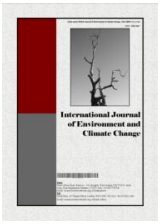

*International Journal of Environment and Climate Change*

***10(12): 264-270, 2020; Article no.IJECC.64083***
***ISSN: 2581-8627***
*(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)*

# Yield and Economics of Brinjal (*Solanum melongena*) as Affected by Different Mulching Types and Its Effect on Soil Moisture Content and Weed Dynamics in Post Flood Situation of Coastal Odisha, India

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Authors PM and TRS designed the study. Authors LMG, AP and NM performed the statistical analysis. Author FHR wrote the protocol. Author TRS wrote the first draft of the manuscript. Authors SNM and RB managed the literature searches. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/IJECC/2020/v10i1230303
Editor(s):
(1) Dr. Anthony R. Lupo, University of Missouri, USA.
Reviewers:
(1) Cleide Aparecida Bomfeti, Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), Brazil.
(2) Marcelle Nardelli Baptista, Rural Federal University, Brazil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/64083

***Original Research Article***

***Received 15 October 2020***
***Accepted 20 December 2020***
***Published 31 December 2020***

## ABSTRACT

A field experiment was conducted at the farmer's field at Ratanpur village of Marshaghai block of Kendrapara, Odisha, India to evaluate effect of different mulching practices on weed population, moisture content in soil and yield of brinjal. The village is an adopted village by Krishi Vigyan Kendra Kendrapara, in which various activities in agriculture are going on under National Innovations on Climate Resilient Agriculture (NICRA) programme to combat the flood-affected area

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of the locality. The experiment consists of five mulching treatments like Black polythene mulch, Black and silver polythene mulch, Transparent mulch, Organic mulch (rice straw) and No mulch. Results revealed that black with silver colour polythene mulch was recorded with significantly higher yield per plant (2.59 kg) and yield per ha (62.1 t/ha) which was at par with black colour polythene mulch. Organic mulch was found to be next best treatment with respect to yield per plant (2.40 kg) and yield per ha (53.5 t/ha). The same treatment also resulted in the higher gross return (Rs. 434700/ha), net return (Rs. 274150/ha) and B:C ratio (2.71) which was followed by black polythene mulching and organic mulching practices. Weed suppression and moisture retention was higher with black polythene mulch.

*Keywords: Poly mulch; organic mulch; brinjal; yield; weed population; Coastal Odisha.*

## 1. INTRODUCTION

Brinjal is an important *solanaceous* vegetable grown in tropical and subtropical regions of the world, but it is grown during warm season in temperate regions of the world. Crop yield will be reduced day by day due to biotic and abiotic factors. The factors that reduce yield to larger extent are: high temperature, excessive soil humidity, excessive salinity, water stress and weed competition. All these factors can be managed by the use of mulch [1]. A mulch is natural or artificially spread layer of plant residues or other material on the surface of the soil. The important objectives of mulching in agriculture are namely moisture conservation, temperature control, prevention of surface compaction, reduction of runoff and erosion, improvement in soil structure and weed control. Use of organic mulches prevents the soil erosion and moderate's soil temperature, provides nutrients to the plants as it slowly composts, giving plants a season-long feeding and the landscape as it directly defeats the pathogens and pests, enhances beneficial organisms, neutralizes pollutants. In India, the agriculture sector is the prime (81%) consumer of water in which it is used mostly for irrigation purpose. During last few years, groundwater levels have been dropped by 0.5 to 1 m below the ground surface in the many parts of the country. The large variation in the temporal-spatial variation in rainfall is observed several regions of the country are experiencing the drought. Improving the water use efficiency without increasing cost of production is an ongoing goal in crop production system. Mulching an important soil management practice is reported to reduce water use, suppress weed growth [2] and enhance the soil temperature and soil moisture [3]. Various workers have reported the beneficial effect of both organic mulches viz., straw and inorganic mulches viz., polyethylene mulches on growth and yield parameters in brinjal and alteration in the hydrothermal regime of the crops and suppression of weed growth. Mulches can be derived from either organic or inorganic materials. The colour of mulch determines its energy-radiating behaviour and its influence on the microclimate around the vegetable plant. Colour determines the surface temperature of the mulch and the underlying soil temperatures. The use of plastic mulches for vegetable production was to define the impact of differently coloured mulches on soil temperature, moisture retention and vegetable yields. In this context, present investigation was carried out to know the effect of different mulching practices on weed dynamics, moisture content, yield and economics of brinjal.

## 2. MATERIALS AND METHODS

The field experiment was conducted in the farmers' field at Ratanpur, Marshaghai in Kendrapara district of Odisha, India. This village is an adopted village by Krishi Vigyan Kendra Kendrapara in which various climate-resilient activities on agriculture and allied sector are going on under the National Innovations on Climate Resilient Agriculture (NICRA) programme. The experiment was laid out in a randomized block design with five numbers of treatments and five replications. There were five mulching types *i.e.,* $T_1$- Black polythene mulch (50 micron), $T_2$- Black polythene with silver colour surface (60 micron) , $T_3$- Transparent polythene (50 micron), $T_4$- Organic mulch ( Rice straw) @ 6 t/ha and $T_5$- Without mulch which is the common Farmer's practice in the area. The crop grown was brinjal var. *Swarna Shyamali*. Analysis of the physic-chemical properties of the soil was worked out by collection of the soil samples at 0-15 cm depth taking into consideration of the variation of the soil characteristics. The soil was silt-loam in texture with a pH content of 6.48 (slightly acidic). The available nitrogen was 168.5 kg/ha, phosphorus 13.8 kg/ha, potassium 268.7 kg/ha. The seeds

were sown in nursery beds in the month of October 2018 and seedling transplanted on 3rd week of November 2018 at 4-5 leaf stage. Seedlings were transplanted at a spacing of 60 cm x 50 cm. Fertilizer management was done as per recommendations. Mulching (Organic mulch and polyethylene mulches) was done prior to transplanting. Minimum space of at least 4 inches was maintained between 2 successive strips to allow for transplanting. Soil moisture content (%) was determined from 0-15 cm soil depth by gravimetric method by drying soil samples in aluminum boxes in oven at $105^0$C for 48 hrs and data were recorded after 7 days of irrigation. For weed quadrant of 0.25 meter square (0.25 m x 0.25 m) was fixed randomly before the emergence of weeds. Total numbers of weeds growing within the area were counted. The observations were recorded 15 and 30 days after transplanting. The important weed species found in the experimental plot were *Cynodon dactylon, Eleusine indica, Cyperus rotundus, Phyllanthus niruri, Trianthema portulacastrum, Parthenium hysterophorus, Amaranthus viridi, Euphorbia hirta and Convulvulus arvensis.* The different growth parameters and yield attributing characters were recorded periodically. The total yield of marketable fruits harvested per plant and per hectare was recorded and expressed in kg/plant and t/ha. The cost of cultivation were recorded and expressed as B:C ratio for individual treatments. The yield and yield parameters of brinjal were recorded and subjected to statistical analysis [4]. Total MBC was estimated by the procedure described by Vance et al [5]. The initial soil nutrient status and final soil organic carbon was estimated by using a standard protocol as described by Jackson [6]. Randomized Complete Block Design (RCBD) was applied to the data and analysis was made with ANOVA to arrive at the results.

## 3. RESULTS AND DISCUSSION

### 3.1 Weed Count in Brinjal

Observations on weed density and weed dry matter were recorded at 15 and 30 days after planting (DAP) and presented in Table 1. At 15 DAP, significantly lower weed density and dry weight were recorded with black with silver colour polythene mulch (0.9 nos./ $m^2$ and 0.5 g/ $m^2$) which was at par with black polythene mulch. Significantly higher weed density and dry matter was recorded with no mulch (15.8 nos./$m^2$ and 13.3 g/$m^2$) followed by transparent polythene (10.3 nos./$m^2$ and 9.8 g/$m^2$). Similar trend was followed in case of weed density and dry matter at 40 DAP. All the mulches were effective in checking the weed growth except transparent polythene mulch. More number of weeds under transparent polythene mulch might be due to the fact that transparent mulch absorbs only 5% of short wave radiation, reflects 11% and transmits 84% radiation [7]. The cessation of weed growth under mulches might be due to the dark barrier and subsequent photosynthesis inhibition. Low number of weeds under black polythene mulch may be due to high temperature and reduced light availability as compared to other mulches [8], reduced germination of light responsive seeds and physically blocking the emergence of most weeds [9]. Black colour of the polyethylene absorbed all the incident radiations itself. Therefore, less light penetration occurred through the black polyethylene mulch which ultimately checks the weed seed germination and growth [10].

### 3.2 Moisture Content in Soil

Moisture content on 0-15 cm soil profile was estimated after 7 days of each irrigation and presented in Table 2. Significantly higher moisture content was found with black with silver colour polythene mulch (13.3%) at 7 days after planting that *i.e* after first irrigation which was at par with black polythene mulch (12.9%).The result was followed by transparent polythene mulch (10.7%) and significantly lower moisture content was found under no mulching condition. Similar trend was followed after other irrigations also. This might be due to conservation of moisture by the mulching material by avoiding evaporation losses. The higher moisture content noted both under BPM and TPM may be due to formation of impermeable vapour barrier at soil surface as compared to SM which being porous allowed diffusion of water under vapour pressure gradient. These results are in accordance with findings of [11] in pineapple and [12] in water melon.

### 3.3 Growth Parameters of Brinjal

Observations on different growth parameters were recorded at 30 DAP and presented in Table 3. Significantly higher plant height was observed in black with silver polythene mulch (48.46 cm) which was at par with only black polythene (47.18 cm). The result was followed by organic mulch which recorded 45.29 cm of plant height. The minimum plant height was observed in no mulch condition. Similar trend was also observed

in case of no of primary and secondary branches per plant. Significantly higher no of both primary and secondary branches were recorded in Black with silver colour mulch which was at par with only black colour polythene mulch. There was no significant difference observed with respect to no of leaves per plant. This might be due to plastic mulch induces the early crop emergence, so it increases the biomass production in the early stages of the crop growth [13]. The effect of colored polyethylene which was more effective than the transparent one because ofhigher level of moisture conservation resulting the longest plant. Similar results also reported by Hooda et al. [14] and Rahman et al. [15]. Black colour polythene has more capacity to regulate soil temperature than other mulch material. It might have provided suitable condition of plant in respect to height, number of branches and spread of plant by improving microclimate condition of soil and availability of nutrient to the plant [16]. The vegetative characters like plant height, number of leaves, stem diameter, number of flower, etc. and fruit yield are significantly affected by using both transparent and black plastic mulches [17].

**Table 1. Weed observations in brinjal as influenced by different mulching types**

| Mulching types | Weed (no./$m^2$) | | Weed dry weight (g/$m^2$) | |
|---|---|---|---|---|
| | 15 DAP | 30 DAP | 15 DAP | 30 DAP |
| Black polythene | 1.1 | 3.4 | 0.6 | 2.9 |
| Black with silver colour polythene | 0.9 | 2.8 | 0.5 | 2.4 |
| Transparent polythene | 10.3 | 21.3 | 9.8 | 19.2 |
| Organic mulch (rice straw) | 4.5 | 9.5 | 3.7 | 9.2 |
| No mulch (FP) | 15.8 | 27.8 | 13.3 | 25.9 |
| SEm± | 0.13 | 0.45 | 0.15 | 0.42 |
| C.D. (0.05) | 0.41 | 1.36 | 0.45 | 1.25 |

**Table 2. Moisture content in soil (0-15 cm) as influenced by different mulching types**

| Mulching types | Moisture Content % | | | |
|---|---|---|---|---|
| | 7 Days after Planting ($1^{st}$ Irrigation) | 7 Days after ($2^{nd}$ Irrigation) | 7 Days after ($3^{rd}$ Irrigation) | 7 Days after ($4^{th}$ Irrigation) |
| Black polythene | 12.9 | 11.4 | 13.2 | 12.7 |
| Black with silver colour polythene | 13.3 | 12.8 | 13.9 | 13.1 |
| Transparent polythene | 10.7 | 11.1 | 9.9 | 10.2 |
| Organic mulch (rice straw) | 9.1 | 9.7 | 8.7 | 7.9 |
| No mulch (FP) | 4.9 | 5.8 | 5.5 | 5.2 |
| SEm± | 0.75 | 0.81 | 0.88 | 0.76 |
| CD (0.05) | 2.26 | 2.45 | 2.61 | 2.31 |

**Table 3. Growth parameters of brinjal as influenced by different mulching types**

| Mulching types | Plant Heights (cm) | No. of leaves/Plant | No. of Primary branches/Plant | No. of Secondary branches/Plant |
|---|---|---|---|---|
| Black polythene | 47.18 | 22.5 | 6.2 | 10.3 |
| Black with silver colour polythene | 48.46 | 23.4 | 6.8 | 10.9 |
| Transparent polythene | 44.70 | 22.6 | 4.5 | 9.2 |
| Organic mulch (Rice straw) | 45.29 | 23.2 | 5.2 | 9.7 |
| No mulch (FP) | 42.44 | 22.1 | 3.9 | 8.4 |
| SEm± | 0.93 | 0.83 | 0.54 | 0.64 |
| CD (0.05) | 2.68 | NS | 1.60 | 1.91 |

### 3.4 Yield and Yield Parameters of Brinjal

Observations on yield and yield attributing characters are presented in Table 4. Significantly minimum days (43.4) was required for first harvest of the brinjal in black with silver colour polythene mulch which was found at par with black polythene mulch. This might be due to early vigour and flowering of plant in these treatments favored by congenial growth conditions. Significantly higher no of fruits/plant (19.6) and average weight of fruit (157.9 g) were recorded in black with silver colour polythene mulch which was found at par with black polythene mulch. The next best treatment was found to be organic mulch where, no of fruits/plant (17.3) and average weight of fruit (155.5 g) were recorded. Same trend was also followed in yield per plant and yield per ha. Black with silver colour polythene mulch was recorded with significantly higher yield per plant (2.59 kg) and yield per ha (62.1 t) which was at par with black colour polythene mulch. Organic mulch was found to be next best treatment with respect to yield per plant (2.40 kg) and yield (53.5 t/ha). Mulched treatment showed significant increase in fruit yield as compared to non-mulched treatment. High yield under black polythene mulch as compared to other mulches may be due to favourable hydro-thermal regime and weed free environment thereby significantly influencing the fruit set and yield. The low yield under transparent polythene mulch may be due to more number of weeds as compared to black polythene. Organic mulch resulted better than non-mulched plots in fruit yield, the reason being, besides weed control, straw also acted as manure resulting in increased soil fertility. The result was found conformity with Rao et al. [13] and Nair [18]. Regarding yield and yield contributing characteristics black polyethylene mulch found to be best which increase the yield potential in brinjal 510.55 q/ha as compared to untreated plots (341.06 q/ha) [19]. In grafted brinjal mulching with plastic mulch of thickness 25μ gives higher yield [20]. Similar results were also reported by Dhaliwal et al. [21] in case of tomato where total higher yield under black polythene mulch was the result of increased temperature, net radiation, better development of roots, vegetative growth and better nutrient uptake.

### 3.5 Soil Organic Carbon and Total Microbial Biomass Carbon

The initial and final soil microbial biomass carbon (MBC) were estimated and presented in Table 5. From the table it is evident that there was no much change in the soil organic carbon with respect to mulching. However under organic mulch there is slight increase in organic carbon. This might be due to incorporation of the mulching material (Rice straw) added organic matter to the soil. With respect to total MBC, there was increase in MBC value irrespective of mulching treatments. The inorganic mulching has shown a positive impact on the microbial content in the soil by lessening physiological stress, especially due to moisture availability, which helps microbial flora to flourish and decompose organic matter efficiently [22]. However, higher increase value of MBC was realized under organic mulch as addition of organic matter boosts the activity of soil microbes. Similar results were also reported by Watts et al [23] and Krishna Kumar et al. [24] where addition of organic matter increases the microbial population.

### 3.6 Economics

The economics of brinjal cultivation as influenced by different types of mulching have been presented in Table 6. Polythene mulching

**Table 4. Yield of brinjal as influenced by different mulching types**

| Mulching types | Days to 1st Harvesting | Number of fruits per plant | Average weight of fruit (g) | Yield per plant (kg) | Yield (t/ha) |
|---|---|---|---|---|---|
| Black polythene | 43.6 | 18.7 | 156.4 | 2.46 | 58.4 |
| Black with silver colour polythene | 43.4 | 19.6 | 157.9 | 2.59 | 62.1 |
| Transparent polythene | 44.4 | 16.9 | 153.4 | 2.31 | 49.7 |
| Organic mulch (Rice straw) | 44.8 | 17.3 | 155.5 | 2.40 | 53.5 |
| No mulch (FP) | 45.3 | 13.8 | 138.1 | 1.98 | 40.2 |
| SEm± | 0.39 | 0.42 | 0.51 | 0.17 | 1.87 |
| CD (0.05) | 1.19 | 1.25 | 1.53 | 0.52 | 5.23 |

**Table 5. Organic carbon and total MBC as influenced by different mulching types**

| Mulching types | Soil Organic Carbon | | | Total MBC (μ C/g of soil) | | |
|---|---|---|---|---|---|---|
| | Initial | Final | Change | Initial | Final | Change |
| Black polythene | 0.58 | 0.58 | 0.00 | 136.7 | 150.0 | +10.3 |
| Black with silver colour polythene | 0.58 | 0.58 | 0.00 | 136.7 | 147.2 | +10.5 |
| Transparent polythene | 0.58 | 0.58 | 0.00 | 136.7 | 145.4 | +8.7 |
| Organic mulch(Rice straw) | 0.58 | 0.60 | +0.02 | 136.7 | 151.0 | +14.3 |
| No mulch(FP) | 0.58 | 0.57 | -0.01 | 136.7 | 142.3 | +5.6 |

**Table 6. Economics of brinjal as influenced by different mulching types**

| Mulching types | Cost of Cultivation (Rs) | Gross return (Rs) | Net Return (Rs) | B:C ratio |
|---|---|---|---|---|
| Black polythene | 158750 | 408800 | 250050 | 2.58 |
| Black with silver colour polythene | 160550 | 434700 | 274150 | 2.71 |
| Transparent polythene | 148650 | 347900 | 199250 | 2.34 |
| Organic mulch (Rice straw) | 143000 | 374500 | 231500 | 2.62 |
| No mulch (FP) | 140500 | 281400 | 140900 | 2.00 |

resulted in higher cost than the organic mulch due to higher cost of polythene material. Mulching with black and silver colour polythene resulted in the higher gross return (Rs. 434700/ha), net return (Rs. 274150/ha) and Benefit- Cost (B:C) ratio (2.71) which was followed by black polythene mulching and organic mulching practices. This might be due to higher yield in these treatments attributing to higher returns. Similar results were reported by Rao et al. [13] and Nair [18].

## 4. CONCLUSION

Black with silver colour polythene mulch was recorded with significantly higher yield per plant (2.59 kg) and yield (62.1 t/ha) which was at par with black colour polythene mulch. Organic mulch was found to be next best treatment with respect to yield per plant (2.40 kg) and yield (53.5 t/ha). The same treatment also resulted in the higher gross return (Rs. 434700/ha), net return (Rs. 274150/ha) and B:C ratio (2.71) which was followed by black polythene mulching and organic mulching practices. Weed suppression and moisture retention was higher with black polythene mulch. However, organic mulch resulted in higher organic carbon and total biomass carbon.

## ACKNOWLEDGEMENT

The authors acknowledge ICAR-CRIDA, Hyderabad for providing financial assistance under NICRA-TDC project to Krishi Vigyan Kendra Kendrapara through ICAR-ATARI Kolkata.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*http://www.sdiarticle4.com/review-history/64083*