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Research Article

EFFECT OF DIFFERENT MULCHES ON THE GROWTH, YIELD AND ECONOMICS OF TOMATO (*Lycopersicon esculentum*)

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Abstract- The use of polyethylene mulch in vegetable cultivation has increased the last 10 years. In India due to the benefits of maintain favorable soil temperature, reduced weed growth, moisture conservation and higher crop yields. A field experiment was conducted on tomato (*Lycopersicon esculentum* L.) at Central Institute of Agricultural Engineering, Bhopal during (December-April) in 2013-14 and 2014-15, in a randomized complete block design with four replications. Treatments consisted of inorganic mulchs (red, black and silver), organic mulch and control. Results of the study indicated highest values of plant height, number of flowers per cluster, SPAD values, fruit weight, yield and soil temperature were observes red mulch followed by black and silver plastic mulch as organic mulch and control. All coloured mulching had significantly higher marketable yield of tomato compared to organic mulch and control. Marketable yield increased by 64.54% in red coloured mulched tomato followed by 57.45 % in blak, 45.40% in silver, 21.98% in organic mulched crop over control. The highest soil microbial biomass content (MBC) content were recorded in red mulch (17.2x 106) followed by black mulch (12.4 x 106) than silver (10 x 106) mulch, MBC content in organic mulch was recorded (7.2 x 106) and lowest MBC content was recorded in control (4.4 x 106).

Keywords- Tomato, red, black, silver and organic mulch, soil temperature, economics, MBC.

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Introduction

Tomato *(Lycopersicon esculentum* Mill.) is one of the popularly grown and highly valuable vegetable crop worldwide. It is grown in 0.458 M ha area with 7.277 MT production and 15.9 MT/ha productivity [1] in India. The major tomato producing states are Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh and West Bengal. The tomato is a rich source of vitamins A, C, potassium, minerals and fibre. The practice of mulching has been utilized to great advantage in the development of horticultural crops [2] and has been proven to significantly improve the growing conditions of vegetables. Mulch is any material placed on the soil surface to conserve moisture, maintain favourable soil temperatures around plant roots, prevent erosion and reduce weed growth, which results in better plant growth and development. Mulches can be derived from either organic or inorganic materials [3]. 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 differently coloured mulches had on soil temperature, moisture retention, and vegetable yields [4].

Mulching with drip irrigation system is an effective method of manipulating the crop growing environment to increase yield and quality parameter by improving soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content. Since efficient use of irrigation water is of major importance for sustainable agriculture development, different measures have been introduced to conserve water [5]. Polyethylene mulch is widely used in the production of fresh market tomatoes. Beneficial responses include earlier production, better fruit, quality and greater total yield. The responses have been attributed to enhanced soil warming, more efficient and consistent use of water and fertilizers. Management decisions on mulch colour traditionally have been based on mulch effects on soil temperature.

A phytoregulatory role of upwardly reflected light on tomato plant development in plastic mulch culture has been established [6]. Morphological development of young tomato plants was altered by subtle changes in the wavelength composition of light reflected from various painted colours of polyethylene surfaces. Nutrient uptake of tomato has also been reported to be affected by light spectral quality. Because tomato plant growth is responsive to subtle changes in the plant light environment, alternative colours of mulch that selectively reflect desired wavelengths of light into the plant canopy may have potential for improving tomato yields under field conditions. The objectives of the present study were to measure 1) Effect of different mulches on the growth and yield parameters and 2) to determine the economic variation of different mulches under drip irrigated tomatoes.

Materials and Methods

The experiment was conducted during the winter season of 2013-14 and 2014-15 at Central Institute of Agricultural Engineering, PFDC Bhopal. Which was situated at North of Bhopal at 77° 24' 10" E, 23° 18' 35" N at an elevation of 495 m above mean sea level. A soil at experimental site was classified as heavy clay soils with a clay content varying between 49.7 to 53.7 % with field capacity ranging between 28.5 to 31%. The experiment was carried out in a Randomized Block Design with 5 treatments and 4 replications. Five treatments *viz.,* T1- Without mulch, T2-

Organic mulch (rice straw), T3- Silver mulch, T4- Black mulch and T5- Red mulch. Thirty days old seedlings of tomato hybrid 'Laxmi' were planted at a distance 60 cm x 60 cm between rows and plants. All the recommended packages of practices were followed, including a uniform dose of 120 kg P2O5/ha, 100 kg K2O/ha and half dose of nitrogen (180 kg/ ha) were applied as a basal dose at the time of transplanting and remaining dose of N (90 kg) was applied through drip fertigation in all the treatments of the crop. After transplanting organic mulch was placed in the experimental plots @ 10 tonnes/ha, while silver, black and red polyethylene (25 micron) was placed between the rows. The drip lines were laid out at 60 cm distance and non pressure compensating inbuilt dripper (2 lph) was at the 60 cm distance on laterals. Water was applied on alternate days with drip irrigation operated for 30 min on each irrigation. Data were recorded on growth, yield contributing and yield as per standard methods. Soil MBC was determined by the chloroform fumigation extraction method. Microbial properties of soil were assessed in terms of soil microbial biomass carbon (MBC) and total viable microbial count. The basic principal of the chloroform fumigation extraction method is that soil microorganisms die after their cell membranes are attacked by chloroform, and a part of the microbial constituents, especially in the cytoplasm, is degraded by enzymatic autolysis of C content in the non-fumigated and the fumigated soil samples with a conversion factor of 0.25. Temperature of soil was taken during the experiment with the help of soil thermometer. At 5 and 10 cm depth below the soil surface in all the treatments at 10.00 am and 2.00 pm on a daily basis. The cost of cultivation of tomato includes expenses incurred on land preparation, seeds, transplanting, cost of fertilizer, manure and their application, mulching, weeding, crop protection measures, irrigation water, and the cost of harvesting were considered for economic analysis.

Results and Discussion

Mulch colour had a significant effect on plant height [Table-1]. At the fruit maturity (75 DAT), the highest plant height was observed in red mulch (160.73 cm) followed by black mulch (158.98 cm) than silver (158.14 cm) mulch. According to [7] average plant height and number of branches were higher in inorganic mulches. Plastic mulch induces the early crop emergence, so it increases the biomass production in the early stages of the crop growth. Red mulching increased number of flowers per cluster and significantly influenced by organic mulch and without mulch. According to [4] mulched tomato plants had more and early flowers than that of unmulched plants. SPAD values were non significantly influenced by different mulch treatments.

The highest fruit weight was recorded under red mulch (118.18g) followed by at black and silver mulch and are significantly influenced by organic and without mulch. Our results showed that the tomato grown over red mulch had the highest early yield (81.20 t/ha) followed by grown over black and silver mulched. The lowest yield was recorded without mulch (49.35t/ha). [8] also reported that early yields were higher from plants grown on red and black mulch than plants grown on white, green and brown.

All coloured plastic mulch significantly had a higher marketable yield compared to without mulch. Marketable yield increased by 64.54% in red mulch, followed by black mulch (57.45%), followed by silver mulch (45.40%) than organic mulch (21.98%). According to [6] tomato plants grown with red mulch generally had the greatest early marketable yields and produced the least amount of foliage. Plants grown with black or silver-coloured mulch had lower early marketable yields but produced more foliage. These results suggest that mulch surface colour can induce changes in the plant microclimate (e.g., spectral balance and quantity of light, root zone temperatures) that can act through natural regulatory systems within the growing plant and affect tomato plant growth and fruit production.

Table-1 *Growth and yield contributing parameters influenced by different types of mulch (Two years pooled data)*

Treatments	Plant height (cm) at 75 DAT	No of Flowers/cluster at 60 DAT	SPAD value at 45 DAT	Weight of fruit (g)	Yield (t/ha)	Yield increase over T1
Without mulch	155.02	6	53.05	104.51	49.35	-
Organic mulch	156.72	7	53.37	107.34	60.20	21.98
Silver mulch	158.14	8	55.55	113.63	71.75	45.40
Black mulch	158.98	8	55.23	115.70	77.70	57.45
Red mulch	160.73	9	55.92	118.18	81.20	64.54
SEM±	0.93	0.59	1.73	1.12	3.22	-
CD (0.05%)	2.70	1.79	NS	3.34	9.12	-

Soil microbial biomass carbon in the present study showed in [Table-2]. The MBC content at 0-15 cm depth of soil. The highest MBC content was recorded in red mulch (17.2x 10^6) followed by black mulch (12.4 x 10^6) than silver (10 x 10^6) mulch, MBC content in organic mulch was (7.2 x 10^6) and lowest MBC content was recorded in the control (4.4 x 10^6). According to [9] 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.

Table-2 *Microbial population influenced by different colours of mulch at 0-15 cm depth (Two years pooled data)*

Treatments	CFU/g
Control	4.4 x 10^6
Organic mulch	7.2 x 10^6
Silver mulch	10 x 10^6
Black mulch	12.4 x 10^6
Red mulch	17.5 x 10^6

Influence of soil temperature by different types of mulches

The average daily soil temperature recorded at 5 and 10 cm depth at 10.00 AM and 2.00 PM. From [Fig-1] it can be seen that at 10 AM the average soil temperature at 5 cm depth is lower compared to 10 cm depth under all four types of mulch. At the same time soil temperature has been found maximum under red mulch, followed by black and silver than organic mulch. The result revealed that during forenoon soil temperature increases with increasing depth. Increasing and decreasing trend of soil temperature under inorganic mulches (red, black and silver) depends on daily atmospheric temperature. Similar trend fallows in the case paddy straw and without mulch. Based on the recorded data at 2.00PM the average soil temperature at 5 cm depth is higher compared to 10 cm depth under all four types of mulches. The result revealed that at afternoon soil temperatures decreases with increasing depth.

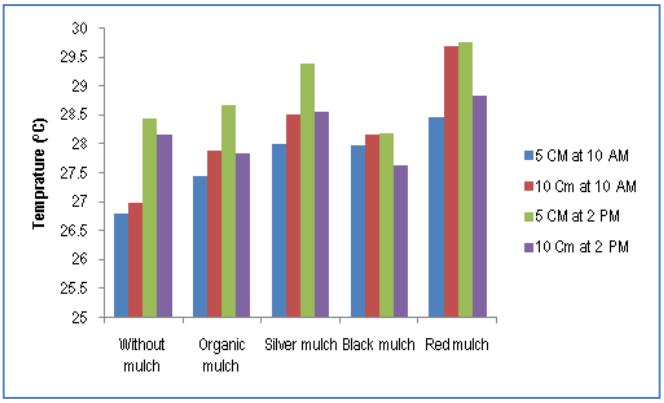

Fig-1 Average of daily-recorded soil temperature under different types of mulch

Economics

The results show that tomato production in general is highly dependent on labour. In other words, tomato production can be described as a labour-intensive business venture. Among the list of cost items for the tomato production technology, labour alone accounts for more than 80% of the cost of operations [Table-3]. The remaining 20% of the cost is distributed among the costs of fertilizers, seeds, fungicides and bags. The cost structure of the trails indicates that a potential user of the mulching technology requires additional investment of 44,700Rs/ha for inorganic mulch (red, black and silver) and 30,960 Rs/ha for organic mulch.

The highest net return (4, 22,460Rs/ha) and the incremental net return (2, 10,060Rs/ha) were recorded in red mulch followed by black and silver mulch. In case of organic mulch net return (2, 68,200Rs/ha) and the incremental net return (55,800Rs/ha) were obtained. The lowest net return (2, 12,400) was obtained in without mulch. Incremental BCR was recorded the highest (4.70) for red mulch, followed by black (4.07) and silver (3.00) mulch than organic (1.80) mulch.

Table-3 *Economic analysis influenced by different types of mulch (Rs/ha) (Two years pooled data)*

Treatments	Total cost of production	Gross return	Net return	Incremental cost over T1	Incremental return over T1	Incremental net return over T1	Incremental BCR*
Without mulch	182400	394800	212400	-	-	-	-
Organic mulch	213360	481560	268200	30960	86760	55800	1.80
Silver mulch	227100	573960	346860	44700	179160	134460	3.00
Black mulch	227100	621600	394500	44700	226800	182100	4.07
Red mulch	227100	649560	422460	44700	254760	210060	4.70

*BCR-Benefit Cost Ratio

Conclusion

The results of this study exhibited the significant effect of inorganic mulches (red, black and silver) during the growing season. The inorganic mulches reduce soil water evaporation and improved soil water availability. Using inorganic mulches produced a more vigorous plant, number of more flowers and fruits, earlier and higher yield and increased soil temperature as compared to organic mulch and without mulch. The marketable yield was also greater with the use of inorganic mulches. The increase in yield of red mulched was probably associated with the conservation of moisture, improved microclimate both beneath and above the soil surface, light reflection and great weed control. Under inorganic mulches increased soil microbial biomass carbon. Mulching facilitates retention of soil moisture and improved physical, chemical and biological properties of soil. Mulching suppresses weed growth, protects the upper fertile soil from erosion, and minimizes variation in soil temperature. Mulching blocks the light stimulus, thereby reducing seed germination in the weeds after mulch application.

Conflict of Interest: None declared

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