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Influence of size of seed-rhizome and plant spacing on growth, yield and quality of ginger (*Zingiber officinale* Rose)

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ABSTRACT

A field experiment was conducted during 2017-18 and 2018-19 at the Private Agricultural-cum-Research Farm, Kapsa, Benda-Semaria Road, Rewa (M.P.) to study the influence of size of seed-rhizome and plant spacing on growth, yield and quality of ginger. Four size of seed rhizonse and five spacing were evaluated in factorcal randomized block design with three replications. The best size of seed rhizome for planting was 50 g which enhanced the growth parameters, chlorophyll contents in leaves and yield attributes upto maximum extent and resulted in highest ginger yield upto 22.27 t ha^{-1} and net income upto Rs.311775 ha^{-1} with B:C ratio 3.31 as well as length and breadth of rhizomes. The most optimum planting spacing was 30 x 30 cm which increased the maximum growth characters, chlorophyll content in leaves, yield attributes upto highest extent, but closer 25 x 15 cm plant spacing resulted in maximum ginger production upto 22.48 t ha^{-1} and net income upto Rs.310685 ha^{-1} with 3.19 B:C ratio as well as length and breadth of rhizomes. The combined impact of 50 g seed size with 25 x 15 cm plant spacing further encouraged all these parameters significantly i.e. ginger yield 27.95 t ha^{-1} and net income Rs.400935 ha^{-1} with 3.53 B:C ratio.

Key words: Seed-rhizome, plant spacings, quality, ginger, 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 flavor, 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 influence 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 mono-cropping system is not sufficient to sustain the dependent families of small and marginal farmers in Madhya Pradesh. Growing of ginger in the orchards 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 present investigation was undertaken as a pioneer work to optimize the seed rhizome size and plant spacing for obtaining higher yield in ginger under existing agro-climatic conditions of Kymore plateau of M.P.

MATERIALS AND METHODS

The field experiment was conducted during 2017-18 and 2018-19 at the Private Agricultural-cum-Research Farm, Kapsa, Benda-Semaria Road, Rewa (M.P.). The field soil was silty clay-loam having pH 7.5-7.6, electrical conductivity 0.32 dS m^{-1}, organic carbon 8.6 g kg^{-1}, available N 230 kg ha^{-1}, available P_2O_5 13.8 kg ha^{-1} and available K_2O 381 kg ha^{-1}. The rainfall received from June to January was 759.8 and 853.2 mm in 2017-18 and 2018-19,

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respectively. The experiment was laid out in a randomized block design with factorial concept with four seed rhizome sizes of ginger viz. 20, 30, 40 and 50 g and five plant spacings viz. 25 x 15, 25 x 25, 30 x 20, 30 x 30 and 40 cm x 20 cm. Twenty treatment combinations were replicated thrice. The land was prepared and brought to fine tilth by ploughing two times followed by two harrowing and plots were prepared for planting. Ginger rhizome pieces were planted in a raised bed of 1.25 m length, 1.25 m width and 10-12 cm height as per the treatment. A basal dose of FYM @ 20 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 as per the fertilizer schedule. Ginger cultivar used in the present experiment is improved high-yielding indigenous variety of this region. Planting of pre sprouted seed rhizomes as per the seed rhizome size treatment was done during 1st week of June and harvesting was done during last week of January. Growth characters were recorded at 150 Dap, YIELD AND YIELD ATTRIBUTES WERE RECORDED AT HARVEST. Economics of various treatments was computed on the basis of market prices of inputs and outputs.

RESULTS AND DISCUSSION

Crop growth

The best size of seed rhizome for planting was 50 g which enhanced the growth parameters upto significantly maximum extent i.e. plant height 65.19 cm, tillers 11.70 $plant^{-1}$ and leaves 57.0 $plant^{-1}$ (Table 1). The variation in growth parameters of ginger due to different seed rhizome sizes could be attributed to more reserve food 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 than the lower seed rhizome sizes. The larger buds and larger amount of food reserves in the larger seed rhizomes has also been reported by Sengupta and Dasgupta (2011), Mahender *et al.* (2015) and Asafa and Akanbi (2018) in ginger. The wider (30 x 30 cm) plant spacing was found the most optimum which recorded 62.55cm plant height, 11.57 tiller $plant^{-1}$ and 86.37 leaves $plant^{-1}$ at 150 DAP stage. On the other hand, the closest (25 x 15 cm) plant spacing resulted in the minimum plant height (56.41cm), tillers (8.02 $plant^{-1}$) and leaves (68.68 $plant^{-1}$).

Table 1: Growth, yield-attributes and yield of ginger as influenced by size of seed-rhizome and plant spacings (Mean of two 2 years)

Treatments	Plant height (cm) at150 DAP	Tillers per plant at150 DAP	Leaves per plant at150 DAP	Rhizome length (cm)	Rhizome breadth (cm)	Rhizome yield $plant^{-1}$ (g)
Size of seed-rhizome (g)						
20	55.25	7.27	57.00	9.75	8.56	138.42
30	59.00	9.44	73.64	11.06	11.26	152.05
40	61.93	10.71	88.90	12.35	12.61	159.16
50	62.22	11.70	93.42	13.47	13.72	163.47
CD (P=0.05)	0.18	0.08	1.13	0.036	0.056	1.19
Plant spacings (cm)						
25 x 15	56.41	8.02	68.68	10.78	11.02	146.15
25 x 25	58.32	9.02	77.07	11.34	11.20	150.04
30 x 20	59.62	9.21	76.21	1153	11.46	152.40
30 x 30	62.55	11.57	86.37	12.39	12.36	162.05
40 x 20	61.11	11.08	82.86	12.24	11.65	155.77
CD (P=0.05)	0.20	0.09	1.26	0.040	0.063	1.33

DAP= days after planting

In fact, the different plant spacings (both ways) indicate the variable plant densities. The present investigation evidently shows that 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. Consequently, the widely spaced plants produced more number of tillers per plant and leaves per plant. These results are in close agreement with those of Kiran *et al.* (2013) in turmeric and Yadav *et al.* (2013) and Mahender *et al.* (2015) in ginger.

Yield-attributes

The biggest 50 g seed size planting resulted in significantly higher rhizome length (13.47 cm), rhizome breadth (13.72 cm) as well as fresh rhizome yield (163.47 g plant^{-1}), whereas 20 g seed size recorded the significantly lowest length (9.75 cm), breadth (8.56 cm) and yield (138.42 g plant^{-1}). 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), Mahender *et al.* (2015) and Asaf and Akanbi (2018) in ginger and Yadav *et al.* (2013) and Mohamed *et al.* (2014) in turmeric. In case of plant spacings, the widest 30 x 30 cm plant spacing resulted in significantly higher rhizome length (12.39 cm), rhizome breadth (12.36 cm) as well as rhizome yield (162.05 g plant^{-1}). On the other hand, the closest 25 x 15 cm plant spacing recorded significantly lowest rhizome length (10.78 cm), rhizome breadth (11.02 cm) and fresh rhizome yield (146.15 g plant^{-1})). 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.

Table 2: Effect of size of seed rhizome and spacings on yield amd economics of ginger (mean of 2 years)

Treatments	Rhizome yield (t ha^{-1})	Net income (Rs. ha^{-1})	Difference over 20 g seed size	B:C ratio
Size of seed-rhizome (g)				
20	13.52	160551	---	2.46
30	15.36	189399	28848	2.59
40	20.48	283967	123416	3.23
50	22.27	311775	151224	3.31
CD (P=0.05)	0.20	--	--	--
Plant spacings (cm)				
25 x 15	22.48	310685	125870	3.19
25 x 25	17.70	231835	47020	2.86
30 x 20	18.95	257905	73090	3.10
30 x 30	14.85	184815	---	2.64
40 x 20	15.56	196875	12060	2.71
CD (P=0.05)	0.22	--	--	--

Productivity parameters

Out of four rhizome seed sizes under study, 50 g size brought about significantly higher rhizome yield (22.27 t ha^{-1}). The second best seed size was 40 g (20.48 t ha^{-1}) and the third best size was 30 g (15.36 t ha^{-1} yield) and then 20 g seed size producing only 13.52 t ha^{-1}) ginger yield (Table 2). The higher ginger yields under larger 40 and 50 g seed sized may be on account of increased yield-attributing parameters under these larger seed sizes. The present findings corroborate with those of Monnaf *et al.* (2010), Ghosh and Hore (2011), Yadav *et al.* (2013), Mahender *et al.* (2015) and Asaf and Akanbi (2018) in case of ginger. Out of five plant spacings, the closest 25 x 15 cm spacing produced significantly higher rhizome yield (22.48 t ha^{-1}). This was followed by 30 x 20 cm (18.95 t ha^{-1})), 25 x 25 cm (17.70 t ha^{-1})), 40 x 20 cm (15.56 t ha^{-1}) and then widest spacing 30 x 30 cm produced the lowest yield(14.85 t ha^{-1}). The closest plant spacing (plant density) accommodated highest number of plants per unit area in comparison to the widest spacing between plants. Thus, the highest number of

plants per hectare brought about the highest ginger yield per hectare. These results are in close agreement with those of Kiran *et al.* (2013) in case of turmeric, Yadav *et al.* (2013) and Mahender *et al.* (2015) in case of ginger.

Economics

The planting of biggest seed rhizome size (50 g) gave the highest net income (Rs.311775 ha^{-1}) i.e. higher by Rs.151224 ha^{-1} over 20 g size. This was followed by 40 g and 30 g seed size being higher by Rs.123416 and Rs.28848 ha^{-1}), respectively over 20 g seed size (Table 2). Thus, planting with 20 g seed size came out with the fourth position i.e. net income being lowest (Rs.160551 ha^{-1}). The wide differences in net income due to different seed sizes were owing to differences in their performances towards growth and yield attributes and the costs of seed involved. Thus, the differences in ginger yield per hectare from the different seed sizes were responsible to finalize the ultimate net income per hectare.

Amongst the different plant spacings, the closest spacing (25 x 15 cm) resulted in highest net income upto Rs.310685 ha^{-1} with 3.19 B:C ratio. This net income was higher by Rs.125870 ha^{-1} over the widest (30 x 30cm) spacing and Rs.12060 ha^{-1} over the wider (40 x 20 cm) spacing. Thus, the net income from the widest spacing was lowest (Rs.184815 ha^{-1} with 2.64 B:C ratio). The differences in the income due to different plant spacings was owing to the differences in the number of plans per unit area, thereby the ultimate yield obtained. Finally the differences in ginger yield would fetch the market value accordingly to give net income after deduction of the expenditure incurred.

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