

Original Research Article

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## Effect of Different Mulching on Weed Intensity, Yield and Economics in Chilli (*Capsicum annum L.*)

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### ABSTRACT

#### Keywords

Chilli, mulching, organic, polythene, weed density, yield, cost benefit ratio.

#### Article Info

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The use of organic and inorganic mulch as a soil cover is effective in improving growth and yield of chilli (*Capsicum annum L.*). A field experiment was carried out at College Orchard, Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2013 to 2016 to study the effect of different types of mulches viz., organic mulch @ 6.0 t/ha, organic mulch @ 9.0 t/ha, organic mulch @ 12.0 t/ha, black / silver polythene (double coated 30 micron), black / white polythene (double coated 30 micron) with a control on growth and yield of chilli. The experiment was laid out in Randomized Block Design (RBD) with six treatments and replicated four times. The results revealed that organic mulch @ 12.0 t/ha (T<sub>4</sub>) recorded the highest plant height (88.17 cm), number of fruits/plant (217.27) with an average fruit weight of 4.67 g, fruit length (8.66 cm), fruit girth (1.96 cm), green fruit yield (0.939 kg/plant and 325.93 q/ha), dry fruit yield (0.226 kg/plant and 75.98 q/ha) followed by black/white polythene double coated 30 micron (T<sub>6</sub>) which recorded 210.20 number of fruits/plant with an average fruit weight of 4.61 g and low weed density (13.23/m<sup>2</sup>) at 75 days after planting with high cost benefit ratio (2.80). Therefore, mulching (organic as well as black/white polythene (double coated 30 micron) appears to be a viable tool to increase the chilli production and recommended for cultivation.

### Introduction

Chilli (*Capsicum annum L.*) is cultivated worldwide and is an important spice cum vegetable crop cultivated extensively in India. It is an indispensable spice essentially used in every Indian cuisine for its pungency, taste, colour and aroma. It is rich in proteins, lipids, carbohydrates, fibres, mineral salts (Ca, P, Fe) and vitamins like A, D, E, C, K, P, B2 and B12 with good medicinal properties. The fruits are an excellent source of health-related phytochemical compounds, such as ascorbic acid, carotenoids, tocopherols, flavonoids, and capsaicinoids that are very important in

preventing chronic diseases such as cancer, asthma, coughs, sore throats, toothache, diabetes and cardiovascular diseases (El-Ghoraba *et al.*, 2013). Thus our country plays a major role in the world chilli market. Keeping the high export potential chilli, production can be increased by a combination of advance production technologies viz., high yielding hybrids, mulching, application of growth regulators, staking, drip fertigation and integrated pest and disease management. Immediately after transplanting, chilli seedlings grow slowly whereas weeds emerge

fast and grow rapidly competing with the crop severely for growth resources, viz. nutrients, moisture, sunlight and space during entire vegetative and early reproductive stages of chilli (Isik *et al.*, 2009). Further, wide space provided to the chilli allows fast growth of variety of weed species causing a considerable reduction in yield by affecting the growth and yield parameters.

Presence of weeds reduces the photosynthetic efficiency, dry matter production and its distribution to economical parts and there by reduces sink capacity of crop resulting in poor fruit yield. Thus, the extent of reduction in fruit yield of chilli by weeds has been reported to be in the range of 60-70% depending on the intensity and persistence of weed density in standing crop (Khan *et al.*, 2012). The choice of any weed control measures therefore, depends largely on its effectiveness and economics. Because of increased cost and non-availability of manual labour for hand weeding, herbicides not only control the weeds timely and effectively but also offer a great scope for minimizing the cost of weed control irrespective of situation. Use of pre-emergence herbicide makes the weed control more acceptable to farmers, which will not change the existing agronomic practices but will allow for complete control of weeds.

Mulching is an essential cultural technique that can reduce the amount of work inherent in gardening, helping to produce healthier plants and potentially increasing vegetable yields. Mulch is often defined as any material applied to the soil surface as cover. Organic mulch has a number of positive attributes. It conserves soil moisture by reducing water lost through evaporation, minimizes soil erosion, moderates soil temperatures, inhibits weed growth, encourages the growth of beneficial soil micro-organisms, and reduces the spread of soil-borne pathogens by preventing soil from splashing onto plants during rainstorms

and watering. Organic mulches, such as paddy straw, wheat straw, leaf moulds, banana trash, grass, plant waste, sugar cane trash decompose over time, improving soil structure and quality and returning nutrients to the soil. Inorganic mulches are generally used to create barriers to weeds. Inorganic mulch, such as gravel, does not readily decompose. They absorb and reflect heat which can be detrimental during hot, dry weather. Because they do not decompose quickly, inorganic mulches do not improve soil health.

Hence, a study on evaluation of different mulching materials for weed control in transplanted chilli was planned to ascertain the effect of different mulching on weed control and growth and yield of chilli.

### **Materials and Methods**

The experiment was conducted during three consecutive *Kharif* seasons of 2013 to 2016 at College Orchard (11.0152° N latitude, 76.9326° E longitude and 426 m altitude), Department of Vegetable Crops, HC&RI, Tamil Nadu Agricultural University, Coimbatore. The experimental soil was well drained and sandy loam in texture, having pH of 6.92. The experiment was laid out in a randomized block design (RBD) with seven treatments with three replications.

The experimental field was ploughed three times and well decomposed FYM @ 25 t/ha and 75 per cent of recommended dose of fertilizer (RDF) of P<sub>2</sub>O<sub>5</sub> (60 kg / ha) as super phosphate were incorporated uniformly in the last plough and seven raised beds were formed with height of 15 cm, width of 1.20 m and length of 40 m. The individual bed was earmarked for 12 m length and a gap of 1m was provided between them for assigning treatments and replications. The drip laterals were spread over the beds for irrigation. The treatments consists of

- T<sub>1</sub> : No Mulch
- T<sub>2</sub> : Organic mulch @ 6 t/ha
- T<sub>3</sub> : Organic mulch @ 9 t/ha
- T<sub>4</sub> : Organic mulch @ 12 t/ha
- T<sub>5</sub> : Black / silver polythene (double coated 30 micron)
- T<sub>6</sub> : Black / white polythene (double coated 30 micron)
- T<sub>7</sub> : Black polythene (30 micron)

The raised beds assigned for treatments T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> were covered with required quantity of chopped paddy straw and leaf mould. Similarly mulch sheets were spread over the beds for the treatments T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub>. The treatment T<sub>1</sub> left as such without any mulch. Thirty five days old Chilli Hybrid “TNAU Chilli hybrid CO 1” seedlings were transplanted in the raised bed with row to row and plant to plant distances of 60 and 50 cm respectively. The remaining recommended dose of fertilizers (120:20:80 kg NPK/ha) were given as WSF through drip fertigation system uniformly for all the treatments throughout the cropping period. The observation on weed density 75 days after transplanting, fruit length, fruit girth, fruits/plant and yield were recorded. The benefit cost ratio was arrived by using the formula given below.

$$BCR = \frac{\text{Net returns (Rs. ha}^{-1}\text{)}}{\text{Total cost of expenditure (Rs. ha}^{-1}\text{)}}$$

Data were subjected to statistical analysis by analysis of variance method (Panse and Sukhatme, 1985). The critical difference was worked out for 5 per cent probability. The results of the experiment was tabulated and presented below.

## **Results and Discussion**

### **Influence of mulching on growth character**

The results of the experiment conducted over the three years were pooled and the mean value was presented (Table 1, 2, 3 and 4) and discussed hereunder. The plant height varied

significantly due to different types of mulches. Organic mulches showed superior performance in plant height than control, indicating organic mulches had positive effect on the growth and development of chilli. The highest plant height (88.17 cm) was observed in Organic mulch @ 12 t/ha (T<sub>4</sub>) followed by organic mulch @ 9 t/ha (84.97 cm). The lowest plant height (71.93 cm) was recorded in control. Application of straw mulch @ 6 t/ha increased yield of tomato and okra by 100 and 200 per cent, respectively over control and marketable fruit yield from mulched plot was significantly higher than those produced on bare soil (Gupta and Gupta, 1987). This difference can be attributed to moisture conservation, higher soil temperature, weed control, and increased mineral nutrient uptake in the mulched plot through improved root temperatures, as reported by Orozco *et al.*, (1994). The increased plant height in mulched plants was possible due to better availability of soil moisture and optimum soil temperature provided by the mulches.

Change in the plant height of chilli was observed by using different mulches and plastic mulch increased the plant height than other mulches. The increase in plant height might be due to reducing water loss through evaporation, minimizes soil erosion, moderates soil temperatures, inhibits weed growth, encourages the growth of beneficial soil microorganisms and reduces the spread of soil-borne pathogens by preventing soil from splashing onto plants during rainstorms and watering.

### **Effect of mulching on yield and yield attributes**

Among the various treatments, organic mulch @ 12 t/ha (T<sub>4</sub>) produced more number of fruits per plant and average fruit weight compared to control (Table 1). It meant that mulching had positive influence on fruit setting in chilli. The highest number of fruits per plant (217.27) and average fruit weight (4.67 g) was observed in organic mulch @ 12 t/ha (T<sub>4</sub>) followed by black / white polythene double coated 30 micron (T<sub>6</sub>) (210.20 fruits per plant and 4.61 g of average fruit weight). In contrast, control (T<sub>1</sub>) recorded the lowest fruits per plant (170.80) and average fruit weight (4.23 g). The increase in the number of fruits per plant in mulched plot was probably associated with the conservation of moisture and improved micro climate both beneath and above the soil surface. The micro climate condition improved by the mulches might have provided a suitable condition for producing higher number of leaves and fruit bearing nodes in the plant compared to the control.

Considering the relationship between the soil moisture content and fruit number, it was clear that fruit number was strongly related with soil moisture content. Higher soil moisture content and soil temperature under mulch improve the plant microclimate leading to early growth and development, which advances the flowering.

Similar kind of observations with respect to plant growth parameters were also reported by Igbal *et al.*, (2009) in hot pepper, Singh and Kamal (2012) in tomato and Parmar *et al.*, (2013) in watermelon.

These researchers indicated that plants under polyethylene mulch produce larger fruit and have higher fruit yield per plant because of the better plant growth that due to favorable hydro-thermal regime of soil and complete weed free environment. Furthermore, they mentioned that the extended retention of moisture and availability of moisture also lead to a higher uptake of nutrient for proper growth and development of plants, resulted in higher growth of plant as compared to control. Fruit length, fruit diameter and number of seeds per fruit were statistically on par with the other treatments (Table 2) indicating these traits were controlled by genes and not environmentally.

The results revealed that different types of mulching materials (Table 2 and 3) significantly influenced green fruit yield and dry fruit yield over control. Among the different mulching treatments, the treatment T<sub>4</sub> - Organic mulch @ 12 t/ha recorded the highest values for fruit length (cm), fruit girth (cm), green fruit yield (kg/plant), green fruit yield (q/ha), dry fruit yield (kg/plant) and dry fruit yield (q/ha) followed by T<sub>6</sub>.

The increase in the fruit yield was attributed to the sufficient soil moisture in the root zone and minimized evaporation loss due to mulching. The extended retention of moisture and availability of moisture also leads to higher uptake of nutrients for proper growth and development of fruits which resulted in higher yield as compared to the control. Organic mulches return organic matter and plant nutrients to the soil and improve the physical, chemical and biological properties of the soil after decomposition, which in turn increases crop yield.

**Table.1** Effect of different plastic mulches on plant height, number of fruits per plant and average fruit weight of Chilli

Treatments	Plant height (cm)				No.of fruits/ plant				Average fruit weight (g)			
	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean
T <sub>1</sub>	75.7	68.9	71.2	71.93	157.1	182.0	173.3	170.80	4.19	4.23	4.28	4.23
T <sub>2</sub>	83.5	85.6	79.3	82.80	178.3	192.4	183.2	184.63	4.21	4.60	4.63	4.48
T <sub>3</sub>	86.5	88.3	80.1	84.97	187.7	199.8	190.3	192.60	4.57	4.50	4.55	4.54
T <sub>4</sub>	88.0	90.3	86.2	88.17	281.8	189.5	180.5	217.27	4.58	4.50	4.92	4.67
T <sub>5</sub>	85.0	84.3	80.2	83.17	192.1	193.2	184.0	189.77	4.69	4.60	4.58	4.62
T <sub>6</sub>	82.0	78.9	88.3	83.07	213.6	213.6	203.4	210.20	4.53	4.64	4.66	4.61
T <sub>7</sub>	83.8	77.3	86.6	82.57	189.7	189.7	180.7	186.70	4.52	4.52	4.59	4.54
<b>CD 5%</b>	<b>6.46</b>	<b>6.39</b>	<b>6.34</b>	<b>6.3</b>	<b>27.54</b>	<b>7.45</b>	<b>4.75</b>	<b>37.04</b>	<b>0.056</b>	<b>4.23</b>	<b>0.013</b>	<b>0.199</b>

**Table.2** Effect of different plastic mulches on fruit length, fruit girth and green fruit yield (kg/plant) of Chilli

Treatments	Fruit length (cm)				Fruit girth (cm)				Green fruit yield (kg/plant)			
	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean
T <sub>1</sub>	8.33	8.30	8.36	8.33	1.80	1.68	1.64	1.71	0.743	0.728	0.728	0.733
T <sub>2</sub>	8.59	8.48	8.42	8.50	1.90	1.87	1.67	1.81	0.853	0.836	0.885	0.858
T <sub>3</sub>	8.71	8.59	8.46	8.59	1.90	1.95	1.85	1.90	0.895	0.877	0.854	0.875
T <sub>4</sub>	8.91	8.65	8.41	8.66	2.00	1.98	1.90	1.96	0.928	0.909	0.979	0.939
T <sub>5</sub>	8.62	8.53	8.53	8.56	1.90	1.91	1.86	1.89	0.861	0.844	0.879	0.861
T <sub>6</sub>	8.37	8.36	8.66	8.46	1.82	1.78	1.92	1.84	0.825	0.809	1.021	0.885
T <sub>7</sub>	8.35	8.42	8.45	8.41	1.80	1.85	1.85	1.83	0.832	0.816	0.875	0.841
<b>CD 5%</b>	<b>NS</b>	<b>NS</b>	<b>0.013</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>0.009</b>	<b>NS</b>	<b>4.25</b>	<b>7.62</b>	<b>0.013</b>	<b>0.073</b>

**Table.3** Effect of different plastic mulches on green fruit yield (q /ha), dry fruit yield (kg/plant) and dry fruit yield (q/ha) growth and yield attributes of Chilli

Treat ments	Green fruit yield (q /ha )				Dry fruit yield (kg/plant)				Dry fruit yield (q/ha)			
	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean	2013-14	2014-15	2015-16	Mean
T <sub>1</sub>	247.8	242.8	269.63	253.41	0.144	0.155	0.154	0.151	48.0	46.5	56.5	50.33
T <sub>2</sub>	284.4	278.7	327.78	296.96	0.174	0.183	0.229	0.195	58.0	56.8	84.73	66.51
T <sub>3</sub>	298.3	292.3	318.29	302.96	0.187	0.202	0.220	0.203	62.3	62.5	81.40	68.73
T <sub>4</sub>	309.2	303.0	365.59	325.93	0.203	0.225	0.249	0.226	67.7	68.1	92.13	75.98
T <sub>5</sub>	287.0	281.3	325.50	297.93	0.164	0.162	0.247	0.191	54.7	56.9	90.62	67.41
T <sub>6</sub>	275.0	269.5	369.37	304.62	0.163	0.166	0.260	0.196	54.3	55.8	98.2	69.43
T <sub>7</sub>	277.4	271.9	320.82	290.04	0.168	0.174	0.235	0.192	56.0	56.2	86.3	66.17
<b>CD 5%</b>	<b>4.25</b>	<b>7.62</b>	<b>35.06</b>	<b>29.20</b>	<b>5.75</b>	<b>6.89</b>	<b>0.0013</b>	<b>0.036</b>	<b>5.76</b>	<b>6.85</b>	<b>21.47</b>	<b>14.08</b>

**Table.4** Effect of different plastic mulches on weed infestation at 75 DAT and Benefit cost ratio of chilli.

Treat ments	Weed density) / m <sup>2</sup> at 75 DAT				Benefit cost ratio
	2013-14	2014-15	2015-16	Mean	
T <sub>1</sub>	176	176	185.5	179.17	1.25
T <sub>2</sub>	63	63	75.3	67.10	1.37
T <sub>3</sub>	51	51	53.8	51.93	1.93
T <sub>4</sub>	15	14	26.0	18.33	2.05
T <sub>5</sub>	12	12	23.2	15.73	1.95
T <sub>6</sub>	13	13	13.7	13.23	2.80
T <sub>7</sub>	14	14	25.0	17.67	1.29
<b>CD 5%</b>	<b>8.12</b>	<b>7.20</b>	<b>13.09</b>	<b>5.56</b>	<b>-</b>

Soil under the mulch remains loose and friable. Aeration and soil microbial activity are enhanced. In heavy black soil also, application of mulches like coir pith @ 20 t/ha, press mud @ 10 t/ha decreased the bulk density over control (Mayalagu, 1983).

The organic mulches not only conserve the soil moisture, they also increase the soil nutrients through organic matter addition (Dilip Kumar *et al.*, 1990). Organic mulches have the advantage of being biodegradable, but decomposition may result in a temporary reduction in soil mineral nitrogen (Wallace and Bellinder, 1992). Similar findings have also been observed by (Dean Ban *et al.*, 2004; Ansary and Roy 2005) in watermelon, (Al-Majali and Kasrawi, 1995) in muskmelon, Aruna *et al.*, (2007) in tomato. Plastic mulch reduces evaporation from the soil surface and soil moisture is maintained with greater uniformity. Due to the lack of light under the black plastic mulch, photosynthesis could not be done and weeds cannot grow. Therefore, the plants will have greater access to water and nutrients. In other words, if the mulch is used, less water is consumed and yield can be expected to be higher (Jolaini *et al.*, 2008). The increase in yield per plant might be due to increased uptake of nutrients which resulted in enhanced synthesis of hormones like auxins and gibberellins. Water applied through drip irrigation slowly near to the root zone always maintains soil moisture in field capacity range and no moisture stress occurred during the flowering and fruit development stage and thereby the fruit drop was minimized.

### **Weed population**

Effect of different mulching treatments (Table 4) significantly influenced the weed density / m<sup>2</sup> at 75 days after planting. The common weed species emerged during the experiment was *Acalypha indica*, *Amaranthus viridis*,

*Trianthema portulacastrum*, *Portulaca oleraceae*, *Physalis minima* and *Cynodon spp.* Among the different mulches, black / white polythene double coated 30 micron (T<sub>6</sub>) recorded the lowest weed density (13.23/m<sup>2</sup>) at 75 days after planting, followed by organic mulch @ 12 t/ha (T<sub>4</sub>). The lowest weed density recorded might be due to the suppression of weeds by increasing the soil temperature resulting in killing the weed seeds in the early stages. The effectiveness of black polythene sheet as mulching material in restricting weed growth has been reported by Chirstopher Lourduraj *et al.*, (1997) in brinjal and Agrawal *et al.*, (2000) in banana. The fact that polythene sheet mulch acts as a barrier between sunlight and soil which further leads to a reduction in the weed growth under the mulches. It might be due to lack of percentage of light through black plastic. Black plastic mulch blocked the weeds, except a few, which emerged through the planting holes (Schonbeck, 1998).

### **Cost benefit ratio**

The highest cost benefit ratio was recorded in T<sub>6</sub> (2.80) followed by T<sub>4</sub> (2.05) (Table 4). Even though the yield recorded was slightly higher in T<sub>4</sub> compared to T<sub>6</sub>, the highest cost benefit ratio in T<sub>6</sub> was due to the high cost of organic mulch as well the polythene mulch can be used for two seasons.

In conclusion, the results of this study exhibited the significant effect of organic and black /white polythene (double coated 30 micron) plastic mulch on soil moisture content during the growing season. Based on the experimental results, it could be concluded that mulches had tremendous effect on the growth and yield of chilli, showed superior performance in yield. Weed growth was also suppressed by black / white polythene (double coated 30 micron) mulch and thereby, increased the fruit yield with

high cost benefit ratio. Moreover, using polyethylene plastic mulch produced earlier seedling emergence, more vigorous plant, earlier and higher yield as compared to non-mulched treatment. Therefore, it is recommended to use organics as soil mulching or black / white polythene (double coated 30 micron) to enhance growth and yield of chilli.

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