Journal of Spices and Aromatic Crops 9 (2) : 161-164 (2000)

# Genetic diversity in ginger (*Zingiber officinale* Rosc.) with reference to essential oil content

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Received 24 September 1999; Revised 24 May 2000; Accepted 3 June 2000.

**Abstract**

$D^2$ analysis was carried out on a set of 18 genotypes of ginger (*Zingiber officinale*) involving 8 metric traits, at Nagaland, India. The genotypes could be grouped into three clusters and while inter cluster $D^2$ values ranged from 338.99 to 2029.63, intra cluster $D^2$ values ranged from 18.41 to 45.05. The major forces for divergence were rhizome yield per plant, oleoresin and fibre contents.

**Key words** : essential oil, genetic divergence, ginger, *Zingiber officinale.*

Though India is a leading producer and exporter of ginger (*Zingiber officinale* Rosc.) in the world, availability of genetically upgraded strains, containing high essential oil is important. Studies on genetic diversity are important pre-requisites before embarking on genetic improvement of any crop. The present study was made to assess the genetic diversity in the ginger germplasm available in Nagaland, a major ginger producing area in India.

The material for the study comprised of 18 genotypes (17 indigenous and 1 exotic) available with the Department of Horticulture, School of Agricultural Sciences and Rural Development, Medziphema, North Eastern Hill University, Nagaland. The experiment was conducted during 1992–93 at the Expermental Farm of the School of Agricultural Sciences and Rural Development, Medziphema (altitude : 320 MSL; 20°45'43" N latitude and 93° 53' 04" E longitude). The area has a subtropical climate with predominantly humid moderate temperatures, medium to high rainfall and deep sandy loam soil of 5.3 pH. The experiment was laid out in a Randomized Block Design with three replicates. In the third week of April, healthy rhizome bits (25–30 g) were planted at a spacing of 25 cm within and between rows in plots of 2.5 m x 5.0 m. Prior to planting, 20 t/ha well rotten farm yard manure and 60 kg/ha N, P, and K, each was incorporated in the soil. Two split doses of N of 30 kg each were applied 60 and 90 days after planting. Weeding and irrigation were carried out as and when required.

Observations on metric traits namely, plant height, number of leaves, number of tillers per plant, and rhizome yield per plant were recorded after harvesting. Essential oil content on fresh and dry weight basis, oleoresin and fibre contents were recorded after harvesting. Essential oil content on fresh weight basis was obtained by steam distillation of freshly harvested rhizomes using Clevenger type apparatus. For determining the oil content on dry weight basis, the dry ginger rhizome samples were dried in hot air oven at 60° C for 6 h and then steam distilled in Clevenger type apparatus. For extraction of ginger oleoresin, the processed samples were dried in oven for 6 h at 60°C and the oleoresin was extracted from the ginger powder with hexane. The extract was drained after 8 h and the water layer decanted. The last traces of hexane were removed as azeotrope with acetone under vacuum and then

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weighed on electronic balance. Liebig's disgestion apparatus was used for determining the fibre content in rhizomes; 2.0 g of dry material with ether and approximately 0.5 g of dry asbestos was transferred to the digestion flask and 200 ml of boiling $H_2SO_4$ was added to it. The flask was connected to the condensor and brought to boiling within 1 min and the boiling continued exactly for 30 min. After 30 min of boiling, the contents of the flask were filtered through filtering cloth in a fluted funnel and the residue was washed thoroughly with water. The residue was transferred to the Gooch crucible and ignited with a burner (approximately 20 min) and then cooled in a desicator and weighed. The fibre content was calculated as follows :

$$\% \text{ crude fibre} = \frac{\text{Loss in weight in sample} \times 100}{\text{Weight of sample taken}}$$

Statistical analysis was carried out on the basis of mean values pooled over 2 years (1992–93). Mahalanobis's generalized distance was employed to determine the magnitude of divergence between n(n-1)/2 pairs population

The genotypes 7 (Thinglaidum) and 10 (Nadia) had the highest rhizome yield per plant and essential oil content (333.92 g, 56% and 316.8 g, 51%, respectively) (Table 1). Analysis of variance revealed significant variations among the genotypes for all the characters studied. 'V' statistics also revealed highly significant results in respect of pooled data for all the eight traits.

Significant association of essential oil content with rhizome yield per plant and per cent oleoresin content (Table 2) indicated that they could be considered as reliable variates for prognosis of oil content potential in ginger. On the basis of $D^2$ values, the 18 genotypes could be grouped into three clusters (Table 3). Cluster I accounted for 16 genotypes of which 9 were from Meghalaya, 2 each from Assam and Kerala and 1 each from

**Table 1.** Performance of ginger cultivars

| Cultivar/ Variety | Plant height (cm) | No. of leaves /plant | No. of tillers/ plant | Yield/ plant (g) | Oil content (fresh wt basis %) | Oil content (dry wt basis %) | Oleoresin content (%) | Fibre content (%) |
|---|---|---|---|---|---|---|---|---|
| Tura | 82.45 | 14.63 | 7.27 | 195.67 | 0.20 | 0.38 | 4.38 | 5.46 |
| Jorhat hard | 77.60 | 17.24 | 7.49 | 244.33 | 0.21 | 0.46 | 4.48 | 5.76 |
| Thingpui | 81.83 | 17.03 | 9.05 | 299.33 | 0.21 | 0.43 | 4.60 | 6.08 |
| Shillong local | 72.78 | 17.45 | 6.40 | 242.77 | 0.22 | 0.42 | 5.03 | 5.19 |
| Rio-de-Janeiro | 84.63 | 16.17 | 6.87 | 285.75 | 0.30 | 0.50 | 5.25 | 4.81 |
| Karakal | 70.84 | 15.82 | 5.36 | 228.58 | 0.23 | 0.44 | 4.69 | 5.28 |
| Thinglaidum | 83.65 | 12.12 | 9.35 | 333.92 | 0.33 | 0.56 | 5.44 | 4.53 |
| Poona | 82.38 | 17.74 | 7.16 | 214.33 | 0.19 | 0.40 | 4.26 | 5.12 |
| Juggijan | 82.67 | 17.18 | 8.00 | 227.00 | 0.20 | 0.40 | 4.26 | 5.56 |
| Nadia | 87.67 | 18.88 | 9.93 | 316.83 | 0.29 | 0.51 | 4.29 | 9.37 |
| Khasi local | 81.33 | 18.16 | 8.29 | 301.17 | 0.20 | 0.46 | 5.08 | 4.52 |
| Deomali local | 84.45 | 20.03 | 8.93 | 229.38 | 0.24 | 0.46 | 4.26 | 5.98 |
| Checkrel | 78.49 | 17.81 | 7.40 | 225.25 | 0.23 | 0.40 | 4.80 | 5.12 |
| Sigmakhir | 76.73 | 17.63 | 7.16 | 271.58 | 0.24 | 0.41 | 4.90 | 4.86 |
| Maran | 71.75 | 15.62 | 7.07 | 287.67 | 0.23 | 0.40 | 4.37 | 4.63 |
| Ernad | 81.78 | 17.15 | 8.01 | 281.67 | 0.23 | 0.35 | 4.14 | 5.20 |
| Wynad | 76.72 | 16.80 | 8.20 | 298.00 | 0.24 | 0.40 | 4.63 | 4.80 |
| HP 666 | 84.38 | 18.92 | 7.47 | 184.58 | 0.25 | 0.40 | 4.60 | 4.33 |

**Table 2.** Genotypic and phenotypic correlation of six plant traits with oil content in ginger

| Character | % oil content (fresh weight) | | % oil content (dry weight) | |
|---|---|---|---|---|
| | Genotypic | Phenotypic | Genotypic | Phenotypic |
| Plant height | 0.360 | 0.290 | 0.347 | 0.309 |
| No. of leaves | -0.342 | -0.318 | -0.278 | -0.242 |
| No. of tillers | 0.338 | 0.290 | 0.439 | 0.430 |
| Yield/plant | 0.520 | 0.483* | 0.542 | 0.522* |
| % oleoresin content | 0.525 | 0.477* | 0.576 | 0.546* |
| % fibre content | 0.133 | 0.123 | 0.275 | 0.265 |

Brazil, Maharastra and Himachal Pradesh. Clusters II and III had single entries from Meghalaya and Assam, respectively. The pattern of distribution of genotypes from different geographical regions into different clusters was random, as reported in other crops (Lee & Kaltsikes 1973; Nagarajan & Prasad 1980; Rao *et al.* 1980; Mathur 1992).

Intra cluster $D^2$ values vis-a-vis group means coupled with percentage of contribution of individual characters towards divergence (Table 4), showed that there was major role of rhizome yield per plant (49.02), oleoresin content (17.65) and fibre content (17.65) and minor role of remaining five traits. The highest mean for rhizome yield per plant, oleoresin content and fibre content were observed in clusters II and III, respectively. Further these cluster values also showed high mean for oil content when compared to cluster I.

However, being a vegetatively propagated crop, ginger offers little scope for heterosis breeding in achieving a high level of yield of rhizomes as well as essential oil content. Thus, it is expected that the varieties selected and subjected to artificial

**Table 3.** Intra and inter cluster $D^2$ values in three clusters formed in genotypes of ginger

| Cluster | I | II | III | Genotype |
|---|---|---|---|---|
| I | 338.99 | 1520.30 | 1239.37 | Tura, Thingpui, Shillong local, Karakal, Juggijan, Khasi local, Deomali local, Checkrel, Sigmakhir (Meghalaya), Jorhat hard,Maran, (Assam), Ernad, Wynad (Kerala), Rio-de-Janeiro (Brazil), Poona (Maharastra), HP 666 (Himachal Pradesh) |
| II | | 0.00 | 2029.63 | Thinglaidum (Meghalaya) |
| III | | | 0.00 | Nadia (Assam) |

Table 4. Intracluster group means for eight traits and their contribution towards their genetic divergence in ginger

| Character | Cluster I | Cluster II | Cluster III | Contribution |
|---|---|---|---|---|
| Plant height | 79.43 | 83.65 | 87.86 | 4.96 |
| No. of leaves | 17.21 | 12.12 | 18.88 | 1.31 |
| No. of tillers/plant | 7.54 | 9.33 | 9.93 | 3.27 |
| Yield/plant | 251.06 | 333.92 | 316.83 | 49.02 |
| % oil content (fresh weight) | 0.23 | 0.33 | 0.29 | 0.65 |
| % oil content (dry weight) | 0.42 | 0.56 | 0.51 | 8.50 |
| % oleoresin content | 4.61 | 5.44 | 4.29 | 17.65 |
| % fibre content | 5.71 | 4.53 | 9.37 | 17.65 |

variability induction from clusters II and III, may give better results as they exhibit greater diversity and better mean performance.

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