PRODUCTION OF QUALITY PLANTING MATERIAL OF GINGER

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Ginger (*Zingiber officinale*), a native of tropical South East Asia, is mainly cultivated in tropical and subtropical countries (Table 1). Ginger grows well in warm humid climate, up tp 1500 m above mean-seal-level, both under rainfed and irrigated conditions. For successful cultivation a moderate rainfall at sowing time till the rhizome sprouts, a well distributed rainfall during growing period and dry weather for one month before harvesting are necessary. A wide range of soils with good drainage and aeration are suitable for ginger cultivation.

India is the largest producer of dry ginger in the world, contributing about 30% of the total world production. It is cultivated in almost all states in India. The maximum area being under ginger cultivation in Kerala followed by Orissa. Kerala and Meghalaya contribute about 50,000 tonnes each in the production (Table 1).

Table 1. Area, production and productivity of ginger in major ginger-growing states in India (1998-99)

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ ha)	Major producing centres/districts
Kerala	14.57	49.95	3428	Wynad, Eranakulam, Idukki, Kozhikode, Kottayam, Pattanamthitta, Quilon, Cannanore, Palghat, Kasaragode, Malappuram, Trichur, Alleppy
Orissa	13.52	26.91	1990	Koraput, Phulbani, Sambalpur, Cuttack, Mayurbhanj, Balasore, Sundargarh, Dhenkanal, Ganjam, Keomjhar, Kalahandi, Puri, Bolangir.
Arunachal Prades	4.34	31.09	7164	Anini, Dibangualley
Meghalaya	9.55	49.06	5137	West Garo, East Garo
West Bengal	9.40	18.84	2004	Darjeeling, Jalpaiguri, Midnapur East, Birbhum, Midnapur West, Cooch-Behar, Murshida bad, Purulia, 24-parganas (North), Nadia, Burdwan, Malda, 24 Parganas (South), Bankura.
Mizoram	4.10	20.50	5000	Aizwal West, Aizwal East
Sikkim	2.49	4.32	1734	Sikkim
Himachal Pradesh	1.81	0.87	481	Sirmaur, Solan, Shimla, Sirmour, Mandi, Bilaspur, Kangra, Chamba, Hamirpur

Source: Johny and Ravindran (2002)

Mizoram is one of the important states ginger-growing state and contributing a major share to the states economy. Among different agricultural and horticultural crops grown in Mizoram, ginger gives highest revenue for the state (Table 2). In 1999-2000, the state received around Rs12 crore from ginger alone. Thinglaidum (local) and Nadia are most popular cultivars in Mizoram.

Table 2. Production of spices in Mizoram (2000-2001)

Spice	Production (tonnes)	Area (ha)	Productivity (tones/ha)
Ginger	25,377	5130	7 to 8
Turmeric	2,915	320	7 to 8
Chilli	1,819	1460	1 to 1.5
Onion	252	128	1.5 to 2.0
Garlic	71	36	1.5-2
Black pepper	7.5	25	0.3

Source: Report on Spices Production in Mizoram

More than 90% of spices produced in the country are consumed domestically leaving only 10% for export. Indian dry ginger is known in the export market as Cochin ginger and Calicut ginger. Indian ginger is only next to Jamaican ginger in quality, which is considered to be the best in the world market. The export of ginger for the recent years is presented in Table 4. Ginger in different forms is exported from India. India is exporting ginger mainly to Pakistan, Bangladesh, Saudi Arabia, U.A.E., Morocco, USA etc. Major competitors are China, Nigeria and Thailand.

Though India tops the list in total production of ginger, its productivity is considerably low compared to China and other ginger- producing countries (Table 3).

Table 3. Average and potential yield in ginger in India

Average yield (kg/ha)	Progressive farmer (kg/ha)	Potential yield (kg/ha)	Production constraints
2,421	5,500	8,250	Rhizome rot and Bacterial wilt diseases, insect pests such as rhizome scales

Several biotic and abiotic factors are responsible for low yields in ginger. Among biotic factors, diseases, plant parasitic nematodes and insect pests both in field and storage, are important which affect yield and quality of ginger. Many diseases that affect ginger are seed borne. Besides, several insect pests damage the rhizomes in storage reducing the quality and viability of the seed materials. Therefore, good quality seed material is a major requirement in increasing its yield.

Production of Quality Planting Material

Availability of adequate quantity of quality planting material is a major step in increasing the production of ginger. The demand for seed rhizome is increasing every year as area under its cultivation on is also increasing. The estimated requirement of planting material of ginger during the Tenth Five-Year Plan is given in Table 4.

Table 4. Estimated quality planting material required during Tenth Plan

Year	Planting material (tonnes)
2002-03	4,888.8
2003-04	5,287.8
2004-05	5,287.8
2005-06	5,499.2
2006-07	5,719.0
Total	**26,479.0**

Several technologies have been developed for the production of quality ginger which includes cultivation practices, varieties for different quality traits, management of pests and diseases and harvesting and post harvesting processing.

Cultivars/varieties

Several cultivars, indigenous as well as exotic are grown in different ginger growing areas in India (Tables 5,6 and 7). Exotic varieties available are Rio-de-Janeiro, Bangkok, China, Jamaica, Sierra Leone and Taiwan. Of them, Rio-de-Janeiro is very popular in Kerala and its adjoining areas.

Table 5. Important cultivars of ginger

Cultivar	Specific features of rhizome
Assam	Bold, highly flavoured, pungent, high fibre
Burdwan-1	Bold, highly flavoured, pungent, high fibre
Ernad Chernad	Bold, highly flavoured, pungent, high fibre
Gurubathan	Bold, buff skin, flavoured, pungent and fibrous
Himachal Pradesh	Bold, lemon-flavored and fibrous
Jorhat	Bold, pungent, highly flavoured and fibrous
Karakkal	Bold, buffed skin, pungent, flavoured and less fibrous
Kuruppampadi	Bold, pungent, flavoured and fibrous. Used as green and dry
Manamthodi	Bold, pungent, flavoured and fibrous
Maran	Bold, pungent, flavoured and fibrous
Nadia	Slender, pungent, lemon flavoured and less fibrous
Narasapattam	Bold, buffed skin, pungent, flavoured and less fibrous
Poona	Bold, buff skin, flavoured and less fibrous
Taffingiva	Extra bold, yellowish white skin, pungent, flavoured and less fibrous
Thinladium	Bold, buff skin, pungent, flavoured and fibrous.
Thingpuri	Slender, whitish gray skin, slightly pungent, flavoured and less fibrous
Tura	Slender, pungent, flavoured and fibrous.
Uttar Pradesh	Bold, buff skin, pungent, flavoured and fibrous.
Valluvanad	Slender, pungent, flavoured and fibrous.
Wynad local	Bold, buff skin, pungent, flavoured and less fibrous.
Wynad Kunnamangalam	Bold, pungent and flavourous.

Source: Mohanty and Panda (1994)

Table 6. Cultivars popular in major ginger-growing states

State	Popular cultivars
Kerala	Maran, Manathody, Wynad local, Eranad, Chernad, Kuruppampadi, Thodupuzha local, Nadia, Valluvanad
Meghalaya	Lakhadong, Garubathan, Assam, China, Maran (Moran), Nadia, Rio-de-Janeiro, Thingpuri, Poona, Wynad local
Karnataka	Maran, Barasapatam, Manathody, Karakkal, Narasapattam, Thaiguppa, Wynad local
Orissa	Suprabha, Suruchi, Suravi, Kuruppampadi, Anamika, Bhitarkatta, Daring badi, Junagarh, Kunduli local, Kotagarh, Laxmipur, Raikia, Thingpuri, Vengar
Himachal Pradesh	Narag, SG-666, Himachal Pradesh, Dharija local, Himgiri
Andhra Pradesh	Medak, Tuni, Kandhaght local, Narasapatam
West Bengal	Garubathan, Malli, Maran, Sambak-A, Thingpuri, Tura, Taruk Sadan, Burdman
Arunachal Pradesh	Shillong local
Mizoram	Maran, Rio-de-Janeiro, Thingladium.
Manipur	Shing Shingtam, Thingladium.
Meghalaya	China, Maran, Nadia, Rio-de-Janeiro, Thingpuri, Poona, Wynad local, Sikkim, Garubathan, Nadia, Rio-de-Janeiro, Sikkim selection,
Assam	Maran, Nadia, Thingpuri, Jorhat, Thingladium
Bihar	Darbhanga desi
Maharashtra	Satara local

Source: Johny and Ravindran (2002)

Seven ginger varieties were released for commercial cultivation. Out of them Suprabha and Suravi were released at national level, and they perform well in hilly areas, drought-prone areas and are suitable for both early and late-sowing. Suprabha having plumpy and flat rhizomes is used for both green and dry ginger. Himgiri is used mainly as a vegetable ginger. Ginger IISR Varada, released from Indian Institute of Spices Research, Calicut is high-yielding, high-quality with less fibre and medium-bold rhizomes. It is popular throughout the country. Ginger, IISR Mahima and IISR Rejatha have also been recommended for release.

Ginger varieties and cultivars vary considerably in yield, dry recovery, fibre and oleoresin contents. Different varieties are identified for various quality traits (Table 7).

Table 7. Ginger cultivars for different quality attributes

Character/trait	Cultivar/ accession
High dry recovery	Tura local –2 (29.7%)
High oleoresin	Assam (9.3%) and Mananthody (9.2%), Rio-de-Janeiro (10.5%), Maran (10.0%) and Wynad Local (9.1%)
High essential oil	Mananthody (2.2%), Karakkal (2.4%), Rio-de-Janeiro (2.3%), Vengara (2.3%) and Valluvanad (2.2%), Acc. Nos. 118 (2.6%), 14 (2.5%), Acc. Nos. 418, 399, 389, 205, 110, 236, 104 and 296 (2.9 - 3.2%), BLP-6, SG-723, BDJR-1054, SG-55 and Maran (2.0 - 2.8%)
Low crude fibre	China (3.4%), UP (3.7%), Himachal Pradesh (3.8%), Nadia (3.9%), Tura (3.5%), Ernad-Chernad (4.43%), Acc. Nos. 287 (3.0%), 288, 22 and 18 (3.2%), Acc. Nos. 419, 386, 415, 200, 110 and 336 (2.2 - 3.3%)
High yield of dry ginger	Rio-de-Janeiro, Maran (3.27 tonnes/ha), Thingpuri (2.79 tonnes/ha), Maran (Av. 4.40 tonnes/ha), Nadia (Av. 3.80 t ha^{-1}), Narasapattam (Av. 3.80 tonnes/ha)
High gingerol and Shogaol	Mizo, Nadia, Maran, Ernad, Chernad, Kada & Narianpara (high gingerol – 22% of oleoresin); Rio-de-Janeiro, Santhing Pin (Manipur-I), PGS-37, S-641, Maran, Erattupetta, Nadan Pulpally, Jorhat Local, PGS-16, Mizo and Nadia (high shogaol – 5% of oleoresin)

To ensure maximum productivity and quality of its produce the crop should be managed properly adopting proper technologies. Various components of management that influence production and quality of the produce.

Planting

The planting time depends on the onset of the monsoon. Studies have shown that planting during April gives better growth and development of rhizomes with less incidence of diseases. Ginger is propagated by planting cuttings of rhizomes. Use of large rhizome bits of 100 g is a common practice. Large rhizome bit gives more number of tillers. However, seed material is a very costly input as it accounts for about 50% of the total cost of production. The optimal size of seed rhizome and spacing recommended for different states are given in Table 8.

Table 8. Seed rate and spacing recommended for different states

State	Recommendation
Kerala	15 g with at least one viable bud, 1500 to 1800 kg/ha, 20 cm X 20 cm to 25 X 25 cm spacing, depth of sowing 4-5 cm.
Orissa	15-20 g having 2-3 healthy buds, 1800 kg/ha 25 X 20 cm spacing, depth of sowing 5 cm
Himachal Pradesh	25-30 g having 2-3 buds, 1800 – 2250 kg ha, 30 X 20 cm spacing.
Bihar	18-20 g with at least 2 buds, 1,800 kg/ha, 25 X 20 cm spacing.
Andhra Pradesh	20-25 g having 2-3 buds, 1700 kg/ha. 30 X 20 cm spacing.

Transplanting has been found feasible in raising ginger crop at Solan (Himachal Pradesh). Though transplanting in ginger is not conventional, it has been observed that transplants raised from seed rhizomes (about 5 g bits) in nursery and planted in field after 60 days with the onset of monsoon after treating with NAA or IBA (1 ppm) enhanced the rhizome yield with a cost:benefit ratio of 1:1.89 and 1:9.4 respectively. Transplanting in ginger though labour intensive and costly it helps in reducing the rhizome-borne diseases to a great extent.

Mulching

Mulching ginger beds with green leaves is important for incresing the yield. Mulching increases germination, suppresses weeds, increases soil moisture and organic matter as well as conserves soil moisture and prevents soil erosion. The application of farmyard manure @ 15 tonnes/ha and green leaves @ 12 tonnes/ha as mulch in three equal splits, at planting, 45 and 90 days after sowing is ideal.

Green manure

Green manure crops like sunhemp (*Crotalaria juncea)* and daincha (*Sesbania maculata*) can be successfully raised in the interspace of ginger beds in the initial stage of crop growth which provide material for second mulch and also prevent weed growth and enrich soil through N_2 fixation.

Nutritional requirement

Ginger is a high-nutrient consuming crop, therefore application of organic manures and fertilizers is highly essential. Fertilizer requirement of ginger in different states is given in Table 9.

Application of neem cake 2 tonnes/ha together with inorganic fertilizers, resulted in significant increase in availability of nutrients in soil, increased yield and reduced incidence of rhizome rot.

Application of micronutrient increases the yield of ginger. Application of zinc (20 kg/ha), boron (10 kg/ha), Mb (1 kg/ha), Mg (10 kg/ha) and Jagromin (chelated form of micronutrients) along with recommended dose of NPK (100:50:50 kg/ha) result in significant increase in the yield with NPK along with 2 sprays of Jagromin (0.7%), once at rhizome initiation stage and again one month after first spraying.

Weed control

Weeds pose serious problem in ginger cultivation and reduce its yield considerably. The traditional method of hand-weeding is the common practice. Weeding should be done just before fertilizer application. About 2-3 weedings are required depending on the intensity of weed growth. In the studies

Table 9. Manures and fertilizers recommended for ginger in different states

State	Recommendation
Kerala	FYM 30 tonnes/ha, NPK 70:50:50 kg/ha. Full dose of P and 50% K may be applied as basal dose. Half the quantity of N applied at 60 DAS. The remaining quantity of N and K applied at 60 DAS.
Karnataka	FYM/compost 25 tonnes/ha , NPK 100:50:50 kg/ha. Apply the entire dose of P and K at planting. Half quantity of N to be applied at 30-40 DAS and other half at 60-70 DAS.
Orissa	FYM 25 tonnes/ha, NPK 125:100:100 kg/ha. Full P and half K applied as basal dose in furrows before planting and N and K in 2 splits at 45 and 90 DAS.
Himachal Pradesh	FYM 20-30 tonnes/ha, CAN @ 400 kg/ha, NPK 100:50:60 kg ha^{-1}. Apply P and K at the time of planting and N in 3 equal splits, first at the time of planting and subsequent 2 doses at monthly interval. K_2O also can be applied in two splits, half at sowing and other half at rhizome initiation.
Bihar	FYM 20-30 tonnes/ha, NPK @ 60:60:120 kg/ha
Andhra Pradesh	FYM 20-30 tonnes/ha, NPK @ 75:50:50 kg/ha
Chattisgarh	FYM 20-30 tonnes/ha, NPK @ 150:125:125 kg/ha

conducted at Pottangi. Highest fresh ginger yield is obtained with 4 hand-weedings. Atrazin @ 1.5 kg/ha after sowing and before emergence of ginger shoot and one hand-weeding give higher rhizome yield. Pre-sowing application of Stomop @ 2 kg/ha is more effective in reducing weeds compared to Goal @ 0.5 kg/ha.

Harvesting

Fresh and dry yields of rhizomes increasing steadily up to 210 days and remained unchanged afterwards. The quality and quantity of ginger are affected by stage of rhizomes at harvesting. The fibre content after increasing initially, decreases gradually till 210 days. It increases again with rhizome attaining maturity. For vegetable purpose, ginger should be harvested from sixth month onwards. For dry ginger, mature rhizomes are harvested after 8 months. The maximum fresh yield and dry recovery are obtained 225-240 days after sowing. However, harvesting of rhizomes 210 days after planting gives minimum crude fibre with maximum essential oil. Hence harvesting 225-240 days after planting is recommended to get highest oleoresin.

Crop Protection

A number of fungal and bacterial diseases, plant parasitic nematodes and insect pests affect ginger both in field and in storage, yield and quality of seed rhizomes. The pests and pathogens cause severe damage to ginger storage also affecting germination in field.

Rhizome rot/soft rot

Soft rot/rhizome rot is a serious disease of ginger, many times leading to total loss of the crop. A soil-borne disease, it is caused by *Pythium aphanidermatum*. *P. vexans* and *P. myriotylum*. The fungus multiplies with the build up of soil moisture with the onset of South-West monsoon. Young sprouts are most susceptible. Its infection starts at the collar region of pseudostem and progresses upwards

and downwards. The collar region of affected pseudostem becomes water-soaked and rotting spreads to rhizomes resulting in soft rot. At later stage, roots are also infected. Foliar symptoms appear as light yellowing of tips of lower leaves, which gradually spreads to leaf blades. In early stages of disease, the middle portions of leaves remain green while the margins turn yellow. Yellowing spreads to all leaves of plants and is followed by drooping of leaves, withering and drying of pseudostems. management of the disease.

Management

- Select fields having good drainage, follow clean cultivation
- Adapt crop rotation with cereals, oilseeds and millets. Rotate with rice at least once in 3 years wherever irrigation facilities are available
- Heat surface soil by solar energy. Use of optimum pesticides result in 95% rhizome germination, low incidence of rhizome rot (<10%) and increase in yield by 34%.
- Use disease-free, healthy seed rhizomes collected from disease free areas.
- Provide optimum and timely irrigation
- Spread of rhizome rot disease in field can be checked by removing the diseased clumps and subsequently drenching the soil around infected plants with fungicides (blitox 50 @ 300 g/litre of water during August/ September.
- Use biocontrol agents such as *Trichoderma* sp., which increases germination, reducing rhizome rot disease.
- Adopt crop protection measures such as soaking ginger seed rhizomes in fungicides and insecticides before storing.

Bacterial wilt

Bacterial wilt, caused by *Ralstonia solanacearum*, is soil-and seed- borne disease that occurs during South-West monsoon when the crop is in the initial stages of growth. Water-soaked spots appear at the collar region of the pseudostems and progresses both upwards and downwards. The first conspicuous symptom is drooping and curling of leaf margins of the lower leaves which spreads upwards. Yellowing starts from lowermost leaves and gradually progresses to upper leaves. In advanced stage, plants show severe yellowing and wilting symptoms. The affected pseudostem and rhizome when pressed gently exudes milky ooze from vascular strands.

Detection of pathogen in soil is important so as to ascertain its suitability for cultivation of ginger. A protocol was refined for isolation of DNA of the pathogen from soil, which can detect *R. solanacearum* in soil at a concentration of 10^4 cells/g soil using PCR. A simple technique to disinfect seed rhizomes of ginger had been developed at Indian Institute of Spices Research, Calicut. The seed rhizomes are packed in transparent polythene bags and solarized for 2-4 hours during 9.0 A.M to 1.0 P.M in May, before sowing in the field. The heat generated inside the polythene bags during solarization destroys the rhizome-borne bacterial pathogens. The solarized rhizomes can also be stored for one month without affecting germination. However, exposure beyond 2 hours affects firmness of rhizome tissues.

Dry rot and eye rot

These two diseases mostly occur in storage, affect quality of the seed rhizomes severely. *Macrophomina* sp. causes dry rot while *Fusarium* sp. causes eye rot. Due to infestation by these fungi, rhizomes are shrivelled and do not germinate upon sowing in the field.

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 common aerial symptoms. Characteristic root galls and lesions result in rotting of roots and rhizomes. Infested rhizomes show brown water soaked areas in outer tissues. Nematodes survive and multiply during storage affecting the quality of seed rhizomes. Nematode infestation aggravates rhizome rot disease. Nematodes infestation can be avoided using nematode-free seed rhizomes or by treating rhizomes with hot water (50□C for 10 minutes) and solarizing ginger beds for 40 days.

Insect pests

Several insect pests attack ginger both in field and storage. The quality of planting materials is affected by rhizome scales (*Aspidiella hartii*) and cigarette beetle (*Loasioderma serricorne)* in storage. The rhizome scale is a major pest of ginger especially in storage. They feed on sap. When rhizomes are severely infested, they become shrivelled and desiccated affecting germination. The pest can be managed by treating seed material with Quinalphos (0.075%) for 20 minutes before sowing. Severely infested rhizomes should be discarded before storage. Cigarette beetle infestation can be prevented by storing dried rhizomes in dried leaves of *Clerodendron infortunatum* in polypropylene containers.

Seed storage

Seed rhizomes are should be stored properly to obtain good germination. Technology for safe storage of seed rhizomes perfected by AICRPS Centers, Solan and Pottangi. Ginger can be stored in pits of 1 m X 1 m X 1 m size, lined with stones in inner walls and bottom filled with dry sand (10 cm thick). Disease-free rhizomes are selected immediately after harvesting and soaked in mancozeb or bavistin (0.3%) for 30 minutes and also treated with malathion (0.05%) and then dried for 48 hours under shade. These treated rhizomes are placed in pits leaving 10-15 cm space on the top, covered with wooden plank and plastered with cowdung, leaving a small space for aeration.

Zero energy cool chamber, is a double-walled brick structure filled with sand between the walls. The sand is kept moist by frequently watering. This structure is found ideal for storing fresh ginger. The loss in weight of rhizomes is only 23% after storing for 4 months in this chamber, while ginger stored in open conditions is shrunken in 4 months.