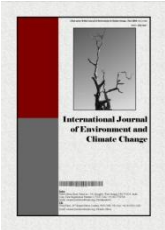

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Effect of Different Colour Mulches on Water Use Efficiency in Cucumber (*Cucumis sativus*) under Protected Cultivation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the effect of different colour mulches on Water use efficiency under protected cultivation a field experiment was carried out during April–June 2021 in Cucumber (*Cucumis sativus*).
Study Design: Split plot design statistical design.
Place and Duration of Study: Department of Soil and Water Conservation Engineering, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, between April to June 2021.
Methodology: Different coloured Plastic mulches (black-M1, silver-M2, yellow-M3, red-M4, white-M5) and no cover M6 (control) with different irrigation levels (I1-100% PE, I2-75% PE and I3-50% PE) was adopted with split plot design.
Results: The observed data revealed that using mulches decreased irrigation requirements of

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cucumber crop with comparing to no cover (without mulch). The data shows that Black Mulch M_1 with I_3-50%PE recorded the highest values of WUE (31.30 kg/m^3) followed by White Mulch M_5 with I_3-50% PE (30.03kg/m^3).

Conclusion: Increasing irrigation level up to I2-75% improved yield with different coloured plastic mulch treatments, while the yield decreased with increasing irrigation level to I_1-100%PE. Though using 50% PE with black plastic mulch increased WUE compared to using 75% PE or 100% PE without plastic mulch (control).

Keywords: Water use efficiency; plastic mulch; irrigation level.

1. INTRODUCTION

Irrigation water is progressively becoming scarce not only in arid and semi-arid regions but also in the regions where rainfall is ample. Hence the water saving and conservation is vital to take care of agricultural practices. It is very important to make use of the irrigation water is efficiently. Vegetative measures like zero tillage practices, broad bed furrow and mulching are the best practices to reduce the demand for irrigation water and improve WUE. According to Dunage et al., (2009), the careful utilization of available irrigation water through more efficient methods of water application such as drip irrigation under protected cultivation becomes essential to increase the productivity and WUE. Abdrabbo et al., (2015) stated that efficient use of water by irrigation is becoming increasingly important. Agronomic measures such as varying tillage practices, mulching and anti-transparent can reduce the demand for irrigation water and improve irrigation (WUE). The mulch determines its energy-radiating behavior and its influence on the microclimate around the plant. Black, transparent, and white mulches predominate in the commercial vegetable production today over the world. The use of different colours of polyethylene as soil cover for cucumber has been used mainly in many regions. The crop varies in response to polyethylene mulch covers depending on cultivar, materials used and environmental conditions [1,2,3]. Alenazi et.al., [4] reported that mulching and irrigation water management is among the dynamic practices that are being applied in commercial vegetable production. Ban et al., 2009; and Hochmuth et al., 2012 confirmed that there is a benefit of early harvests with the application of plastic mulch as a result of increase in soil temperature. It was studied that mulching practices might be reduce nutrient leaching, decrease soil evaporation, increase soil moisture conservation and control weeds [5] (Lamont, 2005). It was revealed form the study that the use of drip irrigation in combination with mulching, not only increased the yield but also saving irrigation water (62%) as compared to conventional method with highest WUE (58.19 kg m-3) [6]. Biswas et al., [7] also observed higher water productivity under poly mulched treatments. There was an increase in the yield of guava and minimized the water consumption as reported by Singh et al., [8]. There was 50 to 70 percent saving in irrigation water and 10 to 70 percent increase in yield of fruits and vegetable crops by using drip irrigation [9]. Plastic mulches are used in many horticultural crops to suppress weed growth, conserve soil moisture and to alter temperature in the rhizosphere. Plastic mulch can alter soil temperature, which leads to faster growth and earlier harvest [10,11]. There are many studies available on the mulching effects on vegetables such as onion, okra, tomato. But less attention paid to cucumber crops which are gaining more importance among farmers.

2. MATERIALS AND METHODS

The experiment was carried out at the Department of Soil and Water Conservation Engineering Farm, Agricultural Engineering and Research Institute, Tamil Nadu Agricultural University, Coimbatore to evaluate the WUE of cucumber crop under different coloured Plastic mulches (black-M_1, silver-M_2, yellow-M_3, red-M_4, white-M_5) and no cover M_6 (control) with different irrigation levels (I_1-100%PE, I_2-75%PE and I_3-50%PE) by using drip irrigation under naturally ventilated poly house during the moth April 2021 to June 2021. The treatment was adopted in split plot design with 18 treatments and three replications. Length of the plot is 2.75cm and the width of the plot is 1.2 m. Low density poly ethylene (LDPE) sheets of 25-micron thickness were used as mulch material. F1 Malav Hybrid variety of cucumber was chosen for the experiment. Soil sample were collected for analysis of available nutrients (Table 1).

Table 1. Available nutrients of the soil of the experiment analysed before cultivation

Type of Soil	Texture of Soil	Nitrogen (N) Kg/ha	Phosphorus (P) Kg/ha	Potassium(K) Kg/ha
Red Soil	Sandy Clay Soil	104.0	24.0	254.0

Soil temperature was measured at the depth of 15cm at different time of interval throughout the crop season. Soil temperature was measured with soil thermometer probe and soil moisture was measured with universal soil moisture meter. The package of practices (fertilizer, pest and disease indices) was followed as per the schedule prescribed by TNAU. Discharge rate of emitters was calculated by collecting the discharge of the drippers by catch can method for a specified period at selected laterals in the experimental field [12]. Drip irrigation system was followed for water application based on daily pan evaporation data from class 'A' pan evaporimeter which is located at observatory in the department Agro-climate research centre. The water use efficiency (WUE) was calculated according to FAO [13] as follows: The ratio of crop yield (y) to the total amount of irrigation water use in the field for the growth season (IR), WUE (Kg/m^3) = Y(kg)/IR (m^3).

3. RESULTS AND DISCUSSION

According to research reports different coloured plastic mulches impact crop production in different ways. Their level of impact is extended to the soil, water, and yield and quality of crops [14].

3.1 Soil Temperature

As in the present study, soil temperature was observed at the depth of 15cm and data were presented in the Figs 1, 2 and 3 over the period of April 2021 to June 2021. From the figures it was noted that the highest soil temperature was found under Black mulch with all the treatments throughout the season. White mulch showed comparatively less soil temperature than other colors. Red and yellow were on par with each other in increasing soil temperature. Black absorbs more radiation than any colors so that the temperature of soil below black mulch increased significantly.The observed results are in agreement with the statement of Black plastic mulch which is given by the author Getachew Amare et, al., [14]. According to Shah Jahan et al. [15] it was indicated that higher temperature was recorded by black plastic mulches than other colour mulches. However, Job et al., [10] observed higher soil temperature in transparent mulch and silver mulch than the black. Soil temperature was increased because of trapping the long wave radiation from soil by the plastic film. Franquera [16] reported a higher soil temperature due to colored plastic mulches than bare soil. Gordon et al. [17] showed there is a difference in soil temperature by coloured plastic mulches and row cover.

3.2 Uniformity Coefficient of Emitter

Coefficient of uniformity was found with catch can method in the experimental field. Observed data (99.3) showed that emitter discharge of the whole drip irrigation system is uniform. It implies that the higher the uniformity higher the efficiency of the irrigation system.

3.3 Water Use Efficiency

In the present study the cumulative daily evaporation during crop growth period was calculated about 6.36 mm from the class A pan evaporimeter. In the present study yield, Water applied and water use efficiency were observed and calculated respectively. Data were tabulated in Table 2. This shows that the black mulch recoded the highest WUE in all the treatments. In order to combine the mulch and irrigation level, it was identified that black mulch-M_1 with the level irrigation treatment I_3 50% attained the highest WUE of 31.38kg/m^3 with minimum water application of 867m^3/ha followed by white mulch M_4 with the same irrigation level treatment I_3 50% (30.53 kg/ha). The result indicates that the strategy of Deficit Irrigation (DI) that is an optimization strategy in which irrigation is applied during non-drought, sensitive growth stages of a crop. Mulching plots had retained the soil moisture under deficit irrigation by covering the soil and protecting the moisture against evaporation. This caused the increase in yield under the mulched plots [18-20]. Among them, white mulch helped maintain an optimum rhizosphere environment which resulted in greater yield. Same results were observed by Mukharjee et al., in [21]. He observed higher WUE under deficit irrigation with black mulch and this might be due to the enhancement of deeper

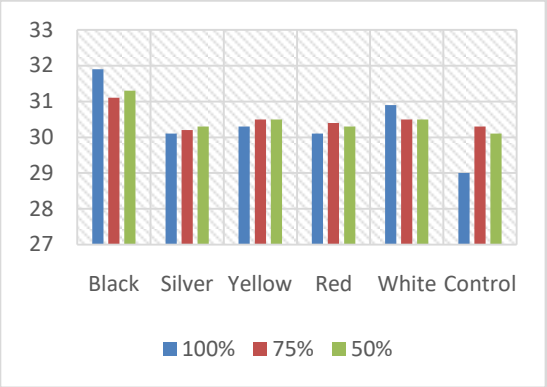

Fig. 1. Effect of soil temperature in different coloured mulch in April 2021

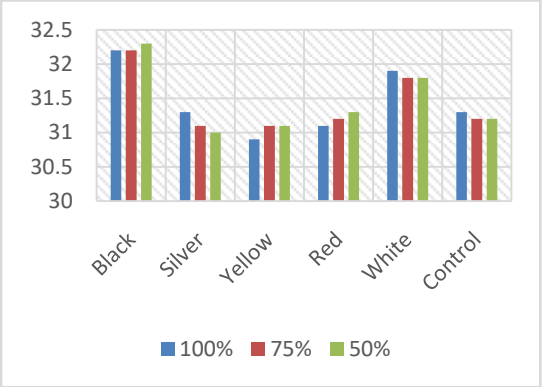

Fig. 2. Effect of soil temperature in different coloured mulch in May 2021

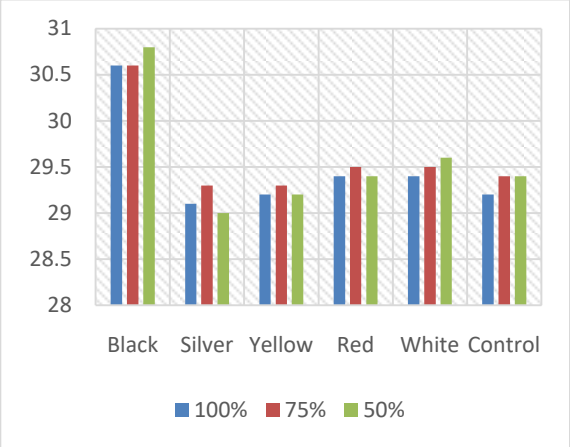

Fig. 3. Effect of soil temperature in different coloured mulch in June 2021

Table 2. Water use efficiency of cucumber crop for different coloured mulches

Sl. No	Treatment	Yield t/ha	Water applied m^3/ha	Water use efficiency, Kg/m^3
1	I_1M_1	36.3	1728.4	20.97
2	I_1M_2	31.5		18.22
3	I_1M_3	33.6		19.44
4	I_1M_4	28.3		16.37
5	I_1M_5	32.1		18.57
6	I_1M_6	26.0		15.04
7	I_2M_1	30.3	1301	23.29
8	I_2M_2	26.9		20.68
9	I_2M_3	28.5		21.91
10	I_2M_4	25.4		19.52
11	I_2M_5	29.7		22.83
12	I_2M_6	24.5		18.83
13	I_3M_1	28.2	867	31.30
14	I_3M_2	26.5		30.53
15	I_3M_3	23.7		27.29
16	I_3M_4	23.0		26.58
17	I_3M_5	27.0		31.09
18	I_3M_6	22.2		25.63

and more extensive rooting system because of reduced irrigation. This would allow plants to use water and nutrient from deeper soil, thus increase both irrigation and nutrient use efficiency. Kumar et al., [5] also reported higher WUE under deficit irrigation and also found reduced WUE under 100% irrigation level. Higher WUE were observed also by Agarwal et al., (2010) under mulched conditions than the controlled plots.This result is agreement with the statement, Deficit Irrigation is also one of the methods to save irrigation water and increase WUE [22], in which crops are deliberately exposed to some degree of deficit irrigation through either the whole growth stages or at certain stages of the growth period [22].

4. CONCLUSION

Protected cultivation offers a favorable environment for cucumber growth and production, and consequently results in a significant yield. Mulching effects in the cucumber growth and the yield under protective cultivation can be increased manifold as compared to than in open field cultivation as reported by numerous authors. Mulching practices reduces the moisture evaporation from the soil and maintain the warmth climate to the growing crops. Mulching effects will reduce the water application throughout the cropping stage. Water Use Efficiency is increased with Mulching practices under protected cultivation. Black mulch with 50% irrigation showed higher WUE among the treatments. Hence, Black mulch with deficit irrigation was recommended for water scarce areas.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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