. It is primarily a disease of nursery and occurs in two phases. In pre-emergence phase, the young seedlings are killed before they reach the surface of soil and post-emergence is conspicuous by topping over the infected seedlings. To control it seeds are treated with Thiram or Captan @ 3g/kg or Bavistin @ 1g/kg before sowing. Seedlings are drenched with a mixture of Mancozeb (0.25%) and Carbendazim (0.05%) to save them from post-emergence damping off disease.

### Black spot

It is a seed borne disease caused by *Alternaria brassicae*, *A. brassicicola* and *A. alternata*. Dark coloured spots appear on leaf, stem, heads and pods which spread rapidly to form circular lesion. It could be controlled by treating seed with metalaxal compound and spraying of crop with Mancozeb @ 0.2% at 10-15 days interval from the time of first risk had given better control.

### Downy mildew

It is caused by an obligate pathogen *Pernospora parasitica*. Small chlorotic, irregular, translucent, light-green lesions appear on leaf lamina in the initial stage with pronounced downy growth of the fungus on lower surface during high humid conditions. Later lesions dry out and become necrotic leading to defoliation and death of plant. In severe form, it may infect heads also. It can be effectively controlled by spray of Ridomil MZ 72 @ 0.025% before the onset of favourable conditions followed by Dithane M 45 @ 0.2% at 10 days interval.

### Sclerotinia rot

It is caused by the fungus *Sclerotinia sclerotiorum*. Wet soft lesions may appear on head. The affected plant parts are covered with white silvery growth so it is also known as white rot. In the pith region of affected parts sclerotia of different sizes are formed. The affected plants wilt and die in due course of time. It could be controlled by four to five sprays alternatively of 0.05% Bavistin combined with 0.2% Dithane M 45 followed by Dithane M 45 (0.2%) alone, at an interval of 15-20 days starting from head formation stage.

### Bacterial soft rot

It is incited by *Erwinia carotovora* and can attack the crop at any stage of growth. Affected plants shows a soft, slimy, bad smelling rot which under favourable conditions rapidly spreads throughout the entire plant. The infection is favoured by high humidity. Spraying of the standing crop with 100-200 ppm Streptomycin or Plantomycin combined with Copper oxychloride (0.3%) proved most effective.

### Insect Pest Management

The major pests reported to damage these crop are diamond back moth (*Plutella xylostella*), cabbage head borer (*Hellula undalis*), cabbage butterfly (*Pieris brassicae*), bihar hairy caterpillar (*Spilosoma oblique*), tobacco caterpillar (*Spodoptera litura*) and cut worms (*Agrotis spp.*). Caterpillars of these insects damage the crop. Conventional pesticides are effective against diamond back moth and tobacco caterpillar. In case of cabbage butterfly, weekly spray of Dipel @ 0.5 kg/ha is very effective. Cabbage cut worm damage the crop in nursery stage or immediately after transplanting. It can be controlled by applying Meparathion (2% dust) @ 5 kg *a.i.* per ha after 3-4 days of transplanting and spraying of Indoxacarb @ 0.8 ml/ liter of water is also effective.

Nymph and adults of cabbage aphids (*Brevicoryne brassicae*), mustard aphid (*Lipaphis erysimi*) and potato aphid (*Myzus persicae*) also attack the crop. Spraying of neem seed kernel extract (NSKE) (4%) or Oxydemeton methyl (0.02%) can control this pest effectively.

### PHYSIOLOGICAL DISORDERS

#### Brown rot

It is caused by boron deficiency. The first sign is the appearance of small water soaked areas in the centre of the curd. In later stages, the stem becomes hollow with water soaked tissue surrounding the walls of the cavity. In more advanced stages, pinkish or rusty brown areas develop on the surface of curd. This may be controlled by applying borax or sodium borate @ 20 kg/ha. In case of acute deficiency, spray of 0.25 to 0.50% solution of borax @ 1-2 kg/ha is more effective.

#### Whiptail

It is caused by deficiency of molybdenum in which the lamina of the newly formed leaves become leathery, irregular and consisting of only mid-rib. It can be controlled by soil application of 1-1.5 kg of molybdenum before planting and spraying of 0.01% Ammonium or Sodium molybdate on plants.

