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Short Research Article

Physiological Parameters and Yield Characters of Ginger Genotypes (*Zingiber officinale* Rosc.) under Coconut Ecosystem

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Abstract

An experiment was conducted at Coconut Nursery, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period from 2012 to 2013 to study the physiological parameters and yield performance of ginger genotypes under coconut ecosystem. The experiment consisted of thirty ginger genotypes viz., ZO 1 to ZO 30 collected from different parts of India were grown as an intercrop in coconut palmsunder Coimbatore condition as treatments replicated three times in a Randomized Block Design. The genotypes were analyzed for leaf area, leaf area index, crop growth rate, relative growth rate, net assimilation rate and fresh rhizome yield of plant^{-1}, plot^{-1} (1.13 m^2) and estimated hectare yield at 180 and 240 DAP. The results showed the supremacy of the genotype Z0 26 (Idukki 1) over the other genotypes, as ZO 26 showed increment in leaf area (2378.72 cm^2) and leaf area index (3.52) at 150 DAP and yield plant^{-1} (175.26 and 179.42 g), yield plot^{-1} (3.21 and 3.22 kg 1.13 m^2) and estimated yield ha^{-1} (28.52 and 28.62 t ha^{-1}) at 180 and 240 DAP, followed by the genotype ZO 28 which recorded yield plant^{-1} (160.72 and 162.00 g), yield plot^{-1} (3.17 and 3.18 kg^{-1} 1.13 m^2) and estimated yield ha (28.15 and 28.27 t ha^{-1}) at 180 and 240 DAP. On the basis of good performance ZO 26 is adjudged as the suitable ginger genotype under coconut shade conditions.

1. Introduction

Ginger (*Zingiber officinale* Rosc.) is a herbaceous perennial belonging to the family Zingiberaceae and is one of the important and widely used spices throughout the world valued all from ancient period for its aroma, flavor and also medicinal properties. Ginger has been used throughout history as an aid for many for its gastrointestinal disturbances and to relieve inflamed joints. India is the largest ginger producing country in the world and is cultivated in most of the Indian states.

Growing of ginger in coconut plantation proves profitable without hampering the performance of the main crop (Maity and Hore, 2010). Presently the income derived from coconut, essentially a crop of small and marginal farmers is not sufficient to sustain the dependent families. One of the feasible ways of increasing the farm level income is intercropping (Ghosh and Hore, 2011). Association of plant character has always been helpful as a basis for selecting desired genotypes. Many varieties of ginger are available in India which are region specific, varying in plant habit, yield and quality parameters. The performance of ginger grown as an intercrop under coconut ecosystem of Coimbatore has shown an immense potential for its commercial cultivation in Tamil Nadu. However, the information on varieties suitable to this region is scanty and no systematic efforts were made to evaluate the ginger genotypes for their suitability to this region. Hence, the present investigation was under taken to identify a suitable genotype for coconut ecosystems of Coimbatore for commercial cultivation.

2. Materials and Methods

2.1. Study sites

The field experiment was conducted 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).

2.2. Method of data collection

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^{-1} at the time of planting. The land was fertilized with 75, 50 and 50 kg of N, P and K ha^{1}, 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). Leaf area was estimated from the procedure given by Ancy and Jayachandran(1994), leaf area index, relative growth rate and net assimilation rateby Williams (1946) and crop growth rate by Watson (1952). The yield observations were taken randomly from five plants in each plot (1.13 m^2). The mean data collected on various parameters were analyzed statistically.

Table 1: Treatment details (Ginger genotypes)

Treatment	Genotypes	SSR
T_1	ZO 1 (PPI Local)	
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)	A
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)	B
T_{22}	ZO 22 (Nadan)	
T_{23}	ZO 23 (Kerala)	C
T_{24}	ZO 24 (MalaiInji)	
T_{25}	ZO 25 (Maran)	D
T_{26}	ZO 26 (Idukki 1)	
T_{27}	ZO 27 (Idukki 2)	E
T_{28}	ZO 28 (Idukki 3)	
T_{29}	ZO 29 (Karthika)	F
T_{30}	ZO 30 (Athira)	

SSR: Source of the seed rhizomes; A: HRS, Pechiparai; B: Horticultural Research Station, Pechiparai; C: Kanyakumari through HRS, Pechiparai; D: Gudalur of Nilgiri through Hybrid Rice Evaluation Center, Gudalur; E: Idukki district of Kerala; F: Kerala Aagricultural University, Thrissur

3. Results and Discussion

3.1. Physiological parameters

The data on leaf area showed significant variation among different genotypes (Table 2). Larger leaf area $plant^{-1}$ was

Table 2: Mean performance of ginger genotypes on physiological parameters

Genotype	Leaf area (cm^2)	LAI	CGR (g m^{-2} day^{-1})	RGR (mg g^{-1} day^{-1})	NAR (mg cm^{-2} day^{-1})
	150 DAP		120−150 DAP		
ZO 1	1786.51	2.65	8.78	0.013	0.000366
ZO 2	1792.38	2.66	8.71	0.013	0.000361
ZO 3	1873.92	2.78	9.54	0.013	0.000373
ZO 4	1628.11	2.41	7.39	0.011	0.000341
ZO 5	1569.08	2.32	7.26	0.011	0.000350
ZO 6	1492.36	2.21	6.88	0.011	0.000349
ZO 7	1573.13	2.33	7.29	0.011	0.000350
ZO 8	1620.48	2.40	7.26	0.011	0.000336
ZO 9	1491.02	2.21	7.07	0.011	0.000360
ZO 10	1790.49	2.65	8.94	0.013	0.000370
ZO 11	1462.23	2.17	8.33	0.013	0.000432
ZO 12	1249.17	1.85	5.96	0.010	0.000353
ZO 13	1527.35	2.26	7.96	0.012	0.000380
ZO 14	1632.73	2.42	8.16	0.012	0.000375
ZO 15	1485.02	2.20	7.20	0.011	0.000364
ZO 16	1362.29	2.02	6.57	0.011	0.000366
ZO 17	1630.72	2.42	7.87	0.012	0.000362
ZO 18	1655.36	2.45	8.13	0.012	0.000370
ZO 19	1762.19	2.61	8.12	0.012	0.000343
ZO 20	1494.48	2.21	7.21	0.011	0.000365
ZO 21	1763.02	2.61	10.63	0.014	0.000448
ZO 22	1976.39	2.93	10.47	0.014	0.000390
ZO 23	1893.18	2.80	9.65	0.014	0.000375
ZO 24	2078.68	3.08	10.70	0.014	0.000378

Continue...

Genotype	Leaf area (cm^2)	LAI	CGR (g m^{-2} day^{-1})	RGR (mg g^{-1} day^{-1})	NAR (mg cm^{-2} day^{-1})
	150 DAP		120−150 DAP		
ZO 25	1992.27	2.95	10.40	0.014	0.000383
ZO 26	2378.72	3.52	10.59	0.014	0.000323
ZO 27	1832.39	2.71	9.60	0.014	0.000385
ZO 28	2179.63	3.23	10.60	0.014	0.000357
ZO 29	1872.19	2.77	9.17	0.013	0.000363
ZO 30	1987.37	2.94	10.48	0.014	0.000390
Mean	1727.760	2.560	8.560	0.0120	0.000369
SEd	0.017	0.015	0.187	0.0003	0.0000
CD (p=0.05)	0.035	0.030	0.375	0.0005	NS

produced by ZO 26 (2378.72 cm^2) at 150 DAP. This was followed by ZO 28 with the leaf area of 2179.63 cm^2. The genotype ZO 26 recorded higher LAI (3.52) followed by ZO 28 (3.23) and lower LAI was found in ZO 12 (1.85). The importance of leaf area index (LAI) on crop growth is well recognized. The reason for increase in LAI due to increased amount of cellular constituents, mainly protoplasm (Dhar et al., 2008) and also due to influence of photochromes in promotion of cell division, cell enlargement, cell differentiation and cell multiplication. An increase in LAI results in better utilization of solar energy. Leaf size, shape, surface characteristics and orientation naturally affect absorption and reflection of incident light energy with the significant alterations in leaf temperature.

The CGR values ranged from 5.96 g m^{-2} day^{-1} to 10.70 g m^{-2} day^{-1}. Higher CGR value was recorded in ZO 24 (10.70 g m^{-2} day^{-1}) at 120-150 DAP. This might be due to higher photosynthetic efficiency obtained from leaves of the middle and lower portion of the ginger plant under shade and effective translocation of nutrients from soil. The least CGR value was found in ZO 12 (5.96 g m^{-2} day^{1}) at 120-150 DAP. The RGR values ranged from 0.010 to 0.014 mg g^{-1} day^{-1}. Higher RGR of 0.014 mg g^{-1} day^{-1} was recorded by the genotypes ZO 21, 22, 23, 24, 25, 26, 27, 28 and 30 and the genotype ZO 12 was recorded the least RGR value (0.010 mg g^{-1} day^{-1}) at 120−150 DAP.

There is no significant difference was observed in NAR at 120−150 DAP. The genotype ZO 21 recorded higher NAR value (0.000448 mg cm^{-2} day^{-1}). Stomatal and mesophyll resistance to diffusion of CO_2 might be the reason for low rate of NAR under increased shade intensity (Meyer et al., 1973) and this result is in agreement with the findings of Durgavathi (2011). The lowest NAR was recorded by ZO 26 (0.000323 mg cm^{-2} day^{-1}) at 120−150 DAP.

3.2. Yield performance

Yield is a complex character and associated with several yield contributing characters. The fresh rhizome yield varied significantly among the different ginger genotypes tested at 180 DAP (Table 3). Among the genotypes, ZO 26 had

Table 3: Mean performance of ginger genotypes on fresh rhizome yield

Geno-type	180 DAP			240 DAP		
	YPt^{-1} (g)	YP^{-1} (kg 1.13 m^{-2})	EY ha^{-1} (t)	YPt^{-1} (g)	YP^{-1} (kg 1.13 m^{-2})	EY ha^{-1} (t)
ZO 1	95.51	1.44	12.77	98.92	1.50	13.33
ZO 2	97.23	1.46	12.96	103.45	1.55	13.78
ZO 3	143.17	2.41	21.43	145.92	2.43	21.60
ZO 4	63.35	0.96	8.56	65.47	0.99	8.80
ZO 5	58.26	0.84	7.49	60.62	0.87	7.73
ZO 6	47.03	0.70	6.21	48.00	0.72	6.40
ZO 7	61.68	0.87	7.72	64.57	0.87	7.73
ZO 8	66.71	1.00	8.89	69.63	1.04	9.24
ZO 9	49.07	0.71	6.27	50.00	0.73	6.49
ZO 10	110.49	1.69	14.99	115.74	1.72	15.29
ZO 11	70.19	1.12	9.94	74.52	1.15	10.22
ZO 12	40.73	0.58	5.11	42.07	0.60	5.33
ZO 13	75.06	1.19	10.61	79.00	1.27	11.29
ZO 14	86.02	1.34	11.89	88.70	1.36	12.09
ZO 15	57.91	0.74	6.54	58.00	0.76	6.76
ZO 16	44.25	0.62	5.48	46.00	0.65	5.78
ZO 17	83.62	1.28	11.34	85.24	1.34	11.91
ZO 18	89.15	1.42	12.64	90.91	1.45	12.89
ZO 19	93.71	1.43	12.73	95.76	1.48	13.16
ZO 20	53.52	0.73	6.52	55.19	0.75	6.67
ZO 21	148.71	2.53	22.47	149.72	2.55	22.67
ZO 22	153.52	2.58	22.95	155.72	2.70	24.00
ZO 23	129.11	2.17	19.29	135.07	2.22	19.73
ZO 24	160.40	2.98	26.48	160.90	3.05	27.11
ZO 25	158.36	2.76	24.56	159.07	2.80	24.89
ZO 26	175.26	3.21	28.52	179.42	3.22	28.62
ZO 27	120.57	1.86	16.54	123.51	1.90	16.89
ZO 28	160.72	3.17	28.15	162.00	3.18	28.27
ZO 29	125.17	2.13	18.91	127.00	2.16	19.20
ZO 30	149.57	2.54	22.60	150.17	2.55	22.67
Mean	98.940	1.620	14.350	101.340	1.650	14.680
SEd	1.999	0.041	0.374	1.829	0.040	0.422
CD*	4.002	0.082	0.748	3.662	0.080	0.844

YPt^{-1}: Yield plant; YP^{-1}: Yield $plot^{-1}$; EY: Estimated yield; CD*: (p=0.05)

recorded higher plant^{-1} yield (175.26 g), yield plot^{-1} (1.13 m^2) (3.21 kg) and estimated yield ha^{-1} (28.52 t). Similarly, at 240 DAP the genotype, ZO 26 had recorded higher plant^{-1} yield (179.42 g), plot yield (3.22 kg 1.13 m^{-2}) and the estimated yield (28.62 t ha^{-1}) respectively. The genotype, ZO 12 had produced lower yield (42.07 g plant^{-1}, 0.60 kg plot^{-1} (1.13 m^2) and 5.33 t of estimated yield ha^{-1} respectively) at 240 DAP. Variation in crop performance at different location has been observed by Anandaraj et al., 2014 in turmeric. According to Minoru and Hori (1969), ginger could efficiently utilize lower light intensities. Under shade conditions, higher values for leaf area, bulking rate, NAR and CGR were noted indicating better performance of ginger under shaded conditions than in open. Higher yield might be due to higher leaf area exhibited throughout the growth period besides increased total photosynthates accumulated. Early bulking with progressive accumulation of photosynthates from the tiller leaves even after the later stages of the plant growth enhanced the weight of the rhizomes in proportion to their dimensions of mother, primary, secondary and tertiary fingers. The yielding ability of the genotypes could be improved with the optimum morphological an d physiological characters of the plant such as plant height, leaf and tiller production, CGR, RGR, NAR and Photosynthetically Active Radiation (PAR). This is in accordance with the previous works (Ushanandhinidevi, 2004).

4. Conclusion

Dissimilarities recorded in this study revealed a wide variation in genotypes of ginger and 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.

5. References

Anandaraj, M., Prasath, D., Kandiannan, K., John Zachariah, T. , Srinivasan, V., Jha, A.K., Singh, B.K., Singh, A.K., Pandey, V.P., Singh, S.P., Shoba, N., Jana, J.C., RavindraKumar, K., Uma Maheswari, K., 2014. Genotype by environment interaction effects on yield and curcumin in turmeric (*Curcuma longa* L.). Industrial Crops and Products 53, 358−364.

Ancy, J., Jayachandran, B.K., 1994. Leaf area measurement in ginger (*Zingiber officinale* Rosc.). South Indian Horticulture 42(1), 56−57.

Anonymous., 2009. Ginger. Extension Pamphlet. Spices Board, Cochin.

Dhar, L.N., Dubey, R.K.,Ramesh Kumar, Prabhjit Kaur., 2008. Effect of nitrogen and phosphorus on plant growth, flowering and bulb production of tuberose (*Polianthus tuberosa* L.). Journal of Ornamental Horticulture 11(4), 302−305.

Durgavathi, V., 2011. Evaluation of ginger (*Zingiber officinale* Rosc.) genotypes for growth, yield and quality under coconut ecosystem. M.Sc., (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Ghosh, D.K., Hore, J.K., 2011. Economics of a coconut-based inter-cropping system as influenced by spacing and seed rhizome size of ginger. Indian Journal of Horticulture 68(4), 449−452.

Maity, T.K., Hore, J.K., 2010. Coconut based farming system-a paying position for coconut growers. In: Proceedings of National Workshop on Coconut Based Farming System in Andaman and Nicober Islands, Port Blair, 60−64.

Meyer, B.S., Anderson, D.B., Bohning, R.H., Pratianne, D.C., 1973. Introduction to Plant Physiology. D.Van Nustard Company, New York, 540.

Minoru, T., Hori,Y., 1969. Studies on photosynthesis of vegetable crops I. photosynthesis of growing plant vegetables in relation to light intensity. Bull. In: Phil. 139−140 Agr. Series A (Hiartsuka). No.8. Horticultural Research Station. Mini. Agriculture and Forestry, Japan 68, 183−191.

Ushanandhinidevi, H., 2004. Induction of mutagenesis in turmeric (*Curcuma longa* L.) through Gamma rays for variability and quality improvement Ph.D., (Hort.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.

Watson, D.J., 1952. The physiological basis of variation in yield. Advances in Agronomy4, 101−145.

Williams, R.E., 1946. The physiology of plant growth with special reference to the concept of net assimilation rate and relative growth rate. Annals of Botany10, 41−47.