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INFLUENCE OF SEED RHIZOME SIZE AND PLANT SPACING ON GROWTH, YIELD ATTRIBUTES AND YIELD OF GINGER*

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ABSTRACT

A research trail was carried out to elucidate the influence of *seed rhizome size and plant spacing on growth and yield characteristics of ginger (Zingiber officinale Rosc.) cv. Maran under coconut cropping system during May to December-2014 at Horticultural College and Research Institute farm, Anantharajupet (Andhra Pradesh). The field experiment was laid out in a factorial randomized block design comprising of three seed rhizome sizes (20, 30 and 40 g) and five plant spacings (25 X 15, 25 X 25, 30 X 20, 30 X 30 and 40 cm X 20 cm) with three replications. Rhizome size and plant spacing and their interaction effects showed significant influence on the growth, yield and yield components of ginger. Tallest plant at harvest (67.87 cm), highest number of tillers per at harvest (11.51), highest number of leaves per plant (115.36) and highest leaf area index (3.59) recorded with 40 g rhizome size. Wider spacing of 30 cm X 30 cm took least number of days to first sprouting (12.78) and recorded highest number of leaves per plant (106.09) and more number of tillers per plant (11.64).The highest green rhizome yield (27.41 t ha^{-1}) was recorded from 40 g seed rhizome size and lowest yield (19.13 t ha^{-1}) was from 20 g seed rhizome size. The maximum yield (26.40 t ha^{-1}) was recorded from closest plant spacing (25 cm X 15 cm) and lowest (19.92 t ha^{-1}) with 30 cm X 30 cm plant spacing. The most satisfactory yield (38.06 t ha^{-1}) was recorded with 40 g seed rhizome size and 25 cm X 15 cm plant spacing.*

Key words: Ginger, seed rhizome size, spacing, yield

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) belonging to the family Zingeberaceae is an important commercial tropical underground spice crop used both as a spice and medicine. The distinct flavour, aroma and pungency of ginger is due to oleoresins and volatile oils. India is the largest producer, consumer and exporter of this crop in the world. Ginger is widely used in food, beverage and confectionery. Ginger is propagated vegetatively from rhizome and the length and weight of pieces used varies from place to place and variety to variety. The seed rhizome is the economic yield as well as the planting material of ginger. The use of very large seed rhizomes means the loss of the commercial product whereas the use of very small seed rhizome means reduced growth and yield (Hailemichael and Tesfaye, 2008). Development of suitable production technology to boost the crop yield is essential as the yield potential of the variety alone is not sufficient for increasing the yield (Yadav *et al.* 2013). Seed rhizome size, plant spacing are the important aspects of production system of ginger. It is well documented that rhizome sizes and plant spacing have significant influences on the growth and yield of ginger (Monnaf *et al.* 2010). One of the feasible ways of increasing the farm level income is intercropping. Presently the income derived from the coconut mono cropping system is not sufficient to sustain the dependent families of small and marginal farmers in Andhra Pradesh. Growing of ginger in coconut orchard proves profitable without hampering the performance of the main crop and the natural resources i.e., soil, water, air space and solar radiation can be better utilized by raising the ginger as intercrop. Considering these facts, the investigation was undertaken to optimize the seed rhizome size and plant spacing for obtaining higher yield in ginger under coconut intercropping system.

MATERIALS AND METHODS

The present experiment was conducted in a 25 year old coconut orchard during May to December-2014 at Horticultural College and Research Institute, Anantharajupet which is located in Rayalaseema region of the Andhra Pradesh and situated at an altitude of 215 m above MSL and located at 13.98^0 North latitude and 79.40^0 East longitudes. The experiment was laid out in a randomized block design with factorial concept with three seed rhizome sizes of ginger *viz.*, 20, 30 and 40 g and five plant spacings *viz.*, 25 X 15, 25 X 25, 30 X 20, 30 X 30 and 40 cm X 20 cm. fifteen treatment combinations were replicated thrice. The soil type of experimental site is sandy loam with good drainage. The land was prepared and brought to fine tilth by ploughing two times followed by two harrowings and plots were prepared for planting. Ginger rhizome pieces were planted in a raised bed of 1.2 m length,

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1.2 m width and 15 cm height as per the treatment. A basal dose of FYM @ 25 t ha^{-1} was applied and mixed with soil at the time of land preparation and 75 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1} was applied along with neem cake @ 2 tonnes per hectare as per the fertilizer schedule. Ginger cultivar used in the present experiment is Maran brought from Fruit Research Station, Sangareddy (A.P). Maran is improved high yielding indigenous variety of Assam and is characterized by plumpy and bold rhizome with high fibre content (6.10 %) and matures in about 210 days. Planting of pre sprouted seed rhizomes as per the seed rhizome size treatment was done on 15th May and harvesting was done on 21st December-2014. The data pertaining to growth, yield attributes and yield was collected at appropriate times throughout the experimental period from 5 randomly selected plants from each treatment and replication. The data obtained during investigation was statistically analysed as per the procedure and design given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of seed rhizome size

The perusal of data (Table 1) indicated significant influence of seed rhizome size on growth parameters of ginger *viz*., days to first sprouting, plant height, number of tillers per plant, number of leaves per plant and leaf area index. The 40 g seed rhizome size took least number of days to sprouting (12.73). Similarly tallest plants at harvest (67.87 cm), highest number of tillers per plant (11.51), highest number of leaves per plant (115.36) and highest leaf area index (3.59) were recorded with 40 g seed rhizome size and lowest with smaller seed rhizome of 20 g. Variation in growth parameters in ginger due to different seed rhizome size could be attributed to more reserve food material in bigger sized rhizomes resulting in quick emergence and more vigorous growth of the plant leading to the production of more number of leaves per plant, highest number of tillers per plant, tallest plants, quick emergence of plants and increase in leaf area index than the lower seed rhizome size. Increase in growth parameters with the increase in seed rhizome size could be due to larger buds and large amount of food reserves in the larger seed rhizomes has also been reported by Kumar (2005) in turmeric, Monnaf *et al.* (2010) and Sengupta and Dasgupta (2011) in ginger.

Table 1: Effect of seed rhizome size on growth, yield and yield attributes of ginger

Seed rhizome size (g)	Growth parameters					Yield and Yield attributes			
	Days to first sprouting	Plant height at harvest (cm)	Tillers per plant at harvest	Leaves per plant	Leaf area index	Rhizome length (cm)	Rhizome breadth (cm)	Yield per plant (g)	Yield ($t.ha^{-1}$)
20	13.93	60.20	8.72	82.39	3.18	13.09	12.20	165.51	19.13
30	13.47	63.76	10.51	100.71	3.43	14.55	14.79	193.55	21.56
40	12.73	67.87	11.51	115.36	3.59	15.82	15.89	204.01	27.41
S.Em ±	0.26	0.40	0.13	0.99	0.06	0.22	0.17	1.79	1.34
CD (P=0.05)	0.76	1.17	0.36	2.87	0.17	0.63	0.49	5.19	3.87

It is also obvious from the data that yield attributes were significantly influenced by seed rhizome size. The length of the rhizome (15.82 cm), breadth of rhizome (15.89 cm), weight of fresh rhizome (204.01 g $plant^{-1}$) and yield (27.41 t ha^{-1}) were highest with 40 g seed rhizome size (S_3). The variation in yield and yield attributes due to seed rhizome size might be due to the fact that the plants produced from the largest rhizome size emerged earlier and showed vigorous and rapid growth using the initial reserve food materials and producing maximum yield and yield attributes than the smaller rhizome size in ginger. Similar results were reported by Monnaf *et al.* (2010), Ghosh and Hore (2011), Yadav *et al.* (2013) in ginger and. Yadav *et al.* (2013) and Mohamed *et al.* (2014) in turmeric.

Effect of plant spacing

The plant spacings (25 X 15, 25 X 25, 30 X 20, 30 X 30 and 40 cm X 20 cm) exhibited conspicuous and promising improvement towards growth, yield attributes and yield of ginger (Table 2). Wider spacing of 30 cm X 30 cm took least number of days to first sprouting (12.78) and recorded highest number of leaves per plant (106.09) and more number of tillers per plant (11.64). The plant density had marked influence on the capacity of plants to utilize environmental factors in building up the plant tissues through regulation of absorption capacity of plants due to better utilization of resources and lesser plant to plant competition. Hence, the widely spaced plants produced more number of tillers per plant and leaves per plant. These results are in line with those of Kiran *et al.* (2013) in turmeric and Yadav *et al.* (2013) in ginger. However, highest plant height (65.07 cm) and leaf area index (5.25) was recorded from a closer spacing of 25 cm X 15 cm. At closer spacing, more plants per unit area can be accommodated compared to medium and wider spacings as a result tallest plant

Table 2: Effect of plant spacing on growth, yield and yield attributing characters of ginger

Plant spacing (cm)	Growth parameters					Yield and Yield attributes			
	Days to first sprouting	Plant height (cm)	Tillers per plant	Leaves per plant	Leaf area index	Rhizome length (cm)	Rhizome breadth (cm)	Yield per plant (g)	Yield ($t.ha^{-1}$)
25 X 15	13.67	65.07	10.53	102.98	5.25	13.98	13.87	181.22	26.40
25 X 25	13.89	64.76	9.20	97.58	3.33	14.87	14.16	189.82	26.34
30 X 20	12.89	63.58	10.00	90.93	3.21	14.16	14.40	185.04	20.67
30 X 30	12.78	62.38	11.64	106.09	2.45	14.90	14.67	203.02	19.92
40 X 20	13.67	63.93	9.84	99.84	2.75	14.53	14.38	179.33	20.17
S. Em ±	0.34	0.52	0.16	1.28	0.07	0.28	0.22	2.31	1.72
CD (P=0.05)	NS	1.51	0.47	3.70	0.21	NS	NS	6.70	5.00

and more leaf area per unit area of land. Similar results were reported by Kandiannan and Chandaragiri (2006) in turmeric. The maximum rhizome length (14.90 cm), rhizome breadth (14.67 cm) and fresh rhizome yield per plant (203.02 g) were recorded with wider spacing of 30 cm X 30 cm. The longest, broadest rhizome with wider spacing might be due to better availability of plant nutrients, moisture and light in wider spaced plants. Under closer spacing rhizome could not expose properly, which ultimately resulted in smaller rhizome. Similar results were reported by Kiran *et al.* (2013) in turmeric and Yadav *et al.* (2013) ginger. However, green ginger yield (26.40 t ha^{-1}) was significantly highest with a closest spacing of 25 cm X 15 cm, while the lowest (19.92 t ha^{-1}) with 30 cm X 30 cm spacing. The significant increase in yield under closer spacing may solely be ascribed on the function of higher plant density per unit area of land together with efficient availability and utilization of nutrients by the growing plants. Similar results were reported by Ghosh and Hore (2011), Yadav *et al.* (2013) in ginger crop and Mohamed *et al.* (2014) in turmeric.

Table 3: Interaction effect of seed rhizome size and plant spacing on growth, yield and yield attributes of ginger

Treatments	Growth parameters					Yield and Yield attributes			
	Days to first sprouting	Plant height (cm)	Tillers per plant	Leaves per plant	Leaf area index	Rhizome length (cm)	Rhizome breadth (cm)	Yield per plant (g)	Yield ($t.ha^{-1}$)
S_1D_1	15.33	61.53	8.93	92.80	5.00	13.20	11.73	169.07	19.00
S_1D_2	15.00	60.40	7.53	71.33	3.13	12.87	11.47	165.87	18.06
S_1D_3	13.67	62.33	8.47	76.33	3.09	12.60	13.13	160.47	18.42
S_1D_4	12.67	55.27	9.53	93.20	2.12	13.00	11.53	184.93	18.36
S_1D_5	13.00	61.47	9.13	78.27	2.56	13.80	13.13	147.20	21.81
S_2D_1	12.67	66.33	10.20	100.07	4.88	13.53	13.93	173.47	22.14
S_2D_2	13.33	64.20	9.53	108.27	3.51	14.53	15.07	196.80	28.58
S_2D_3	13.33	62.00	10.67	88.60	3.36	14.80	14.60	199.53	19.69
S_2D_4	14.33	63.73	12.33	105.53	2.60	14.87	15.40	208.73	19.17
S_2D_5	13.67	62.53	9.80	101.07	2.79	15.00	14.93	189.20	18.22
S_3D_1	13.00	67.33	12.47	116.07	5.88	15.20	15.93	201.13	38.06
S_3D_2	13.33	69.67	10.53	113.13	3.35	17.20	15.93	206.80	32.39
S_3D_3	11.67	66.40	10.87	107.87	3.18	15.07	15.47	195.13	23.89
S_3D_4	11.33	68.13	13.07	119.53	2.65	16.82	17.07	215.40	22.22
S_3D_5	14.33	67.80	10.60	120.20	2.89	14.80	15.07	201.60	20.47
S. Em ±	0.59	0.90	0.28	2.21	0.07	0.49	0.38	4.01	2.99
CD (P=0.05)	1.71	2.62	0.82	6.42	0.21	1.41	1.10	11.61	8.65

S=Rhizome size; D=Spacing; S_1=20 g; S_2=30 g; S_3=40 g; D_1=25 cm x 15 cm; D_2=25 cm x 25 cm; D_3=30 cm x 20 cm; D_4=30 cm x 30cm; D_5=40 cm x 20 cm

Interaction

Interaction between seed rhizome size and plant spacing differed significantly with respect to growth, yield and yield attributes (Table 3). A combination of 40 g seed rhizome size with 30 cm X 30 cm plant spacing took less number of days to first sprouting (11.33). Similarly highest number of tillers per plant (13.07), maximum rhizome breadth (17.07

cm) and yield per plant (215.40 g) were recorded with 40 g seed rhizome size and 30 cm X 30 cm plant spacing. However, tallest plants (69.67 cm) and maximum rhizome length (17.20 cm) were produced from a combination of 40 g seed rhizome size with 25 cm X 25 cm plant spacing. The highest green ginger yield (38.06 t ha^{-1}) was recorded with combination of 40 g and closest spacing of 25 cm X 15 cm. The highest rhizome yield with larger seed rhizome size and closer spacing might be due to more number of plants per unit area with vigorous and rapid growth of the plant using the initial reserve food material. However growth parameters like tillers per plant and leaves per plant and yield attributes like rhizome length, breadth and yield per plant was highest with larger seed rhizome and wider plant spacing might be due to better availability of plant nutrients, light and moisture and better utilization of resources due to lesser plant competition. Similar results were reported by Ghosh and Hore (2011) in ginger and Mohamed *et al.* (2014) in turmeric.

From the results it can be concluded that both seed rhizome size and plant spacing had significant influence on growth, yield attributes and yield of ginger. Fresh rhizome yield increased with increase in seed rhizome size. Closer spacing had maximum plant height, leaf area index and rhizome yield. However, wider spacing improves the rhizome length, rhizome breadth and rhizome yield per plant. A combination of 40 g seed size with closest spacing of 25 cm X 15 cm has recorded highest rhizome yield due to accommodation of more number of plants per unit area with closer spacing.

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