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*RESEARCH ARTICLE*

# EFFECT OF MULCH ON SOIL TEMPERATURE, SOIL MOISTURE CONSERVATION AND YIELD OF CHILLI

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**ABSTRACT**

The experiment was conducted at Regional Agricultural Research Station (RARS), Jamalpur, Bangladesh during the period of 2017-18 and 2018-19 with the objectives to evaluate the effect of different mulch on soil temperature, soil moisture conservation and yield attributes of chilli. There were five treatments comprising $T_1$: no mulch, $T_2$: rice straw mulch @ 5 t ha$^{-1}$, $T_3$: water hyacinth mulch @ 5 t ha$^{-1}$, $T_4$: black polyethylene mulch and $T_5$: white polyethylene mulch. The results revealed that, all the mulch treatment had higher soil temperature and soil moisture content at 5 cm and 10 cm depth compared to no mulch treatment. Soil temperature was highest in black polyethylene mulch, it increased average soil temperature by about 5.7 $^oC$ at 5 cm depth and 5.1 $^oC$ at 10 cm depth compared to no mulch treatment at 120 Days. Rice straw mulch treatment recorded highest soil moisture, it increased average soil moisture about 27.87 % at 5 cm depth and 28.57% at 10 cm depth over no mulch treatment. Rice straw mulch treatment produced highest green chilli yield (8.81 t ha$^{-1}$) which was 26.94 % increased over no mulch treatment (6.94 t ha$^{-1}$).Considering economic analysis, highest gross return (Tk 352400 ha$^{-1}$), gross margin (Tk 235400 ha$^{-1}$) and BCR (3.01) was obtained from same treatment $T_2$ i.e., rice straw mulch treatment.

**KEYWORDS**

Chilli, Yield, Mulch, Soil temperature, Soil moisture.

## 1. INTRODUCTION

Chilli (*Capsicum annuum* L.), is a valuable spice and also one of the most important cash crops grown in Bangladesh, belongs to the Solanaceae family. It is available and used in the form of green, dried and powdered. It has become an essential ingredient in Bangladeshi meals. It has diversified uses. The peoples of Bangladesh are usually used chillies in all curry preparation like meat, fish, vegetables, pulses etc. for its typical color, taste and flavor. Red chillies contain large amounts of vitamin-C and small amounts of carotene (provitamin-A). Green chillies (unripe fruit) contain a considerably lower amount of both substances. In addition, chillies are a good source of most vitamin-B and vitamin-B6 in particular. They are very high in potassium, magnesium and iron. It is a long duration and energy rich crop require proper manuring and balanced fertilizers along with sufficient moisture level for higher yield and quality produce (Prasad *et al*., 2009). Chilli being indeterminate in nature, vegetative and reproduction stages overlap and plant need nutrients even up to maturity and fruit ripening and proper water management. Chili is sensitive to water stress, young chili seedlings cannot withstand earlier water stress while older plants can withstand deflects or excess of soil moisture (Ashrafuzzaman *et al*., 2011).

Mulching is the process or practice of covering the soil/ground to make more favorable conditions for plant growth, development and efficient crop production. Mulches are either organic or inorganic. The organic mulch include plant remains such as straw, hay, peanut hulls, leaf mold and compost, wood products such as sawdust, wood chips and animal manures while inorganic mulch includes plastic mulch which is the most important mulch material use in commercial crop production (Kumar *et al*., 2012).

Mulches are known to increase the soil temperature since the sun's energy passes through the mulch and heats the air and soil beneath the mulch directly and then the heat is trapped by the "greenhouse effect" (Hu et al., 1995). Mulches also promote crop development and early harvest and increase yields. Very little weed growth occurs under the mulch as the mulches prevent penetration of light or exclude certain wavelengths of light that are needed for the weed seedlings to grow (Ossom et al., 2001). Mulches greatly retard the loss of moisture from the soil. As a result, higher and uniform soil moisture regime is maintained reducing the irrigation frequency.

Farmers of Bangladesh are growing chillies following indigenous methods

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with the poor yield rate. In Bangladesh, chilli grown on an area of 2,56,000 acres with annual production of 1,37,000 M.ton, and per acre yield is 535 kg (BBS, 2017). The reasons behind such low yield due to lack of high yielding variety and method of production practices followed by the local growers. The yield of chilli can be increased by adopting improve production technology. Although chilli is a major spice crop of Bangladesh, but its production technologies has not been standardized from the scientific and economic point of view. Therefore, research needs to bring improvement in production technologies as well as considering economic return. With the above point of view, the present study was carried out to study the effect of different mulching materials on soil temperature, soil moisture conservation and yield of chili and to sought out a suitable mulching material for maximum growth and yield of chili.

## 2. Materials and Methods

An experiment was conducted at Regional Agricultural Research Station (RARS), Jamalpur during 2017-18 and 2018-19 to increase the soil moisture retention and to increase yield of chilli using different mulch. Nutrient status of initial soil prior to fertilization, initial soil temperature(°C) & soil moisture (%) and weather data, 2018-19 are presented in Table 1, Table 2 and Table 3, respectively.

**Table 1:** Initial soil status of the experimental soils

| Location | pH | OM (%) | Ca | Mg | K | Total N% | P | S | B | Cu | Fe | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meq 100g$^{-1}$ | | | | µg g$^{-1}$ | | | | | | |
| RARS, Jamalpur | 7.1 | 0.97 | 7.2 | 2.5 | 0.087 | 0.051 | 7.8 | 6.1 | 0.22 | 2.1 | 46 | 6.9 | 1.61 |
| Critical level | - | - | 2.0 | 0.5 | 0.12 | - | 10 | 10 | 0.20 | 0.2 | 4 | 1 | 0.6 |

**Table 2:** Initial soil temperature (°C) and soil moisture (%) at 5cm and 10 cm depth under different mulches

| Treatments | Soil temperature (°C) | | Soil moisture (%) | |
|---|---|---|---|---|
| | 5 cm | 10 cm | 5 cm | 10 cm |
| $T_1$ (no mulch) | 17.4 | 17.1 | 10.3 | 11.6 |
| $T_2$ (rice straw mulch) | 17.6 | 17.3 | 10.9 | 11.1 |
| $T_3$ (water hyacinth mulch) | 17.5 | 16.8 | 11.4 | 11.9 |
| $T_4$ (black polyethylene mulch) | 17.7 | 16.9 | 10.8 | 11.1 |
| $T_5$ (white polyethylene mulch) | 17.9 | 16.8 | 11.4 | 12.1 |

**Table 3:** Monthly average weather condition during November 2018 – April 2019 at RARS, Jamalpur

| Month | Fortnight | Temperature (°C) | | | Rainfall (mm) | No. of rainy days |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Mean | | |
| November, 2018 | 1st | 31.33 | 19.61 | 25.47 | 0.00 | 00 |
| | 2nd | 30.10 | 15.80 | 22.95 | 0.00 | 00 |
| December, 2018 | 1st | 28.13 | 13.80 | 20.96 | 0.00 | 00 |
| | 2nd | 25.00 | 11.75 | 18.37 | 15.5 | 1 |
| January, 2019 | 1st | 25.81 | 10.26 | 18.03 | 0.00 | 00 |
| | 2nd | 24.18 | 12.30 | 18.24 | 0.00 | 00 |
| February, 2019 | 1st | 25.12 | 14.12 | 19.62 | 2.5 | 2 |
| | 2nd | 27.53 | 15.61 | 21.57 | 19.75 | 1 |
| March, 2019 | 1st | 29.13 | 17.06 | 23.09 | 9.75 | 1 |
| | 2nd | 32.25 | 18.75 | 25.50 | 5.05 | 2 |
| April, 2019 | 1st | 30.8 | 20.40 | 25.60 | 136.75 | 6 |
| | 2nd | 35.6 | 23.26 | 29.43 | 86.0 | 6 |

The experiment was conducted during the period of November to April 2018 and 2019.The soil was neutral in pH and silty loam in texture. Before mulching, moisture content in rice straw and water hyacinth were estimated and it was 7.4% and 9.1%, respectively. The land was prepared by tilling in two directions with a power tiller. Weeds and crop stubble were removed. Plots were 3m × 2 m on 15 cm high raised beds. Urea, triple superphosphate (TSP) and muriate of potash (MP) were applied (260, 200 and 150 kg ha$^{-1}$, respectively). Total amount of TSP, MP and half of urea were broadcast and incorporated to the soil at final land preparation. The rest of urea was top-dressed at 40 days after transplanting (DAT). Well decomposed cowdung was applied (5 tha$^{-1}$) prior to final tilling. BARI morich -1 was used as test variety transplanted in plots in Randomized Complete Block Design (RCBD) with three replications. The row and plant spacing was maintained at 60 cm and 50 cm respectively and each plot accommodated 20 plants.

Treatments were as follows as

$T_1$ = no mulch
$T_2$ = rice straw mulch @ 5 t ha$^{-1}$
$T_3$ = water hyacinth mulch @ 5 t ha$^{-1}$
$T_4$ = black polyethylene mulch
$T_5$ = White polyethylene mulch

After taking the required length of film for crop, (3 x 2 m$^2$/plot) one end of the mulch film was anchored in the soil approximately 4-6 inch and then film was unrolled along the length and width of the plot. A sharp tin on a handle was used to easily cut a hole on tightly laid mulched at 50 cm spacing and then transplanting done. -before lying of rice straw and water hyacinth, transplanting distance of 50 cm was marked. After marking, seedlings were transplanted and simultaneously organic mulches spread. Thirty-day old seedlings were transplanted at 60 cm × 50 cm spacing on 13 November 2018. Seedlings were watered after transplanting. Guard rows were established around the entire plot. Gap filling of seedling was with healthy seedlings previously planted in the border area. The fungicides of carbendajim group (Autostin at 2 g/L) and insecticide of Imidachloprid (Imitaf @ 0.25 ml/L) were applied to prevent disease and insect infestation.

Soil temperature was determined by soil thermometer at 5 cm and 10 cm depth in the experimental field. In everyone month, it was determined in three different times (7 AM, 12 PM and 5 PM) of the day. Soil moisture content was determined by soil moisture meter at 5 cm and 10 cm depth in every fifteen days.

Green fruit were harvested at weekly intervals when fruit length was at least 6.5 cm. Harvesting was started on 2 March 2019 and continued till 25 April 2019.Data on growth parameters were recorded and analyzed statistically using statistical software STAR which was developed by IRRI.

## 3. Result and Discussion

### 3.1 Effect of mulch on soil temperature (°C) and soil moisture (%)

Soil temperature varied with type of mulching and the depth of soil (Table 4). Soil temperature under mulches was higher than that of the control plots. In general, soil temperature was higher at 5 cm depth than 10 cm

depth. The black polyethylene mulch apparently showed highest soil temperature (34.1 °C), followed by rice straw mulch (32.9 °C) at 5cm depth at 120 days. The lowest soil temperature (28.4 °C) was recorded in the control treatment. Suwon and Judah (1985) reported that soil temperature increased with the use of polyethylene mulch. The polyethylene mulches allowed part of the radiation to pass through it but acted as barriers against outgoing thermal radiation (Park et al., 1987).

Soil moisture content was also differed measured under different mulches. Results revealed that all the mulches retained higher amount of soil moisture compared to the control. The rice straw mulch apparently showed highest moisture (21.1 %), followed by black polyethylene (19.5%) and white polyethylene (18.9 %) mulch at 5cm depth at 120 days. The lowest moisture (16.5 %) was recorded in the control treatment. Organic mulches have been shown to improve the moisture retention of soil. This extended water holding capacity which the plants enable to survive during low rainfall periods (Iqbal *et al.,* 2009).According to Cook *et al.,*2006 report the control treatment (no mulch) had the lowest water content than mulched plots with wheat and soybean straw. Similarly, due to the evaporation reducing property of the surface place straw layer, mulching reduced soil water loss as compared to un-mulched control. (Pervaiz *et al.,* 2009)

**Table 4:** Effect of different mulch on monthly average soil temperature (°C) and soil moisture (%) at different soil depth, 2018-19

| Treats | Depth | 30 Days | | 60 Days | | 90 Days | | 120 Days | |
|---|---|---|---|---|---|---|---|---|---|
| | | Temp. (°C) | moisture(%) | Temp. (°C) | moisture(%) | Temp. (°C) | moisture(%) | Temp. (°C) | Moisture (%) |
| $T_1$ | | 22.1 | 12.5 | 18.7 | 14.4 | 23.5 | 15.5 | 28.4 | 16.5 |
| $T_2$ | | 26.2 | 16.3 | 22.5 | 19.1 | 28.1 | 23.2 | 32.9 | 21.1 |
| $T_3$ | 5 cm | 24.1 | 13.9 | 20.9 | 16.1 | 26.0 | 18.7 | 29.3 | 18.6 |
| $T_4$ | | 27.1 | 16.3 | 23.1 | 18.3 | 28.9 | 21. | 34.1 | 19.5 |
| $T_5$ | | 24.7 | 14.7 | 21.3 | 16.1 | 26.9 | 19.5 | 31.6 | 18.9 |
| $T_1$ | | 21.4 | 12.8 | 17.1 | 14.6 | 21.7 | 15.9 | 25.3 | 16.8 |
| $T_2$ | | 24.2 | 17.0 | 20.3 | 19.5 | 24.3 | 23.8 | 28.6 | 21.6 |
| $T_3$ | 10 cm | 22.3 | 14.3 | 18.6 | 16.4 | 24.0 | 19.1 | 26.9 | 18.9 |
| $T_4$ | | 24.9 | 16.5 | 21.3 | 18.7 | 26.5 | 21.8 | 30.4 | 20.6 |
| $T_5$ | | 22.8 | 15.3 | 19.4 | 16.6 | 24.7 | 19.8 | 27.5 | 19.6 |

Note: $T_1$: no mulch, $T_2$: rice straw mulch, $T_3$: water hyacinth mulch, $T_4$: black polyethylene mulch and $T_5$: white polyethylene mulch

### 3.2 Effect of mulch on Yield and yield components of chilli

The response of yield contributing characters and yield of chilli were significant due to different mulch treatment. The highest plant height (36.4 cm) was recorded in $T_2$ (rice straw mulch) and the lowest (20.2 cm) was obtained from control (no mulch) treatment. (Table 5). Mulching had positive influence of fruit setting in chilli. In 2017-18, the maximum number of green chilli per plant (91.01) was observed in $T_2$ (rice straw mulch), followed by $T_4$ (black polyethylene mulch) while, the treatment $T_1$ (control) showed the minimum number of chilli per plant. (55.30). In 2018-19, $T_2$ (rice straw mulch), also produced maximum number of green chilli per plant (85.5) which was statistically identical (81.7) with $T_4$ (black polyethylene mulch). This might be due to increased growth of plant under favorable soil micro climate. Another reason of increasing the number of fruit per plant in treatment $T_4$ (Black polythene mulch) was probably associated with moisture conservation and improved micro climate both beneath and above the soil surface. The suitable conditions enhance the plant growth and development and produced fruit bearing nodes as compared to the control. The results are in close harmony with the result reported by (Singh B. *et al*; 2005) in tomato.

The effect of different mulches on green chilli yield was significant. Treatment $T_2$ (rice straw mulch) produced higher chilli yield (9.13 t ha$^{-1}$) in 2017-18 and (8.49 t ha$^{-1}$) in 2018-19 which were statistically at par with $T_4$ (black polyethylene mulch) (8.97 t ha$^{-1}$) in 2017-18 and (8.14 t ha$^{-1}$) in 2018-19 over other treatments. Obviously, control plot ($T_1$) showed the lowest chilli yield (7.21 t ha$^{-1}$) in 2017-18 and (6.67 t ha$^{-1}$) in 2018-19.The yield increase under rice straw mulch could be due to their ability to reduce soil temperature fluctuation, to add organic matter by decomposition, increased water holding capacity, smothering weed population, which led to favorable condition for plant growth and development. The positive influence of organic mulch materials on yield was also reported by (Uniyal S.P. and Mishra A.C. 2003) in potato. Black plastic alters the plants growth by enhancement in soil temperature; so that plants can increase growth, profuse flowering and fruiting, resulting in earlier and high yields as compared to control. Similar kind of observation was also reported by (Singh B. et al 2005) in tomato and (Nimah M.N. 2007) in cucumber.

From the two years results, it was observed that maximum average green chilli yield (8.81 t ha$^{-1}$) was found in $T_2$ (rice straw mulch) treatment and minimum (6.94 t ha$^{-1}$) was recorded in no mulch treatment which indicating that 26.94 % yield increase was possible due to using of rice straw mulch

**Table 5:** Yield and yield attributes of chilli under different mulch during 2017-18 and 2018-19

| Treat | Plant height (cm) 2018-19 | No. of green chilli plant$^{-1}$ | | Wt. of green fruits plant$^{-1}$ (g) | | Yield of green chilli (t ha$^{-1}$) | | Average green chilli yield (t ha$^{-1}$) | % increase over control |
|---|---|---|---|---|---|---|---|---|---|
| | | 2017- 18 | 2018-19 | 2017-18 | 2018-19 | 2017-18 | 2018-19 | | |
| $T_1$ | 20.2 d | 55.3 d | 49.4 d | 127.5 d | 119.3 c | 7.21 c | 6.67 d | 6.94 | - |
| $T_2$ | 36.4 a | 91.0 a | 85.5 a | 223.1 a | 216.3 a | 9.13 a | 8.49 a | 8.81 | 26.94 |
| $T_3$ | 28.2 c | 76.6 c | 65.9 c | 186.9 c | 171.6 b | 7.94 bc | 6.96 cd | 7.45 | 7.34 |
| $T_4$ | 34.5 b | 85.5 b | 81.7 a | 218.5 a | 214.8 a | 8.97 ab | 8.14 ab | 8.55 | 23.19 |
| $T_5$ | 29.1 c | 79.5 c | 74.1 b | 204.5 b | 173.3 b | 8.15 c | 7.51 bc | 7.83 | 12.82 |
| CV (%) | 3.3 | 8.4 | 6.7 | 13.3 | 12.76 | 11.65 | 9.53 | | |
| Lsd (0.05) | 1.4 | 5.0 | 4.0 | 7.4 | 5.53 | 0.98 | 0.80 | | |

Note: $T_1$: no mulch, $T_2$: rice straw mulch, $T_3$: water hyacinth mulch, $T_4$: black polyethylene mulch and $T_5$: white polyethylene mulch

### 3.3 Cost and return analysis

Higher money value and low cost of cultivation are desirable characters for higher returns. Hence, economics of the various treatments was worked out (Table 6). Considering economics of the different treatments, the highest gross return (352400 TK ha$^{-1}$), gross margin (235400 TK ha$^{-1}$) and BCR (3.01) were obtained from $T_2$ treatment i.e., rice straw mulch. The lowest gross return (277600 TK ha$^{-1}$) was found from $T_1$ i.e., no mulch treatment. Due to high cost of polyethylene, lowest gross margin (141800 TK ha$^{-1}$) was obtained from $T_5$ (white polyethylene mulch) treatment. Therefore, $T_2$ treatment (rice straw mulch treatment) is more profitable than other mulching treatment for cultivation of chilli.

**Table 6:** Cost and return analysis of chilli from different mulching treatments

| Treat. | Average green chilli yield (t ha$^{-1}$) | Gross return (TK ha$^{-1}$) | Total variable cost(TVC) (TK ha$^{-1}$) | Gross margin (TK ha$^{-1}$) | BCR |
|---|---|---|---|---|---|
| $T_1$ (no mulch) | 6.94 | 277600 | 108890 | 168710 | 2.54 |
| $T_2$ (rice straw mulch) | 8.81 | 352400 | 117000 | 235400 | 3.01 |
| $T_3$ (water hyacinth mulch) | 7.45 | 298000 | 110500 | 187500 | 2.69 |
| $T_4$ (black polyethylene mulch) | 8.55 | 342000 | 181200 | 160800 | 1.88 |
| $T_5$ (white polyethylene mulch) | 7.83 | 313200 | 171400 | 141800 | 1.82 |

**Input:** Urea 16 TKKg$^{-1}$, TSP 22 TKKg$^{-1}$, MoP 15 TKKg$^{-1}$, Zinc sulphate 120 TKKg$^{-1}$, Boric acid 150 TKKg$^{-1}$, rice straw 12 TKKg$^{-1}$, water hyacinth 10 TKKg$^{-1}$, black polythene 40 TKgauze$^{-1}$, white polythene 35 TK gauze$^{-1}$

**Output:** green chilli 40 TKKg$^{-1}$

## 4. Conclusion

Finally results revealed that, $T_2$ treatment (rice straw mulch treatment) was the most productive and profitable among the treatments tested in chilli field. So, it can be concluded that, farmers will be benefitted by applying rice straw mulch @ 5 tha$^{-1}$ in chilli production.

## References


Ashrafuzzaman, M., M.A. Hakim, M.R. Ismail, S.M. Shahidullah & M.A. Hossain. 2011. Effect of plastic mulch on growth and yield of chili (*Capsicum annum*). *Brazil. Arch. Boilogy and Technology,* 54(2), 321-330.

BBS. 2017. Yearbook of Agricultural Statistics, Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Govt. of the People' Republic of Bangladesh, P. xii.

Cook, H.F., G.S.B. Valdes and H.C. Lee. 2006. Mulch effects on rainfall interception, soil physical characteristics and temperature under *Zea mays* L. Soil Tillage Res., 91, 227-235.

Hu, W., S. Duan and Q. Sui. 1995. High yield technology for groundnut. Int. Arachis Newsletter 15 (Suppl.), 1–22.

Iqbal, Q., M. Amjad, M.R. Asi, M.A. Ali and R. Ahmad. 2009. Vegetative and reproductive evaluation of hot peppers under different plastic mulches in poly/plastic tunnel. *Pak. J. Agric. Sci.*, 46, 113-118.

Kumar, S.D. and B.R. Lal. 2012. Effect of mulching on crop production under rainfed condition. International Journal of Research Chemistry and Environment, 2(2), 8-20.

Nimah, M.N. 2007. Acta Horticulture, (731), 189-194.

Ossom, E.M., P.F. Pace, R.L. Rhykerd and C.L. Rhykerd. 2001. Effect of mulch on weed infestation, soil Temperature, nutrient concentration, and tuber yield in *Ipomoea batatus* (L.) Lam. In Papua New Guinea. Trop. Agric. (Trinidad) 78, 144–151.

Park, S.U., K.Y. Park, Y.K. Kang and S.K. Jong. 1987. Effect of polythene mulching and tunnel on the growth and yield of early produced sweet corn. *Res. Rep. Rural Dev. Adm. Crops.*, 29, 245– 250

Pervaiz, M.A., M. Iqbal, K. Shahzad and A. Hassan. 2009. Effect of mulch on soil physical properties and N, P, K concentration in maize (*Zea mays*) shoots under two tillage systems. *Int. J. Agric. Biol.*, 11, 119-124

Prasad, S.M., M.H.D. Kumar, B.M. Chittapur, M.H. Tatager and R.K. Mesta. 2009. Yield and quality of chilli (cv. Bydigidabbi) as influenced by primary and secondary nutrients, Karnataka. *J. Agri. Sci.*, 22, 1090-1092.

Singh, B., M. Kumar and G.C. Singh. 2005. *Indian J. of Hort.*, 62(2), 200-202.

Uniyal, S.P. and A.C. Mishra. 2003. *J. Indian Potato Assoc*, 30(3-4), 315-317.