

## Evaluation of Ginger (*Zingiber officinale* Rosc.) Genotypes on Rhizome Characteristics and Quality Performance Under Coconut Ecosystem

K. S. Sangeetha, S. Subramanian, V. Marthandan

Received 9 June 2016 ; Accepted 20 July 2016 ; Published online 30 August 2016

**Abstract** An experiment was conducted during the period from 2012 to 2013 to study the yield and quality performance of ginger genotypes under coconut ecosystem. The experiment consisted of thirty ginger genotypes as treatments replicated three times in a randomized block design. The results showed the supremacy of the genotype ZO 26 over the other genotypes, as ZO 26 showed increment in per plant yield (179.42 g) and yield attributing characters such as number (3.01), length (4.93 cm) and weight (47.83 g) of mother rhizomes, number (6.37) of primary rhizome, number (8.01), length (7.18 cm) and weight (70.06 g) of secondary rhizomes and essential oil content (2.10%). ZO 4 recorded significantly higher crude fiber content (6.21%), ZO 18 recorded higher oleoresin content (9.90%) and ZO 12 had recorded higher dry recovery (25.16%). On the basis of good performance on per plant yield, yield attributing characters and

quality, ZO 26 (Idukki 2) may be considered as the most suitable genotypes for cultivation under the coconut ecosystems of Coimbatore.

**Keywords** Ginger, Genotypes, Yield, Quality, Coconut ecosystem.

### Introduction

Ginger (*Zingiber officinale* Rosc.) is one of the major tropical spices of the world which is prized for its flavor, aroma and medicinal properties. It belongs to the family Zingiberaceae cultivated all over tropical and subtropical countries. Ginger has been used throughout history as an aid for many for its gastrointestinal disturbances and to relieve inflamed joints [1]. India is the largest ginger producing country in the world and is cultivated in most of the Indian states.

Due to the gaining importance of ginger in the domestic and export trade, it is very much essential to increase the area and production of ginger in Tamil Nadu and in India. There is a scope to increase the area and production of ginger in Tamil Nadu by way of intercropping the ginger in the existing coconut gardens having an age of 15 years and above. Ginger is known to vary widely for the quality traits besides yield [2]. A critical analysis of variability for the important quality traits in the germplasm from different sources grown under uniform conditions / season will help us to know the spectrum of variability for

---

K. S. Sangeetha\*  
Department of Spices and Plantation Crops, Tamil Nadu  
Agricultural University, Coimbatore

S. Subramanian  
Horticultural Research Station, Thadiyankudisai, Dindigul,  
Tamil Nadu

V. Marthandan  
Department of Seed Science and Technology, Tamil Nadu  
Agricultural University, Coimbatore  
e-mail: sangy.666@gmail.com

\*Correspondence

**Table 1.** Treatment details (ginger genotypes).

Treat-ments	Genotypes	Source of the seed rhizomes
T <sub>1</sub>	ZO 1 (PPI Local)	Collected from HRS, Pechiparai
T <sub>2</sub>	ZO 2 (Sengottai Local)	
T <sub>3</sub>	ZO 3 (Suprabha)	
T <sub>4</sub>	ZO 4 (Narasipatnam Local)	
T <sub>5</sub>	ZO 5 (V1S1-2-Pottangi Type-1)	
T <sub>6</sub>	ZO 6 (V1E8-2-Pottangi Type-2)	
T <sub>7</sub>	ZO 7 (PGS-8-Pottangi Type-3)	
T <sub>8</sub>	ZO 8 (V1K1-1)	
T <sub>9</sub>	ZO 9 (Muktha)	
T <sub>10</sub>	ZO 10 (V1C-8-Pottangi type-4)	
T <sub>11</sub>	ZO 11 (V1S1-8-Pottangi type-5)	
T <sub>12</sub>	ZO 12 (PGS-7-Pottangi type-6)	
T <sub>13</sub>	ZO 13 (S-666-Pottangi type-7)	
T <sub>14</sub>	ZO 14 (Ranga)	
T <sub>15</sub>	ZO 15 (PGS-24-Pottangi type-8)	
T <sub>16</sub>	ZO 16 (Nadia)	Collected from Horticultural Research Station, Pechiparai
T <sub>17</sub>	ZO 17 (Suruchi)	
T <sub>18</sub>	ZO 18 (Suravi)	
T <sub>19</sub>	ZO 19 (Idukki 4)	
T <sub>20</sub>	ZO 20 (Idukki 5)	
T <sub>21</sub>	ZO 21 (Varada)	
T <sub>22</sub>	ZO 22 (Nadan)	Collected from Kanyakumari through HRS, Pechiparai
T <sub>23</sub>	ZO 23 (Kerala)	
T <sub>24</sub>	ZO 24 (Malai Inji)	Collected from Gudalur of Nilgiri through Hybrid Rice Evaluation Center, Gudalur
T <sub>25</sub>	ZO 25 (Maran)	
T <sub>26</sub>	ZO 26 (Idukki 1)	
T <sub>27</sub>	ZO 27 (Idukki 2)	
T <sub>28</sub>	ZO 28 (Idukki 3)	
T <sub>29</sub>	ZO 29 (Karthika)	
T <sub>30</sub>	ZO 30 (Athira)	

oleoresin, essential oil and crude fiber in this clonally propagated crop without the confounding effects of the micro and macro climatic factors. With this background in consideration, the present study was undertaken with thirty ginger genotypes collected from different sources and evaluated their performance under coconut ecosystems at Coimbatore condition for growth and yield.

### Materials and Methods

An experiment was conducted to evaluate the performance of 30 genotypes of ginger under coconut ecosystem at Coconut Nursery, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period from 2012 to 2013. The site of the experiment is situated at 11°02' N

latitude and 77°03' E longitude with an altitude of 426.76 m MSL. Planting was done in the month of July and rhizomes were harvested in about 240 days after planting (during March).

The ginger genotypes were received from different parts of India and are tested under Coimbatore condition as an intercrop in coconut palms (Table 1). The experiment was laid out in RBD with three replications. The land was prepared thoroughly by giving 4 deep ploughing and at the time of last ploughing, FYM was applied @ 20 t ha<sup>-1</sup>. After levelling, ridges of 2.5 m length, 45 cm breadth, 20–25 cm height were formed to accommodate the treatments. The rhizomes were planted in ridges with a spacing of 15 cm between plants. Neem cake was applied @ 2 t/ha at the time of planting. The land was fertilized with 75, 50

**Table 2.** Mean performance of ginger genotypes on yield and rhizome characters (240 DAP).

Geno- type	Yield per plant (g)	Mother rhizomes			Primary rhizomes			Secondary rhizomes		
		No.	Wei- ght (g)	Len- gth (cm)	No.	Wei- ght (g)	Len- gth (cm)	No.	Wei- ght (g)	Len- gth (cm)
ZO <sub>1</sub>	98.92	2.21	21.71	2.47	4.88	35.07	4.83	5.83	41.83	4.94
ZO <sub>2</sub>	103.45	2.14	26.91	2.63	4.99	34.19	4.76	6.40	47.03	5.24
ZO <sub>3</sub>	145.92	1.47	30.51	3.17	5.71	35.77	5.82	6.83	36.61	4.33
ZO <sub>4</sub>	65.47	1.71	32.18	3.46	3.91	17.83	2.55	4.93	38.19	5.41
ZO <sub>5</sub>	60.62	1.55	39.03	3.71	3.66	20.07	2.84	6.47	24.83	2.80
ZO <sub>6</sub>	48.00	1.38	19.07	2.32	3.17	28.51	3.24	4.76	48.19	5.28
ZO <sub>7</sub>	64.57	1.56	27.76	2.74	3.76	23.76	3.58	3.77	52.57	6.63
ZO <sub>8</sub>	69.63	1.76	31.70	2.98	4.05	19.63	2.71	5.37	30.57	4.61
ZO <sub>9</sub>	50.00	1.40	26.73	2.58	3.19	21.15	3.07	3.83	25.35	3.17
ZO <sub>10</sub>	115.74	2.28	29.82	2.96	5.03	31.18	4.17	4.42	28.26	3.54
ZO <sub>11</sub>	74.52	1.85	28.14	3.01	4.07	29.32	4.55	4.53	20.18	2.37
ZO <sub>12</sub>	42.07	1.23	27.03	2.93	2.98	23.14	3.11	5.63	37.94	4.52
ZO <sub>13</sub>	79.00	1.88	27.41	2.39	4.18	25.58	3.71	5.50	23.97	2.52
ZO <sub>14</sub>	88.70	1.90	34.76	3.58	4.49	30.05	4.32	4.08	39.51	5.07
ZO <sub>15</sub>	58.00	1.50	43.70	4.67	3.58	27.74	2.53	3.17	39.76	4.38
ZO <sub>16</sub>	46.00	1.33	29.53	2.87	3.08	21.73	2.93	4.33	58.03	7.03
ZO <sub>17</sub>	85.24	1.90	23.76	2.44	4.41	25.96	3.88	5.57	18.63	2.25
ZO <sub>18</sub>	90.91	1.97	39.58	4.47	4.63	34.52	3.53	3.52	50.11	4.87
ZO <sub>19</sub>	95.76	2.01	40.91	4.03	4.71	28.92	3.18	5.98	26.44	2.85
ZO <sub>20</sub>	55.19	1.47	26.40	2.53	3.49	45.91	6.02	5.89	57.21	6.13
ZO <sub>21</sub>	149.72	2.70	28.89	2.83	5.93	38.46	5.90	7.74	33.03	3.63
ZO <sub>22</sub>	155.72	2.81	41.76	4.82	6.03	43.76	5.59	6.49	66.17	6.68
ZO <sub>23</sub>	135.07	2.60	38.52	4.18	5.63	37.18	5.63	7.33	55.73	6.25
ZO <sub>24</sub>	160.90	2.96	35.92	3.93	6.24	57.83	6.06	6.91	60.70	5.55
ZO <sub>25</sub>	159.07	2.90	38.17	3.76	6.19	37.72	5.17	7.51	65.81	6.71
ZO <sub>26</sub>	179.42	3.01	47.83	4.93	6.37	47.19	5.95	8.01	70.06	7.18
ZO <sub>27</sub>	123.51	2.39	35.53	3.81	5.32	36.35	4.91	6.62	53.91	5.94
ZO <sub>28</sub>	162.00	2.96	37.65	3.74	6.27	40.53	5.03	7.83	65.53	5.77
ZO <sub>29</sub>	127.00	2.45	27.62	2.76	5.45	39.54	5.32	6.70	68.00	6.95
ZO <sub>30</sub>	150.17	2.80	33.82	3.72	5.98	51.00	6.00	7.09	62.89	5.72
Mean	101.340	2.070	32.410	3.350	4.710	32.990	4.360	5.770	44.900	4.940
SEd	1.829	0.051	0.725	0.076	0.114	0.745	0.108	0.117	0.996	0.125
CD at 5%	3.662	0.102	1.452	0.153	0.228	1.492	0.216	0.235	1.995	0.249

and 50 kg of N, P and K per hectare, respectively. Cultural operations were carried out as per the package of practices given in the extension pamphlet for ginger of Spices Board India, Cochin [3].

The crop was harvested 240 days after planting and observations on rhizome characters were taken randomly from ten plants in each plot. The various quality parameters viz. essential oil content [4], crude fiber content [5], oleoresin content [6] and dry recovery percentage [7] were estimated from the ginger rhizomes harvested at 240 days after planting. The data collected were subjected to statistical analysis following standard procedure [8].

## Results and Discussion

The fresh rhizome yield per plant varied significantly among different ginger genotypes tested at 240 DAP and it varied from 42.07 to 179.42 g (Table 2). Yield is a complex character and associated with several yield contributing characters. Among thirty ginger genotypes tested, the genotype, ZO 26 (Idukki 2) had recorded higher per plant yield (179.42 g) and ZO 12 had produced lower yield (42.07 g / plant). The rhizome yield of ginger is a better outcome of rhizome characteristics viz., number, weight and length of mother, primary and secondary rhizomes. This was in line with the earlier work of [9]. The result on rhizome

**Table 3.** Mean performance of ginger genotypes on quality parameters (240 DAP).

Geno- type	Essen- tial oil (%)	Crude fiber (%)	Oleo- resin con- tent (%)	Dry reco- very percen- tage (%)
ZO <sub>1</sub>	1.93	5.38	6.17	23.61
ZO <sub>2</sub>	1.55	4.93	6.83	24.76
ZO <sub>3</sub>	1.85	4.57	8.80	23.17
ZO <sub>4</sub>	1.67	6.21	7.53	23.70
ZO <sub>5</sub>	1.51	5.28	7.89	19.71
ZO <sub>6</sub>	1.59	5.69	5.79	21.17
ZO <sub>7</sub>	1.72	5.07	7.37	22.07
ZO <sub>8</sub>	1.63	4.76	8.31	22.93
ZO <sub>9</sub>	2.05	4.37	8.07	22.82
ZO <sub>10</sub>	1.52	4.50	5.96	24.55
ZO <sub>11</sub>	1.60	5.47	6.49	18.56
ZO <sub>12</sub>	1.65	3.63	7.78	25.16
ZO <sub>13</sub>	1.53	3.70	5.87	23.88
ZO <sub>14</sub>	1.69	3.78	6.70	18.89
ZO <sub>15</sub>	1.56	5.32	6.63	23.38
ZO <sub>16</sub>	1.66	5.54	7.41	21.43
ZO <sub>17</sub>	1.61	3.76	9.82	19.47
ZO <sub>18</sub>	1.74	4.18	9.90	24.38
ZO <sub>19</sub>	1.86	4.49	7.10	18.28
ZO <sub>20</sub>	1.78	4.30	6.02	21.36
ZO <sub>21</sub>	2.03	4.31	6.41	22.56
ZO <sub>22</sub>	1.94	3.57	9.70	20.22
ZO <sub>23</sub>	1.58	3.82	9.21	24.06
ZO <sub>24</sub>	1.99	5.74	5.50	20.89
ZO <sub>25</sub>	1.77	3.53	9.53	21.70
ZO <sub>26</sub>	2.10	4.46	8.51	23.42
ZO <sub>27</sub>	1.97	4.07	8.65	21.81
ZO <sub>28</sub>	2.00	3.18	6.76	22.31
ZO <sub>29</sub>	2.06	5.10	6.92	22.64
ZO <sub>30</sub>	1.82	4.68	7.83	20.56
Mean	1.770	4.580	7.520	22.120
SEd	0.036	0.099	0.180	0.389
CD at 5%	0.073	0.198	0.361	0.778

parameters revealed that there was a significant difference among the genotypes for mother, primary and secondary rhizome parameters like number, length and weight at 240 DAP (Table 2). The genotype, ZO 26, had recorded higher value for all mother rhizome parameters viz., number (3.01), length (4.93 cm) and weight (47.83 g) respectively. The genotype, ZO 24 had recorded higher primary rhizome characters viz., length (6.06 cm) and weight (57.83 g) and the genotype ZO 26 (Idukki 2) had recorded higher number (6.37). The genotype, ZO 26 (Idukki 2) had produced

higher number of secondary rhizomes (8.01) which was followed by ZO 28 (7.83) and both are on par with each other. The genotype, ZO 26, produced longer (7.18 cm) rhizomes coupled with higher weight (70.06 g) secondary rhizome.

Characters of primary rhizome as well as secondary rhizomes registered higher values in the genotypes of ZO 26 and ZO 28. This might be due to the fact that the secondary rhizomes being farthest in the accumulation zone, received lesser quantities of photosynthates and probably with lesser quantity which could not be accumulated in the mother and primary rhizome components, getting partitioned to the secondary rhizomes. This is in agreement with the earlier findings in turmeric [10, 11].

The results on quality parameters of the selected ginger genotypes found varied significantly at 240 DAP (Table 3). Quality of ginger is known to be influenced by the environment, growing conditions and the levels of shade [2]. The genotype, ZO 26 (Idukki 2) produced higher essential oil content (2.10%) followed by ZO 29, 9 and 21 (2.06, 2.05 and 2.03%) and were on par with each other. The genotype ZO 5 has recorded a lesser essential oil content (1.51%). This may be due to the growing conditions of the germplasm [12]. Fiber content is the most important criterion for assessing the suitability of ginger rhizome for specific products like ginger paste, salted ginger, ginger powder. For the manufacture of processed foods such as jams, marmalades, cakes and confectionery very less fiber gingers are more suitable. Higher crude fiber content (6.21%) was recorded in ZO 4 followed by ZO 24 (5.74%) and ZO 6 (5.69%) respectively and both are on par with each other. The genotypes ZO 28 has recorded lesser crude fiber content of (3.18%). The probable reason for such higher crude fiber content could be ascribed to higher leaf area and efficient translocation of photosynthates to the developing fingers, as reported earlier [13] in ginger.

The genotype, ZO 18 recorded higher oleoresin content (9.90%) and this was followed by ZO 17 (9.82%) and ZO 22 (9.70%) and all are on par with each other. The variation in the oleoresin content might be due to the genetic potential of genotype and

method of extraction [14]. In the present study, all factors except the genotypes being common, the variability observed for oleoresin could be attributed to the effect of the cultivars. Dry recovery percentage varied significantly from 18.28 to 25.16% with a mean of 22.12%. The genotype, ZO 12 had recorded higher dry recovery of 25.16% followed by ZO 2 and 10 (24.76 and 24.55%) and were on par with each other. High dry recovery percentage might be due to the production of slender rhizomes, perhaps due to lower moisture retention at harvest. Nybe et al. [15] stated that the variation in drying percentage might be attributed to the difference in size of the rhizome, moisture and fiber content of the cultivars.

The study indicated that the local genotypes are able to perform better under standard package of practices. Based on the results of the present investigation, ZO 26 (Idukki 2) may be considered as the most suitable genotype for cultivation under the coconut ecosystems of Coimbatore with respect to yield and essential oil content.

## References

- Katzer G (2007) Spice pages. <http://www.uni-graz.at/~katzer/engl/index.html>.
- Zachariah TJ, Sasikumar B, Nirmal Babu K (1999) Variation for quality components in ginger and turmeric and their interaction with environments. In: Sasikumar B, Krishnamurthy B, Rema J, Ravindran PN, Peter KV (eds). Proceedings of National Seminar on Biodiversity, Conservation and Utilization of Spices, Medicinal and Aromatic Plants, IISR, Calicut, pp 116—120.
- Anonymous (2009) Ginger. Extension Pamphlet. Spices Board, Cochin.
- ASTA (1968) Official analytical methods of the American Spice Trade Association. 3<sup>rd</sup> edn pp 40.
- Chopra R, Kanwar SL (1976) Analytical agricultural chemistry. Kalyani Publ, New Delhi, pp 38.
- AOAC (1975) Official methods of analysis. Association of official Agricultural Chemists, Washington, DC 12<sup>th</sup> edn.
- Sahay KM, Singh KK (1994) Unit operations of agricultural processing, pp 107.
- Panse VG, Sukhatme PV (1985) Statistical methods for agriculture workers. Ind Coun Agric Res, New Delhi, pp 155.
- Durgavathi V (2011) Evaluation of ginger (*Zingiber officinale* Rosc.) genotypes for growth, yield and quality under coconut ecosystem. MSc (Hort) thesis. Tamil Nadu Agric Univ, Coimbatore, Tamil Nadu.
- Vijaya T (2003) Evaluation of turmeric (*Curcuma longa* L.) genotypes under open and coconut shade conditions. MSc (Hort) thesis. Tamil Nadu Agric Univ, Coimbatore, Tamil Nadu.
- Arunkumar R (2003) Evaluation of turmeric accessions for yield, quality and shoot borer resistance. PhD (Hort) thesis. Tamil Nadu Agric Univ, Coimbatore, Tamil Nadu.
- Jaleel Kizhakkayil, Sasikumar B (2009) Variability for quality traits in a global germplasm collection of ginger (*Zingiber officinale* R.). Current trends in Biotechnol and Pharmacy 3 : 254—259.
- Ajithkumar K, Jayachandran BK, Ravi V (2002) Influence of shade regimes on photosynthetic rate and stomatal characters of ginger (*Zingiber officinale* Rosc.). J Spices and Aromatic Crops 11 : 26—29.
- George H (1981) Variability in the open pollinated progenies of turmeric (*Curcuma aromatica* Salisb). MSc (Hort) thesis. Kerala Agric Univ, Thrissur, Kerala.
- Nybe EV, Nair PCS, Mohankumar N (1980) Assessment of yield and quality components in ginger. In: Nair MK, Premkumar T, Ravindran PN, Sarma YR (eds). Proc Nat Sem on Ginger and Turmeric—Calicut, CPCRI, Calicut, India, pp 24—29.