EFFECT OF DIFFERENT MULCHING ON MOISTURE CONTENT IN SOIL, WEED DYNAMICS AND YIELD OF TOMATO (*Lycopersicon esculentum* L.*)* IN POST FLOOD SITUATION IN COASTAL ODISHA

ABSTRACT

A field experiment was conducted at the farmer's field at Ratanpur village of Marshaghai block of Kendrapara district of Odisha to assess the effect of different mulching practices on weed population, moisture content in soil, growth and yield of tomato. The experimental field in an adopted village of Krishi Vigyan Kendra Kendrapara where National Innovations on Climate Resilient Agriculture (NICRA) Project activities have been going on to combat the various vulnerable situations like flood, cyclone etc during last nine years. The experiment consists of five mulching treatments like black polythene mulch, black and silver polythene mulch, transparent mulch, organic mulch and without mulch as control. The experiment was laid out in a randomized block design with five replications. Results revealed that, higher moisture content in soil (14.2 %) at 7 days after planting when black with silver colour polythene mulch was used for tomato cultivation. Black with silver colour polythene mulch showed low weed density and dry weight (0.7/ m^2 and 0.4 g/ m^2) at 20 and 40 days after planting as compared to other treatments. The same treatment gave significantly higher yield per plant (2.27 kg) and yield per ha (56.5 t/ha). Organic mulch was also found a better treatment with respect to yield per plant (1.84 kg) and yield per ha (48.4 t/ha). Higher return obtained by the farmers when black with silver colour polythene mulch was used for tomato cultivation. Black polythene mulching and organic mulching practices was also found good in soil moisture content, wood population in field and yield of tomato.

Keywords: Mulching, moisture content, weed dynamics, yield, Tomato, coastal Odisha

INTRODUCTION

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. 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 the 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,

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neutralizes pollutants. Tomato (*Solanum lycopersicum* L.) one of the important members of the *Solanaceaae* family is widely grown crop throughout the world. Mulching an important soil management practice is reported to reduce water use, suppress weed growth (Ramakrishna *et al*., 2006) and enhance the soil temperature and soil moisture (Das *et al*., 2015). 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 tomato 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. On the use of plastic mulches for vegetable production was to define the impact different colour mulches had on soil temperature, moisture retention, and vegetable yields. In this context, present investigation was carried out to assess the effect of different mulching practices on weed dynamics, moisture content and yield of tomato.

MATERIALS AND METHODS

The field experiment was conducted in the farmers' field at Ratanpur village, Marshaghaiin block in Kendrapara district of Odisha. The experimental field in an adopted village of Krishi Vigyan Kendra Kendrapara where National Innovations on Climate Resilient Agriculture (NICRA) Project activities have been going on to combat the various vulnerable situations like flood, cyclone etc during last nine years. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five number of treatments (put the treatment here in the bracket) 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 traditional Farmer's practice in the village. The crop grown was tomato, variety Arka Raksyak. Analysis of the physicochemical 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 of the experimental site was silt loam in texture with a pH of 6.56 (slightly acidic). The available nitrogen was 173.5 kg/ha, phosphorus 14.6 kg/ha, potassium at 283.6 kg/ha. The seeds were sown in nursery beds in the month of October

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2018 and seedling transplanted on 3rd week of November 2018 at 4-5 leaf stage. Seedlings were transplanted at a spacing of 90 x 30 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 two 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 aluminium boxes in oven at 105^0C for 48 hrs and data were recorded after 7 days of irrigation. For weed quadrant of 0.25 meter square (0.25m 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 20 and 40 days after transplanting. The different growth parameters and yield attributing characters were recorded periodically. The total yield of marketable fruits harvested from per plant and per hectare was recorded and expressed in kg/plant and t/ha. The cost of cultivation were recorded and expressed as BC ratio for individual treatments. The yield and yield parameters of tomato were recorded and subjected to statistical analysis (Gomez and Gomez, 1984). Total MBC was estimated by the procedure described by Vance *et al.* (1987). The initial soil nutrient status and final soil organic carbon was estimated by using a standard protocol as described by Jackson in 1967.

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RESULTS AND DISCUSSION

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Weed population in tomato field

Observations on weed density and weed dry matter were recorded at 20 and 40 days after planting (DAP) and presented in Table 1. At 20 DAP; significantly lower weed density and dry weight were recorded with black with silver colour polythene mulch (0.7/ sq. m and 0.4 g/ sq. m) which was at par with black polythene mulch. Significantly higher weed density and dry matter was recorded with no mulch (13.7/sq. m and 11.6 g/sq. m) followed by transparent polythene (9.2/sq. m and 7.3g/ sq. m).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 (Aman and Rab, 2013). 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

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availability as compared to other mulches (Bakht *et al*., 2014)~~.~~, reduced germination of light responsive seeds and physically blocking the emergence of most weeds (Edgar, 2017)~~.~~. Black colour of the polyethylene absorbed all the incident radiations itself. Therefore, least light penetration occurred through the black polyethylene mulch which ultimately ~~check~~checks the weed seed germination and growth (Ngouajio *et al*., 2004).

Table 1. Weed population in tomato as influenced by different mulching

Mulching	Weed number (no./sq.m)		Weed dry weight (g /sq.m)	
	20 DAP	40 DAP	20 DAP	40 DAP
Black polythene	0.7	2.3	0.4	2.6
Black with silver colour polythene	0.6	1.8	0.4	2.2
Transparent polythene	9.2	17.3	7.3	18.5
Organic mulch (Rice straw)	2.3	7.8	1.8	8.9
No mulch (FP)	13.7	22.4	11.6	24.7
S~~.~~E ~~m~~±	0.15	0.48	0.17	0.43
CD (0.05)	0.47	1.56	0.54	1.23

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Moisture Content in Soil

It is evident from Table 2 ~~Data~~ soil ~~of~~ moisture content showed ~~on 0 – 15 cm soil profile estimated after 7 days of each irrigation were presented in Table 2. S~~significantly higher ~~moisture content was found~~ on ~~with~~ black with silver colour polythene mulch (14.2%) at 7 days after planting that i.e after first irrigation which was at par with black polythene mulch (13.8%). The result was followed by transparent polythene mulch (11.2%) 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 Alwis and Herath (2012) in pineapple and Sun *et al*.~~,~~ (2014) in water melon.

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

Mulching	Moisture Content (%) at 7 days interval			
	~~7 Days after Planting (~~1st Irrigation~~)~~	~~7 Days after~~ 2nd Irrigation	~~7 Days after~~ 3rd Irrigation	~~7 Days after~~ 4th Irrigation
Black polythene	13.8	12.8	14.3	13.7
Black with silver colour polythene	14.2	13.6	14.8	13.9
Transparent polythene	11.2	12.1	10.7	11.4
Organic mulch (Rice straw)	9.4	10.4	9.5	8.6
No mulch (FP)	5.6	6.7	6.1	5.9
SE ~~m~~±	0.81	0.84	0.87	0.78
CD (0.05)	2.34	2.41	2.46	2.25

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Growth parameters of tomato

Observations on different growth parameters were recorded at 45 DAP and presented in Table 3. Significantly higher plant height was observed in black with silver polythene mulch (76.23 cm) which was at par with only black polythene (75.47 cm). The result was followed by organic mulch which recorded 73.22 cm of plant height. The minimum plant height was observed in no mulch condition. Similar trend was also observed in case of no of branches per plant. Significantly higher no of 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 (Rao *et al.*, 2016). The effect of colored polyethylene which was more effective than the transparent one because of higher level of moisture conservation resulting the longest plant.Similar results also reported by Hooda *et al.(*1999) and Rahman *et al. (*2016).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 (Rajablariani *et al.*, 2012). The significantly minimum days (33.4) required to first flowering in black with silver colour polythene mulch and the maximum days (35.3) required to first flowering in no mulch condition.

This might be due to mulch material helps to early flowering of plant due to increase in soil temperature. Similar results were also reported by Rahman *et al., (*2016).

Table 3. Growth parameters of tomato as influenced by different mulching

Mulching	Plant height (cm)	No of leaves /Plant	No of branches / Plant	Days to 1st flowering
Black polythene	75.47	68.5	13.3	33.6
Black with silver colour polythene	76.23	68.2	13.8	33.4
Transparent polythene	72.31	66.4	12.1	34.4
Organic mulch (Rice straw)	73.22	67.4	12.5	34.8
No mulch (FP)	65.34	66.3	11.2	35.3
SE~~m~~ ±	0.93	0.83	0.64	0.33
CD (0.05)	2.68	NS	1.92	1.08

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There was a significant result observed in number of flowers clusters and no of flowers per plant (Table 4). Significantly higher number of flowers clusters and no of flowers per plant was recorded in black with silver colour polythene mulch (8.57 and 54.7) which was at par with only black colour polythene much (8.31 and 53.3). The result was followed by organic mulching (7.87 and 48.7). This might be due to the fact that black polyethylene mulch improves the soil physical, biological and chemical condition for better crop performance. It also plays an important role in nutrient uptake as they provide favorable environment for better root growth by increasing the soil temperature and conserving suitable soil moisture regime. Similar results also reported by Jadav *et al.*(2018) in case of rose.

Table 4: No of flower and flower clusters of tomato as influenced by different mulching

Mulching	No. flowers / Cluster	No. flower clusters / plant	No of Flowers/ Plant
Black polythene	5.54	8.31	53.3
Black with silver colour polythene	5.65	8.57	54.7
Transparent polythene	5.32	7.32	44.6
Organic mulch (Rice straw)	5.48	7.87	48.7
No mulch (FP)	5.01	6.48	39.4
SEm±	0.41	0.35	1.51
CD (0.05)	NS	1.21	4.57

Yield and yield attributes of tomato

~~Observations on y~~Yield and yield attributing characters are presented in Table 5. Significantly higher no of fruits/cluster (4.68), no of fruits/plant (32.8) and average weight of fruit (77.9 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/cluster (4.54), no of fruits/plant (26.8) and average weight of fruit (75.5 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 (2.27 kg) and yield per ha (56.5 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 (1.84 kg) and yield per ha (48.4 t). Mulched treatment showed significant increase in fruit yield as compared to no mulched treatment. High yield under black polythene mulch as compared to other mulches may be due to favourable hydrothermal 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 un mulched plots in fruit yield, the reason being, besides weed control, straw also acted as manure resulting in increased soil fertility. Similar results were also reported by Dhaliwal *et al.~~,~~ (*2017) where total higher yield of tomato under black polythene mulch was the result of increased temperature, net radiation, ~~better~~and better development of roots, vegetative growth and better nutrient uptake. The ~~results was~~results were found conformity with Rao *et al.~~,~~* (2016) and Nair (2018).

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Table 5: Yield and yield attributes of tomato as influenced by different mulching

Mulching	No. of fruits/ cluster	No. of fruits/ plant	Avg. weight of fruit (g)	Yield ~~per plant~~(kg/plant)	Yield ~~per ha~~(t/ha)
Black polythene	4.32	30.8	76.4	2.06	53.2
Black with silver colour polythene	4.68	32.5	77.9	2.27	56.5
Transparent polythene	4.15	24.2	73.4	1.73	42.3
Organic mulch (Rice straw)	4.54	26.8	75.5	1.84	48.4
No mulch (FP)	3.98	18.6	70.1	1.45	36.7
SEm±	0.14	1.39	0.59	0.13	1.37
CD (0.05)	0.45	4.21	1.83	0.41	4.12

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Soil organic Carbon and Total Microbial Biomass Carbon

The initial and final soil microbial biomass carbon (MBC) were estimated and presented in Table 6. 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 (Feng *et al.*, 2004). 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.* (2010) and Krishna Kumar *et al.* (2005) where addition of organic matter increases the microbial population.

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Table 6. Organic Carbon and Total MBC as influenced by different mulching

Mulching	Soil Organic Carbon			Total MBC (U C/g of soil)		
	Initial	Final	Change	Initial	Final	Change
Black polythene	0.61	0.61	0.00	134.8	143.2	+8.4
Black with silver colour polythene	0.61	0.61	0.00	134.8	142.3	+7.5
Transparent polythene	0.61	0.60	-0.01	134.8	140.2	+5.4
Organic mulch (Rice straw)	0.61	0.62	+0.01	134.8	146.8	+12.0
No mulch (FP)	0.61	0.60	-0.01	134.8	136.5	+1.7

Economics

The economics of tomato cultivation as influenced by different types of mulching have been presented in Table 7. Polythene mulching 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 339000/ha), net return (Rs 206250/ha) and B:C ratio (2.55) 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 also reported by Rao *et al.* (2016) and Nair (2018).

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Table 7. Economics of tomato as influenced by different mulching types

Mulching	Cost of Cultivation (Rs)	Gross return (Rs)	Net Return (Rs)	B:C ratio
Black polythene	132450	319200	186750	2.41
Black with silver colour polythene	132750	339000	206250	2.55
Transparent polythene	130700	253800	123100	1.94
Organic mulch (Rice straw)	127500	290400	162900	2.28
No mulch (FP)	124500	220200	95700	1.77

CONCLUSION

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Black with silver colour polythene mulch use in tomato cultivation was recorded with significantly higher yield per plant (2.27 kg) and yield per ha (56.5 t/ha) which was at par with black colour polythene mulch ~~use~~. Organic mulch use was found to be next best treatment with respect to yield/ plant (1.84 kg) and yield per ha (48.4 t/ha). The same treatment also resulted in the higher gross return (Rs 339000/ ha), net return (Rs 206250/ha) and B:C ratio (2.55) in tomato cultivation which was followed by black polythene mulching and organic mulching practices. Weed suppression and moisture retention was also found good with black polythene mulch. However, organic mulch resulted in higher organic ~~carbon~~ and total biomass carbon.

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