Effect of drip irrigation levels and weed management practices on quality parameters and yield of turmeric (*Curcuma longa* L.) under mango orchard

Abstract

A field experiment, aimed to study the effect of drip irrigation levels and weed management practices on quality and productivity of turmeric (*Curcuma longa* L.) in mango orchardwas carried out at Pt. K.L. S. College of Horticulture and Research Station, Rajnandgaon (Chhattisgarh) during two consecutive years (2019/20 and 2020/21). The results indicated that all the quality parameters like total carbohydrate in rhizomes, volatile oil yield in rhizomes,oil yield and curcumin content in turmeric were significantly higher values observed when the crop imposed to drip irrigation at 1.0 Epan and hand weeding thrice at 25, 50 and 75 DAPduring 2019/20 and 2020/21 growing seasons. While, flood irrigation at 1.0 Epan and un-weeded control recorded the lowest values of these parameters during both seasons. The combination of drip irrigation at 1.0 Epan with hand weeding thrice at 25, 50 and 75 DAP recorded significantly the highest fresh rhizomes yield (29.10, 32.40 and 30.75 t ha^{-1}) and cured rhizomes yield (6.58, 6.93 and 6.76 t ha^{-1})during 2019/20 and 2020/21 growing seasons and on mean basis, respectively.

Keywords:turmeric,Drip irrigation, quality, turmeric and yield.

INTRODUCTION

Turmeric (*Curcuma longa* L.) is, also, known as “Indian Saffron” as well as the “Spice of life” belongs to the family *Zingiberaceae*, which is native to South Asia, particularly India (Mannikeri, 2006). Turmeric can be grown under partial shaded conditions as an intercrop to the wide spacing crops viz. mango, guava, jack fruit etc. (Randhawa and Mahey, 2002, Vishwakarma *et al*., 2006 and Reddy *et al.,* 2017). Weeds and water are one of the major constrain in turmeric cultivation and cause tremendous reduction in crop yield and quality in the absence of suitable and effective weed and water management practices.Therefore, it is essential to evaluate different weed management practices and drip irrigation levels considering the availability and scarcity of labours and water, cost of weed and water management under Chhattisgarh plains agro-climatic conditions in mango orchard for effective weed control and prices application of water in high production and quality of turmeric.

MATERIALS AND METHODS

A field trial was carried out at Pt. K. .L S. College of Horticulture and Research Station, Rajnandgaon (Chhattisgarh) during 2019/20 and 2020/21 growing seasons. The soil of experimental plot was sandy loam in texture, neutral in soil reaction, low in available of N, medium in P and high in K status. The climate of region is normal tropical moist sub-humid comes under rain shadow zone. The experiment was frame out with four

irrigation levels, which comprised drip irrigation at 1.0 Epan, drip irrigation at 0.8 Epan, drip irrigation at 0.6 Epan and flood irrigation at 1.0 Epan as control in horizontal plot and six weed management practices *viz*., green leaf mulch 12 t ha^{-1}*fb* hoeing at 75 DAP, straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP, metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP, oxadiargyl 0.25 kg ha^{-1}, PE *fb*metsulfuron 0.004 kg ha^{-1}, PoE *fb* hoeing at 75 DAP, hand weeding thrice at 25, 50 and 75 DAP and un-weeded control in vertical plot in strip plot design with three replications. After ploughing and leveling, field plot was divided into 4.6x1.35 m^2 of four bed represented a single treatment. Chhattisgarh haldi-1 variety weighing about 25-30 g were selected for planting. A dosage of 120:100:120 kg NPK ha^{-1} was taken for the crop cultivation. Planting and harvesting was done during the month of June and February 2020 and 2021. The irrigation schedules for drip irrigation was done on cumulative pan evaporation reading from pan evaporimeter. In case of flood irrigation, irrigation was scheduled at 10 days interval. The water received through rainfall was adjusted in successive days. Drip irrigation was applied at 20 mm CPE keeping depth of irrigation equal to sum of corresponding CPE as per treatments. Daily Epan was calculated from location specific weather station.Each plot was dripped with a lateral pipe having inbuilt dripper at spacing of 20 cm with discharge of 2 lph, placed between two rows of turmeric. The recommended package and practices of turmeric cultivation was adopted. Herbicides were sprayed through knapsack sprayer with flat fan nozzle. Paddy straw mulch and banana green leaves at 10 and 12 t ha^{-1}, respectively was spread 5 days after application of pre emergence herbicide. The quality parameters like total carbohydrate in rhizomes, volatile oil yield in rhizomes,oil yield and curcumin content in turmeric were determined.Total carbohydrate in the dried rhizomes was determined by using a colorimetric method as described by Herbert *et al.* (1971). Essential oil in dry rhizomes was isolated by hydro distillation method for 3 hrs in order to extract the essential oil according to base on American Spice Trade Association procedure (ASTA, 2002). Clevenger apparatus was used to determine percentage of volatile oils present in rhizome. Oil content was camputed as follows:

Oil content (%) = Weight of oil recovered (g) X 100 / Weight of rhizomesample distilled (g).

Intensity of yellow colour(curcumin content) was measured at a wavelength of 425 nm by spectrophotometer with the following formula (Thimmaiah,1999).

$$\text{Curcumin content (\%)} = \frac{0.0025x\ A\ 425 \times \text{volume made up} \times \text{dilution factor}}{0.42 \times \text{weight of sample (gm)} \times 1000} \times 100$$

Where;

0.42- absorbance at 425 nm =0.0025 g curcumin

Oleoresinof turmeric was determined as suggested by Anonymous (2010) from Solvent extraction method. One gram of turmeric powder was taken in an extraction flask. Extraction flask was fitted with an air condenser and placed over a heating mantle. 50 ml of 95% alcohol was added in the flask and allowed to reflux at 70^0C for 1 h. Then the extract was cooled and filtered through whatmann No. 1 filter paper. Filtered extract was made up to 100 ml using 95% alcohol and measured at a wavelength of 425 nm by spectrophotometer .

Oleoresin content (%) =Weight of oil (g) X 100 / Wt of rhizome sample taken (g).

After harvesting, the rhizomes were separatedfrom mother rhizomes and fresh weight was recorded accordingly. Rhizomes was washed with water and then boiled in pressure cooker for 50 minutes. Oven dried rhizomes after dry weight were polished manually and dry weight was recorded.

RESULTS AND DISCUSSION

1. Total carbohydrates in rhizomes (%)

The data of total carbohydrates in turmeric rhizomes are presented in Table (1). The total carbohydrates in rhizomes was found to be significantly higher under drip irrigation at 1.0 Epan*i.e*., 68.03, 68.05 and 68.04 per cent, which was at par to drip irrigation at 0.8 Epan during 2019/20 and 2020/21 growing seasonson mean basis, respectively. On the contrary, flood irrigation at 1.0 Epan recorded the lowest total carbohydrate (66.88, 67.86 and 67.87 per cent during bothgrowing seasons and on mean basis, respectively.In respect to weed management practices, application of metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAPrecorded significantly higher total carbohydrates in rhizomes, being 67.84, 67.93 and 67.89 per cent during bothgrowing seasonsand on mean basis, respectively, which was at par to hand weeding thrice carried out at 25, 50 and 75 DAP, while, un-weeded control observed the lowest total carbohydrates content in rhizomes, being 66.88, 67.00 and 66.94 per cent during bothgrowing seasons and on mean basis, respectively.

2. Volatile oil yield in rhizomes (t ha^{-1})

The data presented in Table (1)indicate that drip irrigation levels at 1.0 Epan recorded higher volatile oil yieldin rhizomes, being 1.40, 1.55 and 1.48 t ha^{-1} as compared to other treatments, which was at par to drip irrigation at 0.8 Epan, being 1.35, 1.50 and 1.44 during2019/20 and 2020/21 growing seasonsand on mean basis, respectively. However, flood irrigation at 1.0 Epan recorded the lowest volatile oil yieldin rhizomes, being1.28, 1.43 and 1.35 per cent during bothgrowing seasonsand on mean basis, respectively. Regarding weed management practices, application of metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAPrecorded significantly higher volatile oil yieldin rhizomes, being 1.51, 1.66 and 1.59 t ha^{-1} during both growing seasonsand on mean basis, respectively, which was at par with hand weeding thrice performed at 25, 50 and 75 DAP. On the other hand, un-weeded control recorded the lowest volatile oil yieldin rhizomes, being 1.18, 1.33 and 1.25 t ha^{-1}both growing seasons and mean basis, respectively.

3. Oleoresin content

The data presented in Table (1) emphasized that drip irrigation at 1.0 Epan recorded significantly higher oleoresin content , being10.07, 10.26 and 10.16 % of turmeric as compared to other treatments during 2019/20 and 2020/21 growing seasons and on mean basis, respectively. However, flood irrigation at 1.0 Epanrecordedthe lowest oleoresin content, being9.26, 9.48 and 9.37 per cent during both growing seasons and on mean basis, respectively. Further, application of metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP withered

significantly maximum oleoresin content in turmeric which was at par to hand weeding thrice carried out at 25, 50 and 75 DAP during bothgrowing seasons and on mean basis.

4. Curcumin content (%)

The data presented in Table (1)revealed that drip irrigation levels and weed management practices significantly influenced the curcumin content in turmeric. Among different drip irrigation levels, drip irrigation at 1.0 Epanobserved the higher curcumin content, being 4.11, 4.12 and 4.12 per cent as compared to others during 2019/20 and 2020/21 growing seasons and on mean basis, respectively. However, flood irrigation at 1.0 Epannoticed the lowest curcumin contentviz. 3.98, 4.01 and 4.00 per cent during both growingseasons and on mean basis, respectively. In respect to weed management practices, application of metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP recorded the higher curcumin content, being4.15, 4.16 and 4.15 per cent during both growing seasons and on mean basis, respectively, which was at par to hand weeding thrice at 25, 50 and 75 DAP duringboth growing seasons and on mean basis. The higher quality traits under drip irrigation plot might be due to better soil moisture availability resulted in better crop growth which favoured growth attributed with better turgidity of cell, vital processes of crop and thus enhancement in the quality of turmeric. Kaur and Brar (2019) result revealed that drip irrigated turmeric produced higher curcumin and oil yield as compared to check basin during 2013 and 2014growing seasons. Curcumin content and oil yield are the reflective processes of effective utilization of resources in conducive crop growth environment with minimum stresses due to lesser weed competition reflects further on better quality attributes of turmeric. Singte *et al.* (1997) in Maharashtra reported that higher yield and quality of turmeric in 100 per cent evaporation replenishment (Epan) treatment than 80 and 60 per cent Epan. Similar findings were, also, supported by Tripathi *et al* (2015) where researcher suggested that 0.9 IW: CPE produced good quality of turmeric rhizomes with superior content of oleoresin, curcumin and oil content.

5.Fresh rhizomes yield

The data illustrate in the Table (2) showed that statistically significant higher fresh rhizomes yield, being 24.50, 26.53 and 25.51 t ha^{-1} observed under drip irrigation at 1.0 Epanduring 2019/20 and 2020/21 growing seasons and on mean basis, respectively. However, flood irrigation at 1.0 Epan recorded the lowest fresh rhizomes yield, being 18.12, 19.94 and 19.03 t ha^{-1} during bothgrowing seasons and on mean basis, respectively. Regarding weed control practices, hand weeding thrice carried out at 25, 50 and 75 DAP was recorded significantly higher fresh rhizomes yield, being 25.11, 28.14 and 26.62 t ha^{-1} during bothgrowing seasonsandon mean basis, respectively. However, un-weeded control recorded the lowest fresh rhizomes yield, being16.56, 17.02 and 16.79 t ha^{-1} duringbothgrowing seasons and on mean basis, respectively. The data on interaction between drip irrigation at 1.0 Epan and hand weeding thrice at 25, 50 and 75 DAP are presented in Table (2).Results were significantly higher fresh rhizomes yield viz. 29.10, 32.40 and 30.75 t ha^{-1} during 2019/20 and 2020/21 growing seasons and on mean basis, respectively. The aforementioned treatment was at par to drip irrigation at 1.0 Epan and metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP during bothgrowing seasons and on mean basis. However, interaction between surface irrigation at 1.0 Epan and weedy check evaluated the lowest fresh rhizomes yield, being 13.39, 13.41 and 13.40 t ha^{-1} during bothgrowing seasonsand on mean basis, respectively.

6. Cured rhizomes yield

Significantly higher cured rhizomes yield was obtained when drip irrigation at 1.0 Epan was imposed, being 5.18, 5.67 and 5.48 t ha^{-1} during 2019/20 and 2020/21 growing seasonsand on mean basis, respectively, which was significantly higher over rest of the drip irrigation and flood irrigation levels at 1.0 Epan (Table 2). On the other hand, the lowest cured rhizomes yield wasfound in flood irrigation at 1.0 Epan, being 3.76, 4.21 and 3.98 t ha^{-1} during bothgrowing seasonsand on mean basis, respectively. As regards to weed management practices, significantly higher cured rhizomes yield of turmeric was recorded under hand weeding thrice performed at 25, 50 and 75 DAP, being 5.64, 6.08 and 5.86 t ha^{-1} during both growing seasonsand mean basis, respectively. However, un-weeded control (weedy check) was found to be the lowest in respect of cured rhizomes yield viz. 6.27, 3.37 and 3.32 t ha^{-1} during 2019/20, 2020/21 growing seasonsand on mean basis, respectively over rest of the weed management practices. The interaction among different drip irrigation levels and weed management practices was significant affected towards cured rhizomes yield. The data presented in Table (2)revealed that combination of drip irrigation at 1.0 Epan and manual weeded at 25, 50 and 75 DAP observed the highest cured rhizomes yield, being6.58, 6.93 and 6.76 t ha^{-1} during bothgrowing seasonsand on mean basis, respectively, which was significantly higher over rest of the drip irrigation and flood irrigation levels at 1.0 Epan. Gill *et al.* (2000) assumed that 6 t ha^{-1} straw mulch treatment increased fresh rhizomes yield resulted from quick emergence and rapid germination. Further, Tadesse *et al.* (2015) reported that when the first manual weeding was delayed up to 60 days from planting yield of turmeric was reduced tremendously. Similar findings were also observed by Thiyagarajan *et al*. (2011), Thripathi*et al*. (2014) and Chitra *et al.*(2017) in turmeric.

Conclusion

The results and findings concluded that all the quality parameters like total carbohydrates in rhizomes, volatile oil yield in rhizomes,oil yield and curcumin content in turmeric were significantly higher valuesand were observed when the crop was imposed to drip irrigation at 1.0 Epan and hand weeding thrice at 25, 50 and 75 DAP. While, flood irrigation at 1.0 Epan and un-weeded control recorded the lowest values of these parameters during 2019/20 and 2020/21 growing seasons. The combination of drip irrigation at 1.0 Epan with hand weeding thrice at 25, 50 and 75 DAP recorded significantly the highest fresh rhizomes yield and cured rhizomes yieldduring both seasonson mean basis.

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Table 1. Total carbohydrate, volatile oil yield, oleoresin and curcumin content as influenced by different drip irrigation levels and weed management practices in turmeric

Treatments	Total carbohydrate (%)			Volatile oil yield (t ha^{-1})			Oleoresin content (%)			Curcumin content (%)		
	2019/20	2020/21	Mean	2019/20	2020/21	Mean	2019/20	2020/21	Mean	2019/20	2020/21	Mean
Drip irrigation levels												
I_1: Drip irrigation at 1.0 Epan	68.03	68.05	68.04	1.40	1.55	1.48	10.07	10.26	10.16	4.11	4.12	4.12
I_2: Drip irrigation at 0.8 Epan	67.56	67.84	67.70	1.35	1.50	1.44	9.90	10.03	9.96	4.04	4.06	4.05
I_3: Drip irrigation at 0.6 Epan	67.05	67.10	67.07	1.30	1.45	1.38	9.58	9.86	9.72	4.02	4.05	4.03
I_4: Flood irrigation at 1.0 Epan	66.88	66.86	66.87	1.28	1.43	1.35	9.26	9.48	9.37	3.98	4.01	4.00
SEm±	**0.17**	**0.15**	**0.11**	**0.02**	**0.02**	**0.01**	**0.03**	**0.04**	**0.03**	**0.01**	**0.01**	**0.01**
CD (P=0.05)	**0.58**	**0.51**	**0.34**	**0.06**	**0.06**	**0.04**	**0.09**	**0.15**	**0.08**	**0.03**	**0.03**	**0.02**
Weed management practices												
W_1: Green leaf mulch 12 t ha^{-1} *fb* hoeing at 75 DAP	67.31	67.33	67.32	1.38	1.53	1.46	9.87	9.99	9.93	3.99	4.02	4.00
W_2: Straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP	67.26	67.42	67.34	1.34	1.49	1.42	9.96	10.17	10.06	4.03	4.04	4.04
W_3 : Metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP	67.84	67.93	67.89	1.51	1.66	1.59	10.47	10.64	10.55	4.15	4.16	4.15
W_4 : Oxadiargyl 0.25 kg ha^{-1},	67.28	67.24	67.26	1.24	1.39	1.32	9.10	9.19	9.14	3.98	4.01	3.99

PE *fb*metsulfuron 4 g ha^{-1}, PoE *fb* hoeing at 75 DAP												
W_5: Hand weeding thrice at 25, 50 and 75 DAP	67.68	67.84	67.76	1.45	1.60	1.54	10.30	10.43	10.38	4.13	4.14	4.14
W_6: Unweeded control	66.88	67.00	66.94	1.18	1.33	1.25	8.63	9.15	8.89	3.95	3.98	3.96
SEm±	**0.17**	**0.13**	**0.10**	**0.02**	**0.02**	**0.02**	**0.06**	**0.06**	**0.03**	**0.01**	**0.01**	**0.01**
CD (P=0.05)	**0.52**	**0.40**	**0.29**	**0.07**	**0.07**	**0.05**	**0.18**	**0.19**	**0.18**	**0.04**	**0.04**	**0.03**
Interaction (D X W)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2.Fresh and cured rhizomes yield of turmeric as influenced by drip irrigation levels and weed management practices

Treatments	Fresh rhizomes yield (t ha^{-1})			Cured rhizomes yield (t ha^{-1})		
Drip irrigation levels	**2019/20**	**2020/21**	**Mean**	**2019/20**	**2020/21**	**Mean**
I_1: Drip irrigation at 1.0 Epan	24.50	26.53	25.51	5.29	5.67	5.48
I_2: Drip irrigation at 0.8 Epan	21.41	24.14	22.77	4.59	4.96	4.77
I_3: Drip irrigation at 0.6 Epan	20.01	21.38	20.69	4.22	4.65	4.44
I_4: Flood irrigation at 1.0 Epan	18.12	19.94	19.03	3.76	4.21	3.98
SEm±	**0.44**	**0.45**	**0.31**	**0.03**	**0.02**	**0.02**
CD (P=0.05)	**1.51**	**1.55**	**0.96**	**0.10**	**0.08**	**0.05**
Weed management practices						
W_1: Green leaf mulch 12 t ha^{-1} *fb* hoeing at 75 DAP	19.98	22.26	21.12	4.20	4.71	4.45
W_2: Straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP	21.50	24.36	22.93	4.62	5.28	4.95
W_3 : Metribuzin 0.7 kg ha^{-1}, PE *fb* straw mulch 10 t ha^{-1}*fb* hoeing at 75 DAP	24.26	26.08	25.17	5.25	5.79	5.52
W_4 : Oxadiargyl 0.25 kg ha^{-1}, PE *fb*metsulfuron 0.004 kg ha^{-1}, PoE *fb* hoeing at 75 DAP	18.66	20.11	19.38	3.81	4.01	3.91
W_5: Hand weeding thrice at 25, 50 and 75 DAP	25.11	28.14	26.62	5.64	6.08	5.86
W_6: Un-weeded control	16.56	17.02	16.79	3.27	3.37	3.32
SEm±	**0.27**	**0.26**	**0.27**	**0.03**	**0.07**	**0.02**
CD (P=0.05)	**0.85**	**0.81**	**0.79**	**0.09**	**0.23**	**0.07**