

## VEGETABLES

Vegetables constitute an important item of human diet. In the context of alleviating protein malnutrition in India, efforts are under way to enrich cereals. To supplement them vegetables, being short-duration crops, can be produced in succession on the same plot and all the family labour of the vegetable-grower can be usefully employed throughout the year. The present production and consumption of vegetables in the country are very inadequate, being only about one-fourth to one-third of the requirement.

**Vegetable seed supply.** Like any other crop, seed is an important factor governing the production of vegetables. Seed production is technical job in the case of vegetables, unlike in the case of most other crops. The production techniques are also different in biennial vegetables, including onion, cabbage, beet, etc., and specific environmental conditions are required for producing their seeds. The growers depend mostly on outside agencies for meeting their requirements of seeds. Seed production and trade have not developed in this country on any scientific lines and that the approach is not systematic. That is why the quality of the vegetable seeds has not been what it should be. The National Seeds Corporation, a Government of India undertaking, has recently entered the vegetable seed industry. Some private seed nurseries have also employed qualified technical personnel. The quality seed production will not only help to increase the production within the country but will also open up a big source of potential foreign exchanges\ by exporting vegetables seeds to our neighboring countries in South-East Asia and Africa.



**Types of vegetable gardens.** Vegetable gardens can be classified into six different types according to the purpose for which they have been developed. These are home-gardens or kitchen-gardens, market-gardens, truck-gardens, gardens for processing, gardens for vegetable-forcing, and gardens for seed production. The layout of a home-garden will differ from individual to individual. However, broadly, a city home-gardener will follow a very intensive method of vegetable-growing compared with that followed by a home-gardener in a village. A market garden produces vegetables for the local market. Most of such types of gardens are located within 15 to 20 km from a city. The cropping pattern depends on the demands of the local market. A truck-garden produces selected crops in a relatively large quantity for distant markets. It generally follows a more extensive method of cultivation than the market-garden. The location is determined by soil and climatic factors suitable for raising particular crops. A vegetable garden for processing develops around the processing factories and is mainly responsible for supplying vegetables to the factories regularly. This type of garden grows particular varieties suitable for canning, dehydration or freezing. Vegetable-forcing is concerned with the production of vegetables out of the normal season. The commonest forcing structures are glass and plastic houses.

**Classification of vegetables.** There are more than fifty important vegetables. If the growing of each is dealt with in details, it will lead to much repetition. It is, therefore, desirable to classify the vegetables into certain groups. They are : (1) botanical classification, (2) classification based on hardiness, (3) classification based on the parts used, and (4) classification based on essential methods of culture. The last one is the most convenient method and is generally followed for describing the cultural operations of different vegetables. The vegetables are dealt under thirteen groups, namely potato, solanaceous fruits, cole crops, root crops, bulb crops, peas and beans, cucurbits, sweet-potato, *bhindi* or okra, salad crops, pot-herbs or greens, other root crops and perennial vegetables.

**Solanaceous fruits.** Three important vegetables, tomato (*Lycopersicon esculentum* Mill.), brinjal (*Solanum melongena* L.) and chilli (*Capsicum annum* L.) are included in this group. They all belong to the family Solanaceae.

**CULTIVATION.** All the three vegetables are warm season crops. Their plants cannot withstand frost. In northern India, two sowings are done in June-July for the autumn crop, and in November for the spring-summer crop. A third sowing of brinjal can be done in March for a rainy-season crop. In the east and the south India, the crops can be grown throughout the year, the main sowing season being during July-August. In the hills, the seed is sown in March-April. For a good yield, 20-25 tonnes of farmyard manure per hectare is incorporated into the soil at the time of its preparation. This is to be supplemented with 100 kg of nitrogen, 60-80 kg each of phosphoric acid and potassium. Half the dose of nitrogen and the full dose of phosphoric acid and potassium should be added to the soil at transplanting, and the rest top-dressed after about four weeks.

The foliar application of 35 kg of nitrogen and 45 kg of phosphoric per hectare as 4 to 5 sprays is also recommended. It is necessary to maintain an even moisture supply in the soil; over-watering is as harmful as insufficient irrigation. A dry period, followed by a sudden heavy watering, may cause the cracking of tomato fruits. F<sub>1</sub> hybrids can be used for high yield and uniform fruiting. The yield of tomato is about 20-25 tonnes, of brinjal 25-30 tonnes; and of green chilli 8-10 tonnes and of dry chilli 2-2.5 tonnes per hectare.

Damping off is a common disease of all the three crops. Tomato is attacked by a number of fungal disease, e.g. Fusarium wilt, early blight and late blight. Several sprayings with fungicides, Bordeaux mixture, Marglobe and Manalucie, and the use of resistant varieties, are recommended. The common virus disease is tobacco mosaic and leaf-curl. In the case of brinjal, Phomopsis wilt is the most important fungal disease and is seed-borne. Hot-water treatment (50°C for 30 minutes) of the seed helps to reduce the incidence of the disease. Little leaf is caused by mycoplasma and can be partially controlled with antibiotics. Die-back, mosaic and leaf-curl are the most serious disease of chillies. Fruit-borer is a serious pest of tomato and so are the shoot and fruit-borer of brinjal. Thrips are important insects on chillies. These pests can be controlled with periodical sprayings with insecticides, such as Malathion, DDT or BHC.

**Cole crops.** This group includes cabbage (*Brassica oleracea* L. var. *capitata*), cauliflower (*B. oleracea* L. var. *botrytis*), knol-khol or kohlrabi (*B. caulorapa* L.), broccoli (*B. oleracea* L. var. *italica*), brussels sprouts (*B. oleracea* L. var. *gemmifera* Zenk.), and chinese cabbage (*B. pekinensis* (Lour.) Rupr. and *B. chinensis*). All the above crops have developed from wild cabbage, known as colewart. They belong to the family Cruciferae and the genus *Brassica*. All cole crops are hardy and thrive best in cool weather, except some acclimatized early cauliflower varieties. They have many things in common in respect of their cultural requirements.

**CULTIVATION.** The seeds are sown in nursery-beds in May and June for early, and July-August for mid-season cauliflower. The seeds of other cole crops are sown from the middle of September to the end of October. For the early crop, 600 to 750 g and for late crop 400 g seed, except for knol-khol where about 1 to 1.5 kg of seed is required, to be sown to cover one hectare. In the hills, the seeds are sown from March to June. The seedlings are transplanted when 5-6 weeks old at a spacing of 45 cm each way for the early crop. The row-to-row distance is increased to 60 cm for late varieties. In the case of knol-khol, it is reduced to 30 cm from row to row and 20 cm from plant to plant.

For best results, 15 to 20 tonnes of farmyard manure, compost or sludge should be incorporated into the soil about four weeks before transplanting. Sixty kg of nitrogen, 80 kg of phosphorus and 40 kg of potassium per hectare should be applied just before transplanting. A top-dressing of 60 kg of nitrogen, about six weeks after transplanting, at the time of earthing-up, is recommended. Water must be supplied to ensure continuous growth. An early crop may need irrigation twice a week till the start of the rains. The late crop may be irrigated once a week, depending on the soil and the weather condition. Cauliflower is harvested when the curds attain a proper size and before they begin to 'rice' or discolour. Cabbage heads are harvested when they attain full size and become hard. Knol-khol knobs are harvested before they get fibrous. The average yield per hectare varies from 20 to 30 tonnes in the case of cauliflower, 30 to 40 tonnes in the case of cabbage and 20 to 25 tonnes in the case of knol-khol.



**Root crops.** The important commercial crops grown under this group are radish (*Raphanus sativus* L.), turnip (*Brassica rapa* L.), carrot (*Daucus carota* L.) and beet (*Beta vulgaris* L.). Radish and turnip belong to the family Cruciferae, carrot to the Umbelliferae and beet to the Chenopodiaceae. The other vegetables belonging to this group are parsnip, rutabaga, salsify, charvil, skirret and celeriac. All these crops thrive well in the cool season. However, a number of varieties of radish, turnip and carrot grow well in a comparatively warm season.

**CULTIVATION.** The temperate types are sown from the middle of September to February. The tropical types are generally sown from early August to the end of October. They bolt early, if sown later. The seed-rate per hectare is 3 to 4 kg for turnip, 5 to 6 kg for beet and carrot and 10 to 12 kg for radish. Light friable soil is considered best for root crops. The growth being rapid in a short period, fertile soil is preferred. All root crops need potassic fertilizers. To a normal soil, the application of 100 kg of nitrogen, 50 kg of phosphorus and 70 kg of potassium per hectare is recommended. All root crops require plenty of water till the roots are large enough to be pulled out. Long-rooted varieties need earthing-up at least once. Roots should be harvested when they are tender. A few days' delay in harvesting, particularly in the case of radish may make the roots

pithy. The roots are pulled out along with the tops and then packed for marketing. The yield material vary from 20 to 30 tonnes per hectare.

The seeds of the temperate types are produced only in the hills. The tropical types produce seed in the plains. All the above vegetables are cross-pollinated crops. The roots left *in situ* produce the highest quantity of seed. However, to produce quality seed, the roots are pulled out, selected after examining their characters and then replanted.

**Bulb crops.** The group of bulbs includes onion (*Allium cepa* L.), garlic (*A. sativum* L.), leek (*A. porrum* L.), shallot (*A. ascalonicum* L.), Welsh onion (*A. fistulosum* L.), and chive (*A. schoenoprasum* L.). All these crops belong to the family Liliaceae and genus *Allium*. The two most important crops commercially grown in India are onion and garlic.

*Garlic* : There is no recognized variety of garlic in India



**CULTIVATION.** The seed of onion is sown in the nurseery from the middle of October to the end of November. The seedlings are transplanted 10 to 15 cm apart in December and early January. A crop transplanted early gives a higher yield, but the number of bolters material be high. Sometimes, small bulbs or bulbils are sown at about 1,000 to 1,200 kg per hectare for an early crop. About 20 tonnes of farmyard manure should be incorporated into the soil at the time of preparing the land. The application of 125 kg of nitrogen, 60 kg of phosphorus and 100 kg of potassium per hectare is recommended. Half the dose of nitrogen is to be top-dressed after about a month and the rest is to be applied at the time of transplanting. Weedicides, such as Tenoran at 2.5 kg per hectare in 800 liters of water, applied 3 weeks after transplanting, can control broad-leaved weeds. The crop should be irrigated so that the moisture content of the soil be kept at the optimum level. A dry spell, followed by irrigation, may cause the splitting of the outer

scales. Irrigation is stopped when the tops mature and start falling. For high yields, the  $f_1$  hybrid seed is used in most of the agriculturally advanced countries. For the economic production of hybrid seed male-sterile lines are used.

Garlic is propagated by sowing cloves, the quantity used being about 350-500 kg/ha. It is sown from September to November in the plains.

Onion gives a yield of 25 to 30 tonnes per hectare and garlic about 6 to 10 tonnes. Bulbs should be thoroughly cured before storage. The *kharif* crop does not store well.

Onion seed is commonly produced by sowing bulbs. Bulbs 2.3 to 3 cm in diameter, weighing 1,500 kg are needed to plant a hectare and may yield about 850 kg of seed. Bulbs are planted in the beginning of October. When seedlings are transplanted in early September, most of the bulbs produce flowering stalks and form seed.



**Peas and Beans (legumes).** Peas (*Pisum sativum* L.) and beans occupy a position of considerable importance because of their being good vegetable and pulse crops. They are highly nutritious and contain high percentages of proteins, carbohydrates and vitamins. They all belong to the family Leguminosae. There are at least 18 types of cultivated beans. From the standpoint of green vegetables French bean (*Phaseolus vulgaris* L.), cowpea (*Vigna sinensis* Savi.), cluster-bean (*Cyamopsis tetragonoloba* (L.) Taub) and *sem* (*Dolichos lablab* L.) are the most important.

**CULTIVATION.** Peas are able to withstand relatively low temperature compared with beans. The plants, however, cannot withstand continued frost, especially during flowering and pod formation. Beans are resistant both to frost and very high temperatures. In the plains, peas are sown from the end of September to November. French bean is sown in August-September and February-March; cowpea and cluster-bean in February-march and June-July and *sem* in June-July. In the hills, they are sown from April to the end of May.

The important disease attacking peas and beans are *Fusarium* wilt, powdery mildew, rust, and pea and bean mosaic. For controlling *Fusarium* wilt, the best method is to use resistant varieties, and for controlling powdery

mildew, dusting with sulphur is very effective. Disease-free seed should be used for controlling bean mosaic, as it is transmitted through seed. Aphids and weevils are the most important insect pests which can be controlled by spraying Malathion and DDT respectively.



**CUCURBITS.** This group includes cucumber (*Cucumis sativus* L.), musk-melon (*Cucumis melo* L.), water-melon (*Citrullus vulgaris* Schred. Ex Eckl. & Zeyh.), bottle-gourd (*Lagenaria siceraria* (Mol.) Standl.), bitter-gourd (*Momordica charantia* L.), sponge-gourd (*Luffa cylindrica* (L.) Roem), ridge-gourd (*Luffa acutangula* Roxb.), snake-gourd (*Trichosanthes anguina* L.), pointed-gourd (*parwal*) (*Trichosanthes dioica* Roxb.), round-gourd (*tinda*) (*Citrullus vulgaris* var. *Fistulosus* Duth. & Full), ash-gourd (*Benincasa hispida* (Thunb.) Cogn.), pumpkin (*Cucurbita moschata* Dutch. Ex Poir), summer squash (*C. pepo* L.), winter squash (*C. maxima* Duch.) and a number of other crops mostly of trailing habit. They all belong to the family Cucurbitaceae and are grown during summer.

The majority of them are monoecious and a few are dioecious, hermaphrodite and andrmonoecious.

**CULTIVATION.** The cultural reqs of all the commercially important crops in this group are more or less similar. Cucumber, bottle-gourd, bitter-gourd, pumpkin, sponge-gourd and ridge-gourd can be grown in summer as well as in the rainy season, whereas, musk-melon, water-melon, squashes and *tinda* grow better only in summer. Winter squash grows well under mild climatic conditions. There are two methods of sowing. Ridges are prepared at proper spacing and after adding manure, a number of seeds are sown on each ridge. In the other method, furrows are made and seeds are sown on the edge either on one or both sides. The spacing from row to row, unless staked, varies from 1-1/2 to 3 m, according to the crop. The distance from plant to plant is kept at 60-90 cm. Approximately 2.5 to 3 kg of seed is required for sowing a hectare of cucumber, musk-melons and water-melon, 4 to 5 kg of seed of bottle-gourd, sponge-gourd and ridge-gourd, and 7 to 8 kg of seed of pumpkin and squashes. The summer crop is sown from January to March and the rainy-season crop in June-July. The cucurbits are also grown on the river-beds during summer. Special techniques are followed to get an early crop on the sandy banks of the rivers.



**Sweet potato.** The sweet potato (*Ipomoea batatas* (L.) Poir.) is a very important crop in the tropical regions of India. The chief uses of sweet-potato are for human consumption and for the manufacture of starch and alcohol. It contains about 16 per cent starch and about 4 per cent sugar. It belongs to the family Convolvulaceae.

**VARIETIES.** 'Pusa Suffaid', 'Pusa Lal', 'Pusa Sunheri', 'SP-3', 'SP-9', 'Ranger', 'Bhadrakali', 'Hosur Red', 'Gold Rush', 'Centennial', etc.

**CULTIVATION.** Sweet-potato requires a long and warm growing season. It does not stand frost. A moderate proportion of sand in the top soil, with a fairly retentive subsoil, provides ideal condition for its growth. It is grown from sprouts produced from its tuber-like roots and from vine cuttings. In well-prepared nursery-beds, the selected roots are planted 30 cm apart in rows which are spaced 45 cm. The sprouts are cut and planted for further growth in a second nursery. Ultimately, the cuttings from this nursery are planted at about 60 cm from row to row and 30 cm within the row. About 40 to 50 thousand cuttings are required to plant one hectare. In northern India, the cuttings are planted during June-July and in central and southern India during October-November. In some parts, both *kharif* and *rabi* crops are grown. A mixture of about 60 kg each of nitrogen and phosphorus and 120 kg of potash per hectare may be applied to obtain good yield. Both flat beds and ridges are used in various parts from 10 to 15 thousand kg per hectare. Red-skinned roots generally store better than white-skinned ones.



**Okra or bhindi** The okra (*Abelmoschus esculentus* (L.) Moench), belongs to the family Malvaceae. It is cultivated throughout India for its immature fruits. Its varieties are : 'Pusa Sawani', 'Pusa Makhmali', 'Perkin's Long Green' (for hills only), etc.

**CULTIVATION**  
Bhindi plant prefers a long warm season. The plant is tender and cannot tolerate

cold at any stage of growth. Low temperature true in the early spring results in poor germination of seed. Bhindi seed does not germinate at 20<sup>0</sup>C or below. The best germination takes place between 24<sup>0</sup>C nad 30<sup>0</sup>C.

### **Sowing Time**

Bhindi is soen twice a year in the plains for green pods. For early crop the seed is sown from February to April and for late crop in June-July. For seed production the second crop is most suited. It is not only gives higher yield but seed is also of good quality and also provides an opportunity for roguing of the virus susceptible plants. During dry weather virus does not develop and the undesirable plants are not detectible. Period commencing from last week of June to first week of July has been found to be the best. In case the seed crop is sown in May or early June then the main fruiting period coincides with mansoon rains. Water gets entry into the ripe dehisced fruits and spoils the seed within the pods.

### **Irrigation**

First irrigation in case of ridge sowing should be given immediately after sowing. Care should be taken not to allow the ater to overflow the ridges. In case of flat sowing first irrigation should preferably be given only after the seedings have come up. Subsequently irrigations should be given after every four to five days in the hot season or every 10-14 days in moderate season. On loose sandy type of soils frequency of irrigation should be increased.

### **Harvesting and Marketing**

The fruits attain marketable size when the plants are 45-50 days old, depending upon the temperature. It takes ficve to seven days to form an edible fruit after the opening of the flower. The fruits should not be allowed to over grow to give a fibrous appearance because overgrown fruits are not liked by the consumer. Only tender fruits should picked for better returns. Leaving fruits on the plants for a longer period not only impairs the quality of the fruit but also reduces the rate of apical growth and thus ultimately reflects upon the fruit bearing capacity of the plant. Therefore, frequent picking of fruits is desirable. Picking should be done early in the morning because fruits make a lot of growth during night. If at all fruits are to be picked in the evening it should be in the late hours.