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Effect of Different Organic and Inorganic Mulches on Soil Properties and Performance of Brinjal (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. Author MSH developed the study design, wrote the protocol and wrote the first draft of the manuscript. Author MMS conducted the field study, recorded information through collection of sample and performed the statistical analysis. Author MAA managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at the Experimental Field Laboratory of the Department of Environmental Science, Bangladesh Agricultural University, Mymensingh during the period for 19th March, 2015 to 5th August, 2015 to investigate the effects of different organic and inorganic mulches on soil properties and brinjal growth and yield. The experiment included five treatments viz. black polythene, transparent polythene, rice straw, saw dust and control. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The black polythene mulch reduced soil acidity and increased available potassium content in the soil. On the other hand, saw dust mulch was better in respect of total nitrogen and organic matter contents. All the mulches generated higher soil moisture over the control. The soil moisture content of the black polythene mulch was higher compared to other mulches. Growth parameters like dry weight of

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shoot plant^{-1}, dry weight of roots plant^{-1} and leaf area index (LAI) were significantly influenced by different mulches over the control. Yield also increased significantly over control where maximum yield was found in rice straw treated plot (35.17 t ha^{-1}) and minimum in the control (26.42 t ha^{-1}). The yield was found in order of rice straw > transparent polythene>saw dust>black polythene>control plots. Though black and transparent polythene mulches superior for microclimate but rice straw mulch showed better performance on yield and yield contributing characters of summer brinjal.

Keywords: Mulch; organic; rice straw; polythene; brinjal.

1. INTRODUCTION

Brinjal or Eggplant (*Solanum melongena* L.) is one of the most popular vegetable crop grown in Bangladesh and other part of the world. It belongs to the family Solanaceae. It is widely cultivated in both subtropical and tropical regions of the globe mainly for its immature fruits as vegetables [1]. Brinjal is grown throughout the year in Bangladesh but only a few varieties are grown during the summer season. Brinjal was cultivated in 30,905.5 ha of land with the production of 3,10,354 metric tons during the *Rabi* season and 18,471.4 ha of land with a production of 1,39,792 metric tons during the *Kharif* season of 2014-2015 in Bangladesh [2]. The unripe fruit is primarily used as a cooked vegetable for the preparation of various dishes in different regions of the world. It has potential as a raw material in pickle making and in dehydration industries. It is one of the most important indigenous vegetables in Bangladesh [3]. In term of consumption, brinjal ranks third after potato and onion.

Mulching influences the soil hydrothermal regime by influencing the radiation balance, the rate of heat and water vapor transfer, and heat capacity of the soil. Mulching improves the physical condition of the soil by enhancing soil aggregation and helps in conservation of water by checking evaporation, increasing infiltration and retarding runoff loss. According to [4] conservation of soil moisture is one of the major benefits of mulch farming system. Organic mulches add nutrients to the soil when decomposed by microbes and help in addition to soil organic carbon and nitrogen. Favorable soil edaphic environment under mulch improves crop productivity, enhances input-use efficiency and checks environmental pollution.

Mulched and irrigated treatments have been shown to induce higher root growth in comparison with un mulched and rain fed treatments [5]. Water is the single factor which directly affects the brinjal yield because it required especially at flowering, fruit set, and enlargement stage. But irrigation facilities are not sufficient in all the regions of the country. In Bangladesh, mulching was evaluated to many vegetables like tomato, onion, garlic but there was no record of research work on brinjal. The objective of this study was to investigate the effect of different mulching types on soil properties, plant growth and yield of brinjal in the summer season.

2. MATERIALS AND METHODS

2.1 Location

Geographically the experimental field is located at 24°6′ N latitude and 95°5′ E longitude at an elevation of 18 m above the sea level. It belongs to the Agro-ecological Zone-9 (AEZ-9) named old Brahmaputra floodplain. The experiment was conducted at the Field Laboratory of Department of Environmental Science, Bangladesh Agricultural University, Mymensingh during the period from 19th March to 5th August, 2015. The soil of the experimental site was non-calcareous dark gray floodplain. The soil was more or less neutral in nature, silt loam in texture [6], imperfectly to well drained with slow permeability. The experimental area enjoys a sub-tropical climate which is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in the *Kharif* season (April to September) and a scanty rainfall associated with moderately low temperature during the *Rabi* season (October to March).

2.2 Design and Treatment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The variety of brinjal used in this experiment was Varsha (Plant height is 140 to

150 cm; No. of fruits per plant is 60 to 85; Days to first picking - 70 after T.P; Days to maturity - 145 to 150 Fruit yield in t/ha - 30 to 40). Date of planting was 19th March, 2015. The experimental land was divided into 20 unit plots each measuring 1 m× 1 m. Plot to plot distances were 2 m × 1.5 m. The experiment consisted of five treatments as: T1 =Control (no mulch), T2 = Transparent polythene mulch, T3 = Black polythene mulch, T4 = Rice straw mulch, T5 = Saw dust mulch. 5 t ha^{-1} of rice straw was uniformly spread as a carpet manually as straw mulch treatment. Transparent polythene and black colored polythene with 0.009 mm thickness was spread uniformly in the polythene mulch plots where saw dust @ 2 t ha^{-1} was spread as carpet in saw dust treatment.

2.3 Land Preparation

Land preparation included plowing to a depth of 30 cm and rotovating to a fine tilth to break up clods and to smooth the soil surface of the ridges. Before cultivation cowdung @ 10 t ha^{-1} and during soil preparation and one third of the recommended N 75 kg ha^{-1} N and 30 kg ha^{-1} P_2O_5 and 40 kg ha^{-1} K_2O were added to the experimental plots.

2.4 Measurement of Soil Moisture

The soil moisture was measured at 12, 33, 61 and 95 days after planting (DAP) 0 to 30 cm depth by gravimetric method [7]. The soil was sampled by manual coring and gravimetric moisture content (g/g) of the soil samples was calculated on oven dry weight basis using the formula:

$$\frac{W_1 - W_2}{W_1}$$

Where,

W_1= weight of fresh soil (g)
W_2= weight of oven- dry soil (g)

2.5 Observations Recorded

Vegetative characters like plant height, leaf number, dry weight of shoot, root were recorded on 3 randomly labelled plants and averaged to calculate as treatment. Number of fruit from each plot and total fruit yield for each treatment was also calculated from the randomly selected plant from first harvet to last.

2.6 Soil Analysis

After harvesting, soil samples were collected from each plot from 0 to 15 cm depth. Samples were dried at room temperature, crushed, mixed thoroughly and sieved with a 2 mm sieve. Walkley and Black method as modified by Allison [8] was used to determine organic carbon. The Kjeldahl method of Bremner [9] using $CuSO_4$-Na, SO_4 catalyst mixture was used to determine Total-N. Phosphorus was extracted by shaking 1 g of air dried soil in 10 mL of 0.025 *M* HCl and 0.03 *M* NH_4F for 5 minutes. Phosphorus is determined on the filtrate by the molybdate-blue method using ascorbic acid as a reductant [10]. pH was measured on a Mettler Toledo Seven-Multi pH meter with an InLab Routine Pro combination electrode, the standard ratio of soil:water used was 1:1. Available Potassium was analyzed by atomic emission in a Perkin Elmer Analyst 100 spectrometer.

2.7 Statistical Analysis

The collected data on various parameters under study were analyzed using the SPSS Statistics software package (var. 20.0). The significance of difference of treatment means were evaluated by the Least Significant Difference (LSD) test or Duncan's New Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1 Effect of Organic and Inorganic Mulches on Soil Properties

There was significant variation of soil pH in different mulches treatment where highest soil pH was observed in black polythene treatment (7.13) and lowest was found in saw dust treatment (6.03) (Table 1). Rainfall leaching to soil increases soil acidity. pH reduced in organic mulch treated plot due to the addition or retention of organic matter, with organic acids produced from decomposition of plant-derived materials accumulating or leaching into the soil [11]. Saw dust induced maximum pH reduction because most of the wood product is acidic in nature.

The organic carbon (Org. C.) of the soil was also influenced by different mulch treatments (Table 1). The highest organic carbon content (1.10%) was observed in saw dust mulch followed by transparent polythene mulch (0.74%) and black

polythene (0.70%) mulch which was statistically identical with the rice straw mulch (0.70%) treatment while the lowest (0.40%) was found in control treatment. This might happen due to high decomposition rate of saw dust than other mulches. Mulching affect soil organic matter (SOM) through decomposition and soil moisture preservation [12] and the size and activity of the soil microbial community [13,14].

The effect of different organic and inorganic mulch treatments was found significant in case of nitrogen accumulation. The accumulation of nitrogen from saw dust and black polythene mulches measured 0.130 and 0.109% respectively and they occupied superior position over rest of the mulches (Table 1). Although they were significantly different from each other, their accumulation rate over control treatment is remarkable. Transparent polythene and rice straw mulches were observed 0.075 and 0.065% respectively. Soil microbes facilitate nutrient dynamics and availability and microbial biomass is a sensitive indicator of Total-N regulation and transformation [13]. Sawdust mulch showed higher microbial biomass than that of rubber-tire mulch due to higher N, organic matter and moisture availability [15]. The effect of different organic and inorganic mulch treatments was also found significant in case of phosphorus accumulation. The accumulation of phosphorus from transparent polythene and black polythene mulches measured 18.31 and 18.13 mg kg^{-1} respectively and they occupied superior position over rest of the mulches (Table 1). Saw dust and rice straw mulches were observed 16.74 and 14.58 mg kg^{-1} respectively.

Significant variation of exchangable potassium in different treatment was found (Table 1). The highest (0.15 Cmol kg^{-1}) and lowest (0.11 Cmol kg^{-1}) exchangable potassium were observed from rice straw and black polythene mulch respectively.

3.2 Effect of Organic and Inorganic Mulches on Soil Moisture Content

The amount of moisture stored in the profile to a soil depth of 30 cm was significantly greater under mulch treated plot over control. Soil moisture content was highest under the black polythene mulch followed by saw dust and rice straw mulch (Fig. 1). Lowest moisture was recorded in the control. Soil moisture under mulch is increased through minimizing soil surface evaporation [11] as 25–50% of the total quantity of water used for evaporation [16]. Initially soil water content was same for all treatment but at 61 and 95 DAP, the polythene mulch plots contained more water than the other plots. while organic mulches plots recorded more water content during 33 DAP. Water vapor flux density in the top 20 cm of the soil with polythene mulch was 1.7 times that of unmulch control, as results of greater movement of water from the deeper layers upward [16].

3.3 Effect of Organic and Inorganic Mulches on Plant Growth Parameters

Different mulches produced significantly higher shoot dry weight compared to the control. Maximum shoot dry weight (362.50 g $plant^{-1}$) was found in black polythene mulch followed by rice straw (336.25 g $plant^{-1}$) while the maximum root dry weight (98.07 g $plant^{-1}$) was observed with treatment T4 followed by treatment T2 (88.96 g $plant^{-1}$) (Table 2). It was observed in all the treatments that root-shoot dry weight was significantly higher in mulched plants over the unmulched plants. The results indicated that mulching favoured better development of roots and shoots by protecting the plants from environmental stresses.

Table 1. Effect of organic and inorganic mulches on soil chemical properties

Treatments	pH	Org. C (%)	Total-N (%)	P (mg/kg)	K (Cmol/kg)
Transparent Polythene	6.66 bc	0.74 b	0.075 c	18.31 a	0.12 c
Black Polythene	7.13 a	0.70 b	0.109 b	18.13 a	0.11 c
Rice Straw	6.59 c	0.70 b	0.065 c	14.58 c	0.15 a
Saw Dust	6.03 d	1.10 a	0.130 a	16.74 ab	0.14 b
Control	6.96 ab	0.40 c	0.041 d	14.03 cd	0.15 a
$LSD_{(.05)}$	0.3	0.09	0.01	2.22	0.01

Mean with same letter in a column are statistically similar at 5% level of significant

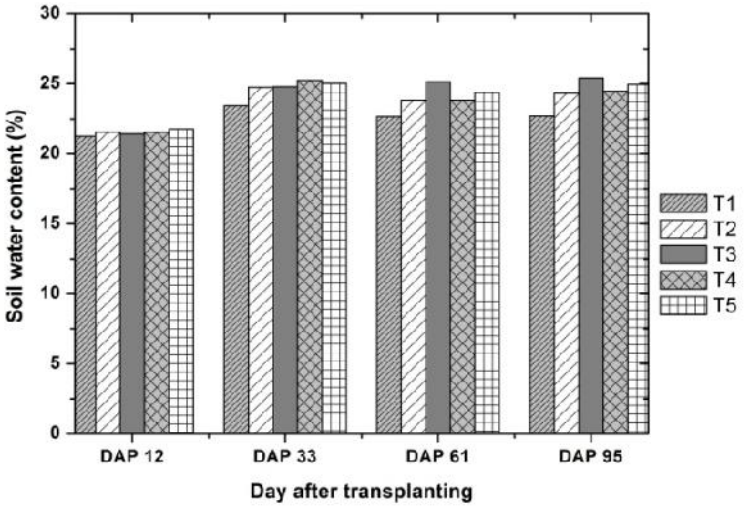

Fig. 1. Effect of organic and inorganic mulches on soil moisture content
(T1 =Control, T2 = Transparent polythene mulch, T3 = Black polythene mulch, T4 = Rice straw mulch, T5 = Saw dust mulch)

Table 2. Effects of different mulches on growth parameters of brinjal

Treatments	Shoot dry wt (g plant^{-1})	Root dry wt (g plant^{-1})	Root/Shoot ratio	Plant height (cm)	LAI (m^2/m^2)
T1	212.50 d	66.93 d	0.31 a	133.30	13.16 b
T2	225.00 cd	77.84 c	0.34 a	138.82	11.50 c
T3	336.25 b	88.96 b	0.26 b	146.62	15.91 ab
T4	362.50 a	98.07 a	0.27 b	138.45	16.79 a
T5	262.50 c	77.79 c	0.29 b	135.85	12.31 bc
LSD (0.05)	25.6	8.7	0.01	16.5	1.2

Within each column, the same letter indicates no significant differences among treatment ($p<0.05$). (T1 =Control, T2 = Transparent polythene mulch, T3 = Black polythene mulch, T4 = Rice straw mulch, T5 = Saw dust mulch)

Present result is supported by Saha [17] where he found that mulching increased stem dry weight of tomato. Bhagat et al. [18] reported that mulch induced higher root-shoot dry weight over unmulched in potato. The highest significant plant dry weight was recorded in plants mulched with rice straw with 6 cm thickness while lowest significant plant dry weight appeared in non-mulched plants in tomato [19]. The roo-shoot ratio indicated that mulched treatment enhanced higher above ground biomass compare to below ground biomass where height roo-shoot ratio was observed in treatment T1 and lowest in treatment T4.

Although longer plant was observed in mulch treated plot than control but no significant variation was seen in case of plant height regarding mulching treatment. Mulching provides a favourable environment for growth. Therefore, mulched plants usually grow and mature more uniformally than unmulched plants. It was observed that different mulching materials highly influenced the plant height and bulb diameter as well as the yield of garlic [20]. There was significant variation of leaf area index (LAI) in different mulches treatment where highest LAI was observed in rice straw treatment (16.79) and lowest was found in transparent polythene treatment (11.50). The increased LAI in response to water hyacinth and rice straw mulches was reported in onion [21] and garlic [22].

3.4 Effect of Organic and Inorganic Mulches on Yield

There was significant variation of total fruit number plot^{-1} in different mulches treatment where highest total fruit number plot^{-1} was observed in control treatment (55) followed by transparent polythene (52) treatments. The lower total fruit number (43) was recorded in black

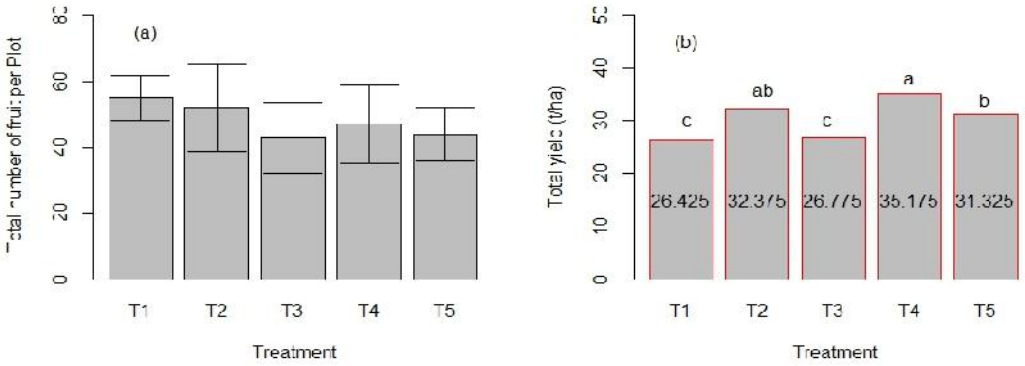

Fig. 2. Effect of organic and inorganic mulches on a) number of fruit per plot and b) yield of brinjal

(T1 =Control, T2 = Transparent polythene mulch, T3 = Black polythene mulch, T4 = Rice straw mulch, T5 = Saw dust mulch)

polythene plot [Fig. 2 (a) above]. Variation in yield of brinjal was found due to use of different mulches. All mulches in this experiment increased the yield significantly over control as shown in Fig. 2 (b) (above).

Rice straw mulch treatment induced height yield (35.175 t ha^{-1}) followed by treatment T2 and T5 where lowest yield found in control treatment (26.425 t ha^{-1}). The increases of yield due to different mulches might be attributed to the retention of suitable soil temperature and conservation of adequate soil moisture. This result is in agreement with Talukder [22] who reported that higher yield produce by the mulching treatment was attributed by the better supply of soil moisture, nutrient and better physical condition of the soil. Fruit length and fruit diameter of eggplant significantly affected ($P<0.01$) by irrigation and straw mulch treatments reported by [23].

4. CONCLUSION

In general, positive change in soil parameters were observed in mulch treated plots compare to control while except soil water content organic mulches applied soils were better than inorganic mulches. The significant variation was observed in case of growth and yield parameters. The effectiveness of growth parameters in order of rice straw > black polythene > saw dust > transparent polythene > control and for yield in order of rice straw > transparent polythene > sawdust > black polythene > control. In conclusion, the present study found that rice staw mulch was significantly more effective in improving water conservation of soil, improving vegetative growth, and yield of brinjal in summer season.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Patel KK, Sarnaik DA. Performance study of long fruited genotypes of brinjal under Raipur conditions. The Orissa J. Hort. 2003;31(1):74-77.
2. BBS (Bangladesh Bureau of Statistics). Statistical Year Book of Bangladesh. Statistics Division, Agriculture Wing, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. 2015;249-288.
3. Saifullah M, Goffar MA, Ahmed S, Bhuya MAJ. Utilization of indigenous vegetables for sustainable vegetables production in Bangladesh. International Symposium on Sustainable Vegetables Production in Southeast Asia, Salatiga, Indonesia; 2012.
4. Pang HY, Li J, Yang, Liang Y. Effect of brackish water irrigation and straw mulching on soil salinity and crop yields under monsoonal climatic conditions. Agric. Water Manage. 2010;97:1971-1977.
5. Kumara S, Dey P. Effects of different mulches and irrigation methods on root growth, nutrient uptake, water-use efficiency and yield of strawberry. Sci. Hortic. 2011;127:318–324.
6. UNDP (United Nations Development Program) and FAO (Food and Agricultural

Organization. Land resources appraisal of Bangladesh for Agricultural Development. Report 2, Agroecological Regions of Bangladesh. UN Dev. Prog. Food and Agric. Org. 1988;212-22.
7. Black CA. Methods of soil analysis: Part I physical and mineralogical properties. Am. Soc. Agron., Madison, Wisconsin, USA; 1965.
8. Allison LE. Organic carbon. In: C. A. Black et al. (Eds). Method of Soil Analysis Part 1. Am. Soc. Agron. 1965;9:1367-1378.
9. Bremner JM. Total nitrogen. In: C. A. Black et al. (Eds). Methods of Soil Analysis Part 1. Am. Soc. Agron. 1965;9:1149-1178.
10. Pradhan S, Pokhrel MR. Spectro-photometric determination of phosphate in sugarcane juice, fertilizer, detergent and water samples by molybdenum blue method. Scientific World. 2013;11(11):58-62.
11. Himelick EB, Watson GW. Reduction of oak chlorosis with wood chip mulch treatments. J. Arboric. 1990;16(10):275-278.
12. Youkhana A, Idol T. Tree pruning mulch increases soil C and N in a shaded coffee agroecosystem in Hawaii. Soil. Biol. Biochem. 2009;41:2527-2534.
13. Huang ZQ, Xu ZH, Chen C. Effect of mulching on labile soil organic matter pools, microbial community functional diversity and nitrogen transformations in two hardwood plantations of subtropical Australia. App. Soil Ecol. 2008;40:229-239.
14. Chaparro JM, Sheflin AM, Manter DK, Vivanco JM. Manipulating the soil microbiome to increase soil health and plant fertility. Biol. Fertil. Soils. 2012;48: 489-499.
15. Arthur MA, Wang Y. Soil nutrients and microbial biomass following weed-control treatments in a Christmas tree plantation. Soil Sci. Soc. Am. J. 1999;63:629-637.
16. Hu W, Duan S, Sui Q. High yield technology for groundnut. International Arachis Newsletter. 1995;15:1–22.
17. Saha R. Effect of different synthetic mulches on growth and development of tomato. MS Thesis, Dept. Crop Bot., BAU. Mymensingh, Bangladesh; 2001.
18. Bhagat P, Gosal SK, Singh CB. Effect of mulching on soil environment, microbial flora and growth of potato under field conditions. Indian J. Agric. Res. 2016;50(6):542-548.
19. Moursy FS, Mostafa FA, Solieman NY. Polyethylene and rice straw as soil mulching: Reflection of soil mulch type on soil temperature, soil borne diseases, plant growth and yield of tomato. Glob. J. Adv. Res. 2015;2(10):1497-1519.
20. Iroc A, Sisson LC, Solidum PP. Effects of different mulching materials on garlic (*Allium sativum* L.). Buletin Penelitian Hortkultura. 1991;4:104-108.
21. Azam MG. Effect of different mulches on growth and yield of onion. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh; 2005.
22. Talukder ANMH. Effect of mulches and clove size on the growth and yield of garlic. MS Thesis, Dept. Crop Bot., BAU. Mymensingh, Bangladesh; 2002.
23. Pirboneh H, Ghasemi M, Gohari AA, Bahari B, Bazkiyaei ZB. Effect of irrigation and straw mulch on yield and yield components of eggplant (*Solanum melongena* L.). Inter. Res. J. App. Basic Sci. 2012;3(1):46-51.

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