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Research Article

EFFECT OF MULCHES AND LEVEL OF IRRIGATION ON SOIL TEMPERATURE, SOIL MOISTURE DEPLETION AND CROP YIELD FOR BOTTLE GOURD

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ABSTRACT
Field experiments were conducted to assess the impacts of different type of mulches with different level of irrigation through drip irrigation system on soil temperature, soil moisture depletion and performance of bottle gourd (*Lagenaria siceraria*) in PFDC, IGKV, Raipur. The crop yield was found maximum under black plastic mulch with 80% of CWR (Crop Water Requirement) through drip irrigation system, followed by paddy straw mulch and without mulch with drip system in a split plot design. The benefit cost ratio was found maximum (2.14) fewer than 80% of CWR through drip irrigation system with black plastic mulch. The soil temperature (at morning) was found maximum in 10 cm depth compared to 5 cm depth under black plastic mulch, followed by paddy straw and without mulch. Similarly, in the afternoon the soil temperature was found maximum in 5 cm depth compared to 10 cm depth under black plastic mulch, followed by without mulch and paddy straw mulch. The soil moisture depletion was found minimum in 10 cm depth compared to 30 cm depth under 100% of CWR through drip irrigation system with black plastic mulch. These improvements of crop growing environment resulted in increased bottle gourd growth and fruit yield.

Key Words: *Mulches, Soil Temperature, Soil Moisture Depletion, Drip Irrigation, Bottle Gourd*

INTRODUCTION
Mulching with drip irrigation system is an effective method of manipulating crop growing environment to increase yield and improve product quality by ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content. The use of wastewater for irrigation purposes is being established as a future alternative in water scarce areas and in those areas where there is heavy competition for water. Since efficient use of irrigation water is of major importance for sustainable agriculture development, different measures have been introduced to conserve water (Taylor *et al.,* 1995).

Drip irrigation is an efficient method of water application for vegetables and horticultural crops. This method is widely used because it allows efficient management of both water and fertilizer (Rajurkar *et al.,* 2012). The cost depends upon the crop, spacing, water requirements, source of water supply etc. The payback period of drip irrigation system was worked out about one to two years for most of the crops and the benefit cost ratio varies from 2 to 5 (Sivannapan, 2009). Bottle gourd is a good source of vitamins and minerals. It provides enough energy and accomplishes water requirement of the body. It is quite bland and tasteless, it has many nutrition benefits. The cooked bottle gourd has cooling and anti-bilious effect on the body.

MATERIALS AND METHODS
Experimental Site
Field experiments were carried out during the year 2011-12 at Precision Farming Development Centre (PFDC), Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), located in the central part of Chhattisgarh at Longitude 81.36^0 E, Latitude 21.16^0 N and at an Altitude of 289.56 meters above the mean sea level.

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Experimental Design and Treatments

The experiments were laid out in a Split Plot Design (SPD) having three replications (Figure 1). In this experiment, the main plot treatment at different levels of irrigation and sub plot treatment at different type of mulches (black plastic mulch, paddy straw and without mulch) were utilized. Bottle gourd was planted utilizing four levels of irrigation, in which three level of irrigation were provided by drip system (60% of CWR, 80% of CWR and 100% of CWR) and fourth level of irrigation was provided by furrow irrigation. Both the treatment was randomized to check the effect of different irrigation levels and different type of mulches on soil temperature, soil moisture depletion and yield of crop. Drip irrigation system consists of drip tubing placed in each row of plant. During the treatment, irrigation levels were maintained by use of control valve in each row. During irrigation, water pressure in the system was maintained at 1.2 kg/cm^2.

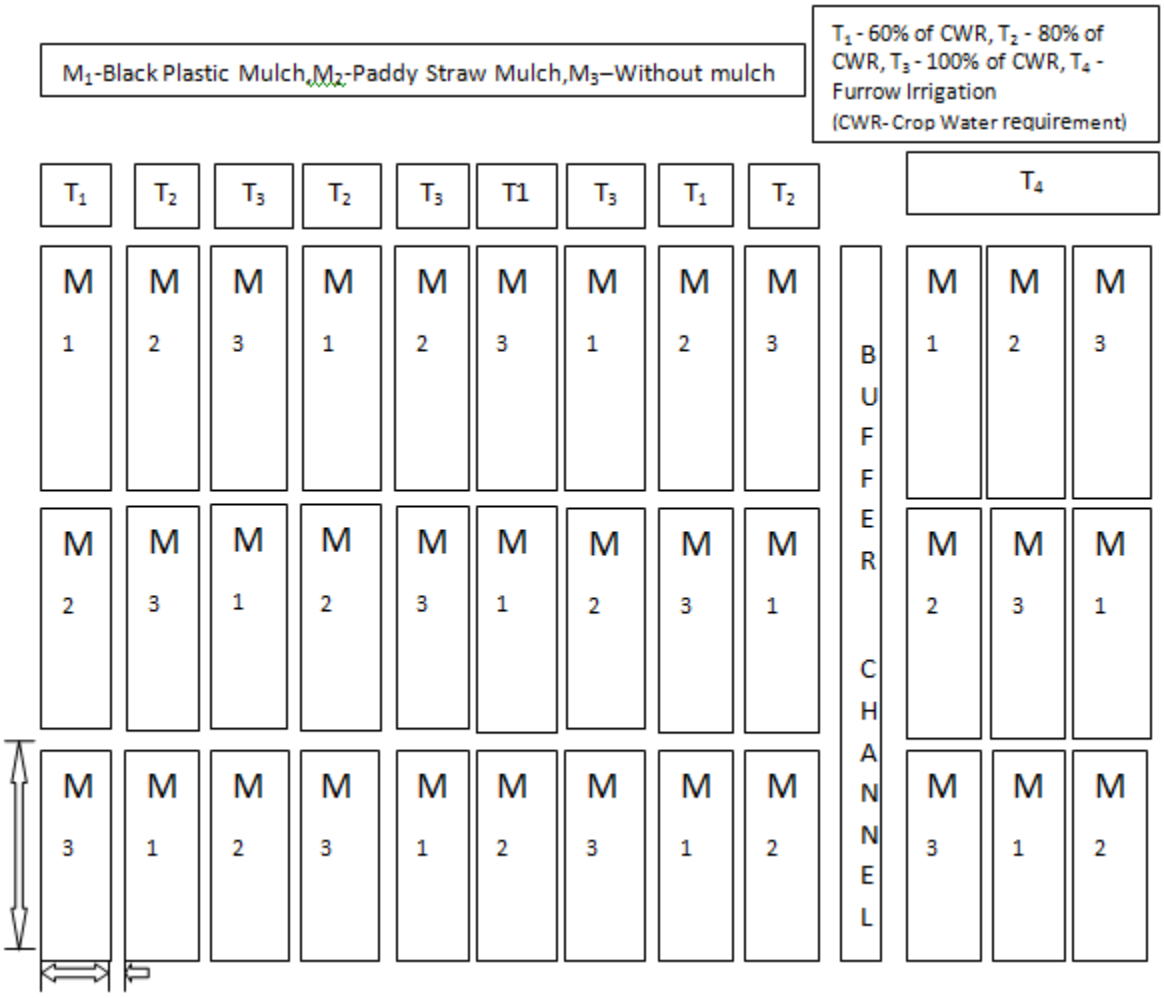

Figure 1: Experimental layout of field in a Split Plot Design (SPD) with three replications

Measurement of Soil Temperature

Temperature of soil was taken during the experiment with the help of digital soil thermometer. Soil temperature was taken at 5 and 10 cm depth by inserting sensor rod of digital soil thermometer below the soil surface. Soil temperature was taken from the plot covered with different mulches as black polythene mulch (50μ), paddy straw mulch and without mulch. Observation was recorded to know the effect of

different mulches on soil temperature which indirectly affect the crop production. The daily records of soil temperature were taken at 7:30 am and 2:00 pm.

Soil Moisture Measurement

Soil samples were collected randomly at 10 and 30cm depth from drip irrigated (100, 60, 80% of CWR) and furrow irrigated plot to know the effect of different irrigation levels under different mulches on soil moisture content. Moisture content of the soil was determined by gravimetric method using the following relation. The soil samples of the experimental plots were collected from the specified locations and moisture contents of each soil sample was determined using standard methods.

$$Moisture\ content\ (percentage\ db) = \frac{(W1\ -\ W2)}{W2} \times 100$$

Where, W_1 = Wet mass of soil (g) and W_2 = Dry mass of soil (g)

Soil moisture depletion (mm)

$$= \frac{(F.C - M.C.) \times Root\ zone\ depth \times B.D}{100}$$

$F.C$ - Field capacity (%), $M.C.$-Moisture content (%), $B.D$ - Bulk density (g/cc).

Yield Parameter

Marketable and total fruit yield per hectare was worked out with the help of fruit yield per plot by using the following formula-

$$\text{Yield (t/ha)} = \frac{\text{Weight of fruit in kg/plot} \times 10000}{\text{Plot area} \times 1000}$$

RESULTS AND DISCUSSION

Effect of different type of mulches (black plastic, paddy straw and without mulch) on soil temperature, soil moisture content, soil moisture depletion and yield of crop under different level of irrigation were recorded and are presented in the form of tables.

Effect of Different Type of Mulches on Soil Temperature

Soil temperature was recorded at 7:00 AM and 2:00 PM from 20 March to 7 May. The weekly average of daily recorded soil temperature at 5 and 10 cm depth is presented in Table 1.

Table 1: Weekly average of daily recorded soil temperature under different type of mulches

	Black plastic mulch				Paddy straw mulch				Without mulch			
S. no.	**7.00 AM**		**2.00 PM**		**7.00 AM**		**2.00 PM**		**7.00 AM**		**2.00 PM**	
	5cm	**10cm**	**5cm**	**10cm**	**5cm**	**10cm**	**5cm**	**10cm**	**5cm**	**10cm**	**5cm**	**10cm**
1.	25.39	27.47	36.10	32.01	21.91	23.39	24.99	23.84	20.87	21.74	32.01	29.67
2.	26.60	28.21	35.46	32.89	23.96	25.24	26.45	25.31	22.40	23.33	32.84	30.29
3.	27.89	28.97	34.61	32.47	24.81	26.09	28.46	27.44	23.21	25.03	33.50	31.89
4.	27.73	28.99	36.49	32.80	25.67	26.67	29.51	28.13	25.14	26.10	33.63	32.17
5.	29.39	30.63	36.19	33.50	26.29	27.57	29.94	28.90	25.86	27.04	35.06	32.44
6.	28.97	30.27	36.90	34.01	27.34	28.37	30.66	29.29	27.06	27.89	34.19	32.96
7.	29.07	30.33	42.93	38.26	27.31	28.54	33.03	31.24	26.84	27.86	40.24	36.37
Mean	27.86	29.26	36.95	33.71	25.33	26.55	28.58	27.74	24.48	25.57	34.50	32.26

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From table it can be seen that at 7:00 AM the average soil temperature at 5cm depth is lower compared to 10 cm depth under all three type of mulches. At the same time soil temperature has been found maximum under black plastic mulch followed by paddy straw mulch and without mulch at 5 and 10 cm depth. The result revealed that during forenoon soil temperature increases with increasing depth. Increasing and decreasing trend of soil temperature under black plastic mulch depends on daily atmospheric temperature. Similar trend fallows in the case of paddy straw and without mulch.

Based on the recorded data at 2:00 PM the average soil temperature at 5cm depth is higher compared to 10 cm depth under all three types of mulches.

At the same time soil temperature has been found maximum under black plastic mulch followed by without mulch and paddy straw mulch at 5 and 10 cm depth. The result revealed that at afternoon soil temperature decreases with increasing depth. The result concluded that at 7:00 AM the average soil temperature under BPM is 2.53 and 3.38°C higher than under PSM and WM at 5 cm depth respectively. Similarly, at 10 cm depth soil temperature under BPM is 2.71 and 3.69°C higher than under PSM and WM respectively. At the same time the average soil temperature under PSM is 0.85 and 0.98 ^{0}C more than under WM at 5 and 10 cm depth respectively. At 2:00 PM the average soil temperature under BPM is 8.37 and 2.45 ^{0}C higher than under PSM and WM at 5 cm depth respectively. Similarly at 10 cm depth soil temperature under BPM are 5.97 and 1.45 ^{0}C more than under PSM and WM respectively. At the same time the average soil temperature under WM is 5.92 and 7.78 ^{0}C higher than under PSM at 5 and 10 cm depth respectively. Variation of soil temperature under BPM, PSM and WM at 7.00AM to 2.00 PM was measured at 5 and 10 cm depth. At 5 cm depth 9.09, 3.25 and 10.02 ^{0}C soil temperature variation was found under BPM, PSM and WM respectively. Similarly, at 10 cm depth 4.45, 1.19 and 6.69 ^{0}C soil temperature variation was found under BPM, PSM and WM respectively. The result revealed that soil temperature variation is low under paddy straw mulch and high under without mulch at 5 and 10 cm depth. The results are in conformity with the findings of Singh and Kamal (2012), El- Shaikh and Fouda (2008), Ramakrishna *et al.,* (2006), Mbagwu (1991) and Lee and Yoon (1975).

Effect of Different Irrigation Levels and Mulches on Soil Moisture Content and Soil Moisture Depletion

Average soil moisture content and soil moisture depletion with different levels of irrigation (100, 80, 60% of CWR and control) and mulches were measured at 10 cm and 30 cm soil depth and is presented in Table 2. At 10 cm depth soil moisture content (29.28, 26.09, 24.67 and 19.06%) and soil moisture depletion (0.72, 2.10, 2.71 and 5.11 mm) were found under BPM respectively.

Table 2: Soil moisture content and soil moisture depletion under different treatment

Mulches	Irrigation level	10 cm depth		30 cm depth	
		M.C. (%)	SMD (mm)	M.C. (%)	SMD (mm)
BPM	100% of CWR	29.28	0.72	26.03	2.12
	80% of CWR	26.09	2.10	22.32	3.72
	60% of CWR	24.67	2.71	19.18	5.06
	CONTROL	19.06	5.11	17.44	5.81
PSM	100% of CWR	27.87	1.33	24.70	2.69
	80% of CWR	25.31	2.43	20.77	4.38
	60% of CWR	22.54	3.62	18.76	5.24
	CONTROL	18.15	5.50	16.45	6.23
WM	100% of CWR	21.92	3.89	23.37	3.26
	80% 0f CWR	18.52	5.35	20.27	4.59
	60% of CWR	16.29	6.30	17.98	5.58
	CONTROL	14.78	6.95	16.02	6.42

At the same depth soil moisture content (27.87, 25.31, 22.54 and 18.15%) and soil moisture depletion (1.33, 2.43, 3.62 and 5.50 mm) were found under PSM respectively. Soil moisture content (21.92, 18.52, 16.29 and 14.78%) and soil moisture depletion (3.89, 5.35, 6.30 and 6.95 mm) were found under WM at 10 cm depth respectively. Similarly, at 30 cm depth soil moisture content (26.03, 22.32, 19.18 and 17.44%) and soil moisture depletion (2.12, 3.72, 5.06 and 5.81 mm) was found under BPM respectively. At the same depth soil moisture content (24.70, 20.77, 18.76 and 16.45%) and soil moisture depletion (2.69, 4.38, 5.24 and 6.23mm) were found under PSM respectively. Soil moisture content (23.37, 20.27, 17.98 and 16.02%) and soil moisture depletion (3.26, 4.59, 5.58 and 6.42 mm) were found under WM at 30 cm depth respectively. From table 2 it can be seen that maximum soil moisture content (29.28% and 26.03%) and minimum soil moisture depletion (0.72mm and 2.12mm) were found under the main plot 100 % of CWR with BPM at 10 and 30 cm depth of soil respectively. Similarly, minimum soil moisture content and maximum soil moisture depletion were found under control WM at 10 and 30 cm depth of soil.

Maximum soil moisture content and minimum soil moisture depletion have been found under BPM followed by PSM and WM. Based on experimental records it is concluded that soil moisture content was found maximum at 10 cm depth compared to 30 cm depth in case of BPM and PSM, but in case of WM soil moisture content was found more at 30 cm depth than at 10 cm depth. Similarly, soil moisture depletion was found minimum at 10 cm depth compared to 30 cm in case of black plastic mulch and paddy straw mulch, but in case of without mulch soil moisture depletion was found minimum at 30 cm depth compared to 10 cm depth. The results are in conformity with the finding of Singh and Kamal (2012), Al-Rawahy *et al.*, (2011), Ramakrishna *et al.*, (2006) and Mbagwu (1991).

Effect of Different Type of Mulches and Irrigation Levels in the Yield of Bottle Gourd

Economics of drip irrigation system for bottle gourd is presented in Table 3.

Table 3: Economics of production of bottle gourd per ha under drip and control method of irrigation with combination of mulches

Irrigation Level with Mulches	Total Cost (Rs.)	Total Yield (q/ha)	Gross Income (Rs.)	Net Income (Rs.)	Benefit Cost Ratio
60% of CWR + BPM	154961.85	446.35	267810	112848.20	1.73
60% of CWR + PSM	108096.75	294.66	176796	68699.20	1.64
60% of CWR + WM	106659.95	263.17	157902	51242.10	1.48
80% of CWR + BPM	155584.15	553.90	332340	176755.90	2.14
80% of CWR + PSM	108302.45	361.70	217020	108717.60	2.00
80% of CWR + WM	106865.75	272.45	163470	56604.30	1.53
100% of CWR + BPM	155255.55	532.41	319446	164190.50	2.06
100% of CWR + PPM	108243.05	340.61	204366	96122.90	1.89
100% of CWR + WM	106806.35	265.74	159444	52637.70	1.50
Control + BPM	135413.50	361.72	217032	81618.50	1.60
Control + PSM	88254.70	229.95	137970	49715.30	1.56
Control + WM	86759.70	213.16	127896	41136.30	1.47

From this table, it is evident that higher cost Rs. 155584.15/ha was estimated under treatment T_2M_1 i.e. drip irrigation with black plastic mulch followed by treatment T_3M_1 and T_1M_1 whereas the lowest cost Rs.

86759.70/ha was calculated under treatment T_4M_3. The maximum net income Rs. 176755.90/ha was estimated under the treatment T_2M_1 (80% of CWR through drip irrigation with BPM) followed by T_3M_1 (Rs. 164190.50/ha) and T_1M_1 (Rs. 112848.20/ha). The lowest net income Rs. 41136.30/ha was found under treatment T_4M_3 i.e. furrow irrigation without mulch. Data regarding benefit cost ratio (B/C) shows that the higher benefit cost 2.14 was obtained under the treatment T_2M_1 i.e. 80% of CWR through drip irrigation with BPM followed by T_3M_1 (2.06), T_2M_2 (2.00), T_3M_2 (1.89) and T_1M_1 (1.73) while the lowest B/C ratio 1.47 was recorded under treatment T_4M_3 i.e. furrow irrigation without mulch.The net income and benefit cost ratio are directly related to cost increased and yield obtained in the treatment. The results are in close agreement with the findings of Singh *et al*. (2009). Duration of bottle gourd is only four months and hence two crops in a year (Rabi and zaid season crop) can be cultivated for maximum utilization of drip irrigation system. This will further help improve the benefit cost ratio.

Conclusion

Use of different type of mulches with different level of irrigation is helpful for providing adequate amount of moisture and temperature which directly help in the to increase production of crop. In the cultivation of bottle gourd use of 80% of crop water requirement through drip irrigation system with black plastic mulch would be more effective for increasing yield of crop and remaining 20% of crop water requirement can be used for taking extra production under this system.

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