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EFFECT OF VARIOUS MULCH MATERIALS AND SPACING ON GROWTH, YIELD AND QUALITY OF STRAWBERRY

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ABSTRACT: An experiment was conducted at the Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow. The experiment was performed to find out the most suitable mulching material and an ideal spacing for strawberry cultivation under Lucknow conditions. The experiment was laid out in a Factorial Randomized Block Design with three replications. The treatments comprised of six mulching materials viz. paddy straw, dry grass (*Saccharum* spp.), dry leaves (dry neem leaves), red polyethylene, green polyethylene and transparent polyethylene) with two spacings (30 x 15 cm and 30 x 30 cm). On the basis of the statistical data, it is concluded that spacing of 30 x 30 cm with green polyethylene mulch was found to be the best in terms of plant growth viz. plant height, spread of plants, number of leaves and leaf area. Similarly, spacing of 30 x 15 cm with green polyethylene mulch significantly influenced number of flowers, fruit length and fruit width, yield and quality. However, there was slight difference in quality parameters among different treatments.

Keywords: *Strawberry, mulching materials, spacing, growth, fruit quality.*

Strawberry (*Fragaria x ananassa* Duch.) is one of the most fascinating fruit of the world being rich source of vitamins, minerals and tantalizing flavour and aroma. Though, it is minor fruit of temperate regions, due to the advent of day neutral cultivars, it can be grown profitably even in tropical and subtropical regions (Ram *et al.*, 7). Recently, strawberry has become the favourite fruit crop among the growers, especially near towns and cities. Because of its remunerative prices; the area under this crop is increasing rapidly (Singh and Asrey, 9). It is amongst the ten fruit crops, which give quicker and very high returns per unit area on the capital interests, as a crop ready for harvesting within six months of planting (Sharma and Sharma 12). However, presently farmers grow strawberry without maintaining proper planting space. Consequent upon this, high percentage of under sized, unmarketable fruit and incidence of pest and diseases have been noticed which is a bottleneck for obtaining good returns. Higher plant population per unit area has generally tended to increase the fruit yield upto 27% in strawberry. There are meager attempts on morphological, phenological and yield attributes under different spacings. Further, strawberry is one of the crop among the other crops that response drastically to the increase of soil temperature/ light reflectance produced with the use of mulches. Gutal *et al.* (5) observed that the use of plastic mulches in agriculture helped to increase the production per unit area for all types of crops as polyethylene mulch films increase soil temperature 5-7 °C facilitating faster germination and better root proliferation, in addition to checking weed growth, preserving the soil structure, retaining soil moisture and increasing CO_2 contents around the plants. Considering these facts, the systematic studies were conducted to standardize the appropriate mulch material and spacing for quality and higher yield of strawberry fruits under Lucknow conditions.

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MATERIALS AND METHODS

Field experiment was conducted during 2008-2009 at the Horticultural Research Farm of the Babasaheb Bhimrao Ambedkar University, Lucknow in a Factorial Randomized Block Design with three replications. Treatment combinations consisting of six mulching materials viz. paddy straw, dry grass (*Saccharum* spp.), dry leaves (dry neem leaves), red polyethylene, green polyethylene and transparent polyethylene) and two spacings i.e. 30 x 15 cm and 30 x 30 cm. Healthy and

disease-free runners of Chandler strawberry were procured from Dr. Y. S. Parmar University of Agriculture and Forestry, Solan, H. P. in the month of October, 2008. Before planting they were planted in shade house for proper acclimatization after which they transplanted in well-prepared beds under open field conditions. Transplanting was done at the last week of October. Red polyethylene sheet, green polyethylene sheet and transparent polyethylene sheet were used and spread over the beds. Corresponding to the position of plant, incisions were given on mulch and the plant stems were taken out through the slits to keep the foliage uncovered. Paddy straw, dry grass and dry leaves were spread over the plots evenly in different treatments to maintain a mulch thickness of about 10 cm. All the necessary cultural practices and plant protection measures were followed uniformly for all the plots and treatments during the experimentation period. Observations were recorded on the height of plant (cm), spread of plants (cm), number of leaves (cm), number of flowers per plant, fruit length (cm), fruit breadth (cm), fruit weight (g), yield per plant (g). Total Soluble Solids (°Brix) of the berry was determined with the help of Hand Refractometer. The titrable acidity (%) and ascorbic acid (mg/100g) were determined as per standard procedures of Ranganna (8).

RESULTS AND DISCUSSION

On the basis of the observations and data recorded it was found that the vegetative growth, yield attributes and quality parameters were significantly affected by mulching and spacings, respectively. Data clearly revealed that the maximum vegetative growth viz. plant height, spread of plants (east-west and north-south), number of leaves and leaf area were observed in green polyethylene mulch followed by red and transparent polyethylene mulch with the wider spacing of 30 x 30 cm over the other treatments (Table 1). The better response in plant growth parameters might be because of suitable conditions found under the green polyethylene mulch which is the combination of the properties of clear and black mulches. With clear mulch, all wave lengths of radiation (light) are transmitted through the mulch. The long wave lengths (infra-red radiation) are converted to heat under the clear film and provide the greatest amount of soil warming. However, photosynthetic active radiation (PAR) is also transmitted and responsible for the vigorous weed growth under clear mulch. Although, black mulch blocks PAR, weeds do not grow underneath. Therefore, it simultaneously generated almost as much heat as clear mulch and suppressed weeds like black mulch. The plants grown under the higher densities produced fewer crowns and leaves as reported by Wright and Sandrang, 18. The present results are in conformity of the finding of (Tarara, 15). However, 30 x 30 cm (plant to plant spacing) provided better space for the root distribution. It also indicated a shift in the most favourable environment in root growth consists of optimal moisture availability. This lead to increase root activities which might have been resulted in better nutrient uptake, subsequently better dry matter formation and gas exchange. These results are also supported by Goulart and Funt (4) and Sharma and Yamdagni (10).

Data presented in Table 2 clearly indicated the influence of various treatments and reflected that the maximum number of flowers were observed in green polyethylene with 30 x 15 cm. This might be because the green polyethylene with 30 x 15 cm spacing creates a better microclimate and made the field weed free. Whereas, the red and transparent polyethylene mulch were not success in controlling the weed population in the field that resulted in absorbing the most of the PAR by the weeds (Johnson and Fennimore, 6). And also it might be because closer spacing provided enough competition to reduce vigorous vegetative growth (Wright and Sandrang, 18). They also stated that the medium density produced the greatest number of flowers per inflorescence. Uselis (17) reported that wider spacing reduced the total number of inflorescences as observed in the present investigation. Slight enhancement in increased fruit

Table 1: Effect of mulching and spacing and their interaction on plant growth and flowers of strawberry cv. Chandler.

Treatments	Plant height (cm)		Plant spred E-W (cm)		Plant spread N-S (cm)		No. of leaves per plant		Leaf area (cm^2)	
Spacing / Mulching	S_1	S_2	S_1	S_2	S_1	S2	S_1	S_2	S_1	S_2
M_1	9.01	10.49	14.31	18.23	14.89	18.91	6.66	83.55	30.58	53.24
M_2	7.76	10.12	12.52	17.63	13.09	18.32	6.10	7.86	28.59	38.27
M_3	7.13	9.28	11.70	17.45	12.29	18.64	5.46	7.61	18.24	36.43
M_4	10.68	12.46	15.28	20.87	16.23	20.82	6.93	10.76	26.80	62.43
M_5	11.23	14.94	17.35	23.75	17.82	24.32	6.93	12.37	38.20	62.89
M_6	10.47	11.49	14.36	18.56	16.14	19.53	6.89	10.03	21.32	58.81
CD (P=0.05)										
Mulching	0.86		0.94		0.98		0.75		2.37	
Spacing	0.49		0.54		0.57		0.43		1.37	
Interaction	1.21		1.33		1.39		1.06		3.36	

Where, M_1 = Paddy straw; M_2 = Dry grass, M_3 = Dry leaves; M_4 = Red polyethylene; M_5 = Green polyethylene, and M_6 = Transparent polyethylene; S_1 = 30 15 cm and S_2 = 30 30 cm.

Table 2: Effect of mulching and spacing and their interaction on flowers, fruit growth and yield of strawberry.

Treatments	No. of flowers per plant		Fruit length (cm)		Fruit breadth (cm)		Fruit weight (g)		Yield/plant (g)	
Spacing / Mulching	S_1	S_2	S_1	S_2	S_1	S2	S_1	S_2	S_1	S_2
M_1	16.29	15.20	3.96	4.43	2.99	3.73	10.31	10.55	137.84	123.75
M_2	16.02	15.16	3.94	4.21	2.90	3.57	9.67	10.34	121.55	102.88
M_3	15.34	14.56	3.79	4.03	2.44	3.56	8.00	9.83	93.76	97.61
M_4	18.18	17.75	4.62	4.71	3.92	4.11	11.23	11.25	161.60	148.61
M_5	19.52	18.69	4.67	5.10	3.92	4.68	12.18	12.65	188.18	165.71
M_6	18.88	18.00	4.47	4.70	3.82	4.10	11.89	12.07	168.24	157.03
CD (P=0.05)										
Mulching	1.35		0.38		0.15		0.78		9.28	
Spacing	0.78		0.21		0.08		0.45		6.35	
Interaction	1.90		0.52		0.21		1.11		13.10	

Where, M_1 = Paddy straw; M_2 = Dry grass; M_3 = Dry leaves; M_4 = Red polyethylene; M_5 = Green polyethylene and M_6 = Transparent polyethylene; S_1 = 30 x 15 cm and S_2 = 30 x 30 cm.

Table 3: Effect of mulching and spacing and their interaction on fruit quality parameters of strawberry cv. Chandler.

Treatments	TSS (°Brix)		Acidity (%)		Ascorbic acid (mg/100g)	
Spacing / Mulching	S_1	S_2	S1	S_2	S_1	S_2
M_1	9.83	9.78	0.70	0.71	64.44	55.12
M_2	8.96	9.67	0.73	0.71	59.81	49.81
M_3	8.70	9.18	0.72	0.72	59.31	52.20
M_4	10.42	10.45	0.69	0.65	63.89	71.93
M_5	9.88	10.02	0.70	0.61	78.46	77.89
M_6	11.23	11.48	0.61	0.61	64.11	76.47
C.D.(P = 0.05)						
Mulching	0.17		0.04		0.14	
Spacing	0.10		0.02		0.09	
Interaction	0.25		0.05		0.19	

Where, M_1 =Paddy straw; M_2 =Dry grass; M_3 =Dry leaves; M_4 = Red polyethylene; M_5 = Green polyethylene and, M_6 = Transparent polyethylene; S_1 = 30 15 cm and S_2 = 30 30 cm.

length, fruit width, fruit weight and yield was found in green polyethylene. Same trend of fruit size (length and width) and weight was significantly reflected in wider spacing (30 x 30 cm). However, closer spacing also revealed good performance. Perhaps it was because of the spacing system. Wider spacing get sufficient light and nutrients which resulted to increase the size and weight. Although, the closer spacing accommodate more number of plants than wider spacing results in overlapping of leaves (shelf shading) to their adjacent plants and intermingled of roots that increased competition for the available resources (water, light and nutrients). Ahmad (1) stated that more space available for uptake of all the nutrients to the fruits where they acted as sink for storing the nutrient and finally translocated to fruits which are the source of sink. These absorbed nutrients might have been utilized by the fruits as a result of which there was increase in size and weight of fruit. Badiyala and Joolka (4) have also observed that wider spacing have better sized fruits. On the contrast, Ram *et al.* (7) registered that the fruit size (fruit length and width) was increased as spacing decreased. Similar result for fruit weight was obtained by Ahmad (1). Fruit yield significantly higher at 30 x 15 cm plant to plant spacing without much affecting fruit quality. Similar results on increased yield with closer spacing have also been reported by Ram *et al.* (7) and Sharma (11).

It is obvious from the data (Table 3) that fruit quality was significantly affected by mulching and spacings. Better fruit quality viz., TSS (°Brix), acidity (%) and ascorbic acid (mg/100g) of strawberry were found in green polyethylene mulch which was at par with transparent polyethylene mulch. This might be because of increase in temperature underneath the green polyethylene mulch. The result was supported by Singh et al. (13) and Tang *et al.* (14). Spacing wise quality attributes like TSS (°Brix), acidity (%) and ascorbic acid (mg/100g) were found to be in 30 x 30 cm enhanced with little or negligible difference in the spacing of 30 x 15 cm (plant to plant). The result was in consonance with Tripathi *et al.* (16) who reported that the TSS (°Brix), acidity (%) and ascorbic acid (mg/100g) were found higher in wider spacing of 40 x 70 cm. It was possible that more light exposure and greater accumulation of photosynthates might have contributed to an increase in vitamin C (ascorbic acid) content in berry. Awasthi and Badiyala (2) reported that TSS and total sugars were significantly higher in wider spacing than closer spacing.

Among all the mulch materials, polyethylene performed better than the organic mulches i. e. straw mulch, grass mulch and leaf mulch. This might be due the fast evaporation from the organic mulches, less suppression of weeds and low temperature under organic mulches. Similar result was also supported by Tang *et al.* (14).

From the above discussion it is therefore, suggested that the green polyethylene mulch with the spacing 30 x 15 cm (plant to plant) suitable for high yield without affecting the fruit quality under the Lucknow conditions.

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