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Effect of Different Soil Amendment Along with Mulching Material under Polyhouse Condition in Stawberry (*Fragaria* x *ananassa* Duch) cv. Winter Dawn

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

An investigation was carried in experimental field of Department of Horticulture, SHUATS (October 2021- March 2022). The experiment was laid out in Randomized Block Design (RBD) with 19 treatments and each treatment replicated 3 times. The study revealed that maximum plant height (18.16 cm), number of leaves (15), maximum plant spread in N-S (21.11 cm) and E-W (20.11 cm), minimum days taken to first flowering (36 days), maximum number of flowers/plant (20), minimum number of days to fruit setting (5.88), maximum total number of fruits/plant (16), berry length (42.27 mm), berry width (37.11 mm), berry weight (25.32 g), maximum yield/plant (371.95 g), maximum yield (q/ha) (165.31 g), lowest acidity (0.80%), highest vitamin-c (55 mg/100 g) and maximum benefit cost ratio (4.15) were observed under T_{17} (Vermicompost + Plastic mulch). Therefore, T_{17} (Vermicompost + Plastic mulch) showed best result as compared to other treatments.

Keywords: Strawberry; soil amendment; mulching material; polyhouse.

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1. INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) is one of the most economically important berry fruits consumed due to its well nutritional value, aroma, attractive and juicy fruit. It is a short day herbaceous perennial plant that grow well in temperature ranging from 22°C -25°C during the day and 7°C - 13°C night [1].

Its cultivation has recently gained popularity in India due to very high returns per unit area in a short period of time. Its production and area have increased dramatically over the decades, with the majority of it being grown under protected structures. It is grown commercially in India viz., Maharashtra, Punjab, Haryana, Delhi, Himachal Pradesh, J & K, Uttarakhand, U.P, and West Bengal (Hills of Darjeeling) as well as Rajasthan [2].

Botanically, strawberry is an aggregate fruit with having seeds on the outer surface of a red fleshy receptacle [3].Since plants grown from seeds are not true forms, commercial strawberry transplants are vegetatively propagated [4]. Its transplants are primarily produced by vegetative propagation using runner plants [5].

Organic amendments have been shown to be an efficient way to improve soil structure, pH, bio-physical conditions and the availability of essential nutrient [6] which leads to increased crop yields and improved soil fertility. Various organic and synthetic mulches are being used in different parts of the country for the production of strawberry. The growing of strawberry on raised beds using plastic mulches is a practice commonly followed worldwide. The yield, quality of the fruit and duration of fruit harvesting is mainly influenced by the mulching [7]. Applying organic mulch (straw, leaves, compost, or similar), further benefits achieved are the increase of organic matter in soil and the stimulation of development of soil micro and macro-flora.

Use of ideal soil amendments and mulching materials have remained an important component in horticulture from time immemorial because they help in increasing crop growth, rooting percentage, yield and quality of the fruit and even provide a reservoir for water holding, nutrient holding and exchange for the plant root system and anchorage for plant roots. Especially mulching is one of the essential cultural practices in strawberry cultivation to protect the fruits from fungal decay and converse soil moisture for better crop and productivity. Applications of chemical fertilizers lead to the health and ecological hazards, depletion of physico-chemical properties of the soil and ultimately poor crop yield. Hence, there is need of alternate source of safe fertilizers which may enhance crop yield without having adverse effects on soil properties. Thus keeping in view above, an experiment on “Effect of different soil amendment along with mulching material under polyhouse condition in strawberry cv. Winter Dawn” was carried out.

2. MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2021-2022. Prayagraj is located at 25.45°N 81.84°E in the southern part of the Uttar Pradesh at an elevation of 98 meters (322 ft) and stands at the confluence of two, the Ganges and Yamuna.

The treatments comprised of ÷ T_0-Control (Soil without amendment), T_1 (Soil without amendment + Paddy straw), T_2 (Soil without amendment + Plastic mulch), T_3 (Soil without amendment + Dry grass), T_4 (Leaf mould + Paddy straw), T_5 (Leaf mould + Plastic mulch), T_6 (Leaf mould + Dry grass), T_7 (Paddy husk + Paddy straw), T_8 (Paddy husk + Plastic mulch), T_9 (Paddy husk + Dry grass), T_{10} (Cocopeat + Paddy straw), T_{11} (Cocopeat + Plastic mulch), T_{12} (Cocopeat + Dry grass), T_{13} (FYM + Paddy straw), T_{14} (FYM + Plastic mulch), T_{15} (FYM + Dry grass), T_{16} (Vermicompost + Paddy straw), T_{17} (Vermicompost + Plastic mulch), T_{18} (Vermicompost + Dry grass).

The planting materials (runners) were planted at spacing of 30 cm x 30 cm on raised bed 27th October, 2021. From transplanting till maturity and harvest, observations were recorded on plant height (cm),number of leaves per plant, plant spread in cm (N-S & E-W), number of Days to first flowering, number of flowers per plant, no. of fruit set, number of days to fruit setting, no. of fruits/plant, fruit length (mm), fruit diameter (mm), fruit weight (g) , yield per plant (g), yield (q/ ha), economic cost ,benefit: cost ratio, total soluble solid (%) ,acidity (%), ascorbic acid (mg/100 gm).

2.1 Total Soluble Solid (%)

To determine TSS three random fruits were selected randomly from each plot. Fruit juice was extracted using two fold muslin cloth. A little

amount of juice (sample) was taken on 6 Erma - Hand Refractometer (0-32%) and the TSS value of the fruit juice was recorded on the scale of the instrument and the mean values were expressed in percentage.

2.2 Acidity (%)

To estimate total titrable acidity of fresh fruit, 10 ml juice was taken and diluted with water to make up the final volume 100 ml, 10 ml of this sample add 2 drops of phenolphthalein indicator was titrated with 0.1 N NaOH end point appeared as pink colour (A.O.A.C 1980).

> Acidity % = (Titre× Normality of alkali× Volume made up × Equivalent wt. of acid×100) / (Volume of sample taken for estimation× Wt. or volume of sample taken×1000)

2.3 Ascorbic Acid (mg/100 gm)

The ascorbic acid of the fruit pulp was determined by the method given by Ranganna (1997).

2.4 Reagents

1. 3% Metaphosphoric acid (HPO_3) aqueous.
2. Ascorbic acid standard 1%, L-ascorbic acid in metaphosphoric solution.
3. Dye solution: 2,6 Dichlorophenol-indophenols in alkaline solution.

2.5 Estimation

5 ml L-ascorbic acid solution with same amount of HPO_3 was titrated against 2,6 Dichlorophenol-indophenol. The end point was assessed by light pink colour. The dye factor was determined by: Dye factor = 0.5S Titre Standard ascorbic acid and solution with HPO3 solution was titrated against the dye solution till the pink colour appeared.

2.6 Procedure

5 ml fruit juice was transferred into 100 ml volumetric flask and volume was made up to the mark with 3% metaphosphric acid. A known volume of aliquot 2;6- Dichlorophenol-indophenol dye solutionto a pink end point, which persisted for 15 seconds . Ascorbic acid of fruit pulp was determined by the following formula:

> Ascorbic acid (mg/100 g) = (Titre × Dye factor × volume made up × 100) / (Aliquot of extract for estimation × wt. /vol. of sample)

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height

At 30 DAP, maximum plant height (8.33 cm) was recorded under the treatment T_{17} (Vermicompost + Plastic mulch) and the minimum plant height (4.22 cm) was observed under control. At 60 DAP, treatment T_{17} (Vermicompost + Plastic mulch) showed maximum plant height (10.88 cm) while T_0 recorded minimum plant height (6.72 cm). At 90 DAP, the maximum plant height (14.50 cm) was recorded under the treatment T_{17} (Vermicompost + Plastic mulch). However the least plant height (9.55 cm) was confirmed under control. At 120 DAP, the superiority of treatment T_{17} (Vermicompost + Plastic mulch) registered maximum plant height (18.16 cm). Nevertheless minimum plant height (12.55 cm) was recorded under control. Similar findings were reported by Hazarika [8], Ali and Gaur [9].

3.1.2 Number of leaves

At 30 DAP, maximum number of leaves/plant (8.11) was recorded under the treatment T_{17} (Vermicompost + Plastic mulch) and the minimum number of leaves per plant (4.44) was recorded under control. At 60 DAP, maximum number of leaves per plant (10.55) was recorded in T_{17} (Vermicompost + Plastic mulch), which was found statistically at par with T_{16} having average number of leaves (9.88). However the minimum number of leaves per plant (6.44) was observed under control. At 90 DAP, the superiority of treatment T_{17} (Vermicompost + Plastic mulch), registered maximum number of leaves per plant (12.70). However the lowest number of leaves per plant (8.44) was recorded under the control. At 120 DAP, T_{17} (Vermicompost + Plastic mulch) produced maximum number of leaves (15), which was significantly differing from rest of the treatment and minimum was recorded in control. Similar findings were reported by Bhagat and Panigrahi [10], Kaur and Kaur [11].

3.1.3 Plant spread (N-S & E-W)

At 30 DAP, maximum plant spread was observed in North-South (18.22 cm) and East-West (17.38 cm) in treatment T_{17} (Vermicompost + Plastic mulch) and least plant spread was found in North-South (13.71 cm) and East-West (12.95 cm) in control.The maximum plant spread in

North-South and East-West at 60 DAP was observed in T_{17} (Vermicompost + Plastic mulch) (19.22 cm) (18.38 cm) and minimum in North-South (14.88 cm) and East-West (13.95 cm) was observed in control. At 90 DAP, plant spread in North-South (20.11 cm) and East-West (19.11 cm) was significantly maximum in T_{17} (Vermicompost + Plastic mulch) and minimum in North-South (15.85 cm) and East-West (14.95 cm) was recorded in control. At 120 DAP, treatment T_{17} (Vermicompost + Plastic mulch) recorded the maximum spread in North-South (21.11 cm) and East-West (20.11 cm) while the minimum plant spread North-South (17.04 cm) and East-West (15.95 cm) was observed in control.

3.1.4 Number of days taken to first flowering and Number of flowers/plant

Earliest flowering (36) was recorded in the treatment T_{17} (Vermicompost + Plastic mulch), which was at par with (Vermicompost + Paddy straw) T_{16} (37.44). However, control (Soil without amendment) was significantly late bloomed (54.33) DAP. The highest number of flowers per plant (20) was noticed under the treatment T_{17} (Vermicompost + Plastic mulch), followed by the treatment T_{16} (Vermicompost + Paddy straw) having average number of flowers per plant 19.44. The least number of flowers per plant (10.88) was recorded under control. The results are also line with the findings of, Singh et al., [12], Soni et al., [13], Ali and Gaur [9].

3.1.5 Days taken to first fruit set

The minimum days to fruit setting (5.88) was noted under the treatment T_{17} (Vermicompost + Plastic mulch), which was at par with T_{16} (Vermicompost + Paddy straw) having days to fruit setting (6.55). The maximum days to fruit setting (10) was observed under control (Soil without amendment),which was at par with T_3 (Soil without amendment + Dry grass) having days to fruit setting (10 days). Similar finding was reported by Khalid et al., [14], Ali and Gaur [9].

3.2 Yield Attributes

3.2.1 Total fruits/plant

The maximum number of fruits per plant was observed (16) in T_{17} (Vermicompost + Plastic mulch) followed by (15.44) in T_{16} (Vermicompost + Paddy straw). Whereas minimum number of fruits per plant observed in control (Soil without amendment) (6.89) which were statistically at par with T_3 (7.56). Similar finding was reported by Khalid et al., [14], Ali and Gaur [9].

3.2.2 Berry length (mm) and Berry width (mm)

The maximum fruit length (43.30 mm) was noticed under the treatment T_{17} (Vermicompost + Plastic mulch) at par with treatment T_{16} (Vermicompost + Paddy straw) (42.27 mm) and the minimum fruit length (31.66 mm) was recorded under control (Soil without amendment). The maximum berry width (37.11 mm) was noticed under the treatment T_{17} (Vermicompost + Plastic mulch) which was found at par with T_{16} berry width of 36.83 mm respectively. The least berry width (29.63 mm) was recorded under Control. Similar results were obtained by Soni et al., [13], BJ Sahana et al., [15].

3.2.3 Berry weight (g)

Heaviest fruit was harvested from treatment T_{17} (Vermicompost + Plastic mulch) (25.32 g) which was followed by treatment T_{16} (24.33 g). The lightest fruits were produced by control (Soil without amendment) having weight (13.58 g) which were found statistically at par with T_3 & T_2 (14.67 g) & (15.67 g).

3.2.4 Yield/plant (g) and Yield (q/ha)

Highest yield per plant (371.95 g) recorded in the treatment T_{17} (Vermicompost + Plastic mulch) followed by T_{16} (Vermicompost + Paddy straw) having a yield of 360.36 g and lowest yield (153.66 g) recorded in control. The highest yield (165.31 q/ha) was recorded under the treatment T_{17} (Vermicompost + Plastic mulch), followed by T_{16} (Vermicompost + Paddy straw) having an average fruit yield of (160.15 q/ha) and the minimum fruit yield (68.29 q/ha) was recorded under control (Soil without amendment). Similar observations have been reported by Bhagat and Panigrahi [16].

3.3 Quality Attribute

3.3.1 Total soluble solids (%)

The maximum total soluble solids (7.80%) was observed under the treatment T_{16} (Vermicompost + Paddy straw), which was found significantly superior with rest of the treatments and was followed by T_{17} (7.70%). The lowest total soluble solid (6.06%) was registered under control (Soil without amendment) T_0. Similar findings was reported by Singh et al., [12].

Table 1. Mean performance of growth parameters in Strawberry

Treatments	Plant height (cm)				No. of leaves				Plant Spread								Days to first flowering	Number of flowers	Days to first fruit set
									N-S				E-W						
	30	60	90	120	30	60	90	120	30	60	90	120	30	60	90	120			
T0	4.22	6.72	9.55	12.60	4.44	6.44	8.44	10.33	13.71	14.88	15.85	17.04	12.95	13.95	14.95	15.95	54.33	10.88	10.00
T1	4.61	7.33	10.33	13.20	4.66	6.66	8.66	10.66	14.14	15.16	16.24	17.30	13.67	14.61	15.63	16.65	51.77	12.11	9.66
T2	4.77	7.44	10.44	13.40	4.88	6.88	8.88	10.88	14.35	15.35	16.48	17.41	13.85	14.85	15.85	16.85	50.66	12.55	9.55
T3	4.50	7.17	10.16	12.90	4.55	6.55	8.55	10.55	13.84	15.00	16.11	17.20	13.38	14.4	15.46	16.31	52.66	11.44	9.77
T4	5.66	8.17	11.16	14.20	5.22	7.22	9.22	11.22	14.66	15.81	16.81	17.81	14.21	15.21	16.11	17.22	48.33	13.44	9.11
T5	5.83	8.33	11.33	14.30	5.33	7.44	9.44	11.44	14.86	16.00	17.37	18.37	14.35	15.35	16.33	17.46	47.44	13.77	9.33
T6	5.33	7.84	10.83	13.80	5.00	7.00	9.00	11.00	14.40	15.55	16.64	17.64	14.03	15.01	16.00	17.06	49.77	13.33	9.33
T7	7.38	9.88	13.11	16.50	7.00	9.44	11.90	13.88	16.53	17.53	18.83	20.27	16.23	17.23	18.23	19.23	39.66	17.22	7.22
T8	7.66	10.2	13.55	16.90	7.33	9.66	12.00	14.00	16.73	17.75	19.02	20.44	16.56	17.56	18.56	19.56	39.11	17.8	6.88
T9	7.11	9.61	12.94	16.20	6.88	9.22	11.60	13.55	16.37	17.37	18.60	20.04	15.91	16.91	17.91	18.91	40.66	16.88	7.55
T10	6.44	8.94	11.94	14.90	5.66	7.88	10.10	12.11	15.32	16.30	17.76	18.76	14.73	15.73	16.77	17.77	45.77	14.44	8.77
T11	6.66	9.16	12.16	15.20	5.77	8.00	10.20	12.22	15.55	16.50	17.81	18.81	14.97	15.97	16.97	17.97	44.77	14.77	8.44
T12	6.22	8.72	11.72	14.70	5.44	7.66	9.77	11.77	15.11	16.16	17.61	18.61	14.56	15.56	16.58	17.55	46.55	14.11	8.88
T13	6.94	9.44	12.55	15.90	6.11	8.88	11.00	12.88	15.96	17.00	18.05	19.50	15.41	16.41	17.41	18.41	42.55	15.88	7.88
T14	7.00	9.50	12.77	16.00	6.33	9.00	11.20	13.00	16.12	17.12	18.24	19.76	15.60	16.60	17.60	18.60	41.44	16.44	7.66
T15	6.88	9.38	12.38	15.50	5.88	8.44	10.80	12.66	15.72	16.87	18.01	19.26	15.22	16.22	17.27	18.27	43.33	15.33	8.11
T16	8.16	10.70	14.05	17.70	7.44	9.88	12.20	14.22	17.61	18.74	19.88	20.96	17.05	18.05	19.05	20.05	37.44	19.44	6.55
T17	8.33	10.90	14.50	18.20	8.11	10.55	12.70	15.00	18.22	19.22	20.11	21.11	17.38	18.38	19.11	20.11	36.00	20.00	5.88
T18	7.83	10.30	13.83	17.30	7.77	10.11	12.80	14.77	17.27	18.27	19.66	20.88	16.88	17.88	18.88	19.88	38.11	18.44	6.44
F-Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
SE.d (±)	0.55	0.56	0.57	0.52	0.7	0.54	0.55	0.55	1.3	1.28	1.18	1.2	1.28	1.3	1.28	1.3	0.96	0.59	0.58
C.D at 5%	1.13	1.14	1.17	1.06	1.43	1.11	1.12	1.13	2.66	2.62	2.42	2.44	2.61	2.66	2.61	2.65	1.96	1.2	1.19

Table 2. Mean performance of Yield and quality parameters in Strawberry

Treaments	Total fruits/ plant	Berry length (mm)	Berry width (mm)	Berry weight (g)	Yield / plant (g)	Yield (q/ha)	TSS	Acidity (%)	Ascorbic acid (mg/100g)
T0	6.89	31.66	29.63	13.58	153.66	68.29	6.06	1.66	50.66
T1	8.11	33.83	30.77	16.43	170.33	75..70	6.13	1.55	51.26
T2	8.67	34.72	31.77	15.67	180.00	79.99	6.23	1.50	51.41
T3	7.56	32.24	30.11	14.67	162.68	72.30	6.03	1.60	51.00
T4	9.44	36.33	32.44	17.78	213.38	94.83	6.43	1.38	51.90
T5	9.89	38.33	32.77	18.33	220.39	97.95	6.53	1.35	52.16
T6	9.33	35.83	32.11	17.17	196.33	87.25	6.33	1.42	51.60
T7	13.22	40.66	35.33	22.67	321.53	142.90	7.36	0.93	53.83
T8	14.00	41.77	36.55	23.33	338.67	150.51	7.46	0.90	54.20
T9	12.89	40.16	35.00	22.33	311.66	138.51	7.26	0.96	53.60
T10	10.11	38.94	33.27	19.32	245.00	108.88	6.73	1.26	52.60
T11	10.78	39.11	33.88	20.33	254.63	113.16	6.83	1.21	52.86
T12	10.11	38.77	33.05	18.83	232.70	103.42	6.63	1.31	52.36
T13	12.11	39.83	34.55	21.33	285.33	126.81	7.03	1.15	53.23
T14	12.33	40.00	34.88	21.86	293.60	130.48	7.13	1.00	53.42
T15	11.33	39.44	34.11	20.67	272.47	121.09	6.93	1.18	53.03
T16	15.44	42.27	36.83	24.33	360.36	160.15	7.80	0.83	54.77
T17	16.00	43.30	37.11	25.32	371.95	165.31	7.70	0.80	55.00
T18	14.44	42.00	36.61	23.83	350.36	155.71	7.60	0.86	54.43
F-Test	S	S	S	S	S	S	S	S	S
SE.d (±)	0.62	2.17	1.97	3.34	1.2	0.53	0.04	0.08	0.48
C.D at 5%	1.27	4.42	4.02	6.79	2.44	1.08	0.09	0.17	0.98

Table 3. Gross returns, net returns and B:C ratio

Treatments	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C Ratio
T0	3,75,550	8,19,480	4,43,930	1.18
T1	3,77,050	9,08,400	5,31,350	1.4
T2	3,78,550	9,59,880	5,81,330	1.53
T3	3,76,550	8,67,600	4,91,050	1.3
T4	3,82,050	11,37,960	7,55,910	1.97
T5	3,83,550	11,75,400	7,91,850	2.06
T6	3,81,550	10,47,000	6,65,450	1.74
T7	3,79,550	17,14,800	13,35,250	3.51
T8	3,81,050	18,06,120	14,25,070	3.73
T9	3,79,050	16,62,120	12,83,070	3.38
T10	3,82,550	13,06,560	9,24,010	2.41
T11	3,84,050	13,57,920	9,73,870	2.53
T12	3,82,050	12,41,040	8,58,990	2.24
T13	3,79,050	15,21,720	11,42,670	3.01
T14	3,80,550	15,65,760	11,85,210	3.11
T15	3,78,550	14,53,080	10,74,530	2.83
T16	3,83,050	19,21,800	15,38,750	4.01
T17	3,84,550	19,83,720	15,99,170	4.15
T18	3,82,550	18,68,520	14,85,970	3.88

3.3.2 Acidity (%) and Vitamin- C (mg/100 g)

The minimum acidity (0.80%) was recorded under the treatment T_{17} (Vermicompost + Plastic mulch), was found significantly different from rest treatments and the maximum acidity (1.66%) was registered under control (Soil without amendment). The maximum ascorbic acid (55 mg/100gm) was recorded under the treatment T_{17} (Vermicompost + Plastic mulch), superior over rest of the treatments. The minimum ascorbic acid (50.66 mg/100 gm) was registered under control (Soil without amendment). In conformity of this observations were analyzed by Kumar et al., [17], Kour and Singh [18].

4. CONCLUSION

In terms of growth parameters (plant height, number of leaves , plant spread, number of days taken to first flowering, number of flowers/plant, days taken to first fruit set) plants treated with Vermicompost + Plastic mulch (T_{17}) showed best results. Even in terms of quality parameters (TSS, acidity, ascorbic acid) and yield parameters (total fruits/plant, berry length, berry width, berry weight, yield/plant and yield q/ha) treatment T_{17} (Vermicompost + Plastic mulch) gave maximum result. Hence, from the present study it can be concluded that vermicompost along with plastic mulch was found significantly maximum.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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