

## Original Research Article

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

### 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 (I<sub>1</sub>-100%PE, I<sub>2</sub>-75%PE and I<sub>3</sub>-50%PE) was adopted with split plot design.

**Results:** The observed data revealed that using mulches decreased irrigation requirements of cucumber crop with comparing to no cover (without mulch). The data shows that Black Mulch M<sub>1</sub> with I<sub>3</sub>-50%PE recorded the highest values of WUE (31.30kg/m<sup>3</sup>) followed by White Mulch M<sub>5</sub> with I<sub>3</sub>-50%PE (30.03kg/m<sup>3</sup>).

**Conclusion:** Increasing irrigation level up to I<sub>2</sub>-75% improved yield with different coloured plastic mulch treatments, while the yield decreased with increasing irrigation level to I<sub>1</sub>-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 (Salman et al., 1991, Pan et al., 1999 and Fonseca et al., 2003). Alenazi et al., (2015) 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 (Lamont, 2005; Kumar and Lal, 2012). It was revealed from 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<sup>-3</sup>) (Khwaitrakpam Lily Devi., et al., 2020). Biswas et al., (2016) 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., (2015). 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 (Santosh et al., 2021). 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 (Job, 2018; Filipovic et al., 2016). 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. MATERIAL 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<sub>1</sub>, silver-M<sub>2</sub>, yellow-M<sub>3</sub>, red-M<sub>4</sub>, white-M<sub>5</sub>) and no cover M<sub>6</sub> (control) with different irrigation levels (I<sub>1</sub>-100%PE, I<sub>2</sub>-75%PE and I<sub>3</sub>-50%PE) by using drip irrigation under naturally ventilated poly house during the month April 2021 to June 2021. The treatment was adopted in split plot design with 18 treatments and three replications. Length of the plot is 2.75m 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. (Raina JN., et al., 1999). 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 (1982) 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. (Getachew Amare and Bizuayehu Desta., et al., 2021).

### 3.1 Soil temperature

As in the present study, soil temperature was observed at the depth of 15cm and data were presented in the Figure 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., 2021. According to Shah Jahan et al. 2018 it was indicated that higher temperature was recorded by black plastic mulches than other colour mulches. However, Job et al., (2018) 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 (2015) reported a higher soil temperature due to colored plastic mulches than bare soil. Gordon et al. (2010) 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.

**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**

### **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 recorded the highest WUE in all the treatments. In order to

combine the mulch and irrigation level, it was identified that black mulch-M<sub>1</sub> with the level irrigation treatment I<sub>3</sub> 50% attained the highest WUE of 31.38kg/m<sup>3</sup> with minimum water application of 867m<sup>3</sup>/ha followed by white mulch M<sub>4</sub> with the same irrigation level treatment I<sub>3</sub> 50% (30.53kg/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. Among them, white mulch helped maintain an optimum rhizosphere environment which resulted in greater yield. Same results were observed by mukharjee et al., in 2010. He observed higher WUE under deficit irrigation with black mulch and this might be due to the enhancement of deeper 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., (2012) 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 (Kirda et al., 2004), 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 (Kirda et al., 2004)

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

Sl. No	Treatment	Yield t/ha	Water applied m <sup>3</sup> /ha	Water use efficiency, Kg/m <sup>3</sup>
1	I <sub>1</sub> M <sub>1</sub>	36.3	1728.4	20.97
2	I <sub>1</sub> M <sub>2</sub>	31.5		18.22
3	I <sub>1</sub> M <sub>3</sub>	33.6		19.44
4	I <sub>1</sub> M <sub>4</sub>	28.3		16.37
5	I <sub>1</sub> M <sub>5</sub>	32.1		18.57
6	I <sub>1</sub> M <sub>6</sub>	26.0		15.04
7	I <sub>2</sub> M <sub>1</sub>	30.3	1301	23.29
8	I <sub>2</sub> M <sub>2</sub>	26.9		20.68
9	I <sub>2</sub> M <sub>3</sub>	28.5		21.91
10	I <sub>2</sub> M <sub>4</sub>	25.4		19.52
11	I <sub>2</sub> M <sub>5</sub>	29.7		22.83
12	I <sub>2</sub> M <sub>6</sub>	24.5		18.83
13	I <sub>3</sub> M <sub>1</sub>	28.2	867	31.30
14	I <sub>3</sub> M <sub>2</sub>	26.5		30.53
15	I <sub>3</sub> M <sub>3</sub>	23.7		27.29
16	I <sub>3</sub> M <sub>4</sub>	23.0		26.58
17	I <sub>3</sub> M <sub>5</sub>	27.0		31.09
18	I <sub>3</sub> M <sub>6</sub>	22.2		25.63

## 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.

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