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Effect of Different Seed Rate and Spacing on Yield and Economics of Ginger (*Zingiber officinale* Rosc) Cultivation

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A B S T R A C T

The experiment was carried out with the aim to study on the effect of different seed rate and spacing on yield of ginger. The experiment was carried out at the Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, and West Bengal during the year 2013-14 and 2014-15. The variety 'cv. Gorubathan' was used under the study. These experiment shows that among the five different spacing (20 x 15 cm, 20 x 20 cm, 25 x 20 cm, 25 x 25 cm and 30 x 20 cm) and two seed rhizome size (20g and 30 g), increasing trend in yield per plant was observed with increase in spacing. The plants raised from the bigger seed rhizome (30 g) produced bigger clump 276.13 g. In case of interaction effect, closest spacing (20 x 15 cm) in combination with bigger seed rhizome (30 g) produced highest yield per ha of 13.95 t and 11.04 t. It was observed that maximum cost of cultivation were recorded (Rs. 104,312/-) and (Rs. 101146/-) in both the year respectively with 20x15cm spacing and 30g seed size. The benefit: cost ratio was highest in P_5S_1 (2.16 and2.29) followed by P_4S_1 (2.12 and 2.27) in the respective years.

Introduction

Ginger (*Zingiber officinale* Rosc) is widely used in food, beverage, confectionery and medicine. It is valued in medicine as a carminative and stimulant of gastro intestinal tract. Dry ginger is used for the manufacture of oil, oleoresin, essence, soft drinks etc. India is the largest producer, consumer and exporter of ginger in the world. The size of planting materials and spacing are among the major factors influencing growth, yield and economics of ginger. Considering these the present investigation was undertaken to study the effect of different spacing and seed rate *i.e.* size of seed materials on yield and yield component and economics of ginger cultivation.

Materials and Methods

The experiment was carried out at H.R.S., Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia in two consecutive year (2013-14 and 2014-15). The experiment was laid out in split plot design with three replications. Five different spacing *i.*e. P_1 (20 x 15 cm) P_2 (20 x 20 cm) P_3 (25 x 20 cm), P_4 (25 x 25 cm) and P_5 (30 x 25 cm) as main plot and two seed rate (size of planting material)

i.e. S_1 (20 g) and S_2 (30 g) as subplot treatments were included in this investigation. There were ten treatments combinations. Indofil-M 45 (0.3%) treated rhizome (cv. Gorubathan) were planted in the middle of April during both the years. Fertilizers were applied @ 125: 100: 100 kg NPK / ha. Entire P with ½ K and $1/_3$ N along with FYM @ 20 t / ha were given as basal application. $1/_3$N at 45 DAP and $1/_3$N and $1/_2$ K were applied at 90 DAP followed by earthing up and mulching. The rhizome was harvested at 210 DAP. The observations on different parameters were recorded from five randomly selected plants per replication.

Results and Discussion

The clump weight increased from 225.33 g to 321.66 g and 188.50g to 267.50g with the increase in spacing from 20 x 15 cm to 30 cm x 25 cm in the respective years, so, increasing trend in yield per plant, was observed with increase in spacing, decrease in plant population level. The plants raised from the bigger seed rhizome (30 g) produced bigger clump 276.13 g and 241.80g in two respective years. The yield increased with seed rate (Mohanty *et al.,* 1988). Among the interactions, maximum clump weight (350.66 g) was recorded in plants raised under widest spacing (30 x 25 cm) coupled with bigger (30 g) rhizome (P_5S_2) in the 1st year but minimum clump weight (184.00 g) was recorded in the P_1S_1 (20 x 15 cm, 20 g) treatment combination in the 2nd year. Data presented in table 2 revealed that maximum length of clump 21.03 cm was recorded under widest spacing (30 x 25 cm) in the 1st year. The longest (22.40 cm) clump was recorded from plant at widest spacing (30 x 25cm) *i*.e. less population in combination with bigger seed rhizome (30 g) in 1st year. Maximum breadth was observed 14.80 cm under 30 x 25 cm spacing with 30 g seed size in the 1st year and 12.63 cm in the 2nd year. Higher growth and yield were associated with greater size of planting material (Ghosh *et al.,* 2008).

Higher length of finger was recorded with wider spacing during both the years of experiment. The maximum length of 10.75 cm and 10.68 cm and maximum breadth of 2.99 cm and 2.89 cm were recorded with 30 x 25 cm spacing in the respective years (Table 3). Bigger seed rhizome produced the longer finger as compared to smaller one. In case of interaction effect P_4S_2 (25 x 25 cm, 30 g) treatment produced the longest finger (10.97 cm). Maximum breadth (3.01 cm) was observed in P_5S_2 (30 x 25 cm, 30 g) treatment combination (Table 4). Such a difference in the production can be sought from source-sink relationship in plant. Bigger size of planting material constitutes a stronger sink than the smaller one. Interaction effects of spacing and corm size indicated that P_1S_2 (40 x 40 cm, 500g) combination produced maximum yield per plot of 74.52 kg, 68.37 kg and 71.45 kg during the respective years (1998-2001) and pooled data as compared to minimum yield of 20.26 kg, 17.29 kg and 18.78 kg with P_5S_1 (90 x 85 cm, 300g) combination in the year 1999, 2000 and pooled data, respectively.

Hence, translocation and mobilization of assimilates and nutrients from the source are more, thereby produced superior fingers. Increasing trend in the weight of finger was noticed with increase in spacing up to certain limit. Yield increased linearly as the spacing reduced due to superior yield in the case of high plant populations over that of low plant population (Ghosh and Bandopadhya, 2008). The bigger size rhizome (30 g) recorded maximum weight (66.35 g) of finger. The bigger seed rhizome (30 g) coupled with 30 x 25 cm spacing (P_5S_2) recorded the maximum weight of finger (71.51 g). These results are in good conformity with the observations of Korla *et al.,* (1989), reported mean pseudo

stem of 5.1,6.2,6.3 and 7.1 found from seed size of 5-10g, 10-15g, 15-20g and 20-25g, respectively and also stated that mean yield of 33.3, 65.4, 79.7 and 122.5g per plant found from seed size of 5-10g, 10-15g, 15-20g and 20-25g, respectively. Closer spacing might affect the growth and development of plants due to competition among them for nutrients and other resources available per unit area but under spacing above the optimum, the utilization of the land may be less and thereby the yield might have been reduced. These results are in good conformity with the observations of Singh *et al.,* (2000).

Table.1 Effect of different spacing and seed rate on yield of ginger

Treatment	Yield(t/ha)		Yield (g/plant)		Clump Length (cm)		Clump Breath (cm)	
	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr
P_1 (20 x 15cm)	13.74	10.88	225.33	188.50	18.92	17.98	11.71	11.50
P_2 (20 x 20cm)	11.38	10.22	229.83	210.16	19.21	18.30	13.11	11.88
P_3 (25 x 20cm)	11.03	9.73	252.16	230.50	21.20	19.13	12.85	11.93
P_4 (25 x 25cm)	10.26	9.06	280.00	250.33	21.23	19.85	13.65	12.68
P_5 (30 x 25cm)	9.95	8.38	321.66	267.50	21.71	20.53	14.03	12.66
S.Em.(±)	**0.607**	**0.718**	**9.708**	**21.890**	**1.214**	**0.745**	**0.464**	**0.346**
CD (P=0.05)	**1.979**	**NS**	**31.657**	**NS**	**NS**	**NS**	**1.513**	**NS**
S_1 (20 g)	10.76	9.31	247.46	217.00	19.69	18.42	12.44	11.72
S_2 (30 g)	11.78	10.00	276.13	241.80	21.22	19.90	13.70	12.54
S.Em. (±)	**0.592**	**0.535**	**7.879**	**4.825**	**0.402**	**0.590**	**0.251**	**0.348**
CD (P=0.05)	**1.761**	**1.688**	**24.81**	**15.198**	**1.301**	**NS**	**NS**	**NS**

Table.2 Interaction effect of different spacing and seed rate on yield of ginger

Treatment	Yield (t/ha)		Yield (g/plant)		Clump Length (cm)		Clump Breath (cm)	
	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr
P_1S_1	13.53	10.72	220.00	184.00	17.85	17.24	10.86	10.56
P_1S_2	13.95	11.04	230.66	193.00	19.99	18.72	12.56	12.43
P_2S_1	11.08	10.09	221.33	204.00	18.86	18.28	13.03	11.26
P_2S_2	11.68	10.36	238.33	216.33	19.56	18.33	13.20	12.50
P_3S_1	10.62	9.36	244.33	217.66	20.66	18.13	11.96	11.66
P_3S_2	11.44	10.10	260.00	243.33	21.73	20.14	13.73	12.20
P_4S_1	9.57	8.60	259.00	232.66	20.05	18.66	13.10	12.40
P_4S_2	10.96	9.52	301.00	268.00	22.42	21.05	14.20	12.96
P_5S_1	9.00	7.78	292.66	246.66	21.03	19.80	13.26	12.70
P_5S_2	10.90	8.98	350.66	288.33	22.40	21.25	14.80	12.63
P x S								
S.Em.(±)	**1.323**	**1.198**	**17.619**	**10.790**	**0.899**	**1.319**	**0.562**	**0.778**
CD(P=0.05)	**4.168**	**3.774**	**NS**	**NS**	**2.831**	**NS**	**1.770**	**NS**

Table.3 Effect of different spacing and seed rate on finger of ginger

Treatment	Number		Weight (g)		Length (cm)		Breadth (cm)	
	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr
P_1 (20 x 15cm)	5.93	4.99	61.32	51.51	9.57	9.35	2.39	2.29
P_2 (20 x 20cm)	6.16	5.36	59.38	54.30	9.78	9.10	2.54	2.47
P_3 (25 x 20cm)	4.26	6.0	64.03	55.27	9.96	9.38	2.76	2.68
P_4 (25 x 25cm)	6.43	6.43	67.94	57.63	10.70	10.07	2.79	2.75
P_5 (30 x 25cm)	6.39	5.81	69.62	60.18	10.75	10.68	2.99	2.89
S.Em.(±)	**0.223**	**0.216**	**2.132**	**1.986**	**0.421**	**0.386**	**0.086**	**0.075**
CD (P=0.05)	**0.700**	**0.678**	**6.694**	**6.236**	**1.321**	**1.212**	**0.270**	**0.235**
S_1 (20 g)	5.994	5.532	62.57	54.658	9.962	9.344	2.602	2.586
S_2 (30 g)	6.532	5.910	66.35	56.904	10.35	10.09	2.794	2.652
S.Em. (±)	**0.148**	**0.143**	**1.613**	**1.121**	**0.213**	**0.198**	**0.102**	**0.092**
CD (P=0.05)	**0.464**	**0.449**	**5.064**	**3.519**	**0.759**	**0.684**	**NS**	**NS**

Table.4 Interaction different spacing and seed rate effect of on finger of ginger

Treatment	Number		Weight (g)		Length (cm)		Breadth (cm)	
	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr
P_1S_1	5.66	4.93	60.1	48.81	9.30	9.21	2.21	2.13
P_1S_2	6.20	5.06	62.55	54.21	9.85	9.49	2.58	2.46
P_2S_1	5.93	5.13	56.22	53.68	9.42	8.44	2.40	2.49
P_2S_2	6.40	5.60	62.55	54.93	10.15	9.77	2.69	2.45
P_3S_1	6.26	5.80	62.36	54.80	9.81	8.77	2.67	2.64
P_3S_2	6.53	6.20	65.71	55.75	10.12	9.99	2.86	2.73
P_4S_1	6.06	6.00	66.42	56.75	10.43	9.60	2.75	2.75
P_4S_2	6.80	6.86	69.44	58.52	10.97	10.55	2.83	2.76
P_5S_1	6.06	5.80	67.73	59.25	10.85	10.70	2.98	2.92
P_5S_2	6.73	5.83	71.51	61.11	10.66	10.66	3.01	2.86
P x S								
S.Em.(±)	0.214	0.196	0.972	2.131	0.257	0.261	0.116	0.096
CD(P=0.05	**0.672**	**0.615**	**0.619**	**6.691**	**0.813**	**0.781**	**NS**	**NS**

Table.5 Effect of different spacing and seed rate on economics of ginger cultivation (Rs. /ha)

Treatment	Cost of cultivation		Gross return		Net return		Benefit : Cost	
	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr
P_1 (20 x 15cm)	96,310	91,145	173,706	153,922	77,396	62,777	1.08	1.68
P_2 (20 x 20cm)	83,091	77,806	152,465	147,801	69,374	69,996	1.83	1.89
P_3 (25 x 20cm)	75,170	69,825	149,316	144,021	74,146	74,195	1.98	2.06
P_4 (25 x 25cm)	68,810	63,407	142,431	137,542	73,621	74,137	2.06	2.16
P_5 (30 x 25cm)	64,510	58,985	139,911	131,422	75,401	67,437	2.16	2.22
S.Em.(±)	**6.992**	**7.124**	**1.614**	**3.056**	**5.583**	**8.216**	**0.01**	**0.05**
CD (P=0.05)	**22.801**	**23.231**	**5.263**	**9.967**	**18.207**	**26.792**	**0.03**	**0.15**
S_1 (20-25 g)	71,118	65,773	146,886	139,773	75,767	74,000	2.06	2.12
S_2 (30-35 g)	84,038	78,693	156,246	146,109	72,208	67,416	1.85	1.85
S.Em. (±)	**4.921**	**3.716**	**1.405**	**2.099**	**4.937**	**5.726**	**0.01**	**0.03**
CD (P=0.05)	**15.503**	**11.705**	**4.425**	**6.612**	**15.554**	**18.036**	**0.03**	**0.09**

Table.6 Interaction effect of different treatments on economics of ginger cultivation (Rs. /ha)

Treatment	Cost of cultivation		Gross return		Net return		Benefit : Cost	
	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr	1st Yr	2nd Yr
P_1S_1	86,310	81,145	1,71,816	1,52,482	85,506	71,337	1.99	1.87
P_1S_2	1,06,312	1,01,146	1,75,597	1,55,362	69,285	54,216	1.02	1.53
P_2S_1	75,593	70,305	1,49,766	1,46,362	74,172	76,057	1.98	2.08
P_2S_2	90,590	85,304	1,55,165	1,49,241	64,575	63,936	1.71	1.74
P_3S_1	69,171	63,825	1,45,626	1,40,600	76,456	76,775	2.10	2.20
P_3S_2	81,173	75,825	1,53,005	1,47,442	71,837	71,617	1.88	1.94
P_4S_1	64,010	58,606	1,36,176	1,33,403	72,166	74,795	2.12	2.27
P_4S_2	73,614	68,207	1,48,684	1,41,682	75,076	73,477	2.01	2.07
P_5S_1	60,510	54,985	1,31,046	1,26,024	70,536	71,037	2.16	2.29
P_5S_2	68,512	62,985	1,48,776	1,36,822	80,266	73,837	2.17	2.17
P x S								
S.Em.(±)	11.005	8.216	3.204	4.695	11.041	11.406	0.03	0.07
CD(P=0.05)	34.665	25.880	10.092	14.789	34.780	35.925	0.09	0.22

The data presented in table 1 revealed that yield per hectare of ginger was maximum with closer spacing in both the years. The increase in spacing from 20 x 15 cm to 30 x 25 cm showed a decreasing trend in total yield. Maximum yield of 13.74 t, 10.88 t were obtained under closest spacing (20 x 15 cm) in the respective years. The plant raised from bigger seed rhizome (30 g) recorded the higher yield of 11.78 t and 10.00 t per hectare in the respective years as compared to 10.76 t and 9.31 t from smaller seed rhizome (20 g).In case of interaction effect, closest spacing (20 x 15 cm) in combination with bigger seed rhizome (30 g) produced highest yield of 13.95 t and 11.04 t as compared to minimum yield of 9.00 t and 7.78 t with widest spacing (30 x 25 cm) in combination with smaller seed rhizome (20 g) in the respective years.

The results are in good agreement with Korla *et al.*, (1989) and Randhwa *et al.*, (1972) and Pandey (1999) reported that closer spacing was optimum for getting maximum yield in mango-ginger and kacholam (Family – Zingiberaceae) respectively. The reduction in yield attributes under narrower spacing might be ascribed due to comparatively poor growth and development of individual plants owing to competition for growth resource like space, sun-light, nutrients, moisture etc. which is supported by the earlier findings (Singh *et al.*, 2000; Mohanty *et al.*, 1993).

The cost cultivation, gross return and net return decreased significantly with the increase in spacing (Table 5) decrease of plant population per unit area. It was observed that maximum cost of cultivation were recorded (Rs. 1,06,312/-) and (Rs. 101146/-) in both the year respectively with 20x15cm spacing and 30g seed size. The gross return (Rs. 175,597/-and Rs 155,362) were also highest with this treatment (Table 6). The benefit: cost ratio was highest in P_5S_1 (2.16 and2.29) followed by P_4S_1 (2.12 and 2.27) in the respective years.

It may be concluded that yield maximization and income enhancement point of view in interaction effect, closest spacing (20 x 15 cm) in combination with bigger seed rhizome (30 g) produced highest yield of 13.95 t and 11.04 t/ha, also the highest income of Rs. 175597/-and Rs 155362 during 2013-14 and 2014-15 respectively. These may be suggested as the most effective cultivation option in the Alluvial zone of West Bengal.

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