

Ginger (*Zingiber officinale Rosc*) (Family: *Zingiberaceae*) is a herbaceous perennial, the rhizomes of which are used as a spice. India is a leading producer of ginger in the world and during 2006-07 the country produced 3.70 lakh tonnes of the spice from an area of 1.06 lakh hectares. Ginger is cultivated in most of the states in India. However, states namely Kerala, Meghalaya, Arunachal Pradesh, Mizoram, Sikkim, Nagaland and Orissa together contribute 70 per cent to the country's total production.

Climate and soil

Ginger grows well in warm and humid climate and is cultivated from sea level to an altitude of 1500 m above sea level. Ginger can be grown both under rain fed and irrigated conditions. For successful cultivation of the crop, a moderate rainfall at sowing time till the rhizomes sprout, fairly heavy and well distributed showers during the growing period and dry weather for about a month before harvesting are necessary. Ginger thrives best in well drained soils like sandy loam, clay loam, red loam or lateritic loam. A friable loam rich in humus is ideal. However, being an exhausting crop it is not desirable to grow ginger in the same soil year after year.

Varieties

Several cultivars of ginger are grown in different ginger growing areas in India and they are generally named after the localities where they are grown. Some of the prominent indigenous cultivars are Maran, Kuruppampadi, Ernad, Wynad, Himachal and Nadia. Exotic cultivars such as Rio-de-Janeiro have also become very popular among cultivators. The improved varieties of ginger and their salient features are given in Table 1 and Table 2.

Season

The best time for planting ginger in the West Coast of India is during the first fortnight of May with the receipt of pre-monsoon showers. Under irrigated conditions, it can be planted well in advance during the middle of February or early March. Burning the surface soil and early planting with the receipt of summer showers results in higher yield and reduces disease incidence.

Table 1. Improved varieties of ginger

Variety	Fresh mean yield (t/ha)	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	Essential oil (%)
1 IISR- Varada	22.6	200	20.7	4.5	6.7	1.8
2 Suprabha	16.6	229	20.5	4.4	8.9	1.9
3 Suruchi	11.6	218	23.5	3.8	10.0	2.0
4 Suravi	17.5	225	23.5	4.0	10.2	2.1
5 Himagiri	13.5	230	20.6	6.4	4.3	1.6
6 IISR Mahima	23.2	200	23.0	3.2	4.4	1.7
7 IISR Rejatha	22.4	200	19.0	4.0	6.3	2.3

Source of planting material

Sl. nos. 1, 6 and 7: IISR Experimental Farm, Peruvannamuzhi - 673 528, Kozhikode District, Kerala.

Sl. nos. 2, 3 and 4: High Altitude Research Station, Orissa University of Agriculture and Technology, Pottangi, 764 039, Orissa.

Sl. No. 5: Y.S. Parmar University of Horticulture and Forestry, Nauni-solar, Himachal Pradesh - 173 230.

Table 2. Local cultivars/land races of ginger

Cultivar	Fresh mean yield (t/ha)	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	Essential oil (%)
China	9.50	200	21.0	3.4	7.0	1.9
Assam	11.78	210	18.0	5.8	7.9	2.2
Maran	25.21	200	20.0	6.1	10.0	1.9
Himachal	7.27	200	22.1	3.8	5.3	0.5
Nadia	28.55	200	22.6	3.9	5.4	1.4
Rio-de-Janerio	17.65	190	20.0	5.6	10.5	2.3

Land Preparation

The land is to be ploughed 4 to 5 times or dug thoroughly with receipt of early summer showers to bring the soil to fine tilth. Beds of about 1 m width, 15 cm height and of convenient length are prepared with an inter-space of 50 cm in between beds. In the case of irrigated crop, ridges are formed 40 cm apart. In areas prone to rhizome rot disease and nematode infestations, solarization of beds for 40 days using transparent polythene sheets is recommended.

Planting

Ginger is propagated by portions of rhizomes known as seed rhizomes. Carefully preserved seed rhizomes are cut into small pieces of 2.5-5.0 cm length weighing 20-25 g each having one or two good buds. The seed rate varies from region to region and with the method of cultivation adopted. In Kerala, the seed rate varies from 1500 to 1800 kg/ha. At higher altitudes the seed rate may vary from 2000 to 2500 kg/ha. The seed rhizomes are treated with mancozeb 0.3% (3 g/L of water) for 30 minutes, shade dried for 3-4 hours and planted at a spacing of 20-25 cm along the rows and 20-25 cm between the rows. The seed rhizome bits are placed in shallow pits prepared with a hand hoe and covered with well rotten farm yard manure and a thin layer of soil and leveled.

Manuring

At the time of planting, well decomposed cattle manure or compost @ 25-30 tonnes/ha has to be applied either by broadcasting over the beds prior to planting or applied in the pits at the time of planting. Application of neem cake @ 2 tonnes/ha at the time of planting helps in reducing the incidence of rhizome rot disease/ nematode and increasing the yield.

The recommended dose of fertilizer for ginger is 75 kg N, 50 kg P₂O₅ and 50 kg K₂O per ha. The fertilizers are to be applied in split doses (Table 3). The beds are to be earthed up, after each top dressing with the fertilizers. In zinc deficient soils basal application of zinc fertilizer up to 6 kg zinc/ha (30 kg of zinc sulphate/ha) gives good yield.

Table 3. Fertilizer schedule for ginger (per ha)

Fertilizer	Basal application	After 45 days	After 90 days
N	-	37.5 kg	37.5 kg
P ₂ O ₅	50 kg	-	-
K ₂ O	-	25 kg	25 kg
Compost/ Cowdung	25-30 tonnes	-	-
Neem cake	2 tonnes	-	-

Mulching

Mulching the beds with green leaves/organic wastes is essential to prevent soil splashing and erosion of soil due to heavy rain. It also adds organic matter to the soil, checks weed emergence and conserves moisture during the latter part of the cropping season. The first mulching is done at the time of planting with green leaves @ 10-12 tonnes/ha. Mulching is to be repeated @ 7.5 tonnes/ha at 45 and 90 days after planting, immediately after weeding, application of fertilizers and earthing up.

Inter Cultivation

Weeding is done just before fertilizer application and mulching; 2-3 weedings are required depending on the intensity of weed growth. Proper drainage channels are to be provided when there is stagnation of water.

Earthing up is essential to prevent exposure of rhizomes and provide sufficient soil volume for free development of rhizomes. It is done at 45 and 90 days after planting immediately after weeding and application of fertilizers.

Crop rotation and mixed cropping

Crop rotation is generally followed in ginger. The crops most commonly rotated with ginger are tapioca, ragi, paddy, gingelly, maize and vegetables. In Karnataka, ginger is also mixed cropped with ragi, red gram and castor. Ginger is also grown as an intercrop in coconut, arecanut, coffee and orange plantations in Kerala and Karnataka. However, crop rotation using tomato, potato, chillies, brinjal and peanut should be avoided, as these plants are hosts for the wilt causing organism, *Ralstonia solanacearum*.

Plant protection

Diseases

Soft rot

Soft rot is the most destructive disease of ginger which results in total loss of affected clumps. The disease is soil-borne and is caused by *Pythium aphanidermatum*. *P. vexans* and *P. myriotylum* are also reported to be associated with the disease. The fungus

multiplies with build up of soil moisture with the onset of south west monsoon. Younger sprouts are the most susceptible to the pathogen. The infection starts at the collar region of the pseudo stem and progresses upwards as well as downwards. The collar region of the affected pseudo stem becomes water soaked and the rotting spreads to the rhizome resulting in soft rot. At a later stage root infection is also noticed. Foliar symptoms appear as light yellowing of the tips of lower leaves which gradually spreads to the leaf blades. In early stages of the disease, the middle portion of the leaves remain green while the margins become yellow. The yellowing spreads to all leaves of the plant from the lower region upwards and is followed by drooping, withering and drying of pseudo stems.

Treatment of seed rhizomes with mancozeb 0.3% for 30 minutes before storage and once again before planting reduces the incidence of the disease. Cultural practices such as selection of well drained soils for planting is important for managing the disease, since stagnation of water predisposes the plant to infection. Seed rhizomes are to be selected from disease free gardens, as the disease is also seed borne. Application of *Trichoderma harzianum* along with neem cake @ 1 kg/bed helps in preventing the disease. Once the disease is located in the field, removal of affected clumps and drenching the affected and surrounding beds with mancozeb 0.3% checks the spread of the disease.

Bacterial wilt

Bacterial wilt caused by *Ralstonia solanacearum* Biovar-3 is also a soil and seed borne disease that occurs during south west monsoon. Water soaked spots appear at the collar region of the pseudo stem and progresses upwards and downwards. The first conspicuous symptom is mild drooping and curling of leaf margins of the lower leaves which spread upwards. Yellowing starts from the lowermost leaves and gradually progresses to the upper leaves. In the advanced stage, the plants exhibit severe yellowing and wilting symptoms. The vascular tissues of the affected pseudo stems show dark streaks. The affected pseudo stem and rhizome when pressed gently extrudes milky ooze from the vascular strands. Ultimately rhizomes rot.

The cultural practices adopted for managing soft rot are also to be adopted for bacterial wilt. Seed rhizomes must be taken from disease free fields for planting. The seed rhizomes may be treated with Streptocycline 200 ppm for 30 minutes and shade dried before planting. Once the disease is noticed in the field all beds should be drenched with Bordeaux mixture 1% or copper oxychloride 0.2%.

Leaf spot

Leaf spot is caused by *Phyllosticta zingiberi* and the disease is noticed on the leaves from July to October. The disease starts as a water soaked spot and later turns as a white spot surrounded by dark brown margins and yellow halo. The lesions enlarge and adjacent lesions coalesce to form necrotic areas. The disease spreads through rain splashes during intermittent showers. The incidence of the disease is severe in ginger grown under exposed conditions. The disease can be controlled by regular spraying of Bordeaux mixture 1% or mancozeb 0.2%.

Nematode pests

Root knot (*Meloidogyne* spp.), burrowing (*Radopholus similis*) and lesion (*Pratylenchus* spp.) nematodes are important nematode pests of ginger. Stunting, chlorosis, poor tillering and necrosis of leaves are the common aerial symptoms. Characteristic root galls and lesions that lead to rotting are generally seen in roots. The infested rhizomes have brown, water soaked areas in the outer tissues. Nematode infestation aggravates rhizome rot disease. The nematodes can be controlled by treating infested rhizomes with hot water (50°C) for 10 minutes, using nematode free seed rhizomes and solarizing ginger beds for 40 days. In areas where root knot nematode population is high, the resistant variety IISR-Mahima may be cultivated. *Pochonia chlamydosporia*, a nematode biocontrol agent can be incorporated in ginger beds (20 g/bed at 10⁶ cfu/g) at the time of sowing.

Insect pests

Shoot borer

The shoot borer (*Conogethes punctiferalis*) is the most serious pest of ginger. The larvae bore into pseudostems and feed on

internal tissues resulting in yellowing and drying of leaves of infested pseudostems. The presence of a bore-hole on the pseudo stem through which frass is extruded and the withered and yellow central shoot is a characteristic symptom of pest infestation. The adult is a medium sized moth with a wingspan of about 20 mm; the wings are orange-yellow with minute black spots. Fully grown larvae are light brown with sparse hairs. The pest population is higher in the field during September-October.

The shoot borer can be managed by spraying malathion (0.1%) at 21 day intervals during July to October. The spraying is to be initiated when the first symptom of pest attack is seen on the top most leaves on the pseudostem. An integrated strategy involving pruning and destroying freshly infested pseudostems during July-August (at fortnightly intervals) and spraying malathion (0.1%) during September-October (at monthly intervals) is also effective against the pest.

Rhizome scale

The rhizome scale (*Aspidiella harti*) infests rhizomes in the field (at later stages) and in storage. Adult (female) scales are circular (about 1 mm diameter) and light brown to grey and appear as encrustations on the rhizomes. They feed on sap and when the rhizomes are severely infested, they become shriveled and desiccated affecting its germination. The pest can be managed by treating the seed material with quinalphos (0.075%) (for 20-30 minutes) before storage and also before sowing in case the infestation persists. Severely infested rhizomes are to be discarded before storage.

Minor pests

Larvae of leaf roller (*Udaspes folus*) cut and fold leaves and feed from within. The adults are medium sized butterflies with brownish black wings with white spots; the larvae are dark green. A spray with carbaryl (0.1%) or dimethoate (0.05%) may be undertaken when the infestation is severe.

Root grubs occasionally feed on tender rhizomes, roots and base of pseudostems causing yellowing and wilting of shoots. The pest can be controlled by drenching the soil with chloropyrifos (0.075%).

Organic Production

Conversion plan

For certified organic production of ginger, at least 18 months the crop should be under organic management *ie.* only the second crop of ginger can be sold as organic. The conversion period may be relaxed if the organic farm is being established on a land where chemicals were not previously used, provided sufficient proof of history of the area is available. It is desirable that organic method of production is followed in the entire farm; but in the case of large extent of area, the transition can be done in a phased manner for which a conversion plan has to be prepared.

Ginger as a best component crop in agri-horti and silvi-horti systems, recycling of farm waste can be effectively done when grown with coconut, arecanut, mango, *Leucaena*, rubber etc. As a mixed crop it can also be grown or rotated with green manure/ legumes crops or trap crops enabling effective nutrient built up and pest or disease control. When grown in a mixed cultivation system, it is essential that all the crops in the field are also subjected to organic methods of production.

In order to avoid contamination of organically cultivated plots from neighboring non-organic farms, a suitable buffer zone with definite border is to be maintained. In smallholder groups, where the holdings are contiguous, the isolation belt is needed at the outer periphery of the entire group of holdings. Ginger grown on this isolation belt cannot be treated as organic. In sloppy lands adequate precaution should be taken to avoid the entry of run off water and chemical drift from the neighboring farms. Proper soil and water conservation measures by making conservation pits in the interspaces of beds across the slope have to be followed to minimize the erosion and runoff. Water stagnation has to be avoided in the low lying fields by taking deep trenches for drainage.

Management practices

For organic production, traditional varieties adapted to the local soil and climatic conditions that are resistant or tolerant to diseases, pests and nematode infection should be used. All crop residues

and farm wastes like green loppings, crop residues, grasses, cow dung slurry, poultry droppings etc. available on the farm can be recycled through composting, including vermicomposting so that soil fertility is maintained at high level. No synthetic chemical fertilizers, pesticides or fungicides are allowed under organic system. Farmyard manure may be applied @ 25-30 t/ha along with vermi compost @ 5 t/ha and mulching with green leaves @ 12-15 t/ha at 45 days intervals. Based on soil test, application of lime/dolomite, rock phosphate and wood ash may be done to get required quantity of phosphorus and potassium supplementation. When the deficient conditions of trace elements become yield limiting, restricted use of mineral/chemical sources of micronutrients by soil application or foliar spray are allowed as per the limits of standard setting or certifying organizations. Further, supplementation of oil cakes like neem cake (2 t/ha), composted coir pith (5 t/ha) and suitable microbial cultures of *Azospirillum* and phosphate solubilizing bacteria will improve the fertility and yield.

Use of biopesticides, biocontrol agents, cultural and phytosanitary measures for the management of insect pests and diseases forms the main strategy under organic system. Integrated strategy involving pruning and destroying freshly infested shoots during July-August (at fortnightly intervals) and spraying Neemgold 0.5% or neem oil 0.5% during September-October (at 21 day intervals) or Dipel (formulation of *Bacillus thuringiensis*) 0.3% during July to October is effective against the shoot borer.

Selection of healthy rhizomes, soil solarization and incorporation of *Trichoderma*, seed treatment and soil application of biocontrol agents like *Trichoderma* or *Pseudomonas* multiplied in suitable carrier media such as coir pith compost, well rotten cow dung or quality neem cake may be done at the time of sowing and at regular intervals to keep the rhizome rot disease in check. To control other foliar diseases spraying of Bordeaux mixture 1% may be done restricting the quantity to 8 kg copper per hectare per annum. Application of quality neem cake mentioned earlier along with the bioagents *Pochonia chlamydosporia* will be useful to check the nematode population.

Certification

Certification and labeling is usually done by an independent body to provide a guarantee that the production standards are met. Govt. of India has taken steps to have indigenous certification system to help small and marginal growers and to issue valid organic certificates through certifying agencies accredited by APEDA. The inspectors appointed by the certification agencies will carry out inspection of the farm operations through records maintained and by periodic site inspections. Documentation of farm activities is must for acquiring certification especially when both conventional and organic crops are raised. Group certification programmes are also available for organized group of producers and processors with similar production systems located in geographical proximity.

Harvesting and curing

The crop is ready for harvest in about 8 months after planting when the leaves turn yellow, and start drying up gradually. The clumps are lifted carefully with a spade or digging fork, and the rhizomes are separated from the dried up leaves, roots and adhering soil.

For preparing vegetable ginger, harvesting is done from sixth month onwards. The rhizomes are thoroughly washed in water and sun-dried for a day.

For preparing dry ginger, the produce (harvested after 8 months) is soaked in water for 6-7 hours. The rhizomes are then rubbed well to clean the extraneous matter. After cleaning, the rhizomes are removed from water and the outer skin is removed with bamboo splinters having pointed ends. Deep scraping may be avoided to prevent damage of oil cells which are just below the outer skin. The peeled rhizomes are washed and dried in sun uniformly for 1 week. The dry rhizomes are rubbed together to get rid of the last bit of skin or dirt. The yield of dry ginger is 19-25% of fresh ginger depending on the variety and location where the crop is grown.

Fresh ginger (with relatively low fibre) harvested at 170-180 days after planting can be used for preparing salted ginger. Tender

rhizomes with a portion of the pseudostem may be washed thoroughly and soaked in 30% salt solution containing 1% citric acid. After 14 days it is ready for use and can be stored under refrigeration.

Storage of Seed rhizomes

In order to obtain good germination, the seed rhizomes are to be stored properly in pits under shade. For seed material, bold 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. The seed rhizomes are treated with a solution containing quinalphos 0.075% and mancozeb 0.3% for 30 minutes and dried under shade. The seed rhizomes are stored in pits of convenient size in sheds. The walls of the pits may be coated with cow dung paste. The seed rhizomes are placed in pits in layers along with well dried sand/saw dust (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. The pits can be covered with wooden planks with one or two small openings for aeration. The seed rhizomes in the pits may be checked once in about 21 days by removing the plank and shriveled and disease affected rhizome are to be removed. The seed rhizomes can also be stored in pits dug in the ground under shade. Storage in saw dust + dried leaves of *Strychnos nuxvomica* also prevents infestation of rhizome scale.



Ginger



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