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Effect of organic sources of nutrients on growth, yield and quality of strawberry (*Fragaria X ananassa* Duch.) CV. Winter Dawn

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ABSTRACT

The Experiment "Effect of an organic source of nutrients on growth yield and quality of strawberry (*Fragaria x ananassa* Duch.) cv. Winter Dawn" was carried out during the year 2021-2022 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences Prayagraj in November 2021 to March 2022. The result revealed that treatment T8 FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB(5kg/ha) + Azotobacter (5kg/ha) was found to be best in terms of maximum plant height (14.26 cm), plant spread (23.8 cm), number of leaves per plant (9.58), number of days to first flowering (68.33), number of flower per plant (22.8), number of days taken to first fruit set (5.63), Number of fruit per plant (18.3), Fruit yield per plant (504.44g), fruit yield (45.3 t ha^{-1}), Vitamin C (87.94 mg/100g, acidity (0.33%), Total soluble solids (12.41°Brix)

Key words : *Growth, Fruit yield, Quality, Strawberry, (Fragaria x ananassa Duch.), Winter dawn*

Introduction

Strawberry (*Fragaria ananassa Duch*.), a member of the family Rosaceae is a hybrid of American native species (*F. chiloensis* × *F. Virginiana).* It was first developed in France in the seventeenth century. It is also grown widely in European countries, Israel, Japan, Turkey, Australia, and New Zealand. Strawberry fruit was introduced in India in Early 1960's. In India, the cultivation of strawberries has taken momentum in the states like Himachal Pradesh, Jammu, and Kashmir, Uttar Pradesh, Haryana, Punjab, Maharashtra, and Uttaranchal. Strawberry is one of the most delicious and nutritious soft fruits in the temperate world and all the cultivated varieties are octoploid (2n=8×=56). Botanically, it is an aggregate perennial fruit plant that is a small herb with a shallow root system. Though strawberry is a crop of temperate climate now it is also being successfully grown in tropical and subtropical regions. The fresh strawberry fruit is a rich source of vitamins and minerals. Strawberry contains about 0.55% pectin (as calcium pectate). It is a fairly good source of vit. A (60 IU/100 g of edible portion) and vit. C (30-120 mg/100 g of edible portion). Strawberry has medicinal properties like anti-carcinogenic, anti-septic and anti-oxidant. Strawberry is gaining popularity among all age groups of consumers due to its low calorific value, absence of cholesterol, and a higher level of minerals like P, K, Ca, and Fe (Ram and Patel, 2003). It prefers slightly acidic soils with a pH of 5.7 – 6.5. Flowering in strawberries is strongly influenced by photoperiod, temperature, and interaction of both. In the subtropical region, flowering oc-

curs in a short light period of (10 hr.) and with a long dark period (14 hr.). An optimum growing temperature of 15 °C has been reported for most of the strawberry cultivars and species, though it grows well at a temperature range between 20 °C and 26 °C (Manakasen and Goodwin, 2001; Sonsteby and Heide, 2006;)

Materials and Methods

The Experiment was carried out during the year 2021-2022 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj in November 2021 to March 2022. The experiment was conducted on strawberry cv. Winter Dawn. All the facilities necessary for cultivation, including labor were made in the Department. The prayagraj District comes under a subtropical belt in the southeast of the U.P. which experiences extremely hot summer and fairly cold winter. During the winter months (Dec.-Jan) temperature falls 2-5 ^{0}C or even low, while in the summer months (May-June) it reaches as high as 49 ^{0}C. Hot blowing winds are a regular feature during the summers and an occasional spell of frost may be during winters. Most of the rainfall is received in the middle of July to the end of September after which the intensity of rainfall decreases. The mean annual rainfall is about 850-1100 mm.

However, occasional precipitation is also not uncommon during the winter months. The average monthly rainfall, maximum and minimum temperature, and relative humidity recorded at SHUATS Prayagraj during the observatory period.

Results and Discussion

Statistically Analysed

Growth Parameters

Plant Height (cm)

The data on plant of strawberry as affected by various treatments are presented in Table 1, it is clear from the Table that there are significant differences among the treatment. At 30 DAT the maximum plant height (8.44 cm) was recorded in treatment T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter 95kg/ha), followed by T4-FYM (10 t/ha) + Vermicompost (4.25 t/ha), T1- FYM (20t/ha), T9- RDF100:60:60 NPK (kg/ha). Minimum plant height (6.3 cm) was recorded under T10-(control).

In the second and third observations (60 DAT and 90 DAT after planting), the maximum plant height (12.69 cm and 14.26 cm, respectively) was recorded in T8- FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter 95 kg/ha), but all the treatments except control were at par to each other and significantly superior over the control.

Plant spread N-S (cm)

The data on plant of strawberry as affected by various treatment are presented. It is clear from the data that there are significant differences among the treatment At 30 DAT The maximum N-S plant spread (15.2 cm) was recorded in T_8- FYM(7.5t/ha) + Vermicompost (3.18t/ha) + PSB(5kg/ha) + Azotobacter (5kg/ha) and all the treatment were statistically at par with T_8 whereas, minimum plant spread was recorded in T10-control.

The second and third reading was taken 60 DAT and 90 DAT of the strawberry. The maximum N-S plant spread in the (21.2 cm and 23.8 cm) was again observed in T_8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter (5kg/ha). All other treatments were at par with T8 and significantly superior over T_{10}- (control).

Number of Leaves per Plant

The data on plant of strawberry as affected by various treatments are presented in Table 2. It is clear from the table that there are significant differences among the treatment.

The number of leaves per plant was taken at 30 DAT intervals starting from 30 DAT up to 90 DAT. In the first observation, i.e. 30 days after planting, maximum number of leaves (5.8) was observed under T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter (5kg/ha). and treatments T1- FYM (20 t/ha), T7- Mustard cake (1.5 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), T9-RDF- 100:60:60 NPK (kg/ha) and T5- FYM (15 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha) were at par with T8 where as, minimum number of leaves (4.4) was found in T10- (Control).

At 60 days after planting, the maximum number of leaves per plant (8.10) was again observed under T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha). followed by T3 – Mustard cake (2t/ha). T_4-FYM (10 t/ha) +

vermicompost (4.25 t/ha). But, a minimum number of leaves per plant was observed under T10-control.

At 90 days after planting, the maximum number of leaves per plant (9.58) were produced under T8-FYM (7.5 t/ha) + Vermicompost (3.18t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), which was at par to T_5 - FYM (15 t/ha) + PSB(5kg/ha), T1- FYM (20t/ha), T_7 - Mustard cake(1.5 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), T_2 - Vermicompost (8.5 t/ha) and T6- Vermicompost (6.37 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha) whereas, minimum number of leaves (7.4) was observed in T10- (Control). The increased vegetative growth by the application of organic sources of nutrients and biofertilizers may be due to the fact that nitrogen has a role in assimilation of numerous amino acids that are sequentially incorporated in proteins and nucleic acid which in turn increase the photosynthetic efficiency of leaves and production of more leaves.

Number of days taken to first flowering

The data on plant of strawberry as affected by various treatments are presented in Table 1. It is clear from the Table that there are significant differences among the treatment. The plants treated with T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter (5 kg/ha), flowered at (68.33) days after transplanting, which was minimum in comparison to all other treatments and T_7-Mustard cake (1.5 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), T_2 - Vermicompost (8.5 t/ha), T_1-FYM (20t/ha), T4-FYM (10 t/ha) + Vermicompost (4.25t/ha), T5 -FYM (15 t/ha) + PSB (5 kg/ha)+ Azotobactor (5 kg/ha), and T9- RDF-100:60:60 NPK (kg/ha) which were at par with T_8 while, T_{10} - (Control) took maximum days to first flowering (81.96) days.

Number of flowers per plant

The data on plant of strawberry as affected by various treatments are presented it is clear from the data that there are significant differences among the treatment. the treatment T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter (5kg/ha) produced maximum number of flowers per plant i.e. (22.8) however, treatment T2-Vermicompost (8.5 t/ha), T7- Mustard cake (1.5t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), T9-RDF 100:60:60 NPK (kg/ha) and T5- FYM (15 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha) were at par with T8 whereas, minimum number of flowers per plant (17.4) was recorded under T10-(Control).

Number of days taken to first fruit set

The data on plant of strawberry as affected by various treatments are presented. it is clear from the data that there are significant differences among the treatment. A close examination of mean values re-

Table 1. Effect of different treatment on Plant Height (cm), no of leaves and spread of plant of Strawberry

S. No.	Treatment	Plant height (cm)			Number of leaves			Spread of plant (cm)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	FYM (20t/ha)	7.10	10.22	12.63	5.6	7.46	8.63	12.33	14.73	17.2
T_2	Vermicompost (8.5t/ha)	6.38	9.38	11.8	4.8	6.06	8.4	10.58	13.5	15.8
T_3	Mustard cake(2t/ha)	6.6	8.85	11.7	5.2	7.36	8.53	12.49	14.46	18.4
T_4	FYM (10t/ha) +Vermicompost (4.25t/ha)	7.19	9.48	11.2	5.2	7.63	8.53	12.38	14.53	17.23
T_5	FYM (15t/ha) +PSB (5kg/ha) + Azotobacter(5kg/ha)	6.94	9.48	11.1	5.2	7.4	8.5	11.75	14.6	17.5
T_6	Vermicompost (6.37t/ha) + PSB (5kg/ha) + Azotobacter (5kg/ha)	6.4	8.76	11.06	5.0	6.7	8.24	10.05	14.03	17.7
T_7	Mustard cake (1.5t/ha) +PSB (5kg/ha) +Azotobacter (5kg/ha)	6.94	12.52	13.9	5.3	6.73	9.4	13.80	20.21	23.4
T_8	FYM (7.5t/ha) +Vermicompost (3.18t/ha) +PSB (5kg/ha) + Azotobacter (5kg/ha)	8.44	12.69	14.26	5.8	8.10	9.58	15.2	21.2	23.8
T_9	RDF-100:60:60 NPK kg/ha	6.97	9.34	12.06	4.8	6.63	8.26	10.27	14.63	18.26
T_{10}	Control	6.3	7.65	10.7	4.4	5.76	7.4	9.58	12.06	16.83
	SE.d	0.51	1.05	0.82	0.39	0.55	0.51	1.51	1.38	1.60
	CD at 5%	1.07	2.20	1.72	0.82	1.15	1.08	3.18	2.91	3.37

vealed that different treatments had a marked effect on the days taken to the first fruit set. The minimum days (5.633) taken to first fruit set was observed in the plants under T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter (5kg/ha). followed by T7- Mustard cake(1.5 t/ha) + PSB (5 kg/ha) + Azotobacter (5kg/ha), T2- Vermicompost (8.5 t/ha), T9- RDF-100:60:60 NPK (kg/ha), and F1-FYM (20t/ha) however, maximum days taken to first fruit set (6.4 days) was observed under T10-(control).

Yield per plant (g)

The data on plant of strawberry as affected by various treatments are presented in Table 4, it is clear from the table that there are significant differences among the treatment. During the investigation, the highest fruit yield per plant (504.44 g) was recorded under T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter (5 kg/ha), and the treatments T7- Mustard cake (1.5 t/ha) + P.S.B. (5 kg/ha) + Azotobacter (5 kg/ha), T6- Vermicompost (6.37 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), T9- RDF100:60:60 NPK (kg/ha), T5- FYM (15 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha) and T2-Vermicompost (8.5 t/ha)were at par with T8. Minimum yield per plant (181.12 g) was obtained with T10- (control).

Yield per ha (t)

The data on plant of strawberry as affected by various treatments are presented in Table 5. It is clear from the table that there are significant differences among the treatment. The highest fruit yield per hectare i.e. 45.3t, respectively was recorded in the plants under T8- FYM(7.5 t/ha) + Vermicompost (3.18t/ha) + PSB (5 kg/ha) + Azotobacter (5kg/ha) and treatments T7- Mustard cake (1.5 t/ha) + PSB (5 kg/ha) + Azotobacter (5kg/ha), T6- Vermicompost (6.37 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), T2- Vermicompost (8.5 t/ha) and T9- RDF 100:60:60 NPK (kg/ha), T3- Mustard cake (2 t/ha) were at par with T8 but significantly superior over T10-(control). The increase in weight, volume, length and breadth of fruits under this treatment may be due to the capability of vermicompost to produce growth hormones, enzymes, anti-fungal and anti- bacterial compounds, which in turn enhance these parameters over other treatments. Beneficial effect of Azotobacter may be due to the fixation of atmospheric nitrogen.

Total Soluble Solids (° Brix)

Maximum total soluble solids i.e. (12.41°) Brix was recorded under T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5 kg/ha) + Azotobacter 95 kg/ha). The other effective treatments in this regard were T4- FYM (10 t/ha) + Vermicompost (4.25 t/ha), T9-RDF 100:60:60 NPK (kg/ha), T3- Mustard cake (2 t/ha). which were at with T8 and statistically superior to T10-(control) which recorded the minimum TSS (7.64° Brix).

Table 2. Effect of different treatment on no of flowers, fruit and yield of Strawberry Plant.

S. No.	Treatment	No. of flower/ plant	No. of fruit/ plant	weight/ plant (gm)	Yield/ ha (t)	Shelf life of fruit (days)
T_1	FYM (20t/ha)	21	16.3	303.10	27.2	2.11
T_2	Vermicompost (8.5t/ha)	20.5	14.3	316.11	28.4	2.05
T_3	Mustard cake (2t/ha)	18.9	14.6	303	27.2	2.33
T_4	FYM (10t/ha) +Vermicompost (4.25t/ha)	19.1	15	287.67	25.8	2.06
T_5	FYM (15t/ha) +PSB (5kg/ha) +Azotobacter(5kg/ha)	19.4	14.6	279.89	25.1	2.11
T_6	Vermicompost (6.37t/ha) + PSB (5kg/ha) + Azotobacter (5 kg/ha)	19.1	15.3	328.56	29.5	2.22
T_7	Mustard cake (1.5t/ha) +PSB (5kg/ha) + Azotobacter (5 kg/ha)	20.2	14.3	407.22	36.6	2.17
T_8	FYM (7.5 t/ha) +Vermicompost (3.18 t/ha) +PSB (5 kg/ha) +Azotobacter (5 kg/ha)	22.8	18.3	504.44	45.3	2.72
T_9	RDF-100:60:60 NPK kg/ha	19.4	15.3	313	28.1	2.28
T_{10}	Control	17.4	11.9	181.12	16.3	1.67
	SE.d	0.81	0.53	29.66	2.67	0.15
	CD at 5%	1.71	1.11	0.37	5.61	0.32

Total titrable acidity (%)

During the investigation, maximum retention of acidity was recorded in control and minimum retention of acidity was recorded under T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), i.e. 0.33% closely followed by T3 (0.34%) and T9 (0.38%).

Ascorbic acid (mg/100 g of fruit)

From perusal of the data, we can clearly say that maximum ascorbic acid content (87.94 mg/100 g of fruit) was recorded in T8-FYM (7.5t/ha) + Vermicompost (3.18 t/ha) + PSB (5kg/ha) + Azotobacter (5 kg/ha). Closely followed by T3- Mustard cake (2 t/ha), T6- Vermicompost (6.37 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha) and T9- RDF 100:60:60 NPK (kg/ha). Minimum ascorbic acid (45.21 mg/100 g of fruit) was recorded under T10-(Control).

Shelf life (days)

A perusal of data in the present investigation, revealed that the shelf life of fruits at ambient temperature (31±1°C) and Relative humidity (82 ± 1%) was maximum (2.83 days) in T8-FYM (7.5t/ha) + Vermicompost (3.18t/ha) + PSB (5kg/ha) + Azotobacter 95 kg/ha) closely followed by T4- FYM (10 t/ha) + Vermicompost (4.25 t/ha), T3- Mustard cake, T6- Vermicompost (6.37 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha) and T9- RDF 100:60:60 NPK (kg/ha). Minimum shelf life was recorded under T10- (control), i.e. 1.54 days. Prolonged shelf life can be attributed to Azotobacter application which might have to altered physiology and biochemistry of fruits and also due to influence of organic and inorganic sources of nutrients which might have reduced transpiration and respiration of fruit which in turn increased shelf life of tomato as reported by Krishna and Krishnappa (2002).

Conclusion

Thus, on the basis of result of this trial and the facts mentioned above, it can be concluded that in order to get higher economical yield with good quality fruits application of FYM (7.5 kg/ha) + Vermicompost (3.18 t/ha) + PSB (5 kg/ha) + Azotobacter (5 kg/ha), i.e. T_8 proved to be the most effective treatment.

The result obtained in the present investigation, thus, indicates the possibility of successful use of integrated application of organic sources of nutrients like FYM, Vermicompost, Mustard cake along with biofertilizers and it might prove to be a better option for enhancing growth, yield, and quality of strawberry.

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