

Effect of Spacing on Growth and Yield Performance of Turmeric (*Curcuma longa* L.) in Vertisols of Chhattisgarh

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ABSTRACT

The present study was conducted in vertisols at the research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG) in 2017-18. The two varieties (V-1 = Ranga & V-2 = Roma) of turmeric (*Curcuma longa* L.) was cultivated at three plant spacing viz; S-1 (50 x 50cm), S-2 (50 x 30 cm) and S-3 (40 x 30 cm) of 3x3m plot in four replications. The PAR was recorded in turmeric crops in the range of 435.47–588.47 $\mu\text{mol s}^{-1} \text{m}^{-2}$. The average temperature was recorded in the range of 22.48–30.58 °C. The average relative humidity was observed in the range of 44.26–92.96 %. The growth performance of turmeric crop viz ; Plant height, number of tiller plant⁻¹, number of leaves plant⁻¹ and leaf size was observed highest in 120 DAS in both the varieties (V-1 and V-2), afterward gradually decreased in 150 DAS. However impact of crop spacing on the yield of the highest fresh weight

and oven dry weight of turmeric was received 252.76 q ha⁻¹ and 71.90 q ha⁻¹, respectively in S⁻¹ (50x50 cm) spacing as compared to S⁻³ (243.05 q ha⁻¹) and S⁻² (241.22 q ha⁻¹) in Ranga variety. The variety of Roma (V-2) highest yield recorded 239.87 q ha⁻¹ in fresh weight and 66.87 q ha⁻¹ in oven dry weight in spacing S⁻¹ (50x50 cm) as compared to other spacing. The varieties V-1 (Ranga) and V-2 (Roma) both received maximum yield in S⁻¹ (50x50 cm) spacing.

Keywords Growth, Yield, Vertisols, Spacing, Variety.

INTRODUCTION

The world today is discovering the magic of turmeric. In the country's tropical and subtropical regions, turmeric is one of the most important spice and medicinal plants. It is third important spice crop grown in India since ancient times and India enjoys monopoly in the production of turmeric (Pandey *et al.* 2011). The herbaceous perennial plant turmeric (*Curcuma longa* L.) is a member of the Zingiberaceae family. It is an ancient, most valuable, sacred spice of India and it contains appreciable quantities of proteins (6.3%), lipids (5.1%), carbohydrates (69.4%), mineral (3.5%) and other important element on dry weight basis (Shakur 2000). Turmeric's rhizomes are commonly utilized as a flavour, color and preservative. Mainly it is used as a condiment and coloring agent in the food industry. Additionally, it has a great demand in many industries such as the cosmetic, pharmaceutical industry and ayurvedic medicines (Abeynayaka *et al.* 2020). Further, it is used to prepare curry mixtures, color in textiles and prepare specific paints.

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Table 1. Micro-climatic conditions available to the crop during July 2017 to December 2017.

Date of observation	PAR ($\mu\text{mol S}^{-1} \text{m}^{-2}$)	Temperature ($^{\circ}\text{C}$)	RH (%)
01 July 2017	565.62	30.22	72.66
16 July 2017	542.22	29.08	92.96
01 Aug 2017	495.36	29.66	91.02
16 Aug 2017	435.47	28.62	87.64
01 Sept 2017	453.41	30.09	66.41
16 Sept 2017	497.28	30.35	66.63
01 Oct 2017	537.16	30.58	73.07
16 Oct 2017	498.41	24.32	65.18
01 Nov 2017	453.65	22.53	51.31
16 Nov 2017	496.22	22.48	46.07
01 Dec 2017	489.28	30.08	44.26

The principal constituent of Turmeric is Curcumin, which is diferuloylmethane. Other constituents are curcuminoids and an essential oil called zingiberene. The yellow coloring substances are known as curcuminoids (Gayathiri and Narendhiran 2020).

Turmeric is an essential component of traditional Indian and Chinese medicine. The main active compound curcumin possesses a vast array of pharmacological effects, including antioxidant, anticancer, anti-inflammatory, antimicrobial (antibacterial, antifungal and antiviral), antidiabetic, antirheumatic, angiogenic, antifertility, wound healing properties and is used in gastrointestinal and respiratory disorders (Chaudhary *et al.* 2010, Dasgupta and Klein 2014).

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and yield performances of Turmeric as affected by different planting spacings in vertisols of Chhattisgarh.

MATERIALS AND METHODS

The study was conducted at the research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) in vertisols with 21°23'39.77" N latitude and 81°36'44.30" E longitude and having an altitude of 295 m above mean sea level. The study region has a dry sub-humid tropical environment with an annual rainfall of 1250 mm. 90% of the rainfall falls between the middle of June and the middle of September, during the monsoon season. Between 65 to 79 rainy days fall on average each year. Between July 2017 and March 2018, the mean monthly maximum temperature ranges from 27.9°C to 39.6°C and the minimum temperature is 9.9°C in January. Mid-June through September observed variations in maximum relative humidity, whereas April and May observed the lowest levels.

The field was prepared as per recommended practice with the application of 10 t ha⁻¹ FYM and bund/ridges were made at a distance of 30 cm. The plot size was kept at 3 × 3 m for three spacing treatments viz ; 50 × 50 cm (S-1), 50 × 30 cm (S-2), and 40 × 30 cm (S-3) with four replications and according to the seeds of turmeric (V-1 Ranga, and V-2 Roma) was sown with a basal dose of NPK followed by split doses @ 120 N, 60 P and 60 k kg ha⁻¹ in form of Urea, SSP and Murate of Potash as recommended.

All the regular operations like weeding, irrigation and disease irradiations were made during the growth period of the crop. The growth behavior of turmeric crops for all the treatments was observed for yield parameters of rhizomes after harvesting at maturity.

Micro-climatic features viz; PAR ($\mu\text{mol s}^{-1} \text{m}^{-2}$), temperature ($^{\circ}\text{C}$) and relative humidity (%) available to crop were measured during the cropping period.

RESULTS

Micro-climatic conditions

The PAR, Temperature and Relative Humidity are

Table 2. Effect of spacing on plant height (cm) of turmeric crop. V-1 = Ranga, V-2 = Roma, S¹ = 50×50 cm, S² = 50×30 cm, S³ = 40×30 cm, DAS= Days after sowing.

Treatments	Plant height (cm)				
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V-1 × S-1	27.00	41.30	71.30	84.80	75.80
V-1 × S-2	28.30	47.00	76.30	80.30	70.30
V-1 × S-3	26.00	42.00	74.00	84.80	71.00
V-2 × S-1	30.00	54.80	81.00	79.30	77.30
V-2 × S-2	28.00	47.30	76.80	89.90	74.80
V-2 × S-3	31.00	51.80	80.30	84.00	71.30

observed at 15 day interval during crop growing period i.e. July 2017 to December 2017 and data are illustrated in Table 1.

Photosynthetically Active Radiation (PAR $\mu\text{mol s}^{-1} \text{m}^{-2}$)

The PAR was observed in ranges of 435.47 to 565.62, 453.41 to 537.16 and 453.65 to 588.47 $\mu\text{mol S}^{-1} \text{m}^{-2}$ during July to August, September to October and November to December respectively. The highest PAR was observed in the month of December (588.47 $\mu\text{mol s}^{-1} \text{m}^{-2}$) and the lowest PAR was observed in the month of August (435.47 $\mu\text{mol s}^{-1} \text{m}^{-2}$). In the rainy season August to September PAR showed less as compared to December (Table 1).

Temperature (°C)

The mean temperature was observed in ranges of 28.62–30.22 °C, 24.32–30.58 °C and 22.48–30.08 °C from July to August, September to October and November to December respectively. The highest temperature was observed in the month of October (30.58 °C) and the lowest temperature was observed in the month of November (22.48 °C) (Table 1).

Relative Humidity (%)

The mean relative humidity was observed in ranges of 72.66 to 92.96%, 65.18 to 73.07%, and 44.26 to 51.31% from July to August, September to October, and November to December respectively. The highest relative humidity was observed in the month of July (92.96%) and the lowest relative humidity was ob-

Table 3. Effect of spacing on no. of tiller plant⁻¹ of turmeric crop. V-1 = Ranga, V-2 = Roma, S¹ = 50×50 cm, S² = 50×30 cm, S³ = 40×30 cm, DAS= Days after sowing.

Treatments	No. of tillers plant ⁻¹				
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V-1 × S-1	2.25	2.25	2.25	2.25	1.75
V-1 × S-2	2.00	2.00	2.00	2.00	1.25
V-1 × S-3	2.25	2.25	2.25	2.25	1.75
V-2 × S-1	2.25	2.25	2.25	2.25	1.75
V-2 × S-2	2.75	2.75	2.75	2.75	1.75
V-2 × S-3	2.75	2.25	2.75	2.75	1.75

served in the month of December (44.26%) (Table 1). Growth performance of turmeric

The effect of spacing on turmeric crops on the growth behaviors of turmeric crops is illustrated in Table 2-5 for plant height; number of tillers, number of leaves and its leaves size.

Plant height (cm)

The maximum average crop height of turmeric (V-1 Ranga) was recorded 84.80 cm in S¹ (50×50 cm) and S₃ (40×30 cm) and the minimum average crop height was observed 80.30 cm in S² (50×30 cm) spacing in 120 DAS. Afterward, the average plant height was decreased in 150 DAS in all spacing. In case of V-2 (Roma), the maximum average plant height was observed 89.90 cm in S² (50×30 cm) followed by 84.0 cm in S³ (40×30 cm) and 79.30 cm in S¹ (50×50 cm) in 120 DAS. Afterward 120 DAS plant height is gradually decreases in all spacing. (Table 2).

Number of tillers plant⁻¹

The maximum No. of tillers plant⁻¹ of turmeric (V-1 Ranga) was recorded 2.25 in S¹ (50×50 cm) and S-3 (40×30 cm) of similar 30–120 DAS and minimum No. of tiller plant⁻¹ was observed 2.0 in S² (50×30 cm) spacing in 30–120 DAS. Afterward average No. of tillers was gradually decrease in 150 DAS in all spacing. In case of V-2 (Roma), the maximum average No of tillers plant⁻¹ was recorded 2.75 in S² (50×30 cm) and S³ (40×30 cm) similar in 30–120 DAS and minimum No. of tiller plant⁻¹ was observed 2.25 in S¹ (50×50 cm) in 30–120 DAS. Afterward 120 DAS No.

Table 4. Effect of spacing on no. of leaves plant⁻¹ of turmeric crop. V-1 = Ranga, V-2 = Roma, S¹ = 50×50 cm, S² = 50×30 cm, S³ = 40×30 cm, DAS= Days after sowing.

Treatments	No. of leaves plant ⁻¹				
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V-1 × S-1	7.00	13.30	24.30	20.80	12.80
V-1 × S-2	7.30	13.00	19.30	20.30	13.30
V-1 × S-3	8.00	14.00	20.00	17.80	14.30
V-2 × S-1	8.00	13.80	21.30	22.30	13.80
V-2 × S-2	8.00	13.00	21.00	21.30	14.00
V-2 × S-3	8.80	11.80	17.80	20.80	14.30

of tillers plant⁻¹ is gradually decreases in all spacing. (Table 3).

Number of leaves plant⁻¹

The maximum No. of leaves plant⁻¹ of turmeric (V-1 Ranga) was recorded 20.80 in S¹ (50×50cm) followed by 20.30 in S² (50×30cm) and 17.80 in S³ (40×30cm) spacing in 120 DAS. Afterward average No. of leaves plant⁻¹ was gradually decreases in 150 DAS in all spacing. In case of V-2 (Roma), the maximum average No. of leaves plant⁻¹ was observed 22.30 in S¹ (50×50 cm) followed by 21.30 in S² (50×30 cm) and 20.80 in S³ (40×30 cm) in 120 DAS. Afterward 120 DAS No. of leaves plant⁻¹ is gradually decreases in all spacing. (Table 4).

Leave size (cm²)

The maximum leave size (cm²) of turmeric (V-1 Ranga) was recorded 211.20 cm² in S¹ (50×50 cm) followed by 202.30 cm² in S² (50×30 cm) and 195.10 cm² in S³ (40×30 cm) spacing in 120 DAS. Afterward leave size was gradually decreases in 150 DAS in all spacing. In case of V-2 (Roma), the maximum leave size was recorded 227.90 cm² in S² (50×30 cm) followed by 226.30 cm² in S-3 (40×30 cm) and 198.20 in S¹ (50×50 cm) in 120 DAS. Afterward 120 DAS leave size is gradually decreases in all spacing. (Table 5).

Growth of rhizomes

The effect of spacing on growth of rhizome of turmeric crop is illustrated in Table 6 for mother rhizome length, Number of finger and its length and width

Table 5. Effect of spacing on leaves size (cm²) of turmeric crop. V-1 = Ranga, V-2 = Roma, S¹ = 50×50 cm, S² = 50×30 cm, S³ = 40×30 cm, DAS= Days after sowing.

Treatments	Leave size (cm ²)				
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V-1 × S-1	27.90	66.00	174.00	211.20	106.70
V-1 × S-2	33.90	83.80	173.30	202.30	117.90
V-1 × S-3	37.00	73.80	186.00	195.10	105.60
V-2 × S-1	38.70	75.00	182.70	198.20	116.70
V-2 × S-2	40.70	77.30	191.80	227.90	123.70
V-2 × S-3	32.80	82.00	184.70	226.30	98.80

and root length.

Mother rhizome length (cm)

The maximum average mother rhizome length of turmeric (V-1 Ranga) was recorded 5.70 cm in S¹ (50×50 cm) followed by 4.30 cm in S-2 (50×30 cm) and 3.70 cm in S³ (40×30 cm) spacing. The highest average length of mother rhizome was observed in S¹ and less mother rhizome length was recorded of S³ spacing in V-1 (Ranga). In case of V-2 (Roma), the maximum average mother rhizome length was recorded 4.70 cm in S³ (40×30 cm) followed by 3.30cm in S-2 (50×30 cm) and 3.0 cm in S¹ (50×50 cm) spacing. The highest average mother rhizome length was recorded in S³ and less mother rhizome length was recorded of S¹ spacing (Table 6).

Number of fingers

The maximum average no. of finger of turmeric (V-1 Ranga) was recorded 4.80 in S¹ (50×50 cm) and S³ (40×30 cm) spacing, and 4.50 in S-2 (50×30 cm) spacing. The highest No. of finger was recorded in S¹ and S³ and less No. of finger was recorded of S-2 spacing in V-1 (Ranga). In case of V-2 (Roma), the maximum average No of finger was recorded 5.30 in S³ (40×30 cm) followed by 5.0 in S¹ (50×50 cm) and S² (50×30 cm) spacing. The highest average No of finger was recorded in S³ and less No of finger was recorded of S¹ and S² spacing (Table 6).

Length of finger (cm)

The maximum average length of finger of turmeric

Table 6. Effect of spacing on growth and yield of rhizome in turmeric crop.

Treatments	Mother rhizome length (cm)	Number	Finger Length (cm)	Width (cm)	Root length (cm)	Yield (q ha ⁻¹)	
						Fresh	Oven dry
V-1 × S-1	5.70	4.80	4.60	3.90	11.10	252.76	71.90
V-1 × S-2	4.30	4.50	5.20	4.10	11.40	241.22	67.31
V-1 × S-3	3.70	4.80	4.90	3.60	11.80	243.05	60.85
V-2 × S-1	3.00	5.00	5.00	4.00	11.60	239.87	66.87
V-2 × S-2	3.30	5.00	4.80	3.60	12.30	189.58	52.67
V-2 × S-3	4.70	5.30	4.90	4.00	11.50	188.30	46.67

(V-1 Ranga) was recorded 5.20 cm in S⁻² (50×30 cm) followed by 4.90 cm in S⁻³ (40×30 cm) and 4.60 cm in S⁻¹ (50×50 cm) spacing. The highest length of finger was recorded in S⁻² and less length of finger was recorded of S⁻¹ spacing in V-1 (Ranga). In case of V-2 (Roma), the highest average length of finger was observed 5.0 cm in S⁻¹ (50×50 cm) followed by 4.90 cm in S⁻³ (40×30 cm) and 4.80 cm in S⁻² (50×30 cm) spacing. The highest average length of finger was recorded in S⁻¹ and less length of finger was recorded of S⁻² spacing (Table 6).

Width of finger (cm)

The maximum average width of finger of turmeric (V-1 Ranga) was recorded 4.10 cm in S⁻² (50 × 30 cm) followed by 3.90 cm in S⁻¹ (50×50 cm) and 3.60 cm in S⁻³ (40×30 cm) spacing. The highest width of finger was recorded in S⁻² and less width of finger was recorded of S⁻³ spacing in V-1 (Ranga). In case of V-2 (Roma), the highest mean width of finger was observed 4.0 cm in S⁻¹ (50×50 cm) and S⁻³ (40×30 cm) followed by 3.60 cm in S⁻² (50×30 cm) spacing. The highest average width of finger was recorded in S⁻¹ and S⁻³ and less width of finger was recorded of S⁻² spacing (Table 6).

Root length (cm)

The maximum average root length of turmeric (V-1 Ranga) was recorded 11.80 cm in S⁻³ (40×30 cm) followed by 11.40 cm in S⁻² (50×30 cm) and 11.10 cm in S⁻¹ (50×50 cm) spacing. The highest root length was recorded in S⁻³ and less root length was recorded of S⁻¹ spacing in V-1 (Ranga). In case of V-2 (Roma), the maximum average root length was recorded 12.30 cm

in S⁻² (50×30 cm) followed by 11.60 cm in S⁻¹ (50×50 cm) and 11.50 cm in S⁻³ (40×30 cm) spacing. The highest average root length was recorded in S⁻² and less root length was recorded of S⁻³ spacing (Table 6).

Yield (q ha⁻¹)

Effect of spacing on turmeric crop on yield of turmeric viz, fresh weight and oven dry weight of turmeric is illustrated in Table 6.

Fresh weight

The maximum fresh weight of turmeric (V-1 Ranga) was recorded 252.76 q ha⁻¹ in S⁻¹ (50×50 cm) followed by 243.05 q ha⁻¹ in S⁻³ (40×30 cm) and 241.22 q ha⁻¹ in S⁻² (50×30 cm) spacing. The highest fresh weight of turmeric was recorded in S⁻¹ and lowest fresh weight of turmeric was recorded of S⁻² spacing in V-1 (Ranga). In case of V-2 (Roma), the maximum fresh weight of turmeric was recorded 239.87 q ha⁻¹ in S⁻¹ (50×50 cm) followed by 189.58 q ha⁻¹ in S⁻² (50×30 cm) and 188.30 q ha⁻¹ in S⁻³ (40×30 cm) spacing. The highest fresh weight was recorded in S⁻¹ and lowest fresh weight of turmeric was recorded of S⁻³ spacing (Table 6).

Oven dry weight

The maximum oven weight of turmeric (V-1 Ranga) was recorded 71.90 q ha⁻¹ in S⁻¹ (50×50 cm) followed by 67.31 q ha⁻¹ in S⁻² (50×30 cm) and 60.85 q ha⁻¹ in S⁻³ (40×30 cm) spacing. The highest oven dry weight of turmeric was recorded in S⁻¹ and lowest oven dry weight of turmeric was recorded of S⁻³ spacing in V-1 (Ranga). In case of V-2 (Roma), the maximum oven

dry weight of turmeric was recorded 66.87 q ha⁻¹ in S⁻¹ (50×50 cm) followed by 52.67 q ha⁻¹ in S⁻² (50×30 cm) and 46.67 q ha⁻¹ in S⁻³ (40×30 cm) spacing. The highest oven dry weight was recorded in S⁻¹ and lowest oven dry weight of turmeric was recorded of S⁻³ spacing (Table 6).

DISCUSSION

PAR, Temperature and Relative humidity observed at 15 days interval during crop period PAR was measure crop in range of 435.47-588.47 $\mu\text{mol s}^{-1} \text{m}^{-2}$. The average temperature was measured in crop range of 22.48–30.58 °C. The mean relative humidity was observed in crop range of 44.26–92.96%. Similar results of micro-climatic conditions were recorded by Dindekar (2012), Harne (2013), Naugraiya (2003-2013), Jiwan Lal and Naugraiya (2022a, 2022b) during cultivation of various *rabi* and *kharif* crops.

The vegetative growth of turmeric viz., height, number of tillers, number of leaves, leaves size are more or less higher in s-1 spacing as compare to two another spacing in variey-1 (Ranga). In case of Variry-2 (Roma) plant height, number of tillers, number of leaves, leaves size are more or less higher in S-2 spacing as compare to two another spacing. Similar result observed in different workers (Tripathi *et al.* 2019, Vidanapathirana *et al.* 2022, Mekonnen and Garedeew 2019, Akamine *et al.* 2007, Choudhary and Rahi 2018, Kumar and Gill 2010, Jiwan Lal and Naugraiya 2022b). Tripathi *et al.* (2019) similar work in growth performance on irrigation schedule in turmeric crop. Vidanapathirana *et al.* (2022) similar kind of work in turmeric crop in three spacing. Plant heights, tiller number per plant, pseudo-stem girth, mother and finger rhizome numbers and weights, fresh rhizome yield, oleoresin and essential oil contents studied in Mekonnen and Garedeew (2019). Akamine *et al.* (2007) similar results found on plant height, leaf number, tiller number and shoot are studied in turmeric crop. The growth behavior and effect of spacing on plant height, number of tiller, collar diameter leaves length and width of ginger crop studied in Jiwan Lal and Naugraiya (2022a and 2022b).

The effect of spacing on two varieties (V-1 Ranga and V-2 Roma) of turmeric in yield was re-

corded in the range 241.22 to 252.76 q ha⁻¹ in fresh weight and 60.85 to 71.90 q ha⁻¹ in oven dry weight in a variety of Ranga. In the case of Roma variety yield was recorded in range 188.30 to 239.87 q ha⁻¹ in fresh weight and 46.67 to 66.87 q ha⁻¹ in oven dry weight in our study. Similar results were observed in different workers (Mohamed *et al.* 2014, Tripathi *et al.* 2019, Vidanapathirana *et al.* 2022, Mekonnen and Garedeew 2019, Akamine *et al.* 2007, Choudhary and Rahi 2018, Kumar and Gill 2010, Jiwan Lal and Naugraiya 2022b, Krishna *et al.* 2019, Kumar and Naugraiya 2020). Mohamed *et al.* (2014) similar kind of results found in the turmeric crop. Tripathi *et al.* (2019) studied in maximum fresh rhizome yield of turmeric 22.99 and 24.82 t ha⁻¹ in different irrigation and nutrient management. The three spacing (30 × 20 cm, 30 × 30 cm, 30 × 40 cm) in turmeric crop in Vidanapathirana *et al.* (2022). Rahman *et al.* (2010) studied the highest yield of turmeric crops in both years (22.01 t/ha and 22.11 t/ha) with the highest BCR (10.67 and 10.72) and lowest yield (8.00 t/ha, 8.01t/ha) with BCR (3.65 and 3.65) was obtained when the plants raised with control treatment. Akamine *et al.* (2007) studied the different applications of NPK in turmeric crop yield was observed in the range 8.6 to 165.9 g plant⁻¹. Mean data of turmeric revealed that Palam Pitamber resulted in the highest rhizome yield (32.94 t ha⁻¹) followed by Palam Lalima (32.35 t ha⁻¹) compared to biennially harvested 'Suketi Haldi' (12.45 t ha⁻¹) studied by Choudhary and Rahi (2018). Kumar and Naugraiya (2020) studied turmeric in AFS and open fields same pattern of the result obtained. Jiwan Lal and Naugraiya (2022b) also studied the effect of spacing in ginger crops similar kind of results obtained.

CONCLUSION

The present study demonstrates the growth and yield parameters of two varieties (V-1= Ranga and V-2 = Roma) of turmeric crops. The variety of Ranga (V-1) was performed highest yield in 252.76 q ha⁻¹ in fresh weight and 71.90 q ha⁻¹ in oven dry weight in spacing S-1 (50×50 cm) followed by other spacing. In the case of variety Roma (V-2), the maximum yield was found 239.87 q ha⁻¹ in fresh weight and 66.87 q ha⁻¹ in oven dry weight in spacing S-1 (50×50 cm) followed by other spacing. The variety of Ranga (V-

1) is most suitable in spacing S-1 (50×50 cm) for the cultivation of turmeric crops and the variety of Roma (V-2) is also best suitable in spacing S-1 (50 × 50 cm) for turmeric cultivation. The Ranga variety produces a higher yield as compared to the variety Roma so Ranga variety is good for cultivation in vertisols of Chhattisgarh as compare to variety Roma.

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