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Response of Brinjal (*Solanum melongena* L. cv Boral.) to Different Organic and Synthetic Mulches

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ABSTRACT

A field study was conducted to evaluate the effect of different mulch materials on growth, yield and different qualitative characters of brinjal (var Boral). Different mulches used during the study were black polyethylene mulch, yellow polyethylene mulch, transparent polyethylene mulch, mango leaf, paddy straw, saw dust and sun grass along with bare soil as the control. Different mulches generated higher soil temperature and moisture regimes over the control. The maximum increase in soil temperature at noon was observed under transparent polyethylene mulch by 3.75^{o}C. Black polyethylene was found most effective in conserving higher moisture level than control, followed by yellow and transparent mulch. Weed population was significantly suppressed under black polyethylene mulch. Days to 50% flowering followed by days to first harvest were recorded at 54.27 and 86.21 days after transplanting under black polyethylene mulch as compared to rest of the treatments. Plant height, number of primary branches per plant, number of leaves/plant, fruit yield and average fruit weight recorded higher values under black polyethylene mulches. Chlorophyll content was markedly increased for the same along with straw mulches. Paddy straw mulch improved the ascorbic acid content in brinjal followed by mango leaf mulch. Increased anthocyanin pigmentation in brinjal fruits were observed in saw dust mulch followed by black polyethylene mulch.

Keywords Brinjal, Mulching, Yield, Soil temperature, Soil moisture, Weed.

INTRODUCTION

Vegetables play an important role in food and nutritional security of ever-growing population of our large vegetarian society. Brinjal (*Solanum melongena* L.) of Solanaceae family is one of the widely used vegetablecrop by most of the people and is popular in many countries viz., central, South and South East Asia, some part of Africa and central America (Grubban 1977). In India, brinjal is cultivated in almost all states under rainfed as well as irrigated conditions. Field level crop production is controlled by several factors viz. variety, spacing, fertilization, water management, plant protection, weed management. Brinjal has high water requirement. Water scarcity and weed infestation is the major problem for suc-

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cessful production of brinjal. Proper scheduling of irrigation is a must to maintain the soil moisture and aeration. Availability of water is of great significance to the plants as it needs for absorbing the nutrients. The response of brinjal in terms of growth and yield potential was reported to be significant under irrigated conditions. The favorable soil moisture by way of application of water and by way of conserving it was considered to be the most essential factor for achieving full production potential of brinjal. In view of conserving soil moisture reducing the weed growth and maintaining congenial soil physical environment mulches are more effective (Bagele *et al.* 2022).

Organic mulch (plant materials) and synthetic mulches (plastic of different colors) are widely used in vegetable production for their efficacy to conserve soil moisture by monitoring water distribution between soil evaporation and plant transpiration and modifies soil temperature. Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes weed infestation and checks water evaporation. Since mulch create well suited condition for the development of plant by managing temperature, controlling weeds, working as a shield to plant roots from excess cold and heat and decreasing soil salinity, it eventually enhances the quality and yield of the crop (Ray and Biswasi 2016). Taking the consequences, an investigation was undertaken to have knowledge on enhancing the productivity of brinjal through use of synthetic and organic mulches. The study includes investigation on differentiation of morphological and yield related characters in brinjal grown under different mulching materials, variation in the major qualitative traits under different sets of mulching, biomass of the weed in terms of dry weight gathered from the mulch plots, average temperature of the soil under different mulch materials and its linkage to water conservation in the crops under study.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Experimental Farm of Calcutta University at Baruipur, 24-Parganas (South) (88 28`E, 22 N during winter to early monsoon (November – June) of 2012-2013. The soil type of experimental site was uniform with medium fertility and clay loam texture. The soil samples from the experimental plots were collected from a depth of 25 cm before transplanting and analyzed for physical and chemical properties. The field experiment was laid out in a Randomized Block Design (RBD) having three replicates with eight treatment combinations including control (Table 1). The seeds treated with Bavistin @ 2 g/kg seeds were sown in Earthen flat pots in December 2012. The experimental land was ploughed and cross ploughed 2 to 3 times. Split application of NPK was applied @ 110:60:60 kg/ha. Full dose of phosphorus, potassium and one third of nitrogen was applied after preparation of pits. The remaining nitrogen was applied in 2 split doses successively at one month interval from transplanting. Mulched layers were placed before date of transplanting and an "x" cut was given at a spacing of 45 × 45 cm, to maintain a population of ten plants per plot. Transplanting on to the mulched plots were carried out after 45 days of sowing. Requisite cultural practices in term of timely irrigation, weeding and pesticide application were done. The data were recorded on five randomly selected plants in each plot for morphological feature, and yield attributing characters as well as some qualitative parameters. For qualitative characters, the observations were recorded from composite samples of five fruits in each plot.

Table 1. Treatment details of the experiment.

Notations	Treatment details
T_1	Black polyethylene mulch
T_2	Mango leaf mulch
T_3	Yellow polyethylene mulch
T_4	Paddy straw mulch
T_5	Transparent polyethylene mulch
T_6	Sawdust mulch
T_7	Grass mulch
T_8	Control (without any mulch)

Qualitative parameters like total chlorophyll content, ascorbic acid content and anthocyanin content was estimated following the method of Arnon (1949), Ranganna (1986). Data collected on various parameters were statistically analyzed (Panse and Sukhante 1978) to evaluate the treatment effects on morphological traits, yield and qualitative performance of brinjal. For weed count half square meter area (0.5 m × 0.5 m) was fixed randomly before emergence of weeds. Total amount of weeds growing

Table 2. Effect of different mulch materials on morphological traits of brinjal (*Solanum melongena* L.) cv Boral. Note: T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Sawdust mulch, T_7- Grass mulch, T_8- Control (without any mulch).

Treatments	Plant height (cm)	No.of primary branches/ plant	Total no. of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Days to 50% flowering	Days to first harvest
T_1	72.51	2.16	46.19	20.63	7.36	110.93	54.27	86.21
T_2	67.94	2.00	40.65	19.88	7.24	110.49	57.11	88.68
T_3	72.07	2.00	45.82	19.82	7.30	110.29	54.54	87.82
T_4	68.51	2.06	41.67	19.25	7.00	110.43	57.02	88.52
T_5	71.81	2.03	43.54	19.06	7.11	110.20	54.96	88.38
T_6	65.70	1.96	40.02	19.53	6.95	108.66	56.42	88.83
T_7	66.22	1.99	36.59	19.22	6.99	110.00	56.18	89.21
T_8	63.24	1.96	29.35	19.43	6.98	110.27	63.88	96.02
CD at 5%	1.88	NS	1.13	NS	NS	NS	3.82	2.39
SE(d)	0.87	0.07	0.52	0.45	0.26	1.09	1.76	1.10

within the area were weighed on fresh weight basis. These observations were recorded 45 days after transplanting. Soil temperature was measured by use of Fisher band bimetal dial thermometer. Thermometers were installed between rows in center of one replication of each treatment at 10 cm depth. The temperatures in °C were recorded daily for maximum at 12.30 hrs. Soil moisture estimation was carried out through gravimetric method.

RESULTS AND DISCUSSION

Organic as well as synthetic mulches significantly increased plant height, number of primary branches per plant, leaf area and fruit yield over the control (Tables 2–3). The effect of synthetic mulches was more pronounced on fruit yield than the organic mulches. Sikder *et al*. (2016) observed increase in warmth of soil as well as better outcome in morphological traits in maize (*Zea mays*) due to the usage of plastic mulch over organic mulch, because of the possible reason that plastic mulch minimize evaporation loss from soil water and also its well retention of precipitation leading to reduced water loss, soil erosion and increased WUE, i.e., water use efficiency.

Maximum plant height was obtained in the plots mulched with black polyethylene mulch. The increase in plant height as a result of use in black polyethylene mulch may be due to conservation of moisture, minimum loss of water through evaporation and availability of all essential nutrients to the

Table 3. Effect of different mulch materials on fruit characters and yield of brinjal (*Solanum melongena* L.) cv Boral. Note: T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Sawdust mulch, T_7- Grass mulch, T_8- Control (without any mulch).

Treatments	Total number of fruits/plant	Individual fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Pedicel length (cm)	Average fruit weight (kg)
T_1	27.88	63.92	6.86	14.31	5.86	1.75
T_2	25.10	61.59	6.52	14.26	5.71	1.59
T_3	27.51	62.07	6.82	14.30	5.71	1.70
T_4	26.44	61.70	6.45	14.22	5.77	1.54
T_5	26.48	61.78	6.64	14.23	5.76	1.60
T_6	24.77	59.97	6.58	14.22	5.74	1.38
T_7	26.66	60.50	6.52	14.18	5.83	1.59
T_8	21.22	58.55	6.33	14.26	5.74	1.39
CD at 5%	1.85	1.15	0.26	0.06	NS	0.21
SE(d)	0.85	0.53	0.12	0.02	0.08	0.10

Table 4. Effect of different mulch materials on qualitative parameters of brinjal (*Solanum melongena* L.) cv Boral. Note: T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Sawdust mulch, T_7- Grass mulch, T_8- Control (without any mulch).

Treatments	Ascorbic acid content (mg/g)	Anthocyanin content (mg/g)	Total chlorophyll content of leaf (mg/1 g)
T_1	8.53	0.175	0.63
T_2	8.46	0.158	0.62
T_3	8.26	0.149	0.60
T_4	8.35	0.151	0.63
T_5	8.49	0.156	0.59
T_6	8.50	0.182	0.60
T_7	8.32	0.153	0.58
T_8	8.21	0.149	0.61
CD at 5%	0.13	0.008	NS
SE(d)	0.06	0.004	0.02

Table 5. Effect of different mulch materials on weed population of brinjal (*Solanum melongena* L.) cv Boral. Note: T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Sawdust mulch, T_7- Grass mulch, T_8- Control (without any mulch).

Treatments	Weed content (g)
T_1	18.39
T_2	22.43
T_3	18.62
T_4	22.44
T_5	31.92
T_6	24.47
T_7	24.57
T_8	42.33
CD at 5%	2.10
SE(d)	0.97

plants, which otherwise would have been utilized by the weed population. All these characters contributed favorably for better plant growth and development ultimately resulting into more plant height. Similar observations have been reported by Mahadeen (2014) in okra. Earliness is a desirable character, which is measured in terms of days to fifty percent flowering. Days to first harvesting determines the maturity period of a crop which affects the harvest duration and early profit to growers. The present study depicted minimum days to 50% flowering (54.27 days) for plants grown under black polyethylene mulch. Mango leaf mulch and control delayed flowering. Early flowering may be attributed to improved crop growth as well as warming effect of soil by the use of mulch, reduced weed population and better soil moisture retention. Similar reports of early flowering in squash due to black polythene mulch has been reported by Mahadeen (2014).

Fruit weight is one of the most important attribute for fresh market brinjal. Black mulch exhibited maximum fruit weight as compared to control (Table 3). This may be due to optimal supply of nutrients due to less crop weed competition which might have enhanced photosynthetic and metabolic activity leading to profitable growth and increased fruit size. Black polyethylene mulch, mango leaf mulch and yellow polyethylene mulch showed increased fruit number which might be a result of lesser weed population, lower nutrient loss through leaching, thereby making more nutrients available for plant growth and favorable soil temperature and moisture, thus creating condition for better growth and more number of fruits per plant (Helaly *et al.* 2017). Fruit quality parameters like fruit length, fruit girth and pedicel length were greatly influenced by mulch treatments (Table 3). Fruit length and diameter (cm) was observed to be maximum under black polyethylene mulch which was superior over yellow mulch, transparent mulch and control. Among the organic mulches, it was superior under mango leaf mulch. Similar result was observed by Das *et al*. (2016).Increased fruit size under these treatments might be attributed to increased movement of carbohydrates from source to sink while higher moisture percentage in the fruits was due to favorable soil moisture regimes, its uptake mediated through soil cover.

Estimation of important qualitative components viz., total chlorophyll content of leaf (mg/g), ascorbic acid content (mg/g) and anthocyanin content (mg/g) are depicted in Table 4. Chlorophyll is one of the major chloroplast components for photosynthesis and higher pigment content is responsible for better yield and growth of plant (Hajnal-Jafari *et al.* 2020).Cholorophyll content can be amplified through several agricultural management practices (Barickman and Kopsell 2016). In brinjal, mulch-

Table 6. Effect of different mulch materials on soil bed temperature (°C) in brinjal field. Note: T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Sawdust mulch, T_7- Grass mulch, T_8- Control (without any mulch).

Treatments	February	March	April	May	June	July
T_1	28.96	34.45	36.11	35.00	35.60	34.80
T_2	27.00	32.32	34.00	33.63	33.87	33.60
T_3	29.00	34.56	36.39	35.57	35.92	35.58
T_4	27.00	32.15	34.82	33.60	34.01	35.52
T_5	32.21	36.90	39.00	39.00	38.58	37.99
T_6	27.10	32.49	35.00	33.60	34.82	34.65
T_7	27.24	32.76	35.13	33.71	34.33	33.59
T_8	28.98	34.95	36.47	36.00	35.64	35.08
CD at 5%	0.62	0.05	0.08	0.06	0.08	0.07
SE(d)	0.28	0.02	0.02	0.03	0.02	0.03

Table 7. Effect of different mulch materials on soil moisture (%) at a depth of 15 cm below the mulch layer in brinjal field. Note: T_1- Black polyethylene mulch, T_2- Mango leaf mulch, T_3- Yellow polyethylene mulch, T_4- Paddy straw mulch, T_5- Transparent polyethylene mulch, T_6- Sawdust mulch, T_7- Grass mulch, T_8- Control (without any mulch).

Treatments	February	March	April	May	June	July
T_1	18.50	16.22	15.00	15.00	15.47	16.17
T_2	16.11	15.00	13.00	13.00	13.45	14.91
T_3	18.30	16.10	14.76	14.79	15.00	16.00
T_4	16.19	15.10	13.10	13.18	13.57	15.00
T_5	18.20	15.90	14.60	14.60	15.00	19.82
T_6	16.00	14.91	12.97	12.97	13.26	14.87
T_7	15.90	14.90	12.91	12.91	13.21	14.80
T_8	15.00	13.00	11.80	11.80	12.27	12.81
CD at 5%	0.05	0.06	0.09	0.09	0.06	0.08
SE(d)	0.02	0.03	0.04	0.04	0.02	0.03

ing with black polyethylene exhibited higher total chlorophyll content followed by paddy straw mulch. Least chlorophyll content was observed in transparent polyethylene mulch. An optimum soil moisture and hydrothermal soil regime with relative water content might have contributed for improved physiological attributes of plant under mulched condition. The study showed that the use of paddy straw mulch increased the ascorbic acid content of brinjal followed by mango leaf mulch. Similarly, increased anthocyanin content was observed in saw dust mulch followed by black polyethylene mulch. Increased content of ascorbic acid and anthocyanin in the fruit might be due to incorporation of organic matter in the soil through their decomposition. Di Miceli *et al.* (2024) reported increased antioxidant activity and phenolic and ascorbic acid contentin eggplant fruits when biodegradable mulching films are used.

Weed is an important factor related to crop growth as it determines the amount of essential nutrients taken up by the weed plants thus checking crop growth, reduces moisture supply to the main crop and finally creates a space crunch for robust growing leading to crop weed competition. The dry weight of weeds (Table 5) was significantly influenced by different mulch materials. Black polyethylene mulched plants showed minimum dry weight followed by yellow mulch. Transparent polyethylene mulch showed higher average dry weight of weed. Among organic mulches, straw mulch showed least dry weight content of weed followed by mango leaf mulch. Rest of the treatments effectively reduced weed population as compared to control in a variable manner. Application of mulches suppresses weed growth. Barring transparent polythylene mulch, rest of the mulch materials were effective in checking weed growth. The cessation of weed growth might be due to the fact that mulch create a barrier against sunlight, which is needed for weed growth (Khan *et al.* 2022).

Soil temperature at 10 cm depth was markedly influenced by different mulch materials (Table 6). The maximum increase in soil temperature at noon was observed under transparent polyethylene mulch by 3.75°C. Increase in soil temperature under transparent polyethylene mulch is due to higher sunlight transmittance rate (Lu *et al.* 2020).

Application of different mulch materials significantly influenced the soil moisture content during the cropping season (Table 7). Black polyethylene was found most effective in conserving higher moisture level than control, followed by yellow and transparent mulch. Increased soil moisture in the synthetic mulch treatments might be due to increased infiltration capacity, reduced atmosphere losses from soil surface and increasing resistance to vapour transfer from soil surface to the atmosphere. Lower soil moisture retention during May-June under polyethylene may be attributed to the profuse growth of

brinjal. Among the organic mulches, paddy straw was found most effective followed by mango leaf. It is an established fact that mulching the soil surface with vapour barrier or with reflecting materials can reduce the intensity with which external factors such as radiation and wind act upon the surface. Since mulch acts as a good soil moisture holder, it ultimately leads to decreased evaporation and enhances filtration (Li *et al.* 2021).

CONCLUSION

On the basis of the results obtained it may be concluded that use of black polyethylene mulch was found superior among all mulching materials used in this study. Similarly, use of organic mulches also had significant effect on growth, yield and yield attributing characters of brinjal. The study also demonstrated that for higher fruit yield as well as higher net returns, paddy straw mulch among the organic mulches was the most suitable for commercial cultivation of brinjal under humid tropical condition of West Bengal, India. During the study, use of black polyethylene mulch reduced weed intensity, conserved soil moisture, increased the availability of the nutrients by reducing the crop weed competition and ultimately resulted in increased growth, development and yield of brinjal. The field-experiments during the study suggests that sub-soil temperature and soil water conservation of mulched beds were affected by the optical characteristics of the mulch shading of the bed by the developing crop canopy probably moderated differences between mulches and weed on the general effect of mulching. Data presented under the study can provide background information that can be used to develop and verify numerical models which would help in simulating the field temperature regime under plastic/organic mulch culture. These modes may be used to evaluate the cumulative effects of mulch properties, the plant canopy, drip irrigation and other factors on crop productivity.

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REFERENCES

Arnon DI (1949) Biochemical methods for Agricultural Sciences, Tamil Nadu Agricultural University, Coimbatore, India, pp 241—257.

Bagele RD, Khandare VS, Waskar DP (2022) Performance of different mulches on growth and yield of brinjal (*Solanum melongena* L.). *The Pharma Innovation Journal* 11 (2) : 2987—2989.

Barickman TC, Kopsell DA (2016) Nitrogen form and ratio impact swiss chard (*Beta vulgaris* subsp. cicla) shoot tissue carotenoid and chlorophyll concentrations. *Scientia Horticulturae* 204 : 99—105. https://doi.org/10.1016/j.scienta.2016.04.007

Das K, Sau S, Sarkar T, Dutta P (2016) Effect of organic mulches on yield, physico-chemical qualities and leaf mineral composition of litchi cv Bombai in Indo-Gangetic plain of West Bengal. *Journal of Crop and Weed* 12 (3) : 67—69.

Di Miceli G, Iacuzzi N, Leto C, Cozzolino E, Di Mola I, Ottaiano L, Bella SL (2024) Assessment of yield and quality of eggplant (*Solanum melongena* L.) fruits improved by biodegradable mulching film in two different regions of Southern Italy. *Agronomy* 14 (4) : 867. DOI: https://doi.org/10.3390/agronomy14040867

Grubban GH (1977) Tropical vegetables and their genetic resources. International Board for plant constraints. Genetic Resources FAO, Rome, pp 18—20.

Hajnal-Jafari T, Seman V, Stamenov D, Đurić S (2020) Effect of *Chlorella vulgaris* on growth and photosynthetic pigment content in swiss chard (*Beta vulgaris* L. subsp. cicla). *Polish Journal of Microbiology* 69(2) : 235—238. DOI: https://doi.org/10.33073/pjm-2020-023

Helaly AA, Goda Y, El-Rehim AAS, Mohamed AA, El-Zeiny OAH (2017) Effect of polyethylene mulching type on the growth, yield and fruits quality of Physalispubescens. *Advances in Plants & Agriculture Research* 6 (5) : 1—7.

Khan BA, Nijabat A, Khan MI, Khan I, Hashim S, Nadeem MA, Ikram M (2022) Implications of mulching on weed management in crops and vegetable. Mulching in Agro ecosystems: Plants, Soil and Environment, pp 199—213. DOI: https://doi.org/10.1007/978-981-19-6410-7_13

Li R, Li Q, Pan L (2021) Review of organic mulching effects on soil and water loss. *Archives of Agronomy and Soil Science* 67 (1) : 136—151. DOI: https://doi.org/10.1080/03650340.2020.1718111

Lu H, Xia Z, Fu Y, Wang Q, Xue J, Chu J (2020) Response of soil temperature, moisture, and spring maize (*Zea mays* L.) root/shoot growth to different mulching materials in semi-arid areas of Northwest China. *Agronomy* 10 (4) : 453. DOI: https://doi.org/10.3390/agronomy10040453

Mahadeen AY (2014) Effect of polyethylene black plastic mulch on growth and yield of two summer vegetable crops under rain-fed conditions under semi-arid region conditions. *American Journal of Agricultural and Biological Sciences* 9 (2) : 202—207. DOI:10.3844/ajabssp.2014.202.207

Panse VG, Sukhatme PV (1978) Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research New-Delhi, pp 48—67.

Ranganna S (1986) Handbook of Analysis and Quality control

for fruit and vegetable products. Tata McGraw-Hill Education.

Ray M, Biswasi S (2016) Impact of mulching on crop production: A review. *Trends Bioscience* 9 : 757—767.

Sikder MU, Haque MA, Jodder R, Kumar T, Mondal D (2016) Polythene mulch and irrigation for mitigation of salinity effects on maize (*Zea mays* L.). *The Agriculturists* 14 (2) : 1—13. DOI:10..3329/agric.v14i2.31336