EFFECT OF IRRIGATION METHODS, COLOUR AND THICKNESS OF PLASTIC MULCHES ON GROWTH AND YIELD OF WATERMELON

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ABSTRACT

This study investigated the combined effects of irrigation methods and plastic mulches on growth, yield and quality of watermelon in summer season. The treatments of the study comprised with three levels of as main plot *viz.*, Irrigation in furrows at 100% of CPE (I_1), Irrigation in alternate furrows at 80% of CPE (I_2) and drip irrigation with fertigation system at 80% of CPE (I_3) and five levels of plastic mulches as sub treatment *viz.*, without mulching (M_0), mulching with black polythene of 80 micron thickness (M_1), mulching with black polythene of 50 micron thickness (M_2), mulching with white polythene of 80 micron thickness (M_3) and mulching with white polythene of 50 micron thickness (M_4). The highest values for growth parameters (plant length, number of nodes and leaves plant^{-1}) and yield parameters (number of fruits plant^{-1}, fruit weight and fruit yield) obtained when irrigation water applied through drip irrigation with fertigation at 80% CPE followed by furrow method at 100% CPE. The highest growth and yield were recorded with Mulching with white polythene of 50-micron thickness (M_4) followed by mulching with white polythene of 80-micron thickness (M_3) and mulching with black polythene of 50-micron thickness (M_2) while lowest values were recorded under without mulch treatment.

INTRODUCTION

Watermelon (*Citrullus lanatus* Thunb) is a wonderful fruit contains enormous antioxidant potential, low calorific value and about 93% of water, so its name called "water" melon. It is a popular dessert fruit and commercial vegetable fruit in India grown mostly in summer season so it required more irrigation water (400 mm to 600 mm) during the entire crop period. Irrigation water is often limited and therefore the techniques which help to conserve water in the field are needed. Efficient use of available irrigation water is essential for increasing agricultural productivity as well as water use efficiency. Surface irrigation method is most widely used all over the world as well as in India. Among the surface irrigation methods, Furrow irrigation is the most common irrigation method in the Madhya Pradesh. Recently, there has been an increasing trend in Madhya Pradesh to switch from furrow to drip irrigation in watermelon cultivation to save more irrigation water because of subsurface drip

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irrigation has been considered more efficient in reducing evaporation and runoff while applying water at crop's root zone. Drip irrigation is hi-tech methods receiving wider acceptance and adoption, particularly to make use of the available water with more productivity. Fertigation ensures higher fertilizer use efficiency, besides providing scope for making soil amendments and even biological methods of plant protection. In the fertigation method, fertilizers can be applied throughout the crop growing season in a phased manner, in various split doses, in any desired concentration. Inorganic materials or mulches like plastic films and polyethylene provide many advantages for the growers such as increased yields, early crop maturity, high quality produces, and insect and weed control (Ennis 1987). Various colour and thickness of plastic mulches especially create a specific microclimate for plants (Csizinzky *et al.*, 1995). The microclimate factors strongly affect the soil temperature and moisture in the root zone, which in turn may influence plant growth (Aguyoh *et al.* 1999; Osiru and Hahn 1994). There are three major colours of plastic mulch used in commercial vegetable production: *i.e.*, black, clear and white reflective mulches. This kind of mulch is recommended when lower soil temperatures are desirable for sowing vegetables, particularly in summer production under warmer arid regions compared with black plastic mulch (Gordon *et al.*, 2010). Economics suggest that the film thickness should be minimum possible commensurate with desired life and strength (Iyenger *et al.*, 2011). This needs a change from maximizing productivity per unit of land area to maximizing productivity per unit of water consumed. Thus, irrigation and mulching practices may contribute to improve crop growth and yield of watermelon. The present study was conducted to determine watermelon growth and yield in summer season using suitable irrigation method along with polythene mulch of different thickness and colour in Malwa Region of Madhya Pradesh.

MATERIALS AND METHODS

The experiment was carried out during rabi season of 2019 and 2020 at Village – Silotiya, Tehsil – Sawer, District – Indore (M.P.). The experiment was laid out in split plot design with 15 treatments combinations and 3 replications on black cotton soil. The main treatments were irrigation methods *viz.*, Irrigation in furrows at 100% of CPE (I_1), Irrigation in alternate furrows at 80% of CPE (I_2) and drip irrigation with fertigation system at 80% of CPE (I_3) along with five plastic mulches as sub treatment *viz.*, without mulching (M_0), mulching with black polythene of 80 micron thickness (M_1), mulching with black polythene of 50 micron thickness (M_2), mulching with white polythene of 80 micron thickness (M_3) and mulching with white polythene of 50 micron thickness (M_4). The irrigation was applied daily based on the cumulative pan evaporation data of previous day and information obtained from the agro meteorological data. The objective of the experiments was to find out suitable irrigation level and colour plastic mulch with different thickness for yield, WUE, water saving and economics of watermelon. The scheduling of irrigation was done at 50 mm cumulative pan evaporation (CPE) with 50 mm depth of irrigation water in furrow method while 50 mm cumulative evaporation (CPE) with 40 mm depth of irrigation water in alternate furrow and drip irrigation method.

RESULT AND DISCUSSION

Effect of irrigation methods

The longest plant with maximum number of nodes and leaves plant^{-1} were detected during both the years of study when irrigation water applied through drip irrigation with fertigation system at 80% of CPE than irrigation water applied through furrow or alternate furrow method. The results are in line with findings of Fuentes *et al.* (2018) in watermelon, Singh *et al.* (2007) in bitter gourd, Anu *et al.* (2014) in okra, Ruby *et al.* (2012) in strawberry. They observed that drip irrigation is efficient in reducing evaporation from the soil, runoff and leaching below the root zone. The irrigation applied through drip method with fertigation system at frequent intervals provides a consistent moisture regimes and nutrient pool in the root zone and therefore, roots remain active for a longer period. Hagin and Lowengart (1996) and Erdem *et al.* (2001) reported that the proper and continuous moisture in the soil also increases the availability of nutrients and translocation of food materials which accelerate the vegetative growth of plant parts and maintain the soil moisture as well as temperature at optimum level. Higher values of vegetative growth traits were found under higher water levels than under lower water levels. This might be due to the fact that maximum amount of water would be stored in the root zone and deep percolation losses would be minimum at lower irrigation levels. The reduction in plant length, number of nodes and leaves under alternate furrow method is due to a decrease of the available water in active root zone, which cause a disturbance in the physiological processes essential for plant growth reported by Alenazi *et al.* (2015).

Yield can be considered to be the final expression of the physiological and metabolic activities of plants and is governed by various factors. Yield component had better expression at adequate quantity and balance of irrigation water applied during the crop growth period which ultimately lead towards an increase in yield parameters. The results revealed that significantly maximum number of fruits, average fruit weight and fruit yield of watermelon was recorded with treatment I_3 (Drip irrigation with fertigation system at 80% of CPE) over other treatments during both the experimental years. The results are in conformity with findings of Srinivas *et al.* (1989), Leskovar *et al.* (2001), Erdem and Yuksel (2003), Wakindiki and Kirambia (2011) Cui-hua *et al.* (2016), Fuentes *et al.* (2018), Rolbiecki *et al.* (2020) who observed that drip irrigation is efficient in reducing evaporation from the soil, runoff and leaching below the root zone. The irrigation applied through drip method with fertigation system at frequent intervals provides a consistent moisture regimes and nutrient pool in the root zone and therefore, roots remain active for a longer period. The proper and continuous moisture in the soil also increases the availability of nutrients and translocation of food materials which accelerate the vegetative growth of plant parts and maintain the soil moisture as well as temperature at optimum level reported by Hagin and Lowengart (1996) and Erdem *et al.* (2001). Other studies that have compared drip irrigation and furrow irrigation systems, resulted in fruit yield increase under drip irrigation (Fuentes *et al.*, 2018). Smaller and more frequent applications of water made through drip irrigation deliver water to crops more efficiently to meet plant and water nutrient needs while avoiding flood stress (Leskovar *et al.*, 2001). Furrow irrigation commonly creates cyclical soil water deficits related to long intervals between each irrigation.

Effect of colour and thickness of plastic mulch

The results revealed that different types of mulching materials significantly influenced the growth parameters of watermelon *viz.*, plant length, number of nods and number of leaves plant^{-1} over control. Among different mulching treatments, treatment M_4 (Mulching with white polythene of 50-micron thickness) resulted higher plant length, number of nodes and leaves plant^{-1}. However, treatment M_0 (Without mulch) recorded the minimum growth. The increase in growth parameters was attributed to sufficient soil moisture near root zone and minimized the evaporation loss due to mulching. The extended retention of moisture and availability of moisture also leading to higher uptake of nutrient for proper growth and development of plants resulted higher growth of plant as compared to without mulch treatment. The changes in soil temperature below polythene mulch could be attributed to different manners of heating and heat transfer to soil and also to heat accumulation during day and loss during night. Similar findings have also been obtained by Parmar *et al.* (2013), Nwokwu and Aniekwe (2014), Abdelrahman *et al.* (2016), Rao *et al.* (2017), Dadheech *et al.* (2018), Moe *et al.* (2018) in watermelon; El- Shaikh and Fouda (2008), Mutetwa and Mtaita (2014) in cucumber; Memon *et al.* (2017), Ali *et al.* (2019) in Okra; Helaly *et al.* (2017) in husk tomato. Maida *et al.* (2019) reported that the microclimate condition improved by the mulches might have provided a suitable condition for producing higher plant height and number of primary and secondary branches in the chili plants.

It was observed that white polythene mulch performed better on growth characters as compare to black polythene mulch during both the experimental years. The results in line with Lament (1993), Dickerson (2012), Dadheech *et al.* (2018) and Maida *et al.* (2019). They stated that white polythene mulch provided favorable condition to plants for early season growth boost and higher growth may be due to reflected sun light and less evapo-transpiration and maintain soil moisture as compare to black polythene mulch during summer season. Lament (1993) noticed that white plastic mulch has been shown to generate cooler soil temperatures than black plastic. Lament (1999) and Dickerson (2012) reported that white plastic mulch is reflected light back into the atmosphere or the plant canopy resulting in slightly cooler soil temperature about -2ºF at 1-inch depth. These mulches can be used to establish crops when reduced soil temperature might be beneficial.

The results also revealed that thickness of polythene mulch was significantly affected to growth parameters of watermelon. These results were in consonance with Iyenger *et al.* (2011), Kulkarni *et al.* (2015) and Job *et al.* (2016). They reported that in plastic mulching, the thickness of mulch film should be in accordance with type and age of crop. Economics suggest that the film thickness should be minimum possible commensurate with desired life and strength. Kulkarni *et al.* (2015) and Job *et al.* (2016) also observed that plastic mulch of 50-micron thickness underwent early deterioration which ultimately affected growth of watermelon and produced highest number of nodes and leaves.

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Table 1: Effect of irrigation methods and plastic mulches on depth of irrigation water applied, water saving, yield and WUE under watermelon (Pooled)

Treatment		Length of the plant (cm)	Number of nodes plant^{-1}	Number of leaves plant^{-1}	Number of fruits plant^{-1}	Average fruit weight (kg)	Yield (q ha^{-1})
Factor A. Irrigation methods (I)							
I_1	Irrigation in channels (Furrows) at 100% of CPE	203.82	43.05	256.07	3.30	2.68	1776.88
I_2	Irrigation in alternate channels (Furrows) at 80% of CPE	187.96	37.20	246.94	2.65	2.42	1298.59
I_3	Drip irrigation with fertigation system at 80% of CPE	226.41	52.07	273.55	3.88	3.16	2476.23
SEm±		**2.29**	**1.00**	**1.62**	**0.03**	**0.03**	**5.96**
CD at 5% level		**8.94**	**3.91**	**6.32**	**0.12**	**0.12**	**23.27**
Factor B. Polythene mulch (M)							
M_0	Without mulching	177.91	33.88	237.08	2.54	2.34	1202.03
M_1	Mulching with black polythene of 80-micron thickness	193.53	41.63	250.81	2.94	2.62	1561.42
M_2	Mulching with black polythene of 50-micron thickness	208.26	44.43	256.75	3.19	2.75	1772.41
M_3	Mulching with white polythene of 80-micron thickness	221.63	48.61	270.04	3.77	2.93	2224.85
M_4	Mulching with white polythene of 50-micron thickness	228.97	51.96	279.58	3.96	3.12	2492.13
SEm±		**2.81**	**1.03**	**2.60**	**0.08**	**0.05**	**19.88**
CD at 5% level		**8.19**	**3.00**	**7.58**	**0.23**	**0.14**	**58.03**