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Effect of dates of planting and spacing on growth and yield characteristics of ginger (*Zingiber officinale* Ros.) var. IISR Mahima

A R Yadav*, R N Nawale, G N Korake & R G Khandekar

Department of Horticulture, College of Agriculture,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Dapoli, Ratnagiri-415 712, Maharashtra, India.
**E-mail: abijit.yadav54@gmail.com*

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Abstract

A field trial was carried out with an objective to determine the optimum date of rhizome planting and spacing to obtain good growth and yield of ginger var. 'IISR Mahima' at Dapoli (Maharashtra). The experiment was laid out in split plot design with planting dates as main plot treatments (15th April, 1st May, 15th May, 30th May and 15th June) and intra row spacing as sub plot treatments (25 cm × 15 cm, 25 cm × 25 cm and 25 cm × 35 cm) in three replications. It is evident from the results that dates of planting had significant effect on almost all the characters under study. Planting of rhizomes on 15th April showed better growth, yield and yield attributing characters. Among spacing levels, the closer spacing of 25 cm × 15 cm recorded significantly higher plant height, green and dry ginger yield. The interaction treatments showed significant effect for most of the characters except for number of days required for sprouting, per cent sprouting and finger characters. Among the various treatment combinations planting on 15th April and 25 cm × 15 cm spacing exhibited higher plant height, yield of green (40.16 t ha^{-1}) and dry ginger (8.58 t ha^{-1}). Planting after 15th May with wider spacing 25 cm × 35 cm resulted in lower yield.

Keywords: dates of planting, ginger, mahima, spacing, yield

Ginger (*Zingiber officinale* Roscoe.) is one of the major tropical spices of the world which is characterized for its distinct flavor, aroma, pungency with medicinal properties and uses. 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. Proper planting period is an important non-monetary input in crop production. Too early or delayed planting will affect the growth, yield and performance of the crop. Another important factor is the plant spacing which determines the optimum plant population, the degree of competition between plants and consequently the yield. It is reported that plant spacing has considerable influence on growth, yield and yield components in ginger (Raut *et al*. 2004). Considering these facts, the investigation was undertaken to optimize the planting dates and intra row spacing for obtaining higher yields in ginger.

The field trial was carried out during 2008–2009 under agro-climatic conditions of Konkan

region of Maharashtra state. The investigation was carried out in split plot design with dates of planting as main plot treatment *viz*., D_1 (15th April), D_2 (1st May), D_3 (15th May), D_4 (30th May), D_5 (15th June) and spacing S_1 (25 cm × 15 cm), S_2 (25 cm × 25 cm), S_3 (25 cm × 35 cm) as sub plot treatment. Thus, there were 15 treatment combinations replicated thrice in split plot design. The experimental area was demarcated into 45 plots. Raised beds were prepared, each bed having 3 m × 1 m size and 15 cm height. Fifteen beds were allotted for one replication. The treatments were Randomized by Standard Procedure as per Panse & Sukhatme (1997). The distance between two raised beds was 30 cm and that of the replications was 1 m. The healthy seed rhizomes of IISR Mahima variety (Nawale 2008) were cut into small pieces each weighing about 25 g and 2.5 cm – 5.0 cm length, having 2–3 buds. These rhizome bits were treated with Mancozeb (0.3% solution) for 30 minutes and then planted. These seed bits were planted on raised beds at 4 cm depth on respective dates of planting according to the various treatments. A fertilizer dose of NPK @ 150:80:60 kg ha^{-1} and FYM @ 25 tones ha^{-1} were applied as recommended. After planting, the bits were covered with soil. The observations were recorded on randomly selected and tagged five plants in each net plot. The height of plant, number of leaves per main tiller, number of tillers per plant were recorded at various growth stages at 30 days, 120 days and 210 days after planting (DAP). The leaf characters *viz*., length, breadth and leaf area were recorded at 180 days after planting. The average of five plants for a particular character was worked out and presented.

Growth parameters

The data pertaining to number of days required for sprouting of rhizomes as influenced by the treatments are presented in Table 1. The effect of different dates of planting was significant. The planting date of 15th June showed lesser number of days (14.92) for sprouting of rhizomes while 15th April planting date had more days (26.04) for sprouting. The effect of spacing on days for sprouting was non-significant. The highest sprouting (91.06%) was observed in 15th April planting date. This might be due to congenial weather conditions, favorable soil temperature and optimum soil spacing (Aggarwal 2000). The spacing treatment *viz*., 25 cm × 35 cm recorded significantly highest sprouting percentage (83.89%).

The different planting dates showed significant effect on plant height throughout the growth stages (Table 2). 15th April planting showed highest plant height at 120 DAP (53.97 cm) and 210 DAP (87.79 cm) and was significantly superior over other dates of planting. It might be due to more beneficial effect of prevailing congenial weather conditions and desired

Table 1. Days required for sprouting and percent sprouting of ginger as influenced by date of planting and spacing

	Days required for sprouting				Percent sprouting of ginger			
T	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
D_1	26.17	26.07	25.90	26.04	90.55	90.97	91.66	91.06
D_2	24.40	24.33	24.20	24.31	86.11	86.11	87.03	86.42
D_3	23.03	23.00	22.83	22.96	84.44	84.72	86.11	85.09
D_4	17.67	17.63	17.60	17.63	79.44	80.55	81.48	80.49
D_5	14.97	14.93	14.87	14.92	71.11	72.22	73.15	72.16
M	21.25	21.19	21.08		82.33	82.91	83.89	
	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean
D	Sig.	0.01	0.04	—	Sig.	0.16	0.50	—
S	N.S.	0.01	0.04	—	Sig.	0.07	0.21	—
D×S	N.S.	0.12	N.S.	21.17	N.S.	0.689	N.S.	83.04

Table 2. Plant height (cm) of ginger as influenced by date of planting and spacing

	30 DAP				120 DAP				210 DAP			
T	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
D_1	3.60	4.00	4.27	3.96	55.50	53.50	52.90	53.97	92.53	86.13	84.70	87.79
D_2	5.10	5.27	5.33	5.23	54.37	52.37	51.57	52.77	86.10	83.57	83.27	84.31
D_3	5.37	5.47	5.73	5.52	51.70	50.90	50.73	51.11	83.63	82.30	81.93	82.62
D_4	6.13	6.17	6.23	6.18	47.90	46.83	40.40	45.04	78.13	77.40	71.83	75.79
D_5	6.43	6.50	6.60	6.51	42.30	41.13	39.83	41.09	71.53	70.23	69.63	70.47
M	5.33	5.48	5.63		50.35	48.95	47.09		82.39	79.93	78.27	
	F test	S.E.m±	C.D.at 5%		M F test	S.E.m±	C.D. at 5%	Mean	F test	S.E.m±	C.D. at M 5%	
D	Sig.	0.02	0.05	—	Sig.	0.9	0.61	—	Sig.	0.11	0.34	—
S	Sig.	0.01	0.04	—	Sig.	0.07	0.2	—	Sig.	0.09	0.26	—
D×S	N.S.	0.12	N.S.	5.48	Sig.	0.77	2.30	48.80	Sig.	0.78	2.31	80.20

D_1=15th April; D_2=1st May; D_3=15th May; D_4=30th May; D_5=15th June; S_1=25 cm × 15 cm; S_2=25 cm × 25 cm; S_3=25 cm × 35 cm; D × S=Interaction

moisture availability for growth and development of the plants (Bandopadhyay *et al.* 2006) in ginger. The spacing level 25 cm × 15 cm showed greatest plant height at 120 DAP (50.35 cm) and 210 DAP (82.39 cm), which was significantly superior over the other treatments. Under closer spacing, plant might have adjusted its canopy in the vertical space by increasing internode length as there was limited horizontal space while in case of wider spacing, there was less interplant competition resulting in greater horizontal spread, less internode length and shorter plants (Suryawanshi 2007).

The highest number of tillers plant^{-1} (9.93) was recorded in 15th April planting, at 120 DAP and also at 210 DAP (15.19) and it was statistically significant over other planting dates. The effect of spacing on number of tillers plant^{-1} throughout the plant growth stages was significant. The 25 cm × 35 cm spacing produced the highest number of tillers plant^{-1} at 120 DAP (8.79) and 210 DAP (13.91) which was significantly superior to 25 cm × 25 cm and 25 cm × 15 cm. The interaction effect showed significant differences throughout the growth period except at 30 DAP. Significantly higher number of tillers plant^{-1} was produced in 15th April planting and spacing of 25 cm × 35 cm at 120 DAP (10.80) and at 210 DAP (16.03) and was superior over remaining treatments. The number of tillers plant^{-1} was lowest for 15th June planting date and 25 cm × 15 cm spacing.

The data regarding length, breadth and area of leaf presented in Table 4 revealed that 15th April planting produced the longest leaf (20.60 cm), the broadest leaf (2.42 cm) and highest leaf area (42.40 cm^2) whereas 15th June planting produced the shortest leaf (15.68 cm) and the lowest leaf area (18.40 cm^2) and least leaf breadth (1.51 cm). Bandopadhyay *et al.* (2006) also recorded maximum leaf breadth in turmeric when planted in early May. 25 cm × 35 cm spacing produced longest leaf (19.15 cm), the broadest leaf (2.16 cm) and the highest leaf area (35.37 cm^2). The shortest leaf (16.62 cm) was produced by 25 cm × 15 cm spacing. Similar observations were reported by Raut *et al.* (2004) in turmeric, the interaction of 15th April planting date and 25 cm × 35 cm recorded significantly longest leaf (22.39 cm), the broadest leaf (2.57 cm) and the highest leaf area (48.18 cm^2). The shortest leaf (15.20 cm), the least breadth (1.43 cm) and the lowest leaf area (15.40 cm^2) were recorded by 15th June planting with spacing 25 cm × 15 cm.

Yield attributes

The data related to length, breadth and weight

Table 3. Number of tillers per plant as influenced by date of planting and spacing

	30 DAP				120 DAP				210 DAP			
T	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
D_1	1.03	1.13	1.13	1.10	9.03	9.97	10.80	9.93	13.80	15.73	16.03	15.19
D_2	1.07	1.17	1.20	1.14	8.97	9.73	9.90	9.53	13.70	14.90	15.27	14.62
D_3	1.20	1.27	1.30	1.26	8.70	9.13	9.37	9.07	13.60	14.47	14.67	14.24
D_4	1.23	1.37	1.43	1.34	7.40	7.67	8.00	7.69	11.27	12.77	13.10	12.38
D_5	1.27	1.47	1.70	1.48	4.80	5.77	5.90	5.49	9.63	10.30	10.50	10.14
M	1.16	1.28	1.35		7.78	8.45	8.79		12.40	13.63	13.91	
	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean
D	Sig.	0.01	0.03	—	Sig.	0.04	0.12	—	Sig.	0.03	0.09	—
S	Sig.	0.01	0.03	—	Sig.	0.01	0.04	—	Sig.	0.02	0.05	—
D × S	N.S.	0.08	N.S	1.26	Sig.	0.15	4.45	8.34	Sig.	0.14	0.43	13.32

Table 4. Leaf characters of ginger as influenced by date of planting and spacing

	Leaf length (cm)				Leaf breadth (cm)				Leaf area (cm^2)			
T	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
D_1	18.27	21.13	22.39	20.60	2.27	2.43	2.57	2.42	36.48	42.55	48.18	42.40
D_2	17.67	19.73	20.08	19.16	1.97	2.17	2.40	2.18	28.36	36.41	41.55	35.44
D_3	16.27	19.17	19.47	18.30	1.80	2.07	2.27	2.04	25.83	30.42	35.54	30.60
D_4	15.70	16.60	17.47	16.59	1.47	1.97	2.00	1.81	22.90	27.42	30.24	26.85
D_5	15.20	15.47	16.37	15.68	1.43	1.50	1.58	1.51	15.40	18.47	21.33	18.40
M	16.62	18.42	19.15		1.79	2.03	2.16		25.79	31.05	35.37	
	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean
D	Sig.	0.04	0.13	—	Sig.	0.02	0.05	—	Sig.	0.02	0.08	—
S	Sig.	0.02	0.16	—	Sig.	0.00	0.01	—	Sig.	0.02	0.05	—
D × S	Sig.	0.19	0.57	18.06	Sig.	0.04	0.17	1.99	Sig.	0.14	0.42	30.74

D_1=15th April; D_2=1st May; D_3=15th May; D_4=30th May; D_5=15th June; S_1=25 cm × 15 cm; S_2=25 cm × 25 cm; S_3=25 cm × 35 cm; D × S=Interaction
DAP = Days after planting; Sig = Significant; N.S. = Non - Significant

of rhizome harvested for green ginger at 210 DAP are presented in Table 5. The 15th April planting recorded the longest rhizome (24.04 cm), and the broadest (10.31 cm) rhizome. The shortest rhizome was produced by 15th June planting (18.49 cm). Significantly superior rhizome weight was produced by 15th April planting (340.44 g), while the lowest rhizome weight was recorded by 15th June planting (174.44 g). The different levels of spacing showed significant variation regarding rhizome characters. The spacing of 25 cm × 35 cm produced the longest (22.66 cm) and the broadest rhizome (9.90 cm) and recorded the highest rhizome weight (292.93 g). The combination of 15th April planting and 25 cm × 35 cm spacing produced significantly the longest (25.13 cm) and the broadest rhizome (10.81 cm). The 15th June planting and 25 cm × 15 cm spacing recorded significantly the shortest rhizome (17.10 cm) and the lowest rhizome breadth (7.25 cm). The highest rhizome weight was observed in 15th April planting and 25 cm × 35 cm spacing (366.67 g) and the least rhizome weight was recorded by 15th June planting and 25 cm × 15 cm spacing (149.33 g).

Significantly higher green yield was produced by 15th April planting (34.54 t ha^{-1}) and the lowest (17.32 t ha^{-1}) was recorded by 15th June planting dates (Table 6). These findings are in conformity with the results recorded by Ishimine *et al.* (2004) in turmeric. The highest green ginger yield was produced by 25 cm × 15 cm spacing (31.57 t ha^{-1}). The green ginger yield decreased with increase in plant spacing and the significantly lowest green ginger yield (22.50 t ha^{-1}) was recorded by 25 cm × 35 cm spacing. These findings are in line with results obtained by Okwuowulu (1992) in ginger. The interaction between dates of planting and spacing showed significant effect on green ginger yield. The highest green yield was produced by 15th April planting and 25 cm × 15 cm spacing (40.67 t ha^{-1}) while the lowest yield was recorded by 15th June planting at 25 cm × 35 cm spacing (16.39 t ha^{-1}). The data related to yield of dry ginger revealed that 15th April planting produced significantly the highest yield (7.33 t). The lowest dry ginger yield was 3.34 t ha^{-1}. The treatment 25 cm × 35 cm spacing

Table 5. Rhizome characters of ginger as influenced by date of planting and spacing

	Rhizome length (cm)				Rhizome breadth (cm)				Rhizome weight (g)			
T	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
D_1	22.93	24.07	25.13	24.04	9.53	10.59	10.81	10.31	317.33	337.33	366.67	340.44
D_2	21.90	23.47	24.03	23.13	9.27	10.48	10.53	10.09	296.33	307.00	330.67	311.33
D_3	22.20	22.67	23.17	22.68	9.41	9.57	10.50	9.83	254.67	268.33	286.00	269.67
D_4	18.37	20.67	21.23	20.09	7.59	8.66	9.21	8.49	214.33	232.00	267.33	237.89
D_5	17.10	18.63	19.73	18.49	7.25	7.53	8.44	7.74	149.33	160.00	214.00	174.44
M	20.50	21.90	22.66		8.61	9.37	9.90		246.40	260.93	292.93	
	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean
D	Sig.	0.03	0.09	—	Sig.	0.01	0.03	—	Sig.	0.37	1.16	—
S	Sig.	0.01	0.04	—	Sig.	0.01	0.02	—	Sig.	0.33	0.97	—
D × S	Sig.	0.13	0.39	21.69	Sig.	0.05	0.16	9.29	Sig.	2.88	8.50	266.76

Sig = Significant

Table 6. Yield of green ginger as influenced by date of planting and spacing

	Green ginger yield (t ha^{-1})				Dry ginger yield (t ha^{-1})			
T	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
D_1	40.67	34.58	28.38	34.54	8.58	7.38	6.03	7.33
D_2	37.97	31.46	25.41	31.61	7.82	6.49	5.26	6.52
D_3	32.63	27.50	21.97	27.37	6.63	5.63	4.49	5.58
D_4	27.46	23.78	20.54	23.93	5.35	4.66	4.02	4.68
D_5	19.13	16.44	16.39	17.32	3.65	3.19	3.16	3.34
M	31.57	26.79	22.50		6.41	5.49	4.57	
	F test	S.E. m±	C.D. at 5%	Mean	F test	S.E. m±	C.D. at 5%	Mean
D	Sig.	0.04	0.13	—	Sig.	001	003	—
S	Sig.	0.03	0.10	—	Sig.	0.01	0.02	—
D × S	Sig.	0.29	0.85	26.95	Sig.	0.06	0.17	5.49

D_1=15th April; D_2=1st May; D_3=15th May; D_4=30th May; D_5=15th June; S_1=25 cm × 15 cm; S_2=25 cm × 25 cm; S_3=25 cm × 35 cm; D × S=Interaction; Sig = Significant

produced significantly highest yield (6.41 t ha^{-1}) however, the lowest dry ginger yield was noticed in 25 cm × 35 cm spacing (4.57 t ha^{-1}). The interaction 15th April planting and 25 cm × 15 cm spacing produced the highest dry ginger yield (8.58 t ha^{-1}), which was significantly superior over rest of the treatments. The lowest yield was recorded by 15th June planting at 25 cm × 35 cm spacing (3.16 t ha^{-1}). In general the treatment combination *viz*., 15th April planting and 25 cm × 15 cm spacing resulted in the maximum yield of green ginger (40.67 t ha^{-1}). The interaction of the time and density of planting showed better performance due to the higher plant population and dry recovery percentage (Raut *et al.* 2004; Filho *et al.* 2004). 1st May planting at 25 cm × 15 cm spacing (37.97 t ha^{-1}) and 15th May planting at 25 cm × 35 cm spacing (32.63 t ha^{-1}) occupied 2nd and 3rd positions respectively in order of ranking for green ginger yield.

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