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Effect of method of planting and harvesting time on growth, yield and quality of turmeric (*Curcuma longa* L.)

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Abstract

An experiment was conducted at Ludhiana (Punjab) to study the influence of method of planting (flat and ridge planting) and harvesting time (10 November-12 March) on growth, yield and of quality turmeric (*Curcuma longa*). Planting methods did not influence growth, yield and quality of turmeric significantly. Harvesting on 12th March produced maximum fresh rhizome yield of 28.94 t ha^{-1} (mean yield) of turmeric which was statistically on par with 20th February (27.61 t ha^{-1}) and 30th January (26.78 t ha^{-1}) harvesting, but was significantly better than all the earlier harvesting dates. A similar trend was observed in processed turmeric yield. The number and weight of rhizomes improved significantly with delay in harvesting. The oil and curcumin content also increased with delay in harvesting.

Keywords: *Curcuma longa*, growth, method of planting, quality, time of harvesting, turmeric, yield.

Introduction

Turmeric (*Curcuma longa* L.) offers good scope in diversification of cereal based cropping system in Punjab. The time of maturity of turmeric may vary in different agro climatic zones of the country and it is important to find out the optimum time for harvesting turmeric to fit this crop in the existing cropping system of the state. Optimum stage of harvesting plays an important role in obtaining high quality turmeric in terms of essential oil and curcumin contents. No information is available on the effect of harvesting time on yield and quality of turmeric under Punjab conditions. Hence, the present study was conducted to determine the optimum harvesting time under flat and ridge planting methods in turmeric.

Materials and methods

The investigation was carried out at Students' Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana (Punjab) during 2003-04 and 2004-05. The soil of experimental field was loamy sand, normal

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with respect to pH (8.0) and EC (0.2 dSm^{-1} at 25°C), low in organic carbon (0.23%) and available nitrogen (210 kg ha^{-1}), medium in available phosphorus (17 kg ha^{-1}) and potash (207 kg ha^{-1}). The treatments consisted of two planting methods (flat and ridge) and seven dates of harvesting namely, 10th November (187 DAP), 30th November (207 DAP), 20th December (227 DAP), 10th January 247 (DAP), 30th January (267 DAP), 20th February (287 DAP) and 12th March (307 DAP). Planting of PCT-8 variety of turmeric was done on 7th May at 30 cm x 20 cm in flat planting treatment and in ridge planting treatment on ridges made at 60 cm apart with a plant to plant spacing of 10 cm to maintain uniform planting density in both the planting methods during both the years. Farmyard manure (30 t ha^{-1}) was thoroughly mixed at the time of seed bed preparation. A basal dose of phosphorus and potassium (each of 25 kg ha^{-1}) was applied at seed bed preparation; 30 kg N ha^{-1} was applied after emergence of crop. To keep the weeds under check, pendimethalin 30 EC (2.5 l ha^{-1}) was sprayed 3 days after planting and four hand weedings were also done. After hoeing (last two), earthing up in ridge planting treatment was done. Growth and yield parameters namely, plant height, green leaves $plant^{-1}$, senescence, number and weight of mother, primary and secondary rhizomes (g), were recorded at harvest. Senescence was computed as number of senescenced (dry) leaves/total number of leaves x 100. The crop was harvested by digging on different dates in both the planting methods just after the removal of shoots near the ground. The essential oil (% v/w) content was determined using Clevenger's apparatus in which 25 g of turmeric powder was distilled for 4.5 h and essential oil yield was determined. The curcumin content was determined following the method given in Thimmaiah (1999).

Results and discussion

Effect of planting method

Different planting methods did not influence the number of green leaves $plant^{-1}$, leaf senescence and the number and weight of mother, primary and secondary rhizomes, during both the years (Tables 1 & 2). Plants were taller in flat method of planting as compared to ridge method during 2003-04 and the differences were not significant during 2004-05 (Table 1).

During 2003-04, fresh turmeric rhizome yield was significantly higher in flat planting method than ridge method while the difference was not significant during 2004-05 (Table 3). Pooled analysis of the mean data indicated that the differences in fresh rhizome yield was not significant. A similar trend was observed with dry and processed yield of turmeric. The non-significant differences in fresh, dry and processed yield due to different planting methods might be attributed to the non-significant differences in growth and yield attributing characters of turmeric. The soil of the experimental field was light and low in organic carbon as well as available nitrogen due to which different planting methods might have failed to influence the yield and growth characters. Ramachandran & Muthuswami (1984) reported non-significant results in fresh rhizome yield, when turmeric was sown by different types of planting methods namely, ridge and furrow, flat bed and broad ridge method. The oil content and curcumin content in rhizome did not change significantly with different planting methods (Table 3). Kaur (2001) also reported that curcumin content did not change in flat and ridge planted turmeric at Ludhiana.

Effect of harvesting date

The effect of different harvesting dates on plant height was not significant during both the years of study (Table 1). The delay in harvesting decreased the number of green leaves $plant^{-1}$ significantly during both the years (Table 1). The reduction in number of green leaves at harvest with delay in harvesting might be due to more drying and deterioration of leaves with passage of time, especially those which come in contact with the soil. In addition to this, tearing / rotting

Table 1. Effect of planting methods and harvesting dates on growth characters of turmeric recorded at harvest

Treatment	Growth parameter					
	2003-04			2004-05		
	Height (cm)	Leaves (green) plant^{-1}	Senescence (%)	Height (cm)	Leaves (green) plant^{-1}	Senescence (%)
Planting method						
Flat	53.9	15.3	67.76 (61.77)*	54.9	14.4	77.99 (69.84)
Ridge	47.5	14.5	65.52 (59.95)	55.0	14.2	76.96 (68.91)
CD (P=0.05)	3.8	NS	NS	NS	NS	NS
Harvesting date						
10 November	47.0	17.6	21.47 (27.55)	53.0	15.5	23.98 (29.28)
30 November	47.5	16.8	27.29 (31.39)	53.4	16.5	38.84 (38.51)
20 December	48.6	16.2	48.12 (43.86)	55.2	14.6	80.99 (62.68)
10 January	51.4	14.6	69.69 (55.63)	54.0	13.7	99.45 (87.40)
30 January	52.8	14.3	100.0 (89.20)	57.9	13.6	100.0 (89.24)
20 February	51.7	13.5	100.0 (89.20)	54.3	13.3	100.0 (89.25)
12 March	52.6	11.3	100.0 (89.20)	57.5	12.8	100.0 (89.25)
CD (P=0.05)	NS	2.2	4.82	NS	1.5	2.90

*Figures in parenthesis are arc-sine transformation; Interactions: NS

of leaves also increased as harvesting was delayed. Similar results were reported by Govind & Gupta (1987), that number of leaves plant^{-1} increased only up to middle of October and thereafter number of leaves plant^{-1} became constant.

Each delay in harvesting increased the number of mother, primary and secondary rhizomes plant^{-1} except mother rhizomes during 2004-05 (Table 2). Govind & Gupta (1987) also reported that total number of rhizomes increased from 7.6 to 47.5 plant^{-1} as the harvesting of turmeric was delayed from mid of August to end of December. The effect of different harvesting dates on fresh weight of mother, primary, secondary as well as total rhizome weight plant^{-1} was significant during both the years (Table 2). With each delay in harvesting, the weight of mother, primary and secondary rhizomes increased except in case of primary (20th December) and secondary rhizome (12th March) during 2003-04. The increase in number and weight of different rhizomes with each delay in harvesting was due to the longer growth period of the plants during which they absorb more moisture and nutrients through their roots and hence resulted in increased number and weight of different rhizomes. Each delay

Table 2. Effect of planting methods and harvesting dates on number and weight of rhizomes plant^{-1}

Treatment	No. of rhizomes plant^{-1}											
	2003-04						2004-05					
	Mother		Primary		Secondary		Mother		Primary		Secondary	
	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)
Planting method												
Flat	3.42	80.10	7.05	55.35	6.12	10.85	3.22	81.92	6.67	76.13	6.41	19.66
Ridge	3.45	79.85	7.38	54.17	5.11	9.36	3.14	81.98	6.73	79.84	6.34	20.35
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Harvesting date												
10 November	3.10	56.66	5.87	35.96	4.85	7.93	3.02	64.07	5.82	49.00	5.02	11.66
30 November	3.30	57.12	6.68	43.75	5.10	9.01	3.07	65.05	5.90	54.45	5.05	12.04
20 December	3.33	62.20	7.15	43.43	5.25	9.32	3.10	70.43	5.92	58.90	5.22	13.55
10 January	3.50	78.41	7.50	55.35	5.27	9.52	3.22	86.78	6.90	76.03	6.48	18.97
30 January	3.55	92.25	7.52	64.50	5.45	10.72	3.20	89.41	7.05	81.18	6.60	20.04
20 February	3.56	104.63	7.80	66.20	6.55	12.21	3.20	95.66	7.50	105.53	7.73	29.43
12 March	3.73	108.38	7.98	75.15	6.82	12.10	3.25	102.25	7.87	120.85	8.53	34.36
CD (P=0.05)	NS	15.19	NS	16.00	NS	2.07	NS	10.64	0.95	17.03	1.22	6.73

Interactions: NS

in harvesting from 10th November to 30th January increased leaf senescence significantly and complete senescence of leaf was recorded on 30th January. The more the number of green photosynthetically active leaves, more will be their contribution towards crop yield. This indicates that all the leaves of the plants became completely dry by 30th January and this might have resulted in the significant increase in turmeric yield only up to 30th January and after this date the increase in turmeric yield due to delay in harvesting was not significant.

During 2003-04, 12th March harvesting produced the highest fresh, dry and processed turmeric yield which was statistically identical to 20th February and 30th January harvesting, but was significantly better than all earlier harvesting dates (Table 3). A similar trend was observed in fresh turmeric rhizome yield during 2004-05. The dry and processed yield of 12th March was on par with January and February harvesting dates but was better than November and December harvestings.

Mean yield of data revealed that each delay in harvesting from 10th November to 12th March increased the fresh, dry and processed turmeric yield (Table 3). The increase in turmeric yield with delay in harvesting was due to increased number and weight of mother, primary, secondary as well as total rhizomes plant^{-1} (Table 2). The quantum of increase in turmeric yield was more during initial harvesting dates and this might be because when the leaves start drying, all the photosynthates are transferred to rhizomes at faster rate and result in more bulking of rhizomes plant^{-1}. However, the increase was less during the later stages (30th January, 20th February and 12th March) since the photosynthates of root only were transferred from the roots to rhizomes as the leaves had become fully dry by 30th January. In addition to this the increased uptake of moisture and nutrient by rhizome from the soil also leads to the increase in yield with each delay in harvesting date. Satheesan & Ramdasan (1988) reported that the stage of maximum rhizome growth rate of turmeric coincided

Table 3. Effect of planting methods and harvesting dates on oil and curcumin content of turmeric

Treatment	2003-04					2004-05					Mean yield		
	Fresh rhizome yield (t ha^{-1})	Dry rhizome yield (t ha^{-1})	Processed rhizome yield (t ha^{-1})	Oil content (%)	Curcumin content (%)	Fresh rhizome yield (t ha^{-1})	Dry rhizome yield (t ha^{-1})	Processed rhizome yield (t ha^{-1})	Oil content (%)	Curcumin content (%)	Fresh rhizome yield (t ha^{-1})	Dry rhizome yield (t ha^{-1})	Processed rhizome yield (t ha^{-1})
Planting method													
Flat	22.37	4.55	4.31	6.77	2.36	26.03	4.93	4.31	7.43	2.49	24.20	4.74	4.49
Ridge	19.18	4.15	3.93	6.46	2.31	26.51	5.10	3.92	7.32	2.43	22.83	4.63	4.39
CD (P=0.05)	1.70	0.34	0.31	NS	NS	NS	NS	0.31	NS	NS	NS	NS	NS
Harvesting date													
10 November	12.29	2.04	1.87	4.22	1.95	17.51	2.63	2.46	6.45	1.81	14.91	2.33	2.17
30 November	16.02	2.99	2.91	6.07	2.01	20.10	3.82	3.59	6.75	1.95	18.06	3.42	3.25
20 December	20.63	4.42	4.18	6.60	1.98	26.20	5.13	4.92	7.23	2.25	23.42	4.77	4.55
10 January	21.61	4.74	4.52	7.22	2.26	28.18	5.73	5.47	7.30	2.56	24.89	5.23	4.99
30 January	24.35	5.33	5.05	7.25	2.48	29.32	5.78	5.51	7.65	2.80	26.78	5.55	5.28
20 February	24.42	5.47	5.12	7.30	2.83	30.79	5.98	5.64	7.90	2.89	27.61	5.72	5.38
12 March	26.07	5.50	5.17	7.62	2.84	31.80	6.03	5.78	8.38	2.98	28.94	5.76	5.47
CD (P=0.05)	3.18	0.64	0.58	0.85	0.40	3.04	0.57	0.58	0.53	0.21	3.10	0.73	0.41

Interactions: NS

with reduction in starch : sugar ratio in leaves. Such marked reduction in starch : sugar ratio in leaves indicated that during rhizome bulking period, there is more translocation of photosynthates to the rhizomes. Govind & Gupta (1987) reported increased fresh rhizome yield when the harvesting was delayed from second week of August to last week of December. Subramaniam *et al*. (1978) recorded 46.3% increase in fresh rhizome yield when turmeric was harvested after 9 months as compared to the 7 months. Pachauri *et al*. (2002) also suggested that January-February is the ideal period of turmeric harvesting in the Indo-Gangetic plains of India.

The effect of different harvesting dates on oil content of turmeric was significant (Table 3). With each delay in harvesting, the oil content in turmeric improved. Maximum oil content of 7.62% and 8.38% was recorded in 12th March harvesting date during both the years and it was on par with 10th January, 30th January and 20th February harvesting dates, but was significantly better than all earlier harvesting dates during both the years of study. Govind & Gupta (1987) also reported continuous increase in oil content when harvesting of turmeric was delayed from middle of August to last week of December. With delay in harvesting curcumin content in turmeric improved. Maximum curcumin content of 2.84% and 2.98% was recorded in 12th March harvesting during 2003-04 and 2004-05, respectively and it was on par with 30th January and 20th February harvesting dates but was significantly better than all other earlier harvesting dates. Pachauri *et al*. (2002) also reported similar results and reported that the curcumin content increased with each delay in harvesting from last week of October (3.65%) to last week of February (6.01%). But Tonnesen *et al*. (1989) reported that the average content of curcumin was 1.11% which did not change significantly when the harvesting was done at weekly intervals starting from 24th October to 13th February. In conclusion, the study indicated that planting method did not influence the growth, yield and quality, whereas, delayed harvest recorded more yield and better quality in turmeric.

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