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EVALUATION OF GINGER (*ZINGIBER OFFICINALE* ROSC.) GENOTYPES UNDER COCONUT ECOSYSTEM

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ABSTRACT
An experiment was conducted to evaluate the performance of thirty ginger genotypes under coconut ecosystem at the Coconut Nursery, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period from 2012 to 2013. The results showed the supremacy of the genotype Z0 26 over the other genotypes, as ZO 26 showed increment in plant height (60.0 cm), number of tillers / plant (9.8), number of leaves / plant (148.56) and leaf area (2378.72 cm^2) respectively at 150 DAP and per plant fresh yield (179.42 g), per plot yield (3.22 kg/1.13 m^2) and estimated yield per hectare (28.62 t ha^{-1}) at 240 DAP. Dry recovery percentage was maximum (25.16%) in the genotype ZO 12. On the basis of good performance ZO 26 is adjudged as the suitable ginger genotype under coconut shade condition.

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is a herbaceous perennial belonging to the family Zingiberaceae and is one of the important commercial spice crops of the tropical and subtropical regions valued all over the world from ancient period for its aroma, flavor and also medicinal properties. The economic part is the underground rhizome, which is pungent and aromatic and is largely used in the manufacture of ginger pill, ginger oil, ginger essence, soft drink, non-alcoholic, ginger oleoresin or gingerin. South East Asia is a major ginger producing region and in this region leading ginger producing countries are China, India, Nepal and Vietnam. India is the largest producer in the world and the production is about 6.55 L tonnes from an area of about 1.33L hectares (NHB, 2014). Growing of ginger in coconut plantation proves profitable without hampering the performance of the main crop (Roy and Hore, 2007). These coconut gardens offer similar climatic conditions that exist in the sub tropical areas where the ginger is a regular crop. Hence, there is an ample opportunity for the remaining shaded area of coconut gardens to grow intercrops such as ginger and turmeric, which are shade loving / tolerant and highly profitable crops (Meerabai *et al*., 2001). Similar results was also obtained by Amin *et al*. (2010) in ginger with agroforestry model and proved ginger is a scicophytic crop performing remarkably well under partial shade (50 ± 5%) than the open field.

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. Practically, it is difficult to increase the area under ginger in the sub tropical region. By using the existing area of coconut gardens having an age of 15 years and above in growing plains of Tamil Nadu, there is a scope to increase the area and production of ginger. 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.

MATERIALS AND METHODS

A field experiment was conducted to evaluate the performance of ginger genotypes under coconut ecosystem at the coconut nursery of the Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period from 2012 to 2013. Planting was done in the month of July and rhizomes were harvested for green ginger in about 180 days after planting (during January) and for dry ginger, 240 days after planting (during March).

Thirty ginger genotypes *viz*., ZO 1 to ZO 30 collected from different parts of India were tested under Coimbatore condition as an intercrop in coconut palms (Table 1). The experiment was laid out in randomised block design, replicated three times under the shade of coconut plantation. The land was prepared thoroughly by giving 4 deep ploughing and at the time of last ploughing, FYM was applied @ 20 t ha^{-1}. 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 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 (Anon., 2009). Data were recorded from the mean of five plants selected randomly from each genotype in each replication on growth, yield and quality parameters, *viz.*,plant height, number of leaves, number of tillers, leaf area, yield per plant, yield per plot and dry recovery. Leaf area was estimated by the leaf average length and breadth measurements (Ancy and Jayachandran, 1994). The data collected were subjected to statistical analysis following the procedure of Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The data on plant height showed significant variation among different genotypes (Table 2). The plant height was significantly higher (60.0 cm) in ZO 26 followed by ZO 28 (57.9 cm) and ZO 23 (57.8 cm) and both are on par with each other. Increased plant height may be due to increase in shade intensity to some extent was also observed earlier in ginger (Thangaraj *et al*., 1983; Jaswal *et al*., 1993; Amin *et al*., 2010). The presence of shade compelled the plant to become taller in receiving natural light. The expression of enhanced plant height among the genotypes may be attributed to the differential ability of genotypes for the synthesis of phytohormones such as auxins and gibberellins and nutritional factors. This might be due to the fact that plants under shade grow taller primarily due to more sunlight. In this context, etiolated seedlings under shading caused the plants to grow taller due to increase in concentration of certain growth promoting substances like auxins and gibberellins. When auxins are more, the plants are able to absorb and translocate the nutrients to the apical bud. This leads to the conclusion that auxins act on some protoplasmic system leading to altered arrangement of cell wall components and hence greater extensibility leading to increased height (Latha *et al*., 1995).

Significant variation was observed with respect to number of leaves among different genotypes and ZO 26 produced maximum number of leaves (148.56) at 150 DAP (Table 2). The number of leaves on a plant is a sign of rapid growth due to the presence of higher content of nitrogen in the soil. The genotypes showed significant variation with respect to number of tillers during the period of growth. The highest number of tillers (9.8) was recorded in ZO 26. This might be due to higher translocation of stored food in the rhizome to the new sprouts along with favourable climatic conditions during the growth period *viz.*, optimum atmospheric and soil temperature and relative humidity. This finding is in concordance with Durgavathi (2011). Shadap *et al*. (2013) reported the better performance of turmeric on number of tillers per clump and number of leaves per clump planted on the month of June. Significant variation in leaf area among the cultivars was recorded and highest leaf area (2378.72 cm^2) was recorded in ZO 26 at 150 DAP. Channappagoudar *et al*. (2013) reported that increase in leaf area from 60-120 DAP and decreased from 180 DAP to harvest in turmeric. Under low light intensities, reduced irradiation slow down the transpiration

Table 1: Treatment details (Ginger genotypes)

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

Table 2: Mean performance of ginger genotypes on growth characters (150 DAP)

Genotype	Plant height (cm)	No. of leaves	No. of tillers	Leaf area (cm^2)
ZO 1	53.9	95.04	4.8	1786.51
ZO 2	51.9	95.75	4.9	1792.38
ZO 3	52.0	111.35	5.8	1873.92
ZO 4	52.7	88.43	4.4	1628.11
ZO 5	48.9	79.58	4.0	1569.08
ZO 6	48.4	70.19	3.8	1492.36
ZO 7	48.9	79.78	4.1	1573.13
ZO 8	47.5	89.54	4.6	1620.48
ZO 9	48.6	62.50	3.4	1491.02
ZO 10	48.9	97.82	4.9	1790.49
ZO 11	47.5	62.17	3.3	1462.23
ZO 12	43.5	60.15	2.8	1249.17
ZO 13	50.5	87.43	4.4	1527.35
ZO 14	47.6	89.73	4.6	1632.73
ZO 15	46.4	77.82	3.9	1485.02
ZO 16	48.9	61.72	3.0	1362.29
ZO 17	51.7	90.82	4.7	1630.72
ZO 18	49.7	91.04	4.7	1655.36
ZO 19	48.0	93.45	4.8	1762.19
ZO 20	49.7	71.51	3.9	1494.48
ZO 21	54.2	115.47	5.8	1763.02
ZO 22	55.8	127.61	7.0	1976.39
ZO 23	57.8	109.80	5.8	1893.18
ZO 24	53.5	137.62	7.0	2078.68
ZO 25	55.7	132.17	7.0	1992.27
ZO 26	60.0	148.56	9.8	2378.72
ZO 27	54.3	98.47	5.0	1832.39
ZO 28	57.9	139.58	7.3	2179.63
ZO 29	52.9	108.62	5.7	1872.19
ZO 30	53.5	119.52	5.9	1987.37
Mean	51.40	96.44	5.00	1727.76
SEd	1.10	1.87	0.10	0.02
CD at 5%	2.19	3.74	0.20	0.04

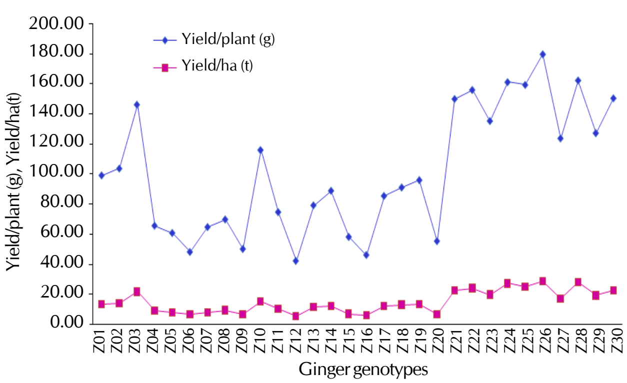

Figure 1: Fresh rhizome yield of different ginger genotypes at 240 DAP

and due to higher leaf water potential marked increase in assimilates were effectively translocated to the growing tips thereby resulting in an increased leaf area. An increased leaf area under reduced light intensity was also reported in ginger by Ravisankar and Muthuswamy (1988).

Significant differences were noticed for yield per plant, yield per plot, estimated yield per hectare and dry recovery percentage of ginger genotypes at 240 DAP (Table.3). Among the genotypes tested, the genotype, ZO 26 had recorded higher per plant yield (179.42 g), plot yield (3.22 kg / 1.13 m^2) and the estimated yield (28.62 t/ha) respectively (Fig. 1). This was closely followed by ZO 28 which recorded a yield of 162.00 g per plant, 3.18 kg per plot (1.13 m^2) and an estimated yield of 28.27 t/ha respectively. Both the genotypes were on par with respect to fresh rhizome yield on per plot and per ha basis. From the data it is obtained that ginger could efficiently utilize lower light intensities for higher growth and yield characters. The variation in the yields of different cultivars grown under similar conditions had been documented by previous work by Indiresh *et al*. (1990) and the research findings are in consonance with the present findings on the variation in yield attributes of different cultivars. From studies conducted in Kerala, India, Jayachandran *et al*. (1998) also indicated that coconut + ginger system under rainfed conditions gave good returns as ginger performed well under shade where a few other crops could do. Dry recovery percentage varied significantly from 18.28 to 25.16 % with a mean of 22.12 %. The genotype, ZO12 had recorded higher dry recovery of 25.16 %. The genotype, ZO 19 had produced the lower dry recovery of 18.28 %. Chongtham *et al*. (2013) stated that agro-climatic condition and cultural practices have a profound influence on determining the quality characters of ginger.

The study indicated that the local genotypes are able to perform better under standard package of practices. It indicated that the suitability of soil and environmental interactions to the particular genotype. The other improved cultivars possibly could not exhibit their fullest potential due to variation in soil and climatic conditions from the area of collection. Based on the

Table 3: Mean performance of ginger genotypes on fresh rhizome yield and dry recovery percentage (240 DAP)

Genotype	Yield per plant (g)	Yield per plot (1.13 m^2)(kg)	Estimated yield per hectare (ton)	Dry recovery percentage (%)
ZO 1	98.92	1.50	13.33	23.61
ZO 2	103.45	1.55	13.78	24.76
ZO 3	145.92	2.43	21.60	23.17
ZO 4	65.47	0.99	8.80	23.70
ZO 5	60.62	0.87	7.73	19.71
ZO 6	48.00	0.72	6.40	21.17
ZO 7	64.57	0.87	7.73	22.07
ZO 8	69.63	1.04	9.24	22.93
ZO 9	50.00	0.73	6.49	22.82
ZO 10	115.74	1.72	15.29	24.55
ZO 11	74.52	1.15	10.22	18.56
ZO 12	42.07	0.60	5.33	25.16
ZO 13	79.00	1.27	11.29	23.88
ZO 14	88.70	1.36	12.09	18.89
ZO 15	58.00	0.76	6.76	23.38
ZO 16	46.00	0.65	5.78	21.43
ZO 17	85.24	1.34	11.91	19.47
ZO 18	90.91	1.45	12.89	24.38
ZO 19	95.76	1.48	13.16	18.28
ZO 20	55.19	0.75	6.67	21.36
ZO 21	149.72	2.55	22.67	22.56
ZO 22	155.72	2.70	24.00	20.22
ZO 23	135.07	2.22	19.73	24.06
ZO 24	160.90	3.05	27.11	20.89
ZO 25	159.07	2.80	24.89	21.70
ZO 26	179.42	3.22	28.62	23.42
ZO 27	123.51	1.90	16.89	21.81
ZO 28	162.00	3.18	28.27	22.31
ZO 29	127.00	2.16	19.20	22.64
ZO 30	150.17	2.55	22.67	20.56
Mean	101.34	1.65	14.68	22.12
SEd	1.83	0.04	0.42	0.39
CD at 5%	3.66	0.08	0.84	0.78

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.

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