

Spice Crops

GINGER

Ginger (*Zingiber officinale* Rosc.) is a herbaceous perennial crop usually grown as an annual for its rhizomes. It is a valuable cash crop and widely used in food, beverage, confectionery and medicine. It is marketed in different forms such as raw ginger, dry ginger, ginger powder, ginger oil, ginger oleoresin, ginger ale, ginger candy, ginger beer, brined ginger, ginger wine, ginger squash, ginger flakes etc. Though it is also cultivated in Jamaica, Nigeria, Sierra Leone, Brazil, China, Japan, and Indonesia, India still is the largest producer of dry ginger. Ginger is cultivated in almost all the states of India. The Major ginger growing states are Kerala, West Bengal and North Eastern Region. About 3 lakhs tones of ginger is being produced annually from 47,641 ha land and the northeast region is emerging as India's organic ginger hub. This region is one among the highest ginger productivity zone in the world. The ginger of the region is known for its quality (less fibre). Ginger produced from Northeastern states are reported to have higher oil and oleoresin content than ginger from other parts of the country. Dry ginger has a good demand abroad and India is the largest exporter of dry ginger.



Photo – Ginger crop (left) and Ginger rhizome (right)

Soil and climate

Ginger is cultivated in different types of soils, provided sufficiently well distributed rainfall or irrigation and adequate drainage facilities are available. The ideal soil for ginger cultivation is sandy or clay loam or red loam or lateritic loam with good drainage and aeration. A deep friable loam rich in humus is ideal for ginger cultivation. However, being an exhaustive crop it is not desirable to grow ginger in the same site year after

year. Ideal pH range of ginger is 5– 7.5. It grows well in humid climate and is cultivated from sea level up to an altitudes of about 1500 m above MSL. However, the optimum elevation for its successful cultivation is in the range of 300-900 m. Ginger can be grown both, under rainfed and irrigated conditions. Moderate rainfall at sowing time till the rhizomes sprout, followed by fairly heavy and well-distributed showers during the growing period and dry weather about one month before harvesting are optimum requirements for its successful cultivation.

Varieties

Cultivars suitable for NEH Region are Nadia, Maran, China, Varada, Himgiri, Mahima, Goru bathane, Rajetha and Rio-de-Janeiro.

Site selection

For organic ginger production, a buffer zone of 25-50 feet is to be left all around from the conventional farm, depending upon the location of the farm. The produce from this zone shall not be treated as organic. Ginger being an annual crop, the conversion period requirement will be 2-3 years. Ginger can be cultivated organically as an intercrop or mixed crop with other crops provided all the other crops are grown following organic methods. The selected site should be well drained and preferably the place where the ginger is not grown earlier. Ginger being an shade loving crop can also be grown as intercrop in plantations.

Field preparation

The land has to be ploughed 4-5 times or dug thoroughly with receipt of early summer showers to bring the soil to medium tilth. Beds of 1m width, 15cm height and of convenient length are prepared with an interspace of 30-50 cm in between beds. Solarisation of beds for 40 days with a transparent polythene sheets is recommended in areas prone to rhizome rot and nematode infestation. In valley region or high rainfall area, proper drainage channels should be provided in the inter- rows to drain off stagnant water.

Seed Selection and treatment

Carefully preserved seed rhizomes, free from pests and disease, collected from organically cultivated farms should be used for planting. However, to begin with, seed material from high yielding local varieties may be used in the absence of organically produced material. Seed rhizomes should be kept in the sun for a period of 20-30 days before planting. Dipping the rhizome sets in cow urine for half an hour is also beneficial. The optimum size of rhizome is about 50 g. The seed should be selected during the month of October – November during harvesting and the infested rhizome should be

removed. The seed selected from a locality where pest and disease problems were not observed gives higher yield.

Rhizome Treatment

To control the soft disease, slurry of *Trichoderma viride* @5 g/kg of seed is prepared and seeds are treated with the slurry. Acacia gum may be applied in to the slurry as sticker material. *Trichoderma* spray or drenching 1 % at 15 days interval is also useful for controlling ginger rot. Rhizome treatment with Garlic-clove and Cinnamon extract has also been found to be very effective.

Planting

The planting season for ginger is from March-April, with the onset of the monsoon. The crop duration is generally around 8-9 months (April/May to December/ January). Ginger is planted in rows, 30 cm apart at distances of 20-25 cm within the row. Bits of seed-rhizomes weighing 30- 50 g each, 3-5 cm in length and having at least one bud are planted at the given spacing. The rhizome used for seed should be true to type and free from disease. About 2.0 t rhizome/ha is required for planting one hectare land. While planting, seed rhizomes mixed with well rotten cattle manure or compost mixed with *Trichoderma* (10 g of compost inoculated with *Trichoderma*) may be put in shallow pits and covered with a thin layer of soil and levelled. The beds are covered with leaf mulch as protection against sun and heavy rains and for consequent enrichment of organic matter in the soil. Farmyard manure can also be used as mulch.

Cropping system and pattern

Different types of cropping systems are followed for ginger cultivation in the region. Generally farmers prefer mono cropping of ginger. However, they also practice mixed cropping with maize, chili, soybean, brinjal, papaya, cucumber, pumpkin, yam, tree tomato, tapioca and different types of leguminous crops in *jhum*. Sometimes ginger is intercropped with maize and pineapple. In Sikkim ginger is grown as an intercrop in mandarin orchards and is commonly rotated with crops like tapioca, chillies and rice in rain fed areas and leguminous crops, maize and vegetables in irrigated conditions. Ginger being shade tolerant is suitable for agroforestry based farming systems. The ginger should be rotated with other crops such as legumes, cereals etc. for higher productivity and prevention from disease problems. In the same field ginger should not be taken up for more than 3 years and must be rotated by other crops.

Cultural practices

Mulching ginger beds with green leaves is an important operation in ginger. Apart from being an organic manure, it helps in soil and water conservation. Mulching may be done with green leaves thrice, once immediately after planting @ 10 to 12 tonnes /ha to

enhance germination, increase organic matter, and conserve soil moisture and prevent washing of soil due to heavy rains. It is repeated @ 4-5 tonnes /ha at 40th and 90th day after planting preferably at the time of weeding, hoeing and earthing up. Use of *Lantana camara* and *Vitex negundo* leaves as mulch may reduce the infestation of shoot borer. In Sikkim mulching with *Schima wallichii* (chilaune) followed by *Artemisia vulgaris* (titepati) is widely practiced to minimize disease problems also. Cow dung slurry or liquid manure (*Jivamrit*) may be poured on the bed after each mulching to enhance the microbial activity and nutrient availability.

Two weeding are generally given to the crop. The first weeding just before the second mulching and repeated depending on the intensity of weed growth. The weeded material may be used for mulching. If necessary weeding is to be repeated a third time. Plants are earthed up once or twice with sufficient soil from inter row spaces for covering the rhizome. Proper drainage channels are to be provided in the inter rows to drain off stagnant water.

Conservation techniques

Mulching conserves soil moisture by checking evaporation loss. Bunds are constructed to prevent soil erosion and to retain the topsoil and proper drainage channels are provided to drain off stagnant water. Seasonal legumes are also grown along with ginger to suppress weed growth, minimize soil erosion and enhance soil fertility.

Nutrient Management

Being exhaustive crop, ginger requires heavy manuring. About 20-25 t FYM/ha is required for a good yield of ginger. However, integrated application of 10 t FYM, 5 t vermicompost, 5t green leaf together with 250 kg neem cake and 150 kg rock phosphate per hectare is optimum for organic ginger production and sustaining soil health. Well rotten cow dung or compost has to be applied either by broadcasting over the beds and incorporating to soil prior to planting or applied in the pits at the time of planting. Application of neem cake at the time of planting helps in reducing the incidence of rhizome rot disease/nematode and increase the yield.

Time schedule of agronomic activities in ginger production

S. No	Activity	Time
1	Collection of dry leaf for mulching and cushioning	Dec-Jan
2	Field preparation and FYM application	Mar-Apr
3	Planting rhizomes on ridges and mulching immediately after planting	Jan-Feb
4	Making drainage channels to drain off the excess water during rain	Mar Apr

5	Removal of weeds and application of additional FYM and manure followed by mulching	May-Jun
6	Application of Bordeaux mixture (1:1:10) at 15 days interval or at the first appearance of initial symptom of bacterial wilt or soft rot	Jul-Sep
7	Water application to be stopped one month before harvest	
8	Harvesting	Oct- Mar

Pest Management

Insects

1. Ginger shoot borer (*Dichocoris punctiferalis*)

Symptoms - Shoot borer is a serious pest of ginger; infestation starts in June and continues till October. The moth lays eggs on the growing bud, petiole or leaf of the young plants. Caterpillar bores through the central shoot of the plant and feeds on the growing buds resulting in withered and dried shoot referred to as 'dead heart'. The presence of a bore hole on the pseudostem through which frass is extruded and the withered and yellow central shoot is a characteristic symptom of pest infestation.

Management

Cultural - Removal and destruction of alternate hosts like castor, cardamom in the immediate vicinity, Roguing and pruning of infested pseudostem during July-August at fortnightly intervals

Biological - Promote predators like *Bracon* sp, *Apanteles taragamae* and parasitoids like *Eriborus* sp., *Friona* Sp, *Agrypone* sp.

Control measures - Apply entomopathogenic nematode *Steinernema carpocopsae* @ 100 IJ/larva or *Hexamermis* sp or Apply *Bacillus thuringiensis* (0.3%) at monthly intervals during July – August or Spraying neem oil or neemgold @ 0.5% during July – October at 21 days interval. Two sprays of Nimbicidine or Neemazal @ 3ml/l at 15 days interval has also been found to be effective against shoot borer.

2. Leaf roller (*Udaspes folus*)

Symptoms - It is an olive green caterpillar with a distinct black head which folds the leaves. Leaf roller folds the leaves and remains inside the fold and defoliates the leaves from the tips and margins. When one portion is completed, it moves and makes another fold.

Control measures – Two sprays of Nimbecidine or Neemazal @ 3ml/l at 15 days interval has also been found to be effective against leaf roller. 2-3 foliar spray of garlic-chilly extract with 2.5% neem oil with soft soap starting from the appearance of pest at an interval of 10-15 days is quite effective.

3. **White grub** (*Holotrichia* spp.)

Symptoms - Sporadic occurrence of white grub occasionally causes up to 75 per cent losses in some areas. The grubs feed on roots and newly formed rhizomes. Pest infestation leads to yellowing of leaves. In severe infestation the pseudostem may be cut at the basal region. The entire crop may be lost in severely infested plantations. The adults of *Holotrichia* spp. commonly occurring are dark brown beetles and measure about 2.5 mm x 1.5 mm in size. The grubs are creamy white and remain in the soil. The adults emerge in large numbers with summer showers during April-May.

Management

Cultural - Mechanical collection and destruction of adults of white grub during their peak period of emergence. Planting of 1.5-2.0 m long fresh branches of *Azadirachta indica* (neem), *Schima wallichii* (chilaune), *Ficus* spp. (nevaro) in the infested areas at the rate of two per hectare daily during the months of June and July. Leaving the land fallow for two consecutive years helped in reducing the pest. Growing of resistant crops such as sunflower also checks the build-up of grub populations. Sowing of trap crops such as sorghum, maize, onion etc. to reduce white grub infestation. Installation of light trap @ /ha and operated during evening hours is very effective in killing the moths.

Control measures - Application of *Beauveria bassiana* or *Metarrhizium anisopliae* mixed with vermicompost or drenching the soil with these entomopathogenic fungi @ 5 g/l gives effective results. Application of aqueous suspension of EPN *Steinernema carpocapsae* with a dosage of 40-50 lakh Infective juveniles/5 l water. Application of EPN *Heterorhabditis* sp @ 50 lah IJ/5 lit of water is also effectively control the pest. Continuous application of EPN builds the native population and helps in managing the pest below ETL



Photo – Ginger leaf roller (left) white grub damage (right)

Diseases

4. Soft rot (*Pythium aphanidermatum*, *P. myriotylum* and *P. vexans*)

Symptoms - The symptom initially appears as water soaked lesions in collar region of pseudostem. The rotting progresses upwards and also downwards damaging the rhizome. The affected pseudostem becomes water soaked and the rotting spreads to the rhizome resulting in soft rot. At a later stage root infection is also noticed. In leaf the symptom starts as yellowing from the tip of lower leaves and progresses upwards to the entire lamina. In early stages, the middle portion of the leaves remain green while the margins become yellow. Yellowing spreads from lower leaves to upper leaves and is followed by drooping, withering and drying of pseudostems

Management

Cultural - Use disease-free, healthy rhizome for planting. Provision of good drainage. Crop rotation. Do not grow ginger in same field for more than 3 years. Mulching of beds with leaves of *Schima wallichii* and *Artemisia vulgaris* will reduce the incidence of disease.

Control measures - Hot water treatment of rhizome at 50-52°C for 30 min. followed by treatment of the rhizome with *Trichoderma viride* @ 8-10 gm/kg seed. Application of FYM and other organic manure to increase the population of beneficial microorganisms. Bio-fumigation with residues of cruciferous crops like

mustard, toria, and rapeseed. Application of neem cake @ 250 kg/ha along with *Trichoderma viride* @ 2.5 kg per hectare, respectively at the time of planting. Drenching with Bordeaux mixture @ 1 per cent or Copper oxychloride @ 0.3 per cent for effective control of the disease.

5. **Bacterial wilt** (*Ralstonia solanacearum*)

Symptoms - Mild drooping and curling of leaf margins of the lower leaves which spreads upwards. Yellowing starts from the lower most leaves and gradually progresses to upper leaves. The wilt progresses upwards, affecting the younger leaves, followed by complete yellowing, inward curling and browning of the entire shoot. Young succulent shoots frequently become soft and completely rotten. These diseased shoots break off easily from the underground rhizome at the soil line. A water-soaked appearance of the central part of the rhizome is common. In advanced infections the entire rhizome becomes soft and rots. A better diagnostic feature is the extensive bacterial ooze that shows as slimy, creamy exudate on the surface of a cut made on the rhizome or on the above-ground stem of an infected plant.

Management

Cultural - Selection of disease-free or healthy seed rhizomes for sowing. Application of FYM and other organic manure to increase beneficial microorganism population in the soil. Selection of well-drained gently slopy field for crop. Flooding the field for 2 or 3 weeks before sowing of ginger rhizome. Rotation of ginger crop with non-host crops like rice, wheat, maize or green manure crops. Solarization of seed rhizomes inside polythene for 2 hours. Biofumigation by growing mustard crop and incorporating the crop residues in to the field at the flowering stage can also suppress the pathogen. Controlling insects and nematodes by suitable organic pesticides because they act as carriers of the pathogen and spread to healthy plants while feeding.

Control measures - Soil amendment with dolomite to increase the pH of the soil. Apply bleaching powder @ 25 kg per ha. Provision of good drainage since water stagnation predisposes the plant to infection. Once the disease is noticed in the field all beds should be drenched with 1 per cent Bordeaux mixture.

6. **Leaf spot** (*Phyllosticta zinziberi*)

Symptoms - Oval to elongated water soaked spots will appear on the leaves. Spots will develop white papery centre and dark brown margin with a yellowish halo surrounding it. The lesions enlarge and adjacent lesions coalesce to form necrotic areas. In severe conditions the leaves become shredded and disfigured.

Management

Growing the crop under partial shade.

Application of Bordeaux mixture @ 1 per cent or copper oxychloride @ 0.3 per cent effectively control the disease.

7. Dry rot / yellows / Fusarium wilt (*Fusarium* spp. and *Pratylenchus* complex)

Symptoms - It is a fungus-nematode complex disease. The disease appears in small patches in field and spreads slowly. Initiates as yellowing of leaves on the margin and gradually the entire leaf blade becomes yellow. Older leaves dry up first followed by younger ones. Plant may show stunting, drooping, wilting, drying. The portion of affected plant will be soft and watery but the plant will not fall on the ground. In advanced stage the rhizome, when cut open, show a brownish ring and is mainly restricted to cortical region. The pseudo stem of the dry rot affected plants does not come off with a gentle pull in contrast to soft rot. A cream to brown discolouration and shriveling can be seen. A white colour growth of mycelium can be seen on the infected stored rhizome. The affected rhizomes are shrunken, dry and are not marketable.

Management

Cultural - Selection of disease free and healthy rhizome for planting. Thick mulching should be provided to check weed growth and to conserve moisture. FYM should be decomposed to avoid white grub infestation. Crop rotation with non-host crops for 3-4 years. Planting should be done on raised bed with proper drainage.

Control measures - Hot water treatment of rhizome at 50-52°C for 30 min. followed by treatment of the rhizome with *Trichoderma viride* @ 8-10 gm/kg seed. Seed treatment and soil application of *Trichoderma viride* and *T. harzianum*. For nematode management *Paecilomyces lilacinus* may also be used along with above biopesticides @ 2.5 kg each/ha mixed with compost/ FYM.

8. Storage diseases

Due to very favourable climatic conditions in North eastern States, ginger under storage is affected by many fungi causing deterioration and subsequent heavy loss. Reports reveal involvement of 32 fungi in storage condition for ginger. All the fungi were not pathogenic but many of them were common saprophytes. In storage, dominance of *Fusarium* spp., *Botryodiplodia theobromae*, *Memnomella echinata* and *Stachybotrys atra* was recorded.

Management

Diseases in storage conditions can be minimized by selecting fully developed and healthy rhizomes free from injuries, insect pests and diseases attack. Rhizome treatment, before storage with mixture of *Pseudomonas fluorescens* and *Bacillus subtilis* @ 10 per cent concentration for 30 minutes dipping and thereafter, drying in shade is helpful to reduce the incidence of the disease in the field. Maintenance of the storage temperature at 13°C and RH 67 per cent is recommended to avoid excessive dehydration and also for longer shelf-life of rhizomes.

Important recommendations for better production

1. Procure ginger seed from the areas/fields where there was no disease incidence.
2. Always use healthy rhizomes for sowing.
3. Always use well-decomposed cow dung manure/FYM/compost in the field.
4. Follow crop rotation of at least 3-4 years.
5. Avoid water-logging in the ginger field.
6. Try to avoid removal of mother rhizomes (*mau*) as it enhances disease intensity.
7. After sowing the rhizomes, cover the beds with dry leaves of *Schima wallichii* (*Chilaune*) / and other suitable organic mulching materials.
8. Keep the field weed free.
9. After every weeding, earthing up should be done. No rhizome should be exposed to directly to sun shine.
10. Suitable intercrop with maize, soybean, French bean, cowpea, and chilli may be practiced.
11. Intercropping with maize will require adequate nutrient supplementation since both are exhaustive crops.
12. Before sowing treat the rhizomes with bio-agents as mentioned in the preceding paras.
13. Take appropriate measures for diseases and pests management.
14. Apply only well-decomposed cow dung compost. If white grub (Khumley) attack is noticed, apply neem cake or *Bacillus thuringensis* or *Metarrhizium anisopliae* @ 3.0 g/l water as soil drench.
15. Select fully mature seed rhizomes for storage free from insects and diseases attack.
16. For the overall management of the insect pests and disease in this hilly state one should Integrated Pest Management (IPM) strategies adopt as a rule. Sikkim is declared as organic state hence, application of chemical to be avoided. Encourage natural bio-control agents and other cultural practices for the management of the insect pest and diseases.
17. Departments / agencies should arrange regular training for the field functionaries and farmers for the adoption and updating on the improved methods of ginger cultivation and plant protection measures.

18. Timely supply of the plant protection inputs to the farmers should be ensured by the State Department agencies.
19. As soon as insect-pest or disease appear farmers should immediately inform the nearest resource / developmental agencies.
20. Local varieties are very promising but their regular cultivation may pose some degeneration problem therefore selection of healthy and bold rhizomes should be mandatory and regular practice.
21. Seed village concept is very good. The Department Officials should select the ginger from fields where no disease is recorded after visiting at least 2-3 times during the growing season to ensure that the crop is healthy.

Harvesting and curing

The crop is ready for harvesting in about 8 to 9 months depending upon the maturity of the variety. When fully mature the leaves turn yellow and the pseudo-stems begin to dry. Rhizomes are lifted either with a digging-fork or with a spade. They are cleaned of roots and adhering soil particles. The removal mother rhizome is practiced by farmers in about 5 months duration of the crop. Such practice increase the incidence of disease in the crops and hence, should be avoided to the extent possible.

The green ginger is soaked in water to facilitate the removal of the skin. The skin is scraped off with pieces of sharpened bamboo. The scraped produce is washed and dried in the sun for 3 or 4 days and hand-rubbed. It is again steeped in water for two hours, dried and then rubbed to remove all the remaining bits of the skin. Sun-drying also bleaches the produce. Peeling should be done with great care and skill. The essential oil which gives ginger the aromatic character is present in the epidermal cells and hence excessive or careless scraping will result in damaging these cells leading to the loss of essential oils. Steel knives are not used as they are found to stain the produce. Storage of dry ginger for longer periods is not desirable. The yield of dry ginger is 15-25 percent of the fresh ginger depending upon the variety and location where the crop is grown. Burning of sulphur for processing ginger is not allowed.

Preservation of seed

The rhizomes to be used as seed material should be preserved carefully. Indigenous practices like spreading layers of leaves of *Glycosmis pentaphylla* being followed by farmers can very well be adopted for this purpose. In order to get good germination, the seed rhizomes are to be stored properly in pits under shade. For seed material, big and healthy rhizomes from disease-free plants are selected immediately after harvest. For this purpose, healthy and disease-free clumps are marked in the field when the crop is 6 - 8 months old and still green. Seed rhizomes are stored in pits of convenient size made in the shed to protect from the sun and rain. Walls of the pits may be coated with cow

dung paste. Seed rhizomes are stored in these pits in layers along with well-dried sand/saw dust (i.e. put one layer of seed rhizomes, then put 2 cm thick layer of sand/saw dust). Sufficient gap is to be left at the top of the pits for adequate aeration. Seed rhizomes in pits need inspection once in twenty days to remove shrivelled and disease affected rhizomes. Seed rhizomes can also be stored in pits dug in the ground under the shade of a tree provided there is no chance for water to enter the pits. In some areas, the rhizomes are loosely heaped over a layer of sand or paddy husk and covered with dry leaves in thatched sheds.

Yield

Ginger become ready for harvesting after 8-9 month of sowing (in the month of December) when the leaves start yellowing and drying. The average yield of ginger rhizome is estimated at about 7 to 12 tonnes per hectare. The recovery of dry ginger varies from 16 - 25 per cent.

Washing and drying

After harvest, the fibrous roots attached to the rhizome should be trimmed off and soil removed by washing. Rhizomes should be soaked in water overnight and then cleaned. Peeling or scraping reduces drying time, thus minimizes mold growth and fermentation. However, scraping process tends to remove some of the oils constituents which are more concentrated in the peel. By removing the external corky skin the fiber content also decreases. After scraping, the rhizomes should be sun dried for a week with frequent turning and well-rubbed by hand to remove the outer skin. This is called as the unbleached ginger. The peeled rhizomes should be repeatedly immersed in 2 per cent lime solution for 6 hours and allowed to dry in the sun for 10 days while the rhizome receive a uniform coating of lime and moisture content should be 8-10 per cent. This is called as bleached ginger which has improved appearance with light bright colour.

Processing

Ginger is an extremely versatile commodity. It can be processed to medical and sweet products. Ginger is processed to give ginger oil, oleoresins, candy, preserves, and ginger powder, starch from sport ginger, ginger brandy wine, beer, medicinal beverages and pastes. Some of the ginger products are drained ginger, syrup ginger, dusted ginger, crystallized ginger, brined ginger, pickled ginger, and dried ginger *etc.* Ginger can be used in a myriad of food product ranging from bakery items to confectionary, beverages, marinades and sources, candies, ice cream and desserts, jams and spreads, prepared foods, health foils and nutraceuticals.