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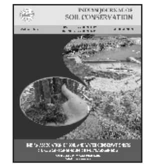

Effect of different mulches on soil moisture conservation and yield of drip irrigated watermelon

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ABSTRACT

The field experiment was conducted on watermelon (*Citrullus lanatus*) cv. Kiran in summer season during two consecutive years *viz.,* 2015 and 2016. The field experiment was laid out in split plot design, wherein main plots were assigned to three irrigation levels based on daily pan evaporation data (I_1 – drip irrigation at 60% of pan evaporation, I_2 – drip irrigation at 80% of pan evaporation and I_3 – drip irrigation at 100% of pan evaporation) and sub plots to four mulches (BPM – Black polythene mulch, TPM – Transparent polythene mulch, SSM – Soybean straw mulch and C – Control, without mulch). Among the mulches, BPM was found to be more effective for conserving soil moisture (9.27% and 11.27%) followed by TPM (6.52% and 9.96%) and SSM (4.81% and 5.33%) over the control in 2015 and 2016, respectively. The total seasonal water use of drip-irrigated watermelon varied from 515.5 mm to 780.5 mm in 2015, and 525.8 mm to 798.8 mm in 2016.Yield of watermelon in BPM was 28.90 t ha^{-1}, which was significantly higher ($P < 0.05$) as compared to other mulches and no mulch. As regard to mulches, the highest B:C ratio (2.07 and 1.71) was observed in BPM treatment followed by TPM (1.81 and 1.49) and SSM (1.73 and 1.46) during 2015 and 2016, respectively. The lowest B:C ratio (1.65 and 1.28) was observed in control. In conclusion, drip irrigation in combination with plastic mulch, especially black mulch, is recommended as more effective method in improving water use efficiency (WUE) and increasing crop yield of watermelon in Marathwada region.

1. INTRODUCTION

Watermelon (*Citrullus lanatus*) is an important vegetable crop of the world belonging to the family of Cucurbitaceae. Watermelon contains about 6% sugar and 92% water by weight. As with many other fruits, it is a good source of vitamin C. Watermelon is native to dry areas in tropical and subtropical Africa, south of the equator. The crop prefers hot, dry climate with mean daily temperatures of 22°C to 30°C. The optimum soil temperature for root growth is in the range of 20°C to 35°C. Fruits grown under hot, dry conditions have a high sugar content of 11% in comparison to 8% under cool, humid conditions. The crop is very sensitive to frost. Total length of the growing period ranges 80-110 days, depending on climate. The crop prefers a sandy loam soil texture with pH of 5.8 to 7.2. For high production, fertilizer requirements are 80-100 kg ha^{-1} N, 25-60 kg ha^{-1} P and 35-80 kg ha^{-1} K. The crop is moderately sensitive to salinity. World production of watermelon is about 77.5 M t fruit from 3.1 M ha (FAO, 2013).

In India, it is grown over an area of 81000 ha with total production of about 1789 thousand metric tons and average yield of 22.08 t ha^{-1}. In Maharashtra, it is grown over an area of 660 ha with average yield in the range of 25-30 t ha^{-1}. Cucurbits share about 5.6% of total vegetables production of India (Anonymous, 2012).

Mulches are used for various reasons, but water conservation and erosion control are the most important objectives for its use in agriculture. Mulching in general is a beneficial practice for crop production. Mulches are either organic (derived from plant and animal materials) or inorganic (plastic film). The use of plastic mulch in agriculture has increased dramatically in the last 10 years throughout the world. This increase is due to benefits such as increase in soil temperature, reduced weed pressure, moisture conservation, reduction of certain insect pests, higher crop yields, and more efficient use of soil nutrients (Subrahmaniyan and Ngouajio, 2012).

Plastic mulches alter the crop microclimate by changing the soil energy balance (Tarara, 2000). Modification of the crop microclimate results in changes in soil temperature that may affect plant growth and yield of crop (Dıaz-Perez and Batal, 2002; Lamont, 2005). The utilization of different mulches in combination with drip irrigation has played a major role in enhancing the production of tomato (Biswas *et al.,* 2015); watermelon (Romic *et al.,* 2003); muskmelon (Ibarra *et al.* 2001); capsicum (Paul *et al.,* 2013); brinjal (Paul *et al.,* 2014) and cucumber (Yaghi *et al.* 2013). Kumar *et al.* (2003) observed that application of mulches at 10 t ha^{-1} conserved more moisture and increased yield of turmeric by 12%. Application of paddy straw mulch resulted in 18% increase in yield over *Gliricidia* mulch. Irrigation used in combination with mulch typically need less water to meet the crop requirement as the other losses are kept minimum thereby increasing the WUE. Patil and Patil (2009) reported that about 23.4% water saving was observed in treatment of drip irrigation with mulch as compared to conventional irrigation method with no mulch for capsicum crop.

According to the literature, watermelon has high water requirement (Özmen *et al*., 2015). In Marathwada region, rainfall is low in the summer, which is the cropping season for watermelon. The total precipitation does not meet the water requirements of watermelon. For higher yields, the seasonal water requirements of watermelon vary from 520 mm to 660 mm, depending on the climate and the total length of the growing period (Özmen *et al*., 2015). Many times, farmers loose entire crop in *rabi* and summer season due to inadequate irrigation. It is, therefore, necessary to use limited water efficiently by adopting water saving methods, like drip irrigation system in combination with mulch for increasing the crop productivity. Without good irrigation management information many growers tend to over-irrigate to eliminate the risk of under-irrigation. Therefore, it is necessary to have proper planning for optimal use of water and maximizing crop productivity. This can be achieved by comparing crop yield with irrigation amounts ranging from deficient to excess. This information can help growers to develop an irrigation strategy, and is necessary for the future development of guidelines to help them improve irrigation management for their own profitability, and to also protect the environment. This information can also help growers to choose best mulch type for conserving soil moisture and achieving higher yield of watermelon. Thus, the present study was undertaken with objective to study the effect of different mulches on soil moisture conservation and yield of drip irrigated watermelon.

2. MATERIALS AND METHODS

Experimental Layout and Design

The field experiment was conducted in summer season during two consecutive years *viz.,* 2015 and 2016 on research farm of All India Co-ordinated Research Project on Irrigation Water Management, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani. Parbhani is situated at 409 m altitude, 19°16'N latitude and 76°47'E longitudes in Marathwada division of Maharashtra State. Parbhani is grouped under assured monsoon rainfall zone with an average annual precipitation of 918 mm. The mean monthly maximum temperature varied from 27.1°C in winter (January) to 43.9°C in summer (May). The mean monthly minimum temperature varied from 7.6°C to 27.3°C during winter (December) and summer (May), respectively. Thus, Parbhani has hot and dry summer, and cold winter.

Weather data during experimental period (Table 1) shows that the maximum and minimum temperatures, relative humidity and pan evaporation were high during experimental period in 2016 as compared to 2015 season.

The soil was clayey in texture (sand = 18.50%; silt = 28.30%; clay = 53.20%) and slightly alkaline (soil pH = 8.08) in reaction. The field experiment was laid out in split

Table: 1
Weather parameters during growing seasons

Month	Weather variables							
	Total rainfall (mm)	T_{MIN} (°C)	T_{MAX} (°C)	RH_{AM} (%)	RH_{PM} (%)	WS (km hr^{-1})	BSS (hrs day^{-1})	PE (mm day^{-1})
2015								
February	0.0	13.8	33.3	67.7	21.6	4.4	9.3	6.9
March	40.9	18.1	34.6	72.5	28.7	5.1	8.5	7.7
April	91.8	20.3	37.9	76.3	24.7	4.7	9.2	8.9
May (upto 10th May)	22.8	24.9	41.7	58.3	19.1	6.5	9.1	12.7
2016								
February	4.2	17.4	35.7	64.8	19.1	4.5	9.1	7.3
March	17.6	20.0	38.2	61.0	26.1	4.7	9.5	9.1
April	7.6	24.1	42.0	49.3	17.0	4.8	9.5	9.4
May (upto 18th May)	0.0	25.6	42.1	45.1	17.9	7.7	9.7	15.8

plot design, wherein main plots were assigned to three irrigation levels based on daily pan evaporation data (I_1 – drip irrigation at 60 % of pan evaporation, I_2 – drip irrigation at 80% of pan evaporation and I_3 – drip irrigation at 100% of pan evaporation) and sub plots to four mulches *i.e.* BPM (30 μ), TPM (30 μ), SSM (5 t ha^{-1}) and C (without mulch). Each main treatment plot had three rows of crops with 20 plants in each sub plot. Layouts of drip irrigation system and experimental details are shown in Fig. 1. The spacing was 2 m row to row and 0.5 m plant to plant. Single seed of cv. Kiran was dibbled at each hill on 1^{st} Feb., 2015 and 1^{st} Feb., 2016. The fertilizers were applied at the rate of 100:50:50 NPK kg ha^{-1}. Full dose of P_2O_5 and K_2O were applied as basal dose, and nitrogen was given in two equal split as basal and top dressing at 30 days after sowing (DAS).

Planning and Adoption of Irrigation Scheduling

Irrigation was scheduled on daily basis as per the treatment and each day's water was applied through drip irrigation, except for days when the crop received more water through rain than was lost through evaporation. The pan evaporation was measured daily from the USWB class 'A' open pan evaporimeter installed at the Agro-meteorology Observatory, Department of Meteorology, VNMKV, Parbhani during the period of experiment. From seed sowing to seedling stage, a total of 91.7 mm and 86.9 mm water was applied to all treatments in 2015 and 2016, respectively to maintain soil moisture content at field capacity. The daily irrigation scheduling to all treatments were initiated from 21 DAS during both the years of experiment. The rows were irrigated using the inline laterals of 16 mm diameter, having 2.4 lph dripper discharge and 0.3 m dripper spacing. For calculation of amount of irrigation water, the method given by Allen *et al.* (1998) was followed as:

$$ET_o = K_p\,PE \qquad ...(1)$$

$$ET_c = K_c\,ETo \qquad ...(2)$$

Where, ET_o is reference evapotranspiration (mm), K_p pan coefficient, PE pan evaporation (mm), ETc is crop evapotranspiration (mm) and K_c is crop coefficient. As suggested by Ertek *et al.* (2004) when calculating ET_c from PE, K_p and K_c was combined as:

$$ET_c = K_{cp}\,PE \qquad ...(3)$$

The calculation of applied amount of water based upon pan evaporation whose fundamentals are given in the articles of Doorenbos and Pruitt (1977) is given by eq. 4.

$$V = A \times PE \times K_{cp} \qquad ...(4)$$

Where, V is the amount of applied irrigation water, A is the area of plot, PE is the pan evaporation and K_{cp} is the plant-pan coefficient. In this experiment three different plant-pan coefficients were consider (K_{cp}1: 0.60; K_{cp}2: 0.80, and K_{cp}3: 1.00). Evaporation between the irrigation intervals was measured with a Class - A pan located near the plots.

After calculating the volume of water to be applied, the operating time of drip unit (t) was calculated by using the following formula:

$$t = \frac{v}{q \times N_e} \times 60 \qquad ...(5)$$

Where, t is operation time of system, min; v is volume of water to be applied (litre); q is average emitter discharge, lph; and N_e is number of emitters per plot.

Determination of Soil Moisture Content

Soil samples were taken with screw auger and soil moisture was determined by gravimetric method at 20, 30,

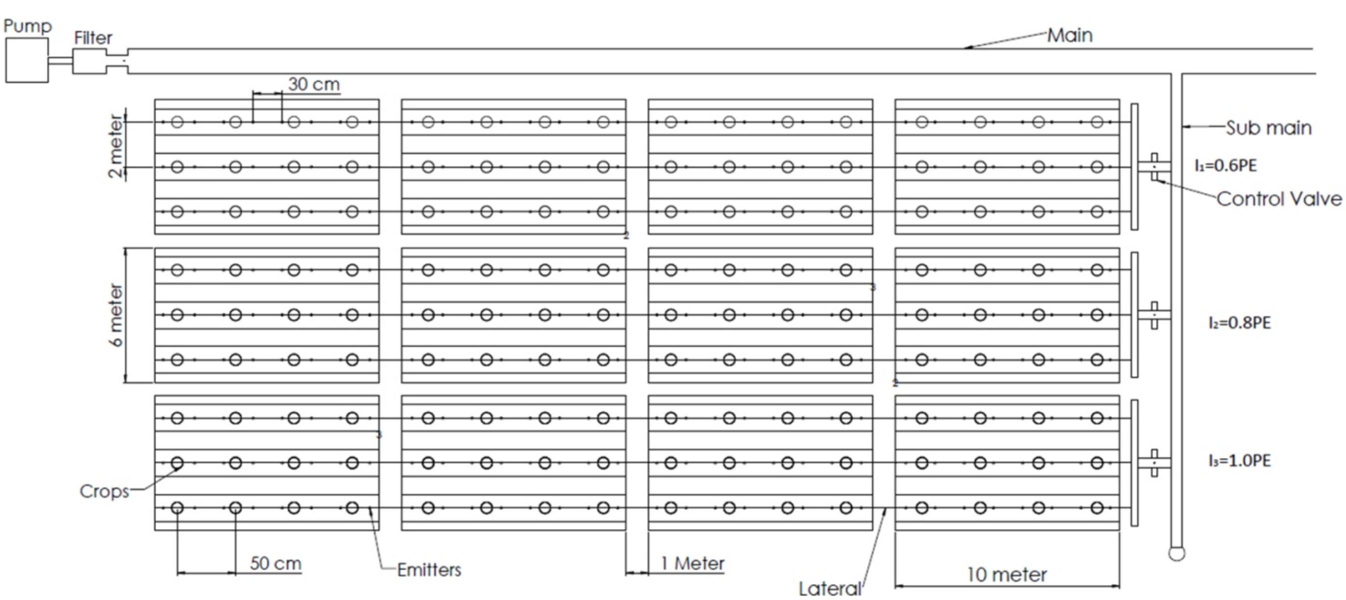

Fig. 1. Experimental layout

40, 50, 60, 70 and 80 DAS, and at harvest. The soil samples were taken at 10 cm from lateral and at the depths of 0-15 cm, 15-30 cm and 30-45 cm down from the surface.

Monitoring of Crop Yield Parameter

The total number of watermelons were counted and their total weight was determined for each plot, and plot wise yield of watermelon was then converted into tons per hectare.

Determination of Water Use Efficiency (WUE)

Irrigation WUE *i.e.* kg of watermelon yield produced per mm of water per hectare in each treatment was worked out by the following formula:

$$\text{WUE} = \frac{Y}{\underset{(\text{mm})}{\text{Applied water}} + \underset{(\text{mm})}{\text{Effective rainfall}}} \quad ...(6)$$

Where, WUE (kg of watermelon $ha^{-1}mm^{-1}$) and Y is watermelon yield (kg ha^{-1}).

Production Cost and Economic Analysis

The cost of cultivation of watermelon includes expenses incurred on field preparation, ploughing, mulching, seeds, sowing, fertilizers and their application, weeding, crop protection measures and harvesting. The seasonal cost of drip irrigation included depreciation, prevailing bank rate of interest @ 12% per annum, and repair and maintenance @ 2% of the fixed cost. The income from produce was estimated using prevailing average market price ₹ 6000 per ton. The net seasonal income from produce was estimated by subtracting the total seasonal cost from the income of the produce. For economic evaluation, gross monetary returns, net monetary return, cost of cultivation and B:C ratio were computed treatment wise.

Statistical Analysis

The statistical method of analysis of variance was used for analyzing the data. The data was statistically analyzed by "Analysis of variance" method (Gomez and Gomez, 1984) and the 'F' test of significance was used for testing the null hypothesis in order to determine whether the observed treatment effects were real and discernible from chance effects. Whenever the results were found to be significant, critical difference (CD) was calculated for comparison of treatment mean.

3. RESULTS AND DISCUSSION

Applied Irrigation Water

The cumulative water application by different irrigation levels alongwith distribution of rainfall during growing period of watermelon in 2015 and 2016 are graphically depicted in Fig. 2.

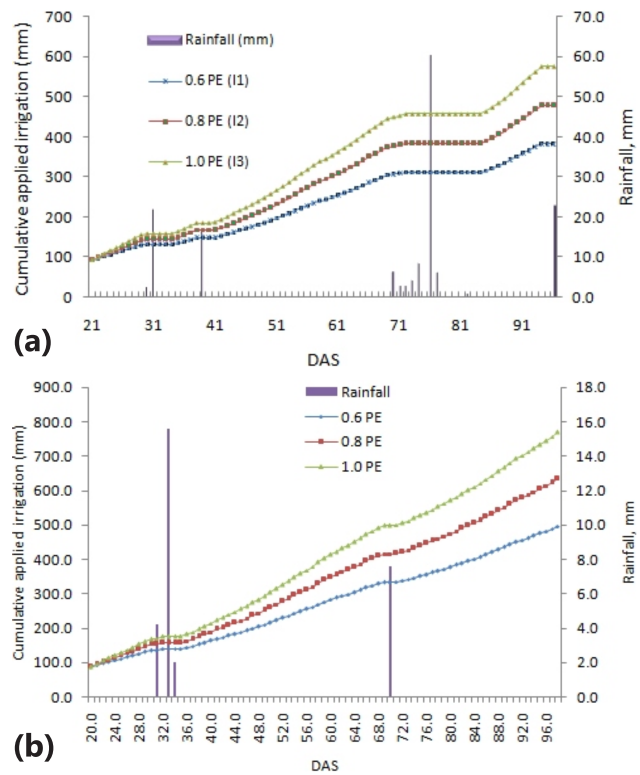

Fig. 2. Cumulative irrigation applied and rainfall distribution during growing period of watermelon in (a) 2015 and (b) 2016

The total precipitation received during growing season in 2015 was 155 mm, and it was 52.2 mm in 2016. In 2015, the amount of irrigation water applied was less for all the treatments compared to irrigation water applied in 2016, because of higher rainfall in growing period in the year 2015. From seed sowing to seedling stage, a total of 91.7 and 86.9 mm water was applied to all treatments in 2015 and 2016, respectively. The daily irrigation scheduling to all treatments were initiated from 21 DAS during both the years of experiment. The total irrigation water applied to the treatments under irrigation levels 0.6 PE (I_1), 0.8 PE (I_2) and 1.0 PE (I_3) were 399, 531 and 664 mm for the 1st year and were 497, 634 and 770 mm for the 2nd year of experiment, respectively.

Variation of Soil Moisture Content

The temporal variations in soil moisture content at 0–15, 15–30 and 30–45 cm depths under different mulches during growing period of watermelon in 2015 and 2016 are graphically illustrated in Fig. 3 and 4, respectively. It revealed that the soil moisture contents declined gradually from 40 DAS to the yield formation stage due to increase in the rate of evaporation and high crop water requirements. The soil moisture content fluctuated greatly in response to mulch type and rainfall. The highest soil moisture values were recorded with BPM and TPM compared to control throughout the season, except at 40 DAS in 2015, because of rainfall events at 31 DAS (21.8 mm) and 39 DAS (16.6 mm), which were responsible for increase in soil moisture

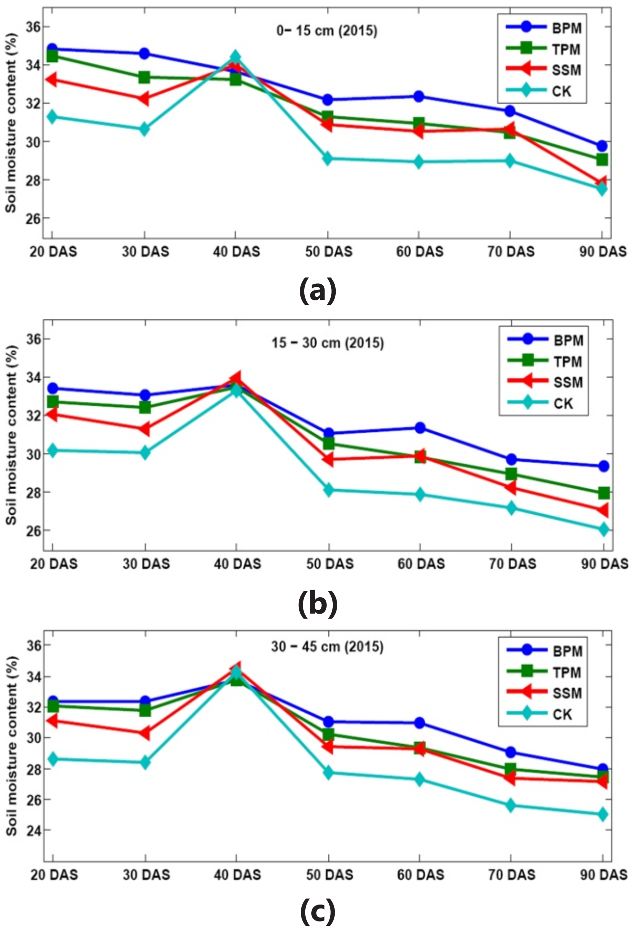

Fig. 3. Variations in soil moisture content at (a) 0–15, (b) 15–30 and (c) 30–45 cm depths under different mulches during the growing period of watermelon in 2015

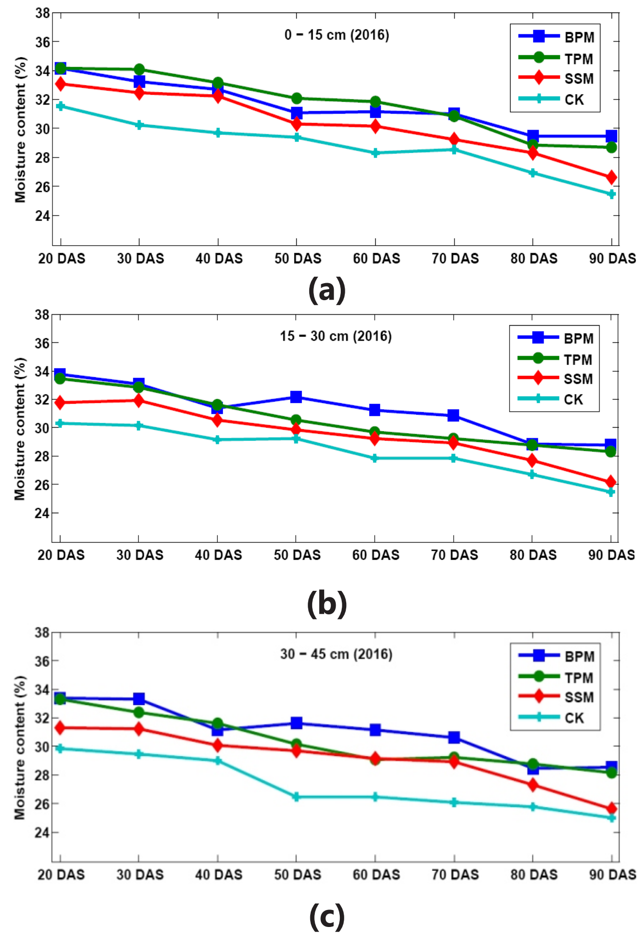

Fig. 4. Variations in soil moisture content at (a) 0–15, (b) 15–30 and (c) 30–45 cm depths under different mulches during the growing period of watermelon in 2016

content in control treatment compared to polythene mulches. There was no substantial variation in soil moisture content amongst the irrigation treatments upto 30-40 DAS, because of availability of sufficient amount of irrigation water to meet water requirement of the crop. The results agree with findings of Kuşcu *et al*. (2015) for cucumber, who reported that there was no considerable variation in soil water status amongst the irrigation treatments upto beginning of flowering. The moisture contents at 60 DAS were significantly higher at irrigation level 1.0 PE as compared to irrigation level 0.6 PE, however it was found at par with irrigation level at 0.8 PE during 2015. Similarly in 2016, moisture content at 40, 50, 60, 70, 80 and 90 DAS were significantly higher at irrigation level 1.0 PE as compared to irrigation level 0.6 PE, however it was found at par with irrigation level at 0.8 PE. During 2015 and 2016, the overall mean soil moisture content was highest under the 1.0 PE (I_3) followed by drip irrigation at 0.8 PE (I_2) and irrigation at 0.6 PE (I_1). Soil moisture profiles under 0.8 PE and 1.0 PE treatments during sowing and at harvest were quite uniform and always near to the field capacity. These indicated that 0.8 and 1.0 PE had been under full or over irrigation states. McCann *et al.* (2007) reported that soil water content under 50% irrigation rate (50% ET_o) was lower and declined over time compared to the two higher rates (100 and 150% ET_o) for watermelon crop.

It was also observed that soil moisture content was found maximum at 0–15 cm depth followed by soil moisture content at 15–30 cm and 30–45 cm depth under different mulches. These results are in accordance with Deshmukh *et al.* (2013). The soil moisture content at 0–15 cm depth under polythene mulches was generally nearer to field capacity throughout the season. This result was in line with the findings of Panigrahi *et al.* (2010) who reported that the mean monthly soil moisture variation observed at 0.3 and 0.6 m depths indicated that drip irrigation at 100% cumulative pan evaporation (Ecp) with plastic mulch showed significantly higher moisture content at 0.3 m depth, which is very near to field capacity of soil throughout the irrigation seasons.

Effect of different mulches on soil moisture conservation under drip irrigated watermelon in the years 2015 and 2016 is presented in Table 2. From Table 2 it can be observed that the percent increase in soil moisture content for BPM was 9.27 and 11.03 over the control in 2015 and 2016, respectively. At the same soil profile, the percent increase in soil moisture content for TPM was found 6.52 and 9.96 over the control in 2015 and 2016, respectively. Similarly, the percent increase in soil moisture content for SSM was found 4.81 and 5.33 over the control in 2015 and 2016, respectively.

From the above result it is evident that the maximum soil moisture content was recorded in drip irrigation with polythene mulch followed by drip irrigation with SSM treatments as compared to treatments of drip irrigation with no mulch. The higher soil moisture content below the mulches in various mulching treatments might be due to reduction in soil surface evaporation and weed density. Soybean straw also conserved the soil moisture moderately in the root zone as compared to the control. Similar results were obtained by Patil and Patil (2009), Dalorima *et al.* (2014), Mahadeen (2014), Kumar *et al.* (2015), and Sharma and Meshram (2015).

Effect of Different Mulching Material on Yield and Water Use Efficiency (WUE)

Effect of irrigation levels

From Table 3 and 4, it can be observed that the maximum watermelon yield was obtained in treatment I_3 (1.0 PE) *i.e.* 29.09 and 24.14 t ha^{-1} during 2015 and 2016, respectively. Results of analysis of yield data further revealed that lowest watermelon yield was obtained in treatment 0.6 PE. Panigrahi *et al.* (2011) also reported that 100% pan evaporation value *i.e.* 1.0 PE gave the highest yield and WUE of tomato in drip irrigation under hot humid climatic condition of West Central Table Land Agro-climatic zone of Odisha. The seasonal total water use of drip-irrigated watermelon varied from 515.5 mm to a high of 780.5 mm in 2015, and 525.8 mm to 798.8 mm in 2016. The effect of irrigation levels on WUE were found non-significant during both the years of experiment. From Tables 3 and 4, it is seen that maximum total WUE *i.e.* 43.04 and 32.89 kg $ha^{-1}mm^{-1}$ was observed in treatment 0.8 PE during 2015 and 2016, respectively, while lower WUE (37.27 and 30.21 kg $ha^{-1}mm^{-1}$) was observed in irrigation level 1.0 PE during both the years of experiment. The overall results indicated that deficit and excess irrigation did not show significant effect on the WUE of watermelon crop.

Effect of mulches

Yield data recorded under different mulches indicated

Table: 2
Effect of various mulches on soil moisture conservation in depth of 0–45 cm during growing period of drip irrigated watermelon in 2015 and 2016

Mulch type	Average soil moisture content (%)	% soil moisture conserved over control
2015		
Black polythene mulch (BPM)	31.8	9.27
Transparent polythene mulch (TPM)	31.0	6.52
Soybean straw mulch (SSM)	30.5	4.81
Control (c)	29.1	-
2016		
Black polythene mulch (BPM)	31.2	11.03
Transparent polythene mulch (TPM)	30.9	9.96
Soybean straw mulch (SSM)	29.6	5.33
Control (c)	28.1	-

Table: 3
Water use efficiency of watermelon influenced by various mulches and irrigation levels during 2015

Treatment	Water applied (mm)	Effective rainfall (mm)	Total water use (mm)	Yield (t ha^{-1})	Water use efficiency (kg ha^{-1} mm)
I_1 = 0.6 PE	399	116.5	515.5	21.70	42.10
I_2 = 0.8 PE	531	116.5	647.5	27.87	43.04
I_3 = 1.0 PE	664	116.5	780.5	29.09	37.27
S.E.±				1.58	2.43
C.D.(P=0.05)				4.39	NS
BPM	531.3	116.5	647.8	31.85	49.32
TPM	531.3	116.5	647.8	28.27	43.96
SSM	531.3	116.5	647.8	24.42	38.05
Control	531.3	116.5	647.8	20.35	31.88
S.E.±				1.66	2.70
C.D.(P=0.05)				3.50	5.67
I x M					
S.E.±				2.73	4.68
C.D.(P=0.05)				NS	NS

Table: 4
Water use efficiency of watermelon influenced by various mulches and irrigation levels during 2016

Treatment	Water applied (mm)	Effective rainfall (mm)	Total water use (mm)	Yield (t ha^{-1})	Water use efficiency (kg ha^{-1} mm)
I_1 = 0.6 PE	497	28.8	525.8	16.93	32.20
I_2 = 0.8 PE	634	28.8	662.8	21.80	32.89
I_3 = 1.0 PE	770	28.8	798.8	24.14	30.21
S.E.±				1.14	1.70
C.D.(P=0.05)				3.17	NS
BPM	633.7	28.8	662.5	25.95	39.24
TPM	633.7	28.8	662.5	22.80	34.76
SSM	633.7	28.8	662.5	20.12	30.55
Control	633.7	28.8	662.5	14.95	22.52
S.E.±				1.62	2.35
C.D.(P=0.05)				3.40	4.93
I x M					
S.E.±				2.81	4.06
C.D.(P=0.05)				NS	NS

that BP recorded maximum yield *i.e.* 31.85 and 25.95 t ha^{-1} which was followed by TPM and SSM, respectively during two years of experiment. Lowest yield *i.e.* 20.35 and 14.95 t ha^{-1} were recorded from the un-mulched plot, respectively during 2015 and 2016. It is thus concluded that BPM gave significantly higher yield over the rest of the treatments. Crop yield was higher under BPM than TPM because transparent polythene plot had a higher density of weeds, which led to a reduction in growth and development because of competition for nutrients and water. Similar results were found by Choudhary *et al.* (2012) for capsicum crop who reported that higher density of weeds under TPM leads to a reduction in growth of capsicum. Parmar *et al.* (2013) found that mulching material had significantly enhanced the fruit yield of watermelon. As regard to mulches, significantly higher WUE (49.32 and 39.24 kg $ha^{-1}mm^{-1}$) was observed in BPM, which was comparable with TPM (43.96 and 34.76 kg $ha^{-1}mm^{-1}$) during both the years of experiment. Lower WUE (31.88 and 22.52 kg $ha^{-1}mm^{-1}$) was observed in control (unmulched drip) during both the years of experiment.

From above results it was clear that drip irrigation with mulch registered higher WUE as compared to drip irrigation without mulch. This result indicated that water was used most effectively with combination of drip irrigation at 0.8 PE and BPM. Similar kinds of results were also reported by Wang *et al.* (2004), Kaya *et al.* (2005), Patil and Patil (2009), and Yaghi *et al.* (2013).

Effect of different mulching material on economics of watermelon

The economic analysis of cultivation of watermelon under various treatments of mulches and irrigation levels are presented in Table 5. Application of irrigation level at 1.0 PE (I_3) recorded maximum B:C ratio (1.98 and 1.71) than the rest of the irrigation level. Similarly, irrigation level at 0.8 PE (I_2) recorded maximum B:C ratio (1.95 and 1.56) followed by irrigation level at 0.6 PE (I_1) (1.54 and 1.22) during 2015 and 2016, respectively. As regard to mulches, highest B:C ratio (2.07 and 1.71) was observed in BPM treatment followed by TPM (1.81 and 1.49) and SSM (1.73 and 1.46) during 2015 and 2016, respectively. Lowest B:C ratio (1.65 and 1.28) was observed in control.

The above results regarding economics of drip irrigation with mulching for watermelon crop revealed that the practice of drip irrigation with BPM was superior over all other treatments. These results are in agreement with Tiwari *et al.* (1998), Tiwari *et al.* (2003), Patil and Patil (2009), Deshmukh *et al.* (2013), Paul *et al.* (2013), Paul *et al.* (2014), and Parmar *et al.* (2013).

4. CONCLUSIONS

Based on the study of effect of different mulches on soil moisture conservation and yield of drip irrigated watermelon, BPM was found to be more effective for conserving soil moisture (9.27 and 11.03%) followed by TPM (6.52 and 9.96%) and SSM (4.81 and 5.33%) as compared to control method in 2015 and 2016, respectively. Drip irrigation in combination with plastic mulch, especially black mulch, was found to be more effective method in improving WUE and increasing crop yield of watermelon. Yield of watermelon in BPM was 28.90 t ha^{-1}, which was significantly higher ($P < 0.05$) as compared to other mulches and no mulch. As regard to mulches, highest B:C ratio (2.07 and 1.71) was observed in BPM treatment followed by TPM (1.81 and 1.49) and SSM (1.73 and 1.46) during 2015 and 2016, respectively. Drip irrigation in combination with plastic mulch, especially black mulch, is recommended as more effective method in improving WUE and increasing crop yield of watermelon in Marathwada region.

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Table: 5
Effect of irrigation levels and mulches on economics of watermelon during 2015 and 2016

Treatments	Cost of cultivation (₹ ha^{-1})		GR (₹ ha^{-1})			NR (₹ ha^{-1})			B:C ratio	
Irrigation levels	2015	2016	2015	2016	Pooled	2015	2016	Pooled	2015	2016
I_1- 0.6 PE	84562	81756	130207	101586	115897	45645	18119	31882	1.54	1.22
I_2- 0.8 PE	85587	89880	167203	130812	149008	81616	45466	63541	1.95	1.56
I_3- 1.0 PE	88222	90811	174555	144810	159683	86333	60337	73335	1.98	1.71
S.E.±	-	-	9492	6865	5857	9566	6745	5828	-	-
C.D. at 5%	-	-	26350	19056	13506	26556	18723	13440	-	-
Mulches										
BPM	92317	94576	191076	155692	173384	98759	64284	81522	2.07	1.71
TPM	93508	95230	169633	136825	153229	76125	44896	60511	1.81	1.49
SSM	84660	84598	146499	120715	133607	61839	37856	49848	1.73	1.46
Control	74009	75525	122079	89713	105896	48070	18194	33132	1.65	1.28
S.E. ±	-	-	9984	9737	6973	9738	9490	6798	-	-
C.D. at 5%	-	-	21182	20459	14191	20460	19938	13835	-	-
(I x M)										
S.E.±	-	-	17293	16866	17081	16867	16701	16784	-	-
C.D. at 5%	-	-	NS	NS	NS	NS	NS	NS	-	-
G.M.	87854	89190	157322	125736	141529	71198	41307	54729	1.82	1.49
Season					**			**		
Season x I					NS			NS		
Season x M					NS			NS		
Season x I x M					NS			NS		

***significant at 1% level; GR - Gross Revenue; NR - Net Revenue*

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