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Growth, yield and quality of turmeric (*Curcuma longa* L.) as influenced by planting time and fertility levels

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Abstract

This study was carried out to evaluate the growth, yield and quality of turmeric as influenced by dates of planting and fertility levels. The experiment was laid out in split plot design with four dates of planting (first fortnight of May (D1), second fortnight of May (D2), first fortnight of June (D3) and second fortnight of June (D4) in main plots, four fertility levels (NPK @ 0:0:0 kg ha^{-1} (F0), NPK @ 125:25:30 kg ha^{-1} (F1), NPK @ 150:50:60 kg ha^{-1} (F2) and NPK @ 175:75:90 kg ha^{-1} (F3) in sub plots and two varieties [Rajendra Haldi-5 (V1) and Rajendra Sonia (V2)] in ultimate plots. Yield attributes i.e. weight of primary, secondary and mother rhizomes, number of primary and secondary rhizomes, fresh rhizome yield $clump^{-1}$ and yield ha^{-1} were found to be significantly higher when planted during first fortnight of June. Fertility levels imparted significant effect on plant height, number of tillers $clump^{-1}$, weight of primary, secondary and mother rhizomes, length of mother rhizome, number of primary and secondary rhizomes, fresh weight of rhizome $clump^{-1}$ and yield. These parameters were significantly higher in F2. Among the varieties, Rajendra Sonia performed better with regard to plant height, number of tillers $clump^{-1}$, weight of mother, primary and secondary rhizomes, length of mother rhizomes, number of primary and secondary rhizomes, fresh rhizome weight $clump^{-1}$ and yield. Among the interactions, Rajendra Sonia supplied with NPK @ 175:75:90 kg ha^{-1} produced higher yield and was at par with F2V2 (NPK @ 150:50:60 kg ha^{-1} + Rajendra Sonia).

Keywords: *Curcuma longa*, dates of planting, fertility levels, yield attributes, yield

Introduction

In India, turmeric is mainly cultivated in Tamil Nadu, Andhra Pradesh, Karnataka and Orissa. Among the various problems faced in turmeric production, imbalanced fertilizer use is the most important. Balanced fertilizer application is a pre requisite for a healthy high yielding crop. Therefore, nutrient management becomes imperative for increasing the production. High yielding varieties play a vital role in enhancing

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yield and profit. Lack of high yielding varieties and meager information on improved/scientific management practices hinders the production of a profitable crop of turmeric in Uttar Pradesh. Hence, the objective of the paper was to develop package of practices comparing suitable varieties, date of planting and fertility levels for realizing higher yield from turmeric.

Materials and methods

The field experiment was conducted during 2004–05 and 2005–06 at the experimental farm of Department of Horticulture, Kulbhaskar Ashram Post Graduate College (KAPG), Allahabad, Uttar Pradesh. The experiment was carried out on a clay loam soil, having near neutral pH (7.6), low organic C (0.30%) and available N (171.2 kg ha^{-1}), P (9.8 kg ha^{-1}) and K (213.4 kg ha^{-1}). The temperature and relative humidity during the experimental period was 11.10°–44.60° C & 27.40%–80.50% (2004–05) and 9.0°–43.20° C & 32.40%–79.80% (2005–06), respectively. The experiment was laid out in split plot design with three replications. Dates of planting were the main plot treatments, fertility levels were the sub plot treatments and varieties the ultimate plot treatments. The crop was planted at 40 cm × 20 cm spacing in flat method.

The four dates of planting were first fortnight of May (D1), second fortnight of May (D2), first fortnight of June (D3) and second fortnight of June (D4). The four fertility levels were NPK @ 0:0:0 kg ha^{-1} (F0), NPK @ 125:25:30 kg ha^{-1} (F1), NPK @ 150:50:60 kg ha^{-1} (F2) and NPK @175:75:90 kg ha^{-1} (F3) as sub plot. The two varieties evaluated were Rajendra Haldi-5 (V1) and Rajendra Sonia (V2). FYM @ 25 t ha^{-1} was thoroughly incorporated along with the total quantity of P and K as basal dose. The N was applied in three equal splits i.e 45, 75 and 105 days after planting as per treatments after weeding and hoeing. For the protection from fungal disease and pests, the rhizomes were treated with bavistin @ 1 mg L^{-1} and monocrotophos @ 2.5 mL L^{-1} of water before planting. A light irrigation was given to each plot immediately after planting. The crop was harvested during the month of January.

Results and discussion

Effect of dates of planting

During both the years, dates of planting imparted significant effect on plant height and number of tillers per clump. The maximum plant height (129.50 cm and 128.90 cm) and number of tillers per clump (2.99 and 3.61) were obtained when planted during first fortnight of June and this was significantly superior over rest of the dates of planting (Table 1). Hu *et al.* (1996) and Mishra *et al.* (1997) reported that mid May was the best planting time, while Yadav (2000) reported that 14th June was best the time for planting. Dates of planting also influenced the yield and yield attributes. The maximum weight and length of mother rhizome (38.85 g, 38.15 g and 4.38 cm, 4.32 cm during 2004–05 and 2005–06, respectively), weight and number of primary and secondary rhizomes were produced due to planting in the first fortnight of June (D3) during both the years (Table 2). Decrease in yield attributes due to delayed planting of turmeric has been reported by Mishra *et al.* (1997) and Yadav (2000). Maximum weight of fresh rhizome per clump and yield (320.50 g, 324.70 g and 389.02, 394.33 q ha^{-1} during 2004–05 and 2005–06, respectively) were observed with planting in the first fortnight of June (D3) and it was significantly higher than the other dates of planting (Table 3). However, as the planting date was delayed, a drastic reduction was observed in the weight of fresh rhizomes per clump and rhizome yield (Table 3). Planting at fortnight intervals did not significantly affect the moisture and dry matter percent of turmeric during both the years. However, planting during first fortnight of June (D3) resulted in significantly higher curcumin content (5.36% and 5.33% during 2004–05 and 2005–06, respectively). There was an increase in curcumin content as the planting date progressed from D1 (first fortnight of May) to D3 (first fortnight of June). However, as the planting date was delayed there was a slight reduction in curcumin content (Table 4).

Table 1. Growth parameters as influenced by dates of planting, fertility levels and varieties of turmeric

Treatment	2004–05		2005–06	
	Plant height (cm)	Number of tillers clump^{-1}	Plant height (cm)	Number of tillers clump^{-1}
Dates of planting				
First fortnight of May (D1)	119.92	2.82	118.57	3.26
Second fortnight of May (D2)	125.61	2.86	126.20	3.40
First fortnight of June (D3)	129.50	2.99	128.90	3.61
Second fortnight of June (D4)	124.77	2.85	119.19	3.34
SEm±	1.31	0.03	2.42	0.04
CD (P<0.05)	4.56	0.11	8.39	0.15
Fertility levels (NPK kg ha^{-1})				
0:0:0 (F0)	73.77	2.33	72.07	2.48
125:25:30 (F1)	122.48	2.75	119.52	3.67
150:50:60 (F2)	150.64	3.21	149.68	3.68
175:75:90 (F3)	152.89	3.23	151.57	3.79
SEm±	1.69	0.03	2.20	0.04
CD (P<0.05)	4.93	0.09	6.43	0.11
Varieties				
Rajendra Haldi – 5 (V1)	121.90	2.84	120.08	3.34
Rajendra Sonia (V2)	128.00	2.92	126.35	3.45
SEm±	1.04	0.02	1.45	0.03
CD (P<0.05)	3.02	0.07	4.20	0.10

Interactions: NS

Table 3. Rhizome yield (q ha^{-1}) as influenced by dates of planting, fertility levels and varieties of turmeric

Treatments	Weight of fresh rhizomes clump^{-1} (g)		Rhizome yield (q ha^{-1})	
	2004–05	2005–06	2004–05	2005–06
Dates of planting				
First fortnight of May (D1)	279.39	284.83	323.93	328.73
Second fortnight of May (D2)	312.05	306.63	363.31	367.46
First fortnight of June (D3)	320.50	324.70	389.02	394.33
Second fortnight of June (D4)	298.01	301.51	371.83	375.96
SEm±	2.26	4.17	2.91	4.35
CD (P<0.05)	7.83	14.43	10.09	15.07
Fertility levels (NPK kg ha^{-1})				
0:0:0 (F0)	180.21	181.99	223.77	226.24
125:25:30 (F1)	295.56	296.71	364.75	369.56
150:50:60 (F2)	365.78	366.37	426.01	432.26
175:75:90 (F3)	368.42	372.60	433.57	438.12
SEm±	3.71	4.19	6.93	4.43
CD (P<0.05)	10.83	12.24	20.23	12.93
Varieties				
Rajendra Haldi – 5 (V1)	298.58	301.06	349.86	353.63
Rajendra Sonia (V2)	306.40	307.77	374.19	379.46
SEm±	2.32	2.08	4.15	3.71
CD (P<0.05)	6.71	6.00	11.99	10.73

Table 2. Yield attributes as influenced by dates of planting, fertility levels and varieties of turmeric

Treatment	Mother rhizome				Primary rhizome				Secondary rhizome			
	Weight (g)		Length (cm)		Number		Weight (g)		Number		Weight (g)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Dates of planting												
First fortnight of May (D1)	34.19	33.32	4.22	4.20	6.72	6.69	173.29	171.72	4.75	4.70	62.32	73.04
Second fortnight of May (D2)	37.30	35.98	4.23	4.21	6.74	6.67	181.14	180.89	4.78	4.74	80.00	91.23
First fortnight of June (D3)	38.85	38.15	4.38	4.32	7.10	7.05	189.38	187.76	4.80	4.82	83.72	94.27
Second fortnight of June (D4)	37.63	36.44	4.22	4.22	6.74	6.66	178.03	174.72	4.67	4.75	78.23	87.80
SEm±	0.33	0.49	0.04	0.02	0.09	0.10	2.37	4.75	0.04	0.03	0.91	0.53
CD (P<0.05)	1.16	1.69	0.14	0.09	0.32	0.35	7.85	NS	NS	NS	3.51	1.86
Fertility levels (NPK kg ha^{-1})												
0:0:0 (F0)	33.46	32.54	3.83	3.80	4.33	4.25	84.34	82.67	4.06	4.17	56.39	64.21
125:25:30 (F1)	35.76	34.72	4.23	4.20	6.46	6.41	175.76	172.19	4.56	4.46	75.73	82.76
150:50:60 (F2)	38.80	37.78	4.46	4.45	8.23	8.18	227.91	226.86	5.15	5.18	85.07	98.22
175:75:90 (F3)	39.96	38.90	4.54	4.50	8.28	8.23	233.82	233.34	5.24	5.20	87.06	101.15
SEm±	0.50	0.42	0.03	0.02	0.07	0.05	2.22	2.89	0.05	0.03	0.83	1.08
CD (P<0.05)	1.46	1.25	0.10	0.06	0.21	0.17	6.50	8.45	0.14	0.09	2.45	3.16
Varieties												
Rajendra Haldi – 5 (V1)	36.04	34.99	4.23	4.20	6.72	6.67	178.02	176.16	4.68	4.72	74.49	84.45
Rajendra Sonia (V2)	37.95	36.95	4.30	4.28	6.93	6.86	182.89	181.38	4.82	4.78	77.63	88.72
SEm±	0.23	0.29	0.03	0.02	0.06	0.06	1.46	2.13	0.03	0.02	0.65	0.67
CD (P<0.05)	0.67	0.84	NS	0.07	0.19	0.17	4.22	NS	0.09	NS	1.89	1.93

Interactions: NS

Table 4. Quality parameters as influenced by dates of planting, fertility levels and varieties of turmeric

Treatment	2004-05			2005-06		
	Moisture (%)	Dry matter (%)	Curcumin (%)	Moisture (%)	Dry matter (%)	Curcumin (%)
Dates of planting						
First fortnight of May (D1)	76.64	23.35	5.03	76.63	23.36	5.00
Second fortnight of May (D2)	76.86	23.07	5.10	76.83	23.16	5.10
First fortnight of June (D3)	76.98	23.02	5.36	76.95	23.04	5.33
Second fortnight of June (D4)	76.96	23.03	5.09	76.94	23.05	5.08
SEm±	0.50	0.10	0.06	0.50	0.22	0.05
CD (P<0.05)	NS	NS	0.22	NS	NS	0.18
Fertility levels (NPK kg ha^{-1})						
0:0:0 (F0)	76.46	23.53	4.80	76.30	23.70	4.77
125:25:30 (F1)	76.79	23.20	5.08	76.93	23.07	5.04
150:50:60 (F2)	77.03	22.96	5.29	77.05	22.94	5.32
175:75:90 (F3)	77.16	22.77	5.79	77.08	22.91	5.40
SEm±	0.52	0.12	0.03	0.67	0.25	0.03
CD (P<0.05)	NS	0.35	0.10	NS	0.75	0.09
Varieties						
Rajendra Haldi – 5 (V1)	76.88	23.11	4.88	76.86	23.13	4.68
Rajendra Sonia (V2)	76.84	23.12	5.59	76.82	23.17	5.58
SEm±	0.39	0.07	0.03	0.64	0.18	0.02
CD (P<0.05)	NS	NS	0.09	NS	NS	0.06

Effect of fertility levels

Fertility levels exerted significant effect on growth characters. The maximum plant height and number of tillers per clump (152.89 cm, 151.57 cm and 2.99, 3.61, respectively) was observed with NPK @ 175:75:90 kg ha^{-1} (F3). However, difference between F3 and F2 was not significant. Similar findings have also been reported by Rana & Ratan (1994), Pranjal *et al.* (1994), Banafar & Tiwari (1995), Shashidharan *et al.* (1997) and Yadav (2000) in turmeric. Yield attributes *viz*., weight of mother, primary and secondary rhizomes (g), length of mother rhizome, number of primary and secondary rhizomes, weight of fresh rhizome per clump and rhizome yield were significantly influenced due to fertility levels during both the years of experiment. The highest weight of mother rhizome (39.96 g and 38.90 g), length of mother rhizome (4.54 cm and 4.50 cm), weight of primary rhizomes (233.82 g and 233.34 g), number of primary rhizomes (8.28 and 8.23), weight of secondary rhizomes (87.06 g and 101.15 g), number of secondary rhizomes (5.24 and 5.20), weight of fresh rhizome clump^{-1} (368.42 g and 372.60 g) and rhizome yield (433.57 and 438.12 q ha^{-1}) were produced by the application of F3 (NPK @ 175:75:90 kg ha^{-1}) during both the years. However, the difference between F3 (175:75:90 kg NPK ha^{-1}) and F2 (150:50:60 kg NPK ha^{-1}) was not significant (Tables 1, 2 & 3). Earlier workers have also reported increase in yield and yield attributes with increasing doses of fertilizers (Sheshagiri & Uthaiah 1994; Yadav 2000). Effect of fertility levels on moisture and dry matter content was not significant. But significant increase in curcumin content was obtained with increasing fertility levels. Maximum curcumin content (5.79% and 5.40%) was obtained with F3 (175:75:90 kg NPK ha^{-1}) during 2004–05 and 2005–06, respectively, however, F3 and F2 were found to be at par during 2005–06 (Table 4).

Effect of varieties

Rajendra Sonia produced taller plants (128.00 cm, 126.35 cm) with greater number of tillers per clump (2.92, 3.45). Rajendra Sonia also had significantly higher weight of mother rhizome (37.95, 36.95), length of mother rhizome (4.30, 4.28), weight of primary rhizome (182.89, 181.38), number of primary rhizomes (6.93, 6.86), weight of secondary rhizome (77.63, 88.72), number of secondary rhizomes (4.82, 4.78), weight of fresh rhizome per clump (306.40 g, 307.77 g) and rhizome yield (374.19, 379.46 q ha^{-1}) during both the years than Rajendra Haldi-5 (Tables 1 to 3). Similar results were also reported by Maurya (1990), Nandi (1990), Mishra *et al.* (1997) and Yadav (2000) in high yielding improved varieties. Less moisture and high dry matter content were observed in Rajendra Sonia (V2) but differences were not significant during both the years (Table 4). Rajendra Sonia had significantly higher curcumin content in both the years than Rajendra Haldi-5.

The conjunctive use of date of planting, fertility levels and varieties failed to bring significant differences in all characters except rhizome yield and curcumin content. The combined effect of fertility levels and varieties was significantly higher with rhizome yield during both the years (Table 5). Maximum yield of rhizomes (q ha^{-1}) i.e. 451.93 during 2004–05 and 457.93 during 2005–06 was observed under the treatment F3V2 (175:75:90 kg NPK ha^{-1} with Rajendra Sonia) which was at par with F2V2 (150:50:60 kg NPK ha^{-1} with Rajendra Sonia). Interaction of date of planting and varieties was found to be significant during both the years (Table 6). Combination of planting in first

Table 5. Yield of rhizome (q ha^{-1}) as influenced by interaction between fertility levels and varieties

Fertility levels (NPK kg ha^{-1})	Varieties	
	Rajendra Haldi-5 (V1)	Rajendra Sonia (V2)
2004–05		
0:0:0 (F0)	221.59	225.95
125:25:30 (F1)	355.64	373.86
150:50:60 (F2)	407.00	445.86
175:75:90 (F3)	415.21	451.93
SEm±	8.35	
CD (P<0.05)	23.98	
2005-06		
0:0:0 (F0)	224.37	228.10
125:25:30 (F1)	360.05	379.07
150:50:60 (F2)	411.79	452.73
175:75:90 (F3)	418.31	457.93
SEm±	7.43	
CD (P<0.05)	21.46	

Table 6. Curcumin content (%) as influenced by interaction between dates of planting and varieties

Varieties	Dates of planting			
	D1	D2	D3	D4
2004–05				
Rajendra Haldi-5(V1)	4.58	4.68	4.81	4.73
Rajendra Sonia (V2)	4.48	5.53	5.93	5.46
SEm±	0.06			
CD (P<0.05)	0.19			
2005–06				
Rajendra Haldi-5(V1)	4.56	4.68	4.78	4.73
Rajendra Sonia (V2)	5.45	5.54	5.90	5.45
SEm±	0.04			
CD (P<0.05)	0.13			

fortnight of June and variety Rajendra Sonia (D3 × V2) performed better than all the combinations and registered curcumin content of 5.93% and 5.90% during 2004–05 and 2005–06, respectively. Hence, planting turmeric variety Rajendra Sonia during first fortnight of June with 150:50:60 kg NPK ha^{-1} will provide better yield and quality.

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