

Effect of mulching and planting density on growth and yield of strawberry (*Fragaria × ananassa* Duch.) cv. Winter Dawn under sub-tropical conditions of Punjab.

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ABSTRACT

The present investigation entitled the 'Effect of mulching and planting density on growth and yield of strawberry (*Fragaria × ananassa* Duch.) cv. Winter Dawn under sub-tropical conditions of Punjab'. In the study, the influence of mulching by using four different types of mulches viz. Black (M₁), Green (M₂), Blue (M₃) and White (M₄) along with unmulched control including the effect of three planting densities viz., 30x15 cm (S₁), 30x30 cm (S₂) and 30x45 cm (S₃) were assessed. The results revealed that the growth characters like 'plant height', 'Number of shoots per plant', 'Number of leaves per plant', 'plant spread', 'leaf area' and 'Number of flowers per plant' found to be maximum with M₂ (Green mulch). Mulching treatments significantly influenced planting density with growth traits. The planting density of S₃ (30 x 45 cm) showed increased 'plant height', 'Number of shoots per plant', 'Number of leaves per plant', 'leaf area' and 'plant spread'. In case of 'Number of flowers per plant', the treatment under S₁ (30 x 15 cm) registered maximum value. The plants under green mulch (M₂) with planting density of S₃ (30 x 45 cm) viz., M₂S₃ had better values for growth related characters. With regard to the effect of mulches on yield characters the treatment M₂ (Green mulch) resulted increased 'Number of fruits set per plant', 'fruit set percentage', 'yield per plant', 'yield per hectare', 'fruit length', 'fruit girth', 'fruit shape index' and 'fruit weight'. The planting density S₃ (30 x 45 cm) showed increased 'Number of fruits set per plant', 'fruit set percentage', 'yield per plant', 'yield per hectare' including several fruiting parameters viz., 'fruit length', 'fruit girth' and 'fruit weight'. With regard to interactions, the green mulch (M₂) with planting density of S₃ (30 x 45 cm) had better values for yield related characters.

Key words: strawberry, growth and yield

INTRODUCTION

Strawberry (*Fragaria × ananassa* Duch.), one among the ancient fruit crop belongs to the family Rosaceae (Maas *et al.* 1991). It is one of most important temperate fruit, valued for its attractive shape, colour, distinct pleasant aroma and refreshing nature. Their fruits are found to have superior grade in world fruit market, both as a fresh fruit and processed product in industries (Sharma and Sharma, 2003). In India, strawberry cultivation ranges from hilly regions to cool climatic zones over an area of 0.21 lakh ha with an annual production of 1.61 lakh tonnes (NHB, 2017). Mulching and planting density plays a vital role in influencing positive impact on yield and quality in strawberry production. Improper mulching and planting density promotes undersized, compact and unmarketable fruit with high disease incidence, results in lesser productivity. Nowadays, plasticulture emerged as a blooming sector in promoting the production of various horticulture crops. Plastic mulches plays a vital role in crop cultivation, which are helpful in increasing the per unit area production of several fruit crops. Mulching help to increases the soil temperature by 5-7°C which results in better root proliferation and quicker germination. In addition, they suppress the weed growth, conserve the soil moisture, preserve soil structure and increases the amount of CO₂ in the field around the plants (Gutal *et al.* 1992). Albinism, a major

physiological disorder is due to photo active radiation that would be influenced with certain type of mulch used. In such point of view, it is necessary to study on the effect of mulches over the growth and development of strawberry. It has been observed that certain coloured mulch sheets found to have an impact over the control of albinism, a serious physiological disorder in strawberry. Planting density plays a major role in influencing the yield and quality of any herbaceous fruit crop. With suitable plant density, plants can effectively use the environmental conditions and also inter or intra specific competition is found to be minimum. In such sense, for strawberry, spacing acts as a reservoir for storing plant nutrients and their translocation to growing fruits for better yield and quality (Ahmad, 2009). Apart, right spacing promotes increased root activity that results in better gas exchange, dry matter production and better the nutrient uptake (Sharma and Yamdagni, 1999).

Material and methods

The experiment was laid out in Factorial Randomized Blocks Design (FRBD) with two factors *i.e.* type of mulch and planting density comprising total of 13 treatment combinations replicated thrice. The influence of mulching by using four different types of mulches *viz.* Black (M_1), Green (M_2), Blue (M_3) and White (M_4) along with unmulched control including the effect of three planting densities *viz.*, 30x15 cm (S_1), 30x30 cm (S_2) and 30x45 cm (S_3) were assessed. The observations were recorded as plant height (cm), number of shoots per plant, number of leaves per plant, leaf area, plant spread (cm), number of flowers per plant, number of fruits per plant, fruit set percentage, yield per plant (g/plant), yield per hectare (kg/hac), fruit length (cm), fruit girth (cm), fruit shape index, fruit weight (g).

Result and Discussion

Growth parameters

Among the type of mulches, the treatment M_2 *i.e.* Green mulch registered the maximum 'plant height' (11.36 cm). Among the planting density, the treatments under S_3 *i.e.*, 30 x 45 cm recorded the maximum 'plant height' (11.06 cm). However, the minimum 'plant height' was registered by M_4S_1 (7.34 cm). Green mulch registered the maximum 'Number of shoots per plant' (28.30) found to be on par with M_1 (28.15). Among the planting density, the treatments under S_3 *i.e.*, 30 x 45 cm recorded the maximum 'Number of shoots per plant' (29.95). However, the minimum 'Number of shoots per plant' was registered by M_4S_1 (22.10). Similar results were also found in number of leaves per plant and plant spread. Green mulch registered the maximum 'leaf area' (50.01 cm²). It was followed by M_1 (43.50 cm²). Among the planting density, the treatments under S_3 *i.e.*, 30 x 45 cm recorded the maximum 'leaf area' (46.92 cm²). The minimum 'leaf area' was registered in M_4S_1 (27.32 cm²). The increase with regard to those growth parameters was attributed to sufficient soil moisture near root zone and minimized evaporation loss due to mulching. The extended moisture retention and moisture availability greatly leading to higher uptake of nutrient for proper growth and development of plants as compared other mulches including control. The changes in soil temperature below various types of mulch could be attributed to different manners of heating and heat transfer to soil and also to heat accumulation during day and loss during night. Similar findings were in accordance with Dean ban *et al.* (2004), Ali and Gaur (2007) in strawberry and Aruna *et al.* (2007) in tomato.

Yield parameters

Black mulch registered the maximum 'Number of flowers per plant' (15.62), which was found to be on par with M₂ (15.60). The minimum 'Number of flowers per plant' was recorded in control (9.54). Regarding planting density, the treatments under S₁ *i.e.*, 30 x 15 cm recorded the maximum 'Number of flowers per plant' (14.19) and the minimum 'Number of flowers per plant' was recorded in S₃ (13.46).

Green mulch registered the maximum 'Number of fruits set per plant' (13.31). It was followed by M₁ (12.81). The minimum 'Number of fruits set per plant' was recorded in control (7.42). Among the planting density, the treatments under S₁ *i.e.*, 30 x 15 cm recorded the maximum 'Number of fruits set per plant' (11.81). It was followed by S₂ (11.09) and the minimum 'Number of fruits set per plant' was recorded in S₁ (10.64). Among the type of mulches, the treatment M₂ *i.e.*, Green mulch registered the maximum 'fruit length' (4.41 cm), which was found to be on par with both M₁ and M₃ (4.38 cm). The minimum 'fruit length' was recorded in control (3.11 cm). Among the planting density, the treatments under S₃ *i.e.*, 30 x 45 cm recorded the maximum 'fruit length' (4.29 cm), which was on par with S₂ (4.25 cm). The minimum 'fruit length' was recorded in S₁ (3.60 cm). Among the type of mulches, the treatment M₂ *i.e.*, Green mulch registered the maximum 'fruit girth' (3.31 cm). It was followed by M₁ (3.18 cm) found to be on par with M₄ (3.14 cm). The minimum 'fruit girth' was recorded in control (2.57 cm). Among the planting density, the treatments under S₃ *i.e.*, 30 x 45 cm recorded the maximum 'fruit girth' (3.23 cm). It was followed by S₂ (3.15 cm) and the minimum 'fruit girth' was recorded in S₁ (2.74 cm). Blue mulch registered the maximum 'fruit shape index' (1.47). It was followed by M₁ (1.38). The minimum 'fruit shape index' was recorded in control (1.21). The treatment M₃S₁ recorded the maximum 'fruit shape index' (1.56) and the minimum 'fruit shape index' was registered by M₄S₁ (1.18). Among the type of mulches, the treatment M₂ *i.e.*, Green mulch registered the maximum 'fruit weight' (19.07 g). It was followed by M₄ (18.08 g). The minimum 'fruit weight' was recorded in control (15.22 g). The treatments under S₃ *i.e.*, 30 x 45 cm recorded the maximum 'fruit weight' (17.88 g), which was on par with S₂ (17.69 g). The minimum 'fruit weight' was recorded in S₁ (16.23 g). Among the type of mulches, the treatment M₂ *i.e.*, Green mulch registered the maximum 'yield per plant' (253.07 g). It was followed by M₁ (222.16 g). The minimum 'yield per plant' was recorded in control (112.87 g). Regarding planting density, the treatments under S₂ *i.e.*, 30 x 30 cm recorded the maximum 'yield per plant' (198.44 g) and the minimum 'yield per plant' was recorded in S₃ (192.54 g). With regard to interaction, the treatment M₂S₂ recorded the maximum 'yield per plant' (259.71 g), which was found to be on par with M₂S₃ (254.45 g) and the minimum 'yield per plant' was registered in control (108.00 g). Among the mulches, the treatment M₂ *i.e.*, Green mulch registered the maximum 'yield per hectare' (632.68 Kg). It was followed by M₁ (555.39 Kg) and the minimum 'yield per hectare' was recorded in control (282.16 Kg). Regarding planting density, the treatments under S₂ *i.e.*, 30 x 30 cm recorded the maximum 'yield per hectare' (496.09 Kg) and the minimum 'yield per hectare' was recorded in S₃ (481.35 Kg). Strawberry under wider spacing tends to receive more light by their photosynthetic leaves due to their higher canopy. Abdel-Mawgoud *et al.* (2010) too related the increase in growth of strawberry is mainly due to higher photosynthesis production that

reflected from increasing leaf area and No. of leaves. In case of 'Number of flowers per plant', the treatment under S₁ (30 x 15 cm) registered maximum value. This might be due to the spacing effect for better microclimate and weed free environment. Moreover, the closer spacing provided enough competition to reduce vigorous vegetative growth (Wright and Sandrang, 1993).

Table 1. Effect of mulching and planting density on 'Plant height (cm)' in strawberry cv. Winter Dawn

Treatments	'Plant height (cm)'		
	S ₁	S ₂	S ₃
C	7.67	7.99	8.07
M ₁	8.11	10.01	10.88
M ₂	8.98	11.87	13.23
M ₃	8.13	11.34	12.90
M ₄	7.34	9.32	10.21
MEAN	8.05	10.11	11.06

Table 2. Effect of mulching and planting density on 'Number of shoots per plant' in strawberry cv. Winter Dawn

Treatments	'Number of shoots per plant'		
	S ₁	S ₂	S ₃
C	22.13	22.49	23.34
M ₁	24.12	28.21	32.11
M ₂	24.21	28.34	32.34
M ₃	23.31	27.12	31.41
M ₄	22.10	26.48	30.56
MEAN	23.17	26.53	29.95

Table 3. Effect of mulching and planting density on 'Number of leaves per plant' in strawberry cv. Winter Dawn

Treatments	'Number of leaves per plant'			MEAN
	S ₁	S ₂	S ₃	
C	28.43	29.60	29.90	29.31
M ₁	30.12	32.21	36.11	32.81
M ₂	36.22	40.23	43.34	39.93
M ₃	29.13	34.32	37.56	33.67
M ₄	28.45	31.45	34.23	31.38

Table 4. Effect of mulching and planting density on 'Leaf area (cm²)' in strawberry cv. Winter Dawn

Treatments	'Leaf area (cm ²)'			MEAN
	S ₁	S ₂	S ₃	
C	31.37	32.66	32.99	32.34
M ₁	32.24	48.14	50.13	43.50
M ₂	32.88	57.34	59.81	50.01
M ₃	30.64	38.54	42.78	37.32
M ₄	27.32	38.78	48.89	38.33

Table 5. Effect of mulching and planting density on ‘Plant spread E-W (cm)’ and ‘Plant spread N-S (cm)’ in strawberry cv. Winter Dawn

Treatments	‘Plant spread E-W (cm)’				‘Plant spread N-S (cm)’			
	S ₁	S ₂	S ₃	MEAN	S ₁	S ₂	S ₃	MEAN
C	12.88	13.45	13.93	13.42	13.35	14.21	15.03	14.20
M ₁	15.13	20.23	21.46	18.94	15.91	21.12	22.34	19.79
M ₂	15.56	21.23	22.11	19.63	16.45	22.31	22.98	20.58
M ₃	14.76	19.57	21.14	18.49	15.13	20.43	21.93	19.16
M ₄	14.76	19.59	20.23	18.19	15.23	20.32	21.45	19.00

Table 6. Effect of mulching and planting density on ‘Number of flowers per plant’ in strawberry cv. Winter Dawn

Treatments	‘Number of flowers per plant’			
	S ₁	S ₂	S ₃	MEAN
C	9.97	9.83	8.81	9.54
M ₁	15.99	15.56	15.32	15.62
M ₂	16.11	15.36	15.33	15.60
M ₃	15.11	14.80	14.77	14.89
M ₄	13.76	13.11	13.08	13.32

Table 7. Effect of mulching and planting density on ‘Number of fruits set per plant’ in strawberry cv. Winter Dawn

Treatments	‘Number of fruits set per plant’			
	S ₁	S ₂	S ₃	MEAN
C	7.85	7.42	6.99	7.42
M ₁	13.60	12.90	11.92	12.81
M ₂	14.10	13.11	12.71	13.31
M ₃	12.60	12.01	11.60	12.07
M ₄	10.90	10.01	9.98	10.30

Table 8. Effect of mulching and planting density on ‘Fruit set percentage (%)’ in strawberry cv. Winter Dawn

Treatments	‘Fruit set percentage (%)’			
	S ₁	S ₂	S ₃	MEAN
C	78.73	71.10	70.60	73.48
M ₁	85.05	82.90	77.80	81.92
M ₂	87.52	85.35	78.99	83.95
M ₃	83.38	81.14	78.53	81.02
M ₄	79.21	76.35	76.29	77.28

Table 9. Effect of mulching and planting density on ‘Yield per plant (g)’ and ‘Yield per hectare (Kg)’ in strawberry cv. Winter Dawn

Treatments	‘Yield per plant (g)’				‘Yield per hectare (Kg)’			
	S ₁	S ₂	S ₃	MEAN	S ₁	S ₂	S ₃	MEAN
C	117.59	113.01	108.00	112.87	293.98	282.52	269.99	282.16
M ₁	226.85	227.69	211.94	222.16	567.12	569.21	529.84	555.39
M ₂	245.06	259.71	254.45	253.07	612.65	649.27	636.14	632.68
M ₃	198.83	202.49	198.59	199.97	497.07	506.22	496.48	499.92
M ₄	177.89	189.29	189.72	185.63	444.72	473.22	474.30	464.08

Conclusion

It was concluded that cultivation of strawberry under green mulches (M₂) along with planting density of 30 x 30 cm found to be beneficial on both yield and quality traits. Though M₂S₃ registered superiority over some of the growth traits, on analysis of entire characters, it was found to be in range with M₂S₂. Therefore, the green mulches (M₂) along with planting density of 30 x 30 cm found to be recommended for strawberry cultivation of the cv. Winter Dawn under subtropical regions of Punjab.

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