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EFFECT OF IRRIGATION AND MULCHING ON GROWTH AND PRODUCTIVITY OF TURMERIC (*Curcuma longa* L.)

AMIT KAMBOJ AND BALWINDER SINGH DHILLON*
College of Agriculture, Guru Kashi University,
Talwandi Sabo, Punjab, INDIA
e-mail: balwinderdhillon.pau@gmail.com

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***Corresponding author**

ABSTRACT
Two irrigation intervals *viz*., 6 and 12 days under four levels of mulching *viz*., 0, 5, 10 and 15 t/ha in turmeric were evaluated. The results showed that the highest plant growth viz., plant height (79.6 cm), leaf length (41.0 cm), leaf breadth (12.1 cm) and leaf area (465.6 cm^2) and rhizome length (7.90 cm) was recorded in irrigation intervals of 6 days which was significantly higher over the irrigation intervals of 12 days at harvest. The growing of turmeric crop with irrigation every 6 days of the interval is best for better growth and rhizome yield (157.5 q/ha). Irrigation interval of 6 days (157.5 q/ha) recorded 32.0% higher rhizome yield than 12 days irrigation intervals (119.3 q/ha). The application of straw mulch @ 15 t ha^{-1} was found to be beneficial and can be practiced for maximizing the yield (214.3 q/ha) of turmeric crop and conserving soil moisture. Mulching @ 5, 10 and 15 t/ha recorded 68.4, 139.5 and 220.8%, respectively, higher rhizome yield than control (no mulch application).

INTRODUCTION

Turmeric (*Curcuma longa* L.) is herbaceous annual plant belonging to the family Zingiberaceae, native of Indo-Malayan region. The species 'Turmeric' or 'Haldi' constitutes boiled, dried, cleaned and polished rhizome (the underground swollen modified stem of plant) of Curcuma longa. In India, turmeric is grown on an area of 193.40 thousand ha with production of 1052.10 thousand tonnes and productivity of 5.44 million tonnes ha^{-1} and in Punjab, it covers an area of 0.90 thousand ha with production of 3.20 thousand tonnes and productivity of 3.56 million tonnes ha^{-1} (Anonymous 2020). In Punjab, turmeric is planted in hot summer months from the end of April to the first week of May and remains in the field up to the end of November. Thus, turmeric is not only a long duration crop but also runs through high evaporation demand period, which make its water requirement quite high. Among the agronomic practices, irrigation 2 scheduling is a paramount importance and application of straw mulch may influence water retention and availability to crop (Swain *et al.,* 2007). One of the most important factors affecting plant growth and production of secondary metabolites is water supply (Randhawa *et al.,* 1992). The application of mulch decreases evaporation losses, weed population, regulates soil temperature and helps to protect the germinating rhizomes from desiccation especially during early growth period of hot and dry months (May and June). Philip *et al*. (1981) observed that mulching reduced the weed growth considerably and enhanced sprouting of rhizomes by conserving soil moisture. The application of straw mulch had favorable effect on growth parameters, yield and yield attributing characters as compared to no mulch and this favourable effect of mulch might be due to early emergence, quick establishment of crop and higher interception of light (Singh and Randhawa 1988).

Considering the beneficial effect of mulching, this investigation was undertaken to assess the effect of organic mulches on growth and productivity of turmeric crop under rainfed conditions of South-west Punjab.

MATERIALS AND METHODS

The field experiment study entitled, "Effect of irrigation and mulching on growth and productivity of turmeric (*Curcuma longa* L.)" was conducted at research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during kharif season 2019-2020. The farm is located at 29.9875ºN latitude and 75.0903ºE longitude with an altitude of 252 meters above the mean sea level as per are extreme. The soil of the experimental field was studied by the Bouyoucos Hydrometer method (Bouyoucos, 1962) and recorded loamy sand. It had a pH of 7.1 which was determined by the glass electrode pH meter (Jackson, 1973). The organic carbon content was determined by Walkley and Black rapid titration method (Walkley and Black, 1934) and was reported to be medium (0.39%). Available nitrogen (178.2 kg ha^{-1}), phosphorous (25.5 kg ha^{-1}) and potassium (140.1 kg ha^{-1}) were all recorded to be in the medium range and they were determined by the Alkaline permanganate method (Subbiah and Asija, 1956), Bray and Kurtz method (Jackson, 1973) and Flame Photometer method (Jackson, 1973), respectively.

The mean maximum and mean minimum temperature ranged 39.7ºC and 21.8ºC , respectively recorded during May, 2019 to December, 2020. The field experiment was conducted at

experimental area of agriculture research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during *Kharif* 2019-2020. The maximum temperature of about 39.7ºC is achieved during month of May and June during the year, while freezing temperature accompanied by frost occurrence may be recorded in the months of December and January in this region. The monsoon generally starts in the first week of July.). The trail was laid out in split plot design with two irrigation intervals *viz*., @ 6 and 12 days interval in main plot and four mulching levels *viz*., control, 5, 10 and 15 t/ha in sub plot. The collected data were statistically analyzed by using Fisher's ANOVA technique and Critical difference (CD) test at 5% probability level was used to compare differences among treatment.

RESULTS AND DISCUSSION

Weed biomass

The maximum weed biomass (3.84, 3.98 and 4.23 kg/ha) at 30, 60 and 90 DAP was recorded when the crop was sown with the irrigation interval of 6 days as compared to the 12 days interval (Table 1). The maximum weed biomass (8.05, 7.78 and 6.70 kg/ha) at 30, 60 and 90 DAP was recorded with the no mulch application which was significantly higher than the other mulching levels.

Table 1: Effect of different irrigation intervals and mulching levels on the weed biomass of the turmeric

Treatments	30 DAP	60 DAP	90 DAP
Irrigation intervals (days)			
6	3.84	3.98	4.23
12	3.7	3.72	3.48
LSD (P=0.05)	0.3	0.05	0.25
Mulching levels (t/ha)			
0	8.05	7.78	6.7
5	3.67	3.32	4.53
10	2.11	2.58	2.52
15	1.25	1.72	1.67
LSD (P=0.05)	0.1	0.1	0.2

Plant height

The maximum plant height (24.3, 44.8, 49.4, 68.8 and 79.6 cm) at 60, 90, 120, 150 DAP and at harvest was recorded when the crop was grown with irrigation interval of 6 days which was significantly higher than the irrigation interval of 12 days (Table 2). Application of mulch resulted in increased plant height. The maximum plant height (15.3, 28.7, 53.8, 57.2, 76.3 and 90.1 cm) at 30, 60, 90, 120, 150 DAP and at harvest was recorded with 15 t/ha of mulch application which was significantly higher as compared to other mulching levels. Increase in plant height with mulch application has been reported by Singh and Randhawa (1988) and Verma and Sarnaik (2006).

Number of leaves per plant

The different irrigation interval has non-significant effect on the number of leaves per plant. The maximum number of leaves per plant (2.3, 4.3, 4.43 and 4.67) at 30, 60, 90 and 120 DAP was recorded with the mulch application of 15 t/ha and was significantly higher than the other mulching levels. More number of leaves per plant under mulched plots has been also reported by Gill (1999), Singh and Randhawa (1988) and Verma and Sarnaik (2006).

Leaf length and breadth

The maximum leaf length (16.5, 22.2, 25.8, 41.0 cm) at 60, 90, 120 and 150 DAP and leaf breadth (3.85, 8.13, 9.03, 10.5 and 12.1 cm) at 30, 60, 90, 120 and 150 DAP was recorded when crop was grown with irrigation interval at every

Table 2: Effect of irrigation intervals and mulching levels on plant height (cm) of turmeric

Plant height (cm)						
Treatments	30	60	90	120	150	At harvest
Irrigation intervals (days)						
6	11.7	24.3	44.8	49.4	68.8	79.6
12	11.2	22.6	38.8	41.2	61.5	71.6
LSD (P=0.05)	0.9	1	2.7	1.3	5.4	6.3
Mulching levels (t/ha)						
0	5.7	18.1	28.4	32.4	52.2	59.7
5	11.4	21.6	38.3	40.8	61.7	70.4
10	13.5	25.3	46.9	50.8	70.5	82.3
15	15.3	28.7	53.8	57.2	76.3	90.1
LSD (P=0.05)	NS	1.1	2.6	2.7	3.1	6.9

Table 3: Effect of irrigation intervals and mulching levels on leaf length and leaf breadth of turmeric

	Leaf length (cm)					Leaf breadth (cm)				
Treatment	30	60	90	120	150	30	60	90	120	150
Irrigation intervals (days)										
6	7.01	16.5	22.2	25.8	41	3.85	8.13	9.03	10.5	12.1
12	6.62	12	20.4	23.3	38.5	3.15	5.49	6.63	9.2	10.9
LSD (P=0.05)	NS	0.6	0.4	1.9	1.9	0.22	0.68	0.65	0.3	0.4
Mulching levels (t/ha)										
0	3.65	12.2	19.4	20.3	33.2	1.9	5.5	6.3	9	11.2
5	7.08	13.7	20.8	23.3	38.7	3.05	6.42	7.42	9.6	11.2
10	7.87	14.8	22.1	25.5	42.8	4.08	7.35	8.5	10.2	12
15	8.65	16.3	23	29.1	44.3	4.97	7.98	9.12	10.6	11.6
LSD (P=0.05)	0.2	0.7	0.3	1.8	1.8	0.23	0.24	0.35	0.1	NS

Table 5: Effect of different irrigation intervals and mulching levels on the productivity parameters of the turmeric

Treatments	Rhizome length (cm)	Rhizome yield (q/ha)
Irrigation intervals (days)		
6	7.9	157.5
12	7.05	119.3
LSD (P=0.05)	0.19	35.8
Mulching levels (t/ha)		
0	5.67	66.8
5	6.78	112.5
10	8.3	160
15	9.15	214.3
LSD (P=0.05)	0.18	15.3

rhizome yield (q/ha). The maximum fresh rhizome yield (157.5 q/ha) was obtained when irrigation was applied after 6 days of interval, which was significantly higher than other irrigation interval of 12 days. Irrigation interval of 6 days recorded 32.0% higher rhizome yield than 12 days irrigation intervals.Significantly higher fresh rhizome yield (214.3 q/ha) was obtained with 15 t/ha of mulch application which was significantly higher than no mulch (66.8 q/ha), 5 t/ha (112.5 q/ha) and 10 t/ha (160.0 q/ha). Mulching @ 5, 10 and 15 t/ha recorded 68.4, 139.5 and 220.8%, respectively higher rhizome yield than control (no mulch application). Mahey et al (1986), Junior et al (2005), Mohanty et al (1991) and Verma and Sarnaik (2006) have also recorded higher fresh rhizome yield with mulch application.

Table 4: Effect of different irrigation intervals and mulching levels on leaf area (cm²) of turmeric

Treatments	Days after sowing				
	30	60	90	120	150
Irrigation intervals (days)					
6	28.8	135.4	202.8	201.6	465.6
12	23.2	67.1	136.8	161.9	448.1
LSD (P=0.05)	0.6	10.7	32.4	17.4	12
Mulching levels (t/ha)					
0	7.1	70.4	123.2	201.6	369.9
5	21.6	90.1	155.7	254.4	430.9
10	32.2	110.9	189.2	291.6	514.4
15	43.1	133.6	211.2	339.4	512.2
LSD (P=0.05)	2.2	4.6	23.5	10.3	0.31

6 days as compared to the irrigation interval of 12 days. The maximum leaf length (8.65, 16.3, 23, 29.1 and 44.3 cm) at 30, 60, 90, 120 and 150 DAP and leaf breadth (4.97, 7.98, 9.12, 10.6 and 11.6 cm) at 30, 60, 90, 120 and 150 DAP was recorded with the mulch application of 15 t/ha which was significantly higher than the other mulching levels.

Leaf area

The maximum leaf area (28.8, 135.4, 202.8, 201.6 and 465.6 cm²) was recorded at 30, 60, 90, 120 and 150 DAP when crop was grown with irrigation interval of 6 days which was significantly higher than the irrigation interval of 12 days. The maximum leaf area (43.1, 133.6, 211.2, 339.4 and 512.2 cm²) at 30, 60, 90, 120 and 150 DAP was recorded with the mulch application of 15 t/ha which was significantly higher than the other mulching levels.

Rhizome length

The irrigation intervals have significant effect on the rhizome length (cm) of the turmeric crop (Table 5). The maximum rhizome length (8 cm) was obtained when the irrigation was given after 6 days of the interval which was significantly higher as compared to the 12 days of the interval.The mulch levels have shown the significant effect on the rhizome length of the turmeric crop. The maximum rhizome length (9.1 cm) was obtained under the mulch application of the 15 t/ha as compared to the other mulch levels. The interaction effect between the irrigation intervals and mulch levels has significant effect on the rhizome length of the turmeric crop. The maximum rhizome length (9.7 cm) was obtained when irrigation was given after 6 days of the interval and 15 t/ha of mulch application as compared to the other treatment combinations.

Rhizome yield

The irrigation intervals has significant effect on the fresh

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