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Effect of different mulches on growth, yield and economics of chilli (*Capsicum annuum* L.)

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Abstract
The present investigation entitled Effect of different mulches on growth, yield and economics of Chilli (*Capsicum annuum* L.) was carried out during kharif season 2018 at Nursery, Department of Horticulture, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Indore, (M.P.). The experimental material for the present investigation was comprised of 11 treatments of different organic and plastic mulches with control. Results revealed that the maximum growth (*viz.* plant height, leaf area per plant, leaf area index and number of branches per plant), Phenological (*viz.* days to flower initiation, days to 50% flowering, no. of fruit per plant, average fruit weight) and yield attributes (*viz.*, fruit length, fruit width, number of fruits per plant, average fruit weight, fruit yield per hectare) were recorded under the treatment T_8 (Reflecting (silver) mulch (30 micron). It is revealed from the data, that maximum yield of 134.88 q/ha with maximum net return of Rs.1,76,665/ha and the Maximum cost benefit ratio of 1:2.90 were found under treatment T_8 (Reflectant (silver) mulch (30 micron).

Keywords: Economics of Chilli, *Capsicum annuum*, Nursery

Introduction
Chilli (*Capsicum annuum* L.) commonly known as hot pepper, belongs to family solanaceae, and is cultivated as an annual crop worldwide. It is an important spice as well as vegetable crop, where both ripe and unripe fruits are used for culinary, salad and processing purposes. Its extract is used in pharmaceutical industry for colouring the drugs. It is an excellent source of vitamin A and C. Being richest source of vitamin C, it is sometimes referred as capsule of vitamin C (Durust *et al.* 1997) [8]. India contributes about 36 percent to the total world production and occupies an area of 0.31 million hectares with a production of 3.76 million tons, while in Madhya Pradesh it covers 0.33 million hectare area and produce 0.574 million tones 2016-2017 Horticulture data base.
Mulches can effectively minimize water vapour loss, soil erosion, weed problems and nutrient loss (Van Derwerken and Wilcox-Lee 1988) [25]. Different type of polythene mulches have significant role in decreasing or increasing soil temperature. Mulching with plant residues and synthetic material is a well-established technique for increasing the profitability of many horticultural crops (Gimenez *et al.* 2002) [9]. Various organic mulching materials include grass clippings, paddy straw, tree bark, sawdust and plastic are utilized. Mulches also create a micro-environment by retaining soil moisture and changing root-zone temperatures and the quantity and quality of light reflected back to the plants which alter plant growth and development (Crizinszky *et al.* 1995) [6].

Materials and Methods
The experiments were carried out during Kharif season 2018, at the research field, Department of Horticulture, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Indore, (M.P.). Indore is situated in Malwa Plateau in western part of M.P. at 22 ^{0}43" N latitude and 75^0 66 " E longitudes with an altitude of 555.7 m above the mean sea level (MSL). It has sub-tropical climate having a temperature range from 29 ^{0}C - 41 ^{0}C as maximum and 7 ^{0}C - 23 ^{0}C as minimum in summer and winter season respectively. It is hottest during March to May while coolest in December and January Relative humidity generally fluctuates between 60 to 85%. In this area, most of the rainfall is received during July to September while winter rains are occasional and uncertain. The average annual rainfall is 941 mm. The south-west monsoon is responsible for the major precipitation. The soil of experimental field was medium black clay in texture with uniform topography. The experimental area was ploughed and harrowed in order to bring the soil in well pulverized condition. FYM was applied @ 20t/ha.

Plots were made according to the layout plan after leveling. The treatments consisted of the 11 different organic and inorganic mulches on chilli were tested in randomized complete block design with three replications with 3.0 X 3.0 m^2 plot size and 60 cm X 59 cm^2 spacing. Observations were recorded under investigation i.e. plant height, number of branches per plant, leaf area, leaf area index, Days to flower initiation, Days to 50% flowering, days to first fruit set, days to first fruit harvest, and Yield and its attributing Parameters.

Results and Discussion

Effect of different mulches on morphology characters of chilli (*Capsicum annuum* L.)

Among Morphology characters, plant height, number of branches per plant, leaf area, leaf area index was studies in chilli. At 30, 60, 90 and 120 days after transplanting.

The maximum plant height (74.56 cm) was recorded in T_8 (Reflectant silver mulch @ 30 micron) which was statistically at par with treatment T_9 (White polythene mulch @ 30 micron) (69.21 cm) while, minimum plant height (58.13 cm) was recorded in the treatment T_1 (Control-without treatment) at 120 DAT. All the treatment significantly increased the plant height over control (No mulch) because it had reduced the weed population without adverse effect to the crop. These findings were supported by Ahmad *et al.* (2011) [3], Belel (2012) [5], Mochiah *et al.* (2012) [17], Rajablariani and Sheykh Mohamady (2015) [19], Reddy *et al.* (2016) [20], Helaly *et al.* (2017) [11], Laxmi Kanth *et al.* (2018) [15]. Similar Leaf area per plant and leaf area index differed significantly due to practice of various type of mulching methods applied on chilli. Significantly higher leaf area per plant (8944) was recorded in T_8 (Reflectant silver mulch @ 30 micron).While minimum leaf area per plant (6295) was recorded in the treatment T_1 (Control-without treatment). The Maximum leaf area per plant and leaf area index among all the mulches used in the experiment may be due to less weed crop competition. Similar results have been reported by Dennis (2007) [7], Ahmad *et al.* (2011) [3], Rajablariani and Sheykh mohamady (2015) [19], Reddy *et al.* (2016) [20], Helaly *et al.* (2017) [11], Laxmi Kanth *et al.* (2018) [15] and Shivaraj *et al.* (2018) [22]. The significantly maximum number of branches per plant (14.50) was recorded in treatment T_8 (Reflectant (silver) mulch (30 micron) while the least number of branches per plant (10.15) was recorded under the treatment T_1 (Control-without application) at 120 DAT. Maximum number of branches per plant among the mulches in the experiment may be due to less weed crop competition. Similar results have been reported by Belel (2012) [5], Reddy *et al.* (2016) [20] and Helaly *et al.* (2017) [11]. Significant variation in phonological parameters *viz*., days to first flowering, days to 50 per cent flowering, days to first fruit set and days to first fruit harvest responded with the application of different treatments of mulches.

Effect of different mulches on phenological characters of chilli (*Capsicum annuum* L.).

The early initiation of flowers and days to 50 per cent flowering was recorded in the treatment T_8 (Reflectant (silver) mulch (30 micron). While late flower initiation was occurred in the treatment T_1 (Control-without treatment). The flower initiation is indirectly correlated with soil temperature and available phosphorus and weeds are directly affected by the crop growth due to crop-weed competition for space, light and nutrient etc. Soil temperatures are increased by the mulching. The findings are also in agreement with the findings of William James (1993) [26], Laxmikanth *et al.* (2018) [15] and Shivaraj *et al.* (2018) [22]. The early days to first fruit set and days to first fruit harvest were recorded in the treatment T_8 (Reflectant (silver) mulch (30 micron).While late first fruit set and days to first fruit harvest was occurred in the treatment T_1 (Control-without treatment. William James (1993) [26], Ahmad *et al.* (2011) [3] and Helaly *et al.* (2017) [11]. The days to first fruit harvest (59.23 days DAT) were recorded in the treatment T_8 (Reflectant (silver) mulch (30 micron) which was statistically at par with the treatment T_9 (White polythene mulch @ 30 micron) (63.41 days) and followed by T_7 (Palash straw mulch @ 9 t/ha) (68.25 days) and T_{11} (Yellow mulch @ 30 micron) (69.29 days). While late first fruit harvest was occurred in the treatment T_1 (Control-without mulch) (73.63 days).

Effect of different mulches on yield and its attributing characters of chilli (*Capsicum annuum* L.)

The Maximum fruit length and fruit width was observed in the treatment T_8 (Reflectant (silver) mulch (30 micron). While, the minimum fruit length and fruit width was recorded in plants under T_1 control-without treatment. This may be due to decrease weed density and less weed crop competition, increased supply of major plant nutrients and are required in larger quantities for growth and development of plants. The similar result has been found Larios and Santos (1997) [14], Belel (2012) [5] and Reddy *et al.* (2016) [20]. Maximum number of fruits per plant (143) was observed in the treatment T_8 (Reflectant (silver) mulch (30 micron) as compared to other treatments. While, the minimum number of fruits per plant (101) was recorded in T_1 (Control-without treatment). This may be due to decrease weed density and increased supply of major plant nutrients and are required in larger quantities for growth and development of plants. Nitrogen accelerates the development of growth and reproductive phases and protein synthesis, thus promoting yield attributing characters. Similar results have been reported by Hassan *et al.* (1995) [10], Hutton and Handley (2007) [12], Ahmad *et al.* (2011) [3], Belel (2012) [5], Mochiah *et al.* (2012) [17] and Reddy *et al.* (2016) [20]. The treatment T_8 (Reflectant (silver) mulch (30 micron) recorded maximum average fruit weight (2.83 g) as compared to other treatments. While, the minimum average fruit weight (2.04 g) was recorded in T_1 (Control-without treatment). This may be due to decrease weed density and less weed crop competition, increased supply of major plant nutrients and are required in larger quantities for growth and development of plants. The findings are also in agreement with the findings of Larios and Santos (1997) [14], Mochiah *et al.* (2012) [17], Belel (2012) [5] and Reddy *et al.* (2016) [20]. The maximum fruit yield per hectare (134.88) was recorded under the treatment T_8 (Reflectant (silver) mulch (30 micron) followed by T_9 (White polythene mulch @ 30 micron) (128.77 q/ha) and T_7 (Palash straw mulch @ 9t/ha) (121.71) as compared to other treatments. While, the minimum fruit yield per hectare (68.78) was observed in T_1 (Control-without treatment). The probable reason for enhanced pod yield may be due to primitive effects of nutrient (macro and micro) on vegetative growth which ultimately lead to more photosynthetic activities which, enhance carbohydrate and nitrogen metabolism of peptic substances, as well as improve the water metabolism and water relation in the plants. White mulches perhaps a combination of the light spectrum reflected and the soil temperature conservation played a role in growth

and yield response of chilli. This can be probable attributed to specific properties of different plastic mulches and their ability to capture more heat during winter season. Similar results have been reported by William James (1993) [26], Larios and Santos (1997) [14], Hassan *et al.* (1995) [10], Hutton and Handley (2007) [12], Agrawal *et al.* (2009) [1], Belel (2012) [5], Masarirambi, *et al.* (2013) [16], Amalia *et al.* (2014) [4], Rajablariani and Sheykh Mohamady (2015) [19], Reddy *et al.* (2016) [20] and Spehia *et al.* (2017) [23]. Higher money value and less cost of cultivation are desirable traits for getting higher returns. Hence economics of the treatments was work out. It is revealed from the data, that maximum yield of 134.88 q/ha with maximum net return of Rs.1,76,665/ha and the Maximum cost benefit ratio of 1:2.90 were found under treatment T_8 (Reflectant (silver) mulch (30 micron), followed by T_9 (White polythene mulch @ 30 micron) gave fruit yield 128.77 q/ha and a net return of Rs. 1,66,245/ha with cost benefit ratio of 1:2.82. While, minimum fruit yield 68.78 q/ha, net return of Rs. 67,640/ha along with cost benefit ratio of 1:1.97 was recorded in treatment T_1 (control-without mulch). Finding corroborates with their results obtained by Sutagundi *et al.* (2000) [24], Agrawal *et al.* (2009) [1], Kumara *et al.* (2016) [13], Sathiyamurthy *et al.* (2017) [21] and Prakash *et al.* (2017).

Conclusion

On the basis of present investigation, it is concluded that Treatment T_8 (Reflectant (silver) mulch (30 micron) was recorded maximum growth, phonological, yield and its attributing traits in chilli variety Pusa Sadabahar. It is revealed from the data, that maximum yield of 134.88 q/ha with maximum net return of Rs.1,76,665 /ha and the Maximum cost benefit ratio of 1:90 were found under treatment T_8 (Reflectant (silver) mulch (30 micron).

Table 1: Effect of different mulches on morphology characters of chilli (*Capsicum annuum* L.)

S. No.	Treatment	Plant height (cm)				Number of branches				Leaf area plant^{-1} (cm^2)	Leaf area index
		30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	120 DAT	120 DAT
1	T1 - Control (Without treatment)	20.27	31.91	47.05	58.13	3.57	5.87	9.77	10.15	6295	3.07
2	T2 - Soybean straw mulch @ 6 t/h	21.34	32.46	53.31	61.43	4.15	6.39	10.33	10.60	6900	3.45
3	T3 - Soybean straw mulch @ 9 t/h	22.84	34.20	57.35	61.67	5.46	7.39	11.47	11.63	7443	3.58
4	T4 - Wheat straw mulch @ 6 t/h	21.07	32.31	53.34	60.08	4.02	6.12	9.85	10.35	6622	3.17
5	T5 - Wheat straw mulch @ 9 t/h	22.57	33.50	56.27	62.85	5.16	7.15	11.17	11.44	7267	3.53
6	T6 - Palash straw mulch @ 6 t/h	22.40	33.23	54.11	60.91	4.34	6.44	10.41	10.77	7100	3.48
7	T7 - Palash straw mulch @ 9 t/h	23.81	35.00	61.65	66.64	6.05	8.39	12.24	12.68	8240	4.22
8	T8 - Reflectant (silver) mulch (30 micron)	27.34	38.58	66.11	74.56	7.10	9.50	13.91	14.50	8944	4.55
9	T9 - White mulch (30 micron)	25.34	35.47	63.04	69.21	6.64	9.11	12.42	14.05	8791	4.31
10	T10 - Blue mulch (30 micron)	23.30	34.02	57.67	62.87	5.65	7.77	12.04	12.41	7564	3.79
11	T11 - Yellow mulch (30 micron)	23.67	34.54	58.77	63.67	5.87	8.03	12.21	12.54	7918	4.12
	S.Em.±	0.73	1.09	1.68	1.84	0.26	0.31	0.51	0.59	219.04	0.11
	C.D. at 5 % level	2.16	3.24	4.96	5.44	0.78	0.93	1.50	1.76	646.18	0.32

T**able 2:** Effect of different mulches on pheonological and yield and characters of chilli (*Capsicum annuum* L.)

S. No.	Treatment	Days to flower initiation	Days to 50% flowering	Days to first fruit set	Days to first fruit harvest	Fruit length (cm)	Fruit width (cm)	Number of fruit per plant	Average fruit weight (g)	Fruit yield (q/ha)
1	T1 - Control (Without treatment)	35.16	44.50	52.18	73.63	5.50	0.70	101.00	2.04	68.78
2	T2 - Soybean straw mulch @ 6 t/h	33.90	42.00	49.50	72.10	5.90	0.72	119.67	2.21	87.96
3	T3 - Soybean straw mulch @ 9 t/h	32.15	40.56	47.20	70.69	6.55	0.76	126.67	2.47	104.04
4	T4 - Wheat straw mulch @ 6 t/h	34.80	43.33	49.70	73.30	5.67	0.72	114.67	2.14	81.91
5	T5 - Wheat straw mulch @ 9 t/h	32.92	40.93	48.74	71.32	6.40	0.75	122.33	2.36	96.16
6	T6 - Palash straw mulch @ 6 t/h	33.34	41.87	48.96	71.87	6.03	0.74	120.67	2.26	90.76
7	T7 - Palash straw mulch @ 9 t/h	30.98	38.30	46.50	68.25	7.13	0.81	134.80	2.70	121.31
8	T8 - Reflectant (silver) mulch (30 micron)	28.00	34.67	41.65	59.23	8.22	0.91	143.00	2.83	134.88
9	T9 - White mulch (30 micron)	29.78	38.12	45.48	63.41	7.81	0.88	139.00	2.78	128.77
10	T10 - Blue mulch (30 micron)	31.75	39.40	47.10	70.51	6.80	0.76	130.00	2.57	111.22
11	T11 - Yellow mulch (30 micron)	31.31	39.10	46.87	69.29	6.93	0.78	134.00	2.66	118.92
	S.Em.±	0.98	1.19	1.44	2.04	0.21	0.03	4.09	0.07	3.10
	C.D. at 5% level	2.91	3.53	4.26	6.01	0.64	0.09	12.06	0.22	9.14

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