

EXPLORATION OF GINGER (*Zingiber officinale* Rosc.) CULTIVATION : A REVIEW

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ABSTRACT : Ginger (*Zingiber officinale* Rosc.) is one of the important spice crop of Asia. India is one of the largest ginger producing country in the world. It is valued for its aroma, flavour and medicinal properties. In India, Kerala, Tamil Nadu and Andhra Pradesh are the major states producing ginger. The productivity of ginger remains low in India due to constraints like diseases and improper management. There is a need to standardize the production technology which may help to improve the yield, quality so as to extend the farmers' hand of reliability so that they can get high net returns per unit area. The present review is focused on production practices of ginger.

Keywords: Ginger, *Zingiber officinale*, production.

Ginger (*Zingiber officinale* Rosc.), a monocotyledonous perennial herb having a respected history as a spice crop, is known to human generation since time immemorial (Anon, 2). It is indigenous to the Indo-China region but is not known to occur in the wild state. India still enjoys the unique position of being the largest producer of ginger in the world. It is valued for its aroma, flavour and medicinal properties. The aroma and flavour of ginger are determined by the composition of its steam volatile oil, which is comprised mainly of sesquiterpene hydrocarbons, monoterpenes hydrocarbons and oxygenated monoterpenes (Zachariah *et al.* 21). More commonly, ginger has been traditionally used in disorders of the gastrointestinal tract, as a stomachic, laxative, sialogogue, gastric emptying enhancer, appetizer, antiemetic, antidyspeptic, antispasmodic, and antiulcer agent with sufficient scientific support. Similarly, ginger has been shown to exhibit anti-inflammatory, hypoglycemic, antimigraine, antioxidant, hepatoprotective, diuretic, hypocholesterolemic, and antihypertensive activities. Recently, ginger has gained wide attention for its therapeutic role as a safe and effective preventive treatment option for nausea and vomiting of pregnancy (Ali and Gilani 1).

It is grown in an area of 1.36 lakh hectares with an average production of 6.83 lakh MT (Anon., 3). It is cultivated extensively in tropical and subtropical regions of the world, from India to Indo-China, the East Indies and parts of China. The other important ginger producing countries in the world are China, Taiwan, Nigeria, Jamaica, Thailand, Australia, Brazil, Japan and Indonesia, Taiwan, Jamaica, and Peru. In India, it is mainly grown in the states of Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, and North-Eastern region. In Karnataka, it is largely

cultivated in Chickmagalur, Hassan, Madikeri, Bidar, Belagavi, Bidar, and Kodagu.

In India Kerala and Tamil Nadu are the major producing countries, there is wide variability for rhizome yield. Hence, there is a need to standardize the production practices to grow the crop economically and produce export quality material. Standardization of production technology may help to improve the yield, quality and net returns per unit area. This may help to promote the cultivation of this crop on commercial scale. In this regard the studies on different aspects of glory lily are reviewed and presented under different headings.

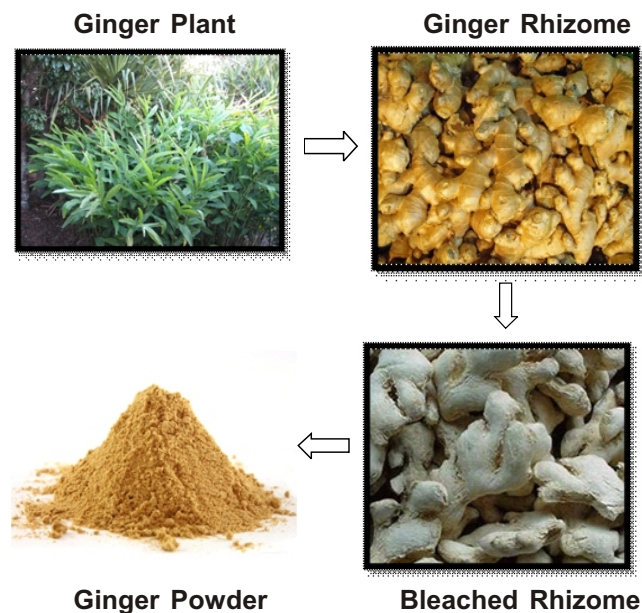


Fig. 1: Different plant parts of ginger

Genotypic evaluation studies

Chongtham *et al.* (7) evaluated 10 varieties of ginger viz, Suprabha, Suruchi, Suravi, V3S1-8, Himgiri, IISR Varada, IISR Mahima, IISR Rejatha, Gorubathan (local cv.), and Sambuk (local cv.) among the different varieties indicated that Gorubathan as the most promising germplasm in terms of growth and yield. The yield attributes like length of primary fingers (2.28 cm), diameter of secondary fingers (1.95 cm), and rhizome yield per plant (0.201 kg) were highest with Gorubathan. The projected fresh yield was maximum (18.27 t ha⁻¹) in Gorubathan.

Rajyalaksmni and Umajyothi (16) conducted an experiment at Agricultural Research Station, Seethampeta, Srikakulam District of Andhra Pradesh for two years during kharif 2007–08 and 2008–09 with eight genotypes viz., Suprabha, V1S1-2, Z-Local, ACC-117, V1S1-8, Varada, ACC-35 and Chintapalli local. The variety Suprabha was taller (50.60 cm) and recorded more number of leaves (18.87/plant), tillers plant⁻¹ (10.07) and number of finger rhizomes plant⁻¹ (11.67). It produced significantly more fresh rhizome yield of 21.71 t ha⁻¹ than all the other the varieties tested. Number of tillers plant⁻¹, number of mother and finger rhizomes plant⁻¹ and fresh rhizome yield showed high GCV, PCV, heritability and genetic advance as per cent mean. The simple correlation studies indicated that number of tillers plant⁻¹, number of mother and finger rhizomes plant⁻¹ recorded highly significant association with yield.

Palai and Rout (14) studied the identification and genetic variation within eight high yielding varieties of ginger through RAPD markers. A total of 55 distinct DNA fragments ranging from 0.5–2.4 Kb were amplified by using twelve selected primers. The cluster analysis indicated that the eight varieties formed two major clusters. The first major cluster had only one variety 'S-558' with 43% similarity with other seven varieties. Second major cluster having seven varieties and divided into two minor clusters. One minor cluster had six varieties ('Jugijan', 'Turia local', 'Nadia', 'Zo 17', 'Nahfrey' and 'Gurubathan) and other having only one variety 'Surabhi'. The second minor cluster further divided into two sub-minor clusters. 'Nadia' and 'ZO-17' had 78% similarity among themselves and 70% similarity with 'Jugijan' and 'Turia local'. 'Jugijan' and 'Turia local' were having 81% similarity among themselves. However, 'Nahfrey' had 64% similarity with 'Jugijan', 'Turia local', 'Nadia' and

'ZO-17'. The present study showed the distant variation within the varieties. This investigation will help to breeders for ginger improvement program.

Sasikumar *et al.* (16) studied the one hindered collection of ginger evaluated for variability and character association of traits the result revealed that plant height, leaf number, tiller number, leaf length and width, days to maturity, dry recovery as well as rhizome yield per plant revealed good variability for tiller number and rhizome yield. Plant height, leaf number, tiller number as well as length and width of leaves had positive significant association with rhizome yield. Plant height followed by leaf length, had maximum direct effects on rhizome yield.

In vitro propagation studies

Biruk *et al.* (6) studied assessing the potential of axillary buds and shoot tips as explant sources and determination of suitable growth regulators for *in vitro* propagation of two ginger cultivars. Murashige and Skoog (MS) medium with four levels of benzyl adenine (BA) and kinetin was used for shoot multiplication in combination with two explant sources. A highly significant difference ($p < 0.0001$) was observed between explant sources and among growth regulators for shoot multiplication. From this study, it was found that shoot tip explants on 2 mg l⁻¹ BA and 1 mg l⁻¹ kinetin was found to be better than other explant-media combinations which gave an average of 7 shoots per explant within six weeks of culture. Consecutively, the plantlets developed an average of 8.75 roots within four weeks of culture period and performed well in acclimatization and subsequently in the field.

Twenty-eight different treatment combinations of benzylaminopurine (BAP) and naphthalene acetic acid (NAA) incorporated into Murashige and Skoog (M S) medium were evaluated (Nkere and Mbanaso, 13) for optimal media composition for ginger micropropagation. The combination of 0.05 mg l⁻¹ NAA and 4.0 mg l⁻¹ BAP resulted the highest shoot regeneration rate of 4.25. Considering the performance of the shoot tip explants in media and the need to lower the cost of micropropagation, the combination of 0.05 mg l⁻¹ NAA and 1.0 mg l⁻¹ BAP) with 80 per cent explants survival was found an appropriate concentration of growth regulators in media composition for ginger propagation.

Clonal propagation of ginger (*Zingiber officinale*) cv. Varada was achieved by *in vitro* culture using buds from rhizome in storage on a medium

consisting of Murashige Skoog, major and Nitch minor elements and vitamins, sucrose, BAP (benzyladenine) and NAA. (Shirsat *et al.*, 19). M S medium was most suitable when supplemented with 2.5 ppm BAP and 0.1 ppm NAA for shooting and rooting.

An efficient, simple micropropagation method was developed for *Zingiber officinale* Rosc (cv, Suprava and Suruchi) using fresh rhizome sprouting bud in semisolid culture media (Behera and Sahoo, 4). Explants were cultured on Murashige and Skoog's (MS) medium supplemented with different concentrations and combinations of BAP (6-benzyl-aminopurine) and NAA (alpha-naphthalene acetic acid) for shoot and root induction. Explants cultured on MS basal medium supplemented with 2.0 mg/l BAP+0.5 mg/l NAA showed highest rate of shoot multiplication. In vitro shoots were rooted on to the half strength MS basal medium supplemented with 2.0 mg/l NAA and rooting was better. Rooted shoots were transplanted in the green house for hardening and their survival was 95% in the field condition.

Nutritional studies

Tiwari *et al.* (20) conducted an experiment in split plot design with four dates of planting (first fortnight of May (D₁), second fortnight of May (D₂), first fortnight of June (D₃) and second fortnight of June (D₄) in main plots, four fertility levels (NPK @ 0:0:0 kg ha⁻¹ (F₀), NPK @ 125:25:30 kg ha⁻¹ (F₁), NPK @ 150:50:60 kg ha⁻¹ (F₂) and NPK @ 175:75:90 kg ha⁻¹ (F₃) in sub plots and two varieties Rajendra Haldi-5 (V₁) and Rajendra Sonia (V₂) in ultimate plots. Yield attributes *i.e.* weight of primary, secondary and mother rhizomes, number of primary and secondary rhizomes, fresh rhizome yield clump⁻¹ and yield ha⁻¹ were found to be significantly higher when planted during first fortnight of June. Fertility levels imparted significant effect on plant height, number of tillers clump⁻¹, weight of primary, secondary and mother rhizomes, length of mother rhizome, number of primary and secondary rhizomes, fresh weight of rhizome clump⁻¹ and yield. These parameters were significantly higher in F₂. Among the varieties, Rajendra Sonia performed better with regard to plant height, number of tillers clump⁻¹, weight of mother, primary and secondary rhizomes, length of mother rhizomes, number of primary and secondary rhizomes, fresh rhizome weight clump⁻¹ and yield. Among the interactions, Rajendra Sonia supplied with NPK @ 175:75:90 kg ha⁻¹ produced higher yield and

was at par with NPK @ 150:50:60 kg ha⁻¹ + Rajendra Sonia.

By assessing the effect of different organic manures on the performance of ginger cv. Humnabad (Sharathpal *et al.*, 18), higher growth, yield and quality attributes were observed in the treatment receiving FYM (25 t ha⁻¹) along with recommended dose of fertilizer (RDF) (100:50:50 kg NPK ha⁻¹) followed by poultry manure (5 t ha⁻¹) along with RDF. Among the treatments, significantly higher fresh rhizome yield was recorded in FYM + RDF (16.52 t ha⁻¹) followed by poultry manure (5 t ha⁻¹) + RDF (16.23 t ha⁻¹) and press mud (10 t ha⁻¹) + RDF (15.47 t ha⁻¹). Net returns per ha ranged between ₹ 1.30 lakh (FYM+RDF) and ₹ 0.48 lakh (Neem cake @ 2 t ha⁻¹).

Hamza *et al.* (9) studied the variation in quality and oil composition of ginger due to incorporation of Zn in the fertilizer schedule. They found that application of Zn increased the fresh yield of ginger from 7.72 to 9.57 kg 3m⁻² indicating an increase of 23%. Zinc application also increased the oil, oleoresin, β-sesquiphellandrene, farnesene, camphene and Z-citral contents of ginger oil.

Modupeola *et al.* (11) conducted an experiment on five phosphorus fertilizer (alesinloye organic fertilizer) rates applied at 0, 15, 30, 45 and 60 kg P ha⁻¹ and three different spacing (25x50, 35x50 and 45x50 cm). These were assigned into a factorial experiment and fitted into a randomized complete block design and replicated thrice. The parameters taken were the plant height, number of leaves, number of shoots, length of rhizome and rhizomes yield. These traits showed significant increase to the application of P rate with optimum value obtained at 60 kg P ha⁻¹ and at 45x50 cm planting distance. The combined effect of spacing and fertilizer rate significantly influenced in most of the characters. The percentage of crude protein, total ash, calcium, phosphorus, total starch, moisture content and crude fibre interaction was not significantly affected by all the measured nutritional values. The highest phosphorus fertilizer applied (60 kg ha⁻¹) at widest spacing of 45 × 50 cm had the highest value in all the nutrition component observed in ginger.

Economics studies

Ghosh and Hore (8) conducted an experiment to study the effect of spacing and seed rhizome size on yield of ginger cv. Garubathan, grown as inter-crop in bearing coconut cv. East Coast Tall garden and to

study the effect of intercrop on the economics of the cropping system model (coconut+lime+ginger+okra). Among the five different spacings (20 x 15 cm, 20 x 20 cm, 25 x 20 cm, 25 x 25 cm and 30 x 25 cm) and two rhizome size (15-20 and 25-30 g) of ginger, the closest spacing (20 x 15 cm) in combination with bigger seed rhizome (25-30 g) produced highest yield (15.39 kg/3m²). The maximum (₹ 1,03,727/-) and minimum (₹ 57,746/-) cost of cultivation were recorded in spacing 20 x 15 cm with rhizome size 25-30 g and spacing 30 x 25 cm with rhizome size 15-20 g, respectively. The maximum net return (₹ 78,421/-) was realised from closest spacing with smaller seed rhizome. While Sharathpal *et al.* (18) found a net return of ₹ 1.30 lakh ha⁻¹ by FYM (25 tha⁻¹) + RDF (100 : 50 : 50 NPK ha⁻¹) and ₹ 0.48 lakh ha⁻¹ by neem cake @ 2t ha⁻¹.

Bhat *et al.* (5) analysed the cost and returns in production of ginger and identified the production problem of ginger. The cost of cultivation was higher in case of small farmers (₹ 89435.17) compared to medium (₹ 87203.30) and large (₹ 87015.34) farmers. However, there were no substantial differences in the cost of cultivation between small, medium and large farmers. High incidence of pest and disease was the major production problem expressed by most of the respondents. Seyic *et al.* (17) found highest net return of ₹ 6,20,108 ha⁻¹ with B:C ratio of 4.87:1 by the application of 125 kg N +60 kg P₂O₅ +60 kg K₂O ha⁻¹ to ginger cv. Akya Local.

Seed treatment with biofertilizers enhanced growth, increased rhizome yield by 19.0% and resulted in 32.4% higher net profit over control (Jyotsana *et al.* 10). Among the seed treatments, *Azotobacter* 5.0 kg ha⁻¹, *Azospirillum* 3.75 kg ha⁻¹ and *Phosphotica* 3.75 kg ha⁻¹ were found optimum in improving most of the growth attributes, increasing yield components and yield of rhizome by 5.6%-13.5%. They also improved rhizome quality by increasing specific gravity, oleoresin and dry matter content and by decreasing crude fibre in rhizome. They resulted in higher net return by 4.0%-12.0% as compared to their other levels. Combined use of *Azotobacter* 5.0 kg ha⁻¹ along with *Phosphotica* 3.75 kg ha⁻¹ was found to be the best treatment combination which greatly improved growth and yield attributes of ginger and ultimately recorded markedly higher productivity (2.0%-23.5%) over other combinations. Combined application of *Azotobacter* 5 kg ha⁻¹ + *Phosphotica* 3.75 kg ha⁻¹ resulted in the highest gross return (\$4,905 ha⁻¹), net return (\$3,525

ha⁻¹) and return per dollar (3.55) invested in ginger cultivation.

Quality studies

Seyie *et al.* (17) studied the effect of nitrogen, phosphorus and potassium on growth yield and quality of two cultivars Akya Local and Suprabha. The cultivar Akya Local was found better than Suprabha in terms of growth, yield and quality attributes. The quality attributes (fresh ginger oil, oleoresin and crude fiber content) were (142.25 q/ha), fresh ginger oil (1.52%) and oleoresin (6.2%).

A field experiment to find out the variation in yield, and quality profile of ginger under organic, inorganic and integrated management systems was carried out by Nileena *et al.* (12) for three consecutive years. Results showed that among the treatments, the yield was on par in organic and integrated management system. The oil content was significantly higher in integrated and inorganic management systems and oleoresin in inorganic system. Among the three varieties, IISR Mahima recorded significantly higher yield, oleoresin, *beta*-sesquiphellandrene and *ar-curcumene* contents. IISR Varada recorded maximum oleoresin, alpha-pinene, citral, 1-8 cineole, z-citral and camphene content while IISR Rejatha recorded the highest farnesene and *ar-curcumene* content.

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