Original Research Article

Influence of vermicompost and bio-fertilizers on growth and yield of strawberry (*Fragaria x ananassa* Duch) cv. Camarosa

ABSTRACT

The present investigation was carried out during 2023-2024 to find out the effect of vermicompost and bio-fertilizers on the growth and yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Camarosa at the Horticultural Research Farm of Doon (P.G.) College of Agriculture Science and Technology, Dehradun, Uttarakhand. The growth and yield parameters of strawberries were significantly influenced by different treatments of vermicompost and bio-fertilizers. The maximum plant height (23.10 cm) and plant spread (24.99 cm) were observed in the treatment T_6 [Vermicompost (50%) + *Azotobacter* (25%) + Arbuscular Mycorrhiza (25%)]. Maximum number of leaves per plant (67.11) and leaf area (96.67 cm^2) were observed in the treatment T_2 [Vermicompost (75%) + *Azotobacter* (50%)]. Treatment T_6 [Vermicompost (50%) + *Azotobacter* (25%) + Arbuscular Mycorrhiza (25%)] exhibits superiority in yield attributing characters like number of runners per plant (7.38), fruit size (15.52 cm^2), fruit weight (21.12 g), fruit volume (5.79 ml), number of fruits per plant (27.99) and yield per plant (569.86 g).

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Keywords: Vermicompost, Biofertilizer, Growth, Yield, Strawberry, *Fragaria*

1. INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) is an important fruit of Rosaceae family. Cultivated strawberry results from the hybridization of two different species *viz.*, *Fragaria chiloensis* Duch. and *Fragaria virginiana* Duch (Singh *et al.,* 2015). Strawberries have become one of the most popular soft fruits in the world after grapes (Umar *et al.,* 2009). It is delicate in flavor, rich in vitamins and minerals and gives the quickest returns in the minimum possible time (Singh *et al.,* 2009). In India the total area under strawberry cultivation is 3,310 ha, production is 19,840 MT and productivity is 5.99 MT/ha (Ministry of Agriculture and Farmers Welfare, 2021).

Strawberry is a rich source of vitamin A (60 IU/100 g fresh weight) and low-calorie carbohydrate fruit. Vitamin C is available as ascorbic acid (58.8 mg/100 g of edible portion).

Strawberry is also rich in fiber and pectin content (0.55%). Regular consumption of strawberries has been reported to prevent cancer and asthma disease (Wange *et al.*, 1998). Anthocyanins, phenolic compounds and ascorbic acid are the major components among the phytochemicals of the fruit, which provide medicinal properties (*viz.*, antioxidant, anticarcinogenic, anti-inflammatory, anti-neuro degenerative) (Fernandes *et al.*, 2012, D'Urso *et al.*, 2015 and Domingues *et al.*, 2018). Strawberry is an herbaceous fruit crop that acts as an annual in sub-tropical and perennial in the cool season (Khalid *et al.*, 2020).

Plant nutrition is one of the most important resources that contribute to the better growth, yield and quality of strawberries and has a direct effect on bearing and development of strawberries (Umar *et al.*, 2009). It is well known that the widespread use of chemical fertilizers has an adverse effect on soil health and contributes to reduced crop productivity and quality (Manolikar *et al.*, 2007). Vermicompost improves soil physical properties, pH, and water-holding capacity, while also adding macro and micronutrients. Thus it increases the nutrient availability and its absorption by plants. Among free living nitrogen-fixing bacteria, *Azotobacter* is the most intensively studied genus. With the ability to fix atmospheric nitrogen, *azotobacter* is also known to synthesise biologically active growth-promoting substances such as Indol Acetic Acid, Gibrellic acid and Vitamin B in culture media. *Azotobacter* fixes atmospheric nitrogen in the soil and enhances the production of various fruit crops (Kumar *et al.*, 2020). Arbuscular mycorrhizae (AM) play an important role in the establishment, growth and productivity of strawberry plants. It can supply phosphorus which affects floral differentiation and growth. Dual inoculation of such fungi with a rhizobium and other bacterium on plants enhanced the growth and other beneficial effects (Sadhana, 2014).

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Keeping in view the above literature, the present investigation was undertaken to find out the effect of the combined application of vermicompost and bio-fertilizers on the growth and yield of strawberry cv. Camarosa under Dehradun conditions of Uttarakhand.

2. MATERIALS AND METHODS

The present investigation was conducted at Horticultural Research Farm, Department of Horticulture, Doon (P.G.) College of Agriculture Science and Technology, Selaqui, Dehradun (UK), India from 2023-2024. The experimental site is located at an altitude of 515 m above mean sea level between 30.21°N latitudes and 77.50°W longitudes. The average annual rainfall

is 2073.3 mm; average temperature (15.5°C) and average humidity (75.25%) are recorded during the crop growth period. The soil of the experimental plot was sandy loam to clay loam with pH ranging from 6.5 to 7.5. The available nitrogen was very low (0.02%), available phosphorus was medium (48.9%) and available potassium was high (2.9%) in the soil of the experimental field. Electrical conductivity of soil ranged between 0.30-0.73 dS/m indicating the nature of soil is normal. Moreover, the soil having organic carbon ranged between 0.31% - 0.80%. The experiment was laid out in a Randomized Block Design (RBD) with 7 treatments and 3 replications. Strawberry cultivar 'Camarosa' was used as planting material. Black polythene mulch is used as mulching material which helps in proper crop management. The treatment consisted of vermicompost and biofertilizers singly or in combination assigned to different plots. T_1 [Control], T_2 [Vermicompost (75%) + *Azotobacter* (50%)], T_3 [Vermicompost (75%) + Arbuscular Mycorrhiza (50%)], T_4 [Vermicompost (100%)], T_5 [*Azotobacter* (75%) + Arbuscular Mycorrhiza (75%)], T_6 [Vermicompost (50%) + *Azotobacter* (25%) + Arbuscular Mycorrhiza (25%)] and T_7 [*Azotobacter* (100%)]. The calculated amount of vermicompost @ 10 tonnes/ha was applied before transplanting strawberry runners in the respective plots as per scheduled treatments. *Azotobacter* @ 7 kg/ha and Arbuscular Mycorrhiza @ 5 kg/ha were applied in the respective plots as per scheduled treatments before planting.

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All data about growth and yield components were collected from five plants from each replication in each experimental plot. A random sampling was done from each plot for the determination of growth attributes [plant height (cm), plant spread (cm), number of leaves per plant and leaf area (cm^2)]. After harvesting, yield attributes [number of runners per plant, fruit size i.e. length x width (mm), fruit weight (g), fruit volume (ml), number of fruit per plant and yield per plant (g)] were recorded. Plant height was measured with the help of measuring tape and expressed in centimeters. Plant spread was calculated by taking east-west and north-south spread with measuring tape and averaged. Leaf area was measured by a portable leaf area meter (BST-LM101, Bionics Scientific). Fruit size (cm^2) was calculated by multiplying fruit length (cm) and fruit diameter (cm) and measured by digital vernier callipers (Corceptive Pvt. ltd.). Fruit weight is expressed in grams. Fruit volume was analyzed by water displacement method and expressed in ml. Yield per plant was calculated by weighing all fruits in each treatment, replication-wise at the time of harvesting by using the electric balance 20 kg capacity. The obtained data was subjected to statistical analysis using the F test according to the procedure of

Gomez and Gomez (1984). The critical difference at 5% was calculated to compare the mean value of the determined criteria of different treatments.

3. RESULTS AND DISCUSSION

The present investigation revealed that the vermicompost and biofertilizers significantly impact the plant growth parameters (plant height, plant spread, number of leaves per plant and leaf area) and yield parameters (number of runners per plant, fruit size, fruit weight, fruit volume, number of fruit per plant and yield per plant) of strawberry fruit cv. Camarosa.

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3.1 Growth characteristics

According to data presented in Table 1, maximum plant height (23.10 cm) was reported with the treatment of T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] whereas minimum (16.55 cm) was reported in T_1 [control]. Effects of individual and combined application of biofertilizers and vermicompost were significantly different among the treatments. The maximum plant spread (24.99 cm) was reported in T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] treated plants followed by T_3 [Vermicompost (75%) + AM (50%)] and minimum plant spread (18.41 cm) was found in T_1 [control]. The maximum number of leaves per plant (67.11) was reported in T_2 [Vermicompost (75%) + *Azotobacter* (50%)] treated plants followed by T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] and the minimum number of leaves per plant (49.99) was recorded in T_1 [control]. Leaf area per plant was recorded as maximum (96.67 cm^2) in treatment T_2 [Vermicompost (75%) + *Azotobacter* (50%)] followed by T_3 [Vermicompost (75%) + AM (50%)] as compared to T_1 [control], which was minimum (87.35 cm^2) among treatments. The plants absorb more minerals & nutrients, thus increasing the number of leaves and growth of plants. Increasing the number of leaves helps the accumulation of carbohydrates through more photosynthetic activity done by plants which is utilized for fruit development. Hence the number of leaves improves the quantity of flowers and fruits which results in better growth and maximum yield of strawberries as reported by Verma and Rao (2013) and Singh *et al.* (2015).

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Table 1: Influence of vermicompost and biofertilizers on growth characteristics of strawberry

Symbols	Treatment Details	Plant Height (cm)	Plant Spread (cm)	Number of leaves per plant	Leaf Area (cm^2)

T_1	Control	16.55	18.41	49.99	87.35
T_2	Vermicompost (75%) + *Azotobacter* (50%)	20.55	22.10	67.11	96.67
T_3	Vermicompost (75%) + Arbuscular Mycorrhiza (50%)	21.55	23.66	63.33	94.64
T_4	Vermicompost (100%)	19.77	20.83	52.66	88.03
T_5	*Azotobacter* (75%) + Arbuscular Mycorrhiza (75%)	18.99	20.49	56.33	88.43
T_6	Vermicompost (50%) + *Azotobacter* (25%) + Arbuscular Mycorrhiza (25%)	23.10	24.99	65.66	88.50
T_7	*Azotobacter* (100%)	17.44	19.77	51.33	88.69
C.D. @ 5 %		1.592	1.264	2.018	1.473
SE(m)		0.511	0.406	0.648	0.473
C.V.		4.491	3.274	1.932	0.907

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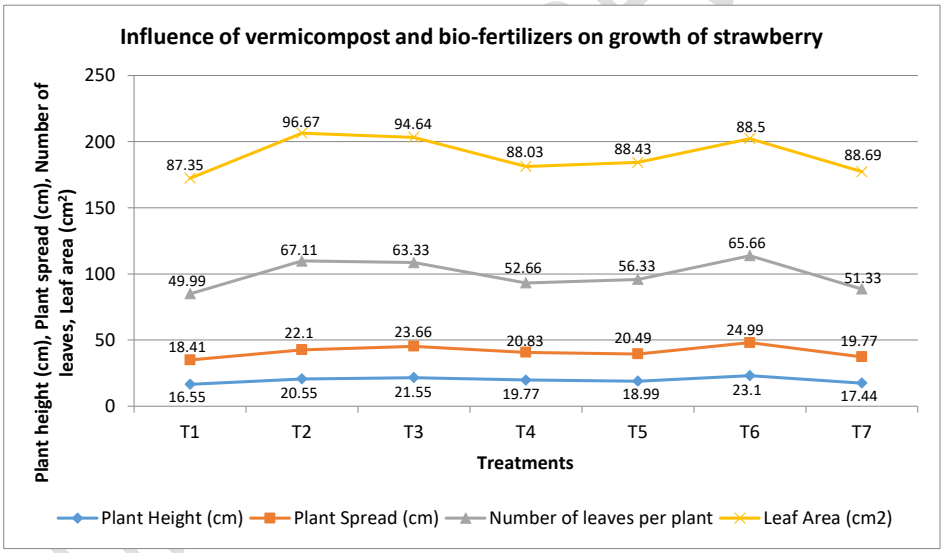

Figure 1: Influence of vermicompost and bio-fertilizers on plant height, plant spread, number of leaves per plant and leaf area of strawberry

3.2 Yield Characteristics

According to data present in Table 2, plants treated with T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] produced a maximum number of runners per plant (7.38)

followed by T_3 [Vermicompost (75%) + AM (50%)] which was significantly higher than all other treatments. Minimum number of runners per plant (3.51) was recorded in T_4 [Vermicompost (100%)]. Biofertilizers and vermicompost combination significantly increased the size of fruits and largest fruit size (15.52 cm^2) were produced in treatment T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] followed by T_3 [Vermicompost (75%) + AM (50%)] and minimum fruit size (7.61 cm^2) was recorded in T_1 [control]. Plants under T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] produced fruits of maximum weight (21.12 g) followed by T_3 [Vermicompost (75%) + AM (50%)] which was statistically at par with treatment T_2 [Vermicompost (75%) + *Azotobacter* (50%)]. Minimum fruit weight (10.49 g) was recorded under treatment T_1 [Control]. The maximum fruit volume (5.79 ml) was recorded in T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] followed by T_2 [Vermicompost (75%) + *Azotobacter* (50%)], while minimum fruit volume (3.89 ml) was recorded in T_1 [control]. The maximum number of fruits (27.99) was produced from T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] followed by T_3 [Vermicompost (75%) + AM (50%)] which was statistically at par with treatment T_2 [Vermicompost (75%) + *Azotobacter* (50%)]. Minimum number of fruits (15.33) was recorded in T_1 [control].

The maximum yield per plant (569.86 g) was recorded in treatment T_6 [Vermicompost (50%) + *Azotobacter* (25%) + AM (25%)] followed by T_3 [Vermicompost (75%) + AM (50%)] and minimum yield per plant (157.00 g) was found in T_1 [control]. The improved strawberry yield with multi-inoculation could be attributed to enhanced N availability in soil from biological N-fixing bacteria and increased P facilitated by phosphate solubilizing bacteria (PSB) (Rana and Chandel, 2003). Synergism among *Azospirillum* along with PSB and *Azotobacter* with PSB might have resulted better in strawberry yield as against single inoculation (Singh *et al.*, 2010).

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Plate 1. Fruiting stage of strawberry at experimental site

Table 2: Influence of vermicompost and biofertilizers on yield characteristics of strawberry

Symbols	Treatment Details	Number of runners per plant	Fruit size (cm^2)	Fruit weight (g)	Fruit volume (ml)	Number of fruits per plant	Yield per plant (g)
T_1	Control	5.44	7.61	10.49	3.89	15.33	157.00
T_2	Vermicompost (75%) + *Azotobacter* (50%)	5.54	14.07	16.24	5.18	23.44	372.80
T_3	Vermicompost (75%) + Arbuscular Mycorrhiza (50%)	6.73	14.80	18.76	4.89	24.99	448.23
T_4	Vermicompost (100%)	3.51	9.87	11.46	4.07	16.66	181.96
T_5	*Azotobacter* (75%) + Arbuscular Mycorrhiza (75%)	5.00	12.76	14.08	4.56	21.11	258.66
T_6	Vermicompost (50%) + *Azotobacter* (25%) + Arbuscular Mycorrhiza (25%)	7.38	15.52	21.12	5.79	27.99	569.86
T_7	*Azotobacter* (100%)	4.67	8.22	11.02	4.39	18.44	198.33
C.D. @ 5 %		0.405	1.060	3.788	0.377	3.349	39.201
SE(m)		0.130	0.340	1.216	0.121	1.075	12.583
C.V.		4.118	4.980	14.285	4.474	8.809	6.976

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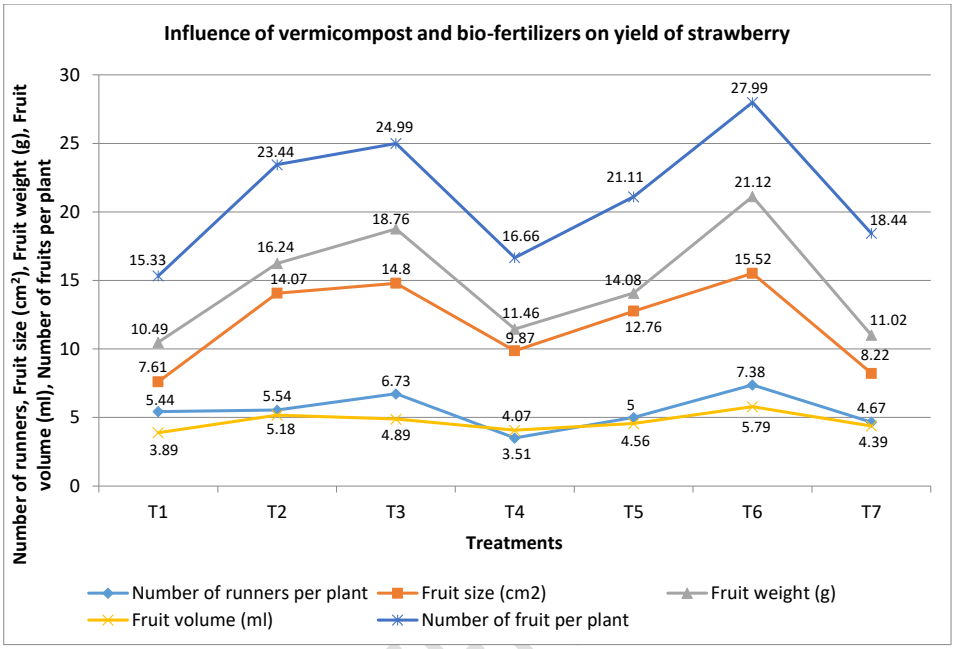

Figure 2: Influence of vermicompost and bio-fertilizers on the number of runners per plant, fruit size, fruit weight, fruit volume and number of fruits per plant of strawberry

4. CONCLUSION

From the results obtained during the present investigation with different treatment combinations of biofertilizers & vermicompost on vegetative growth & yield characters of strawberry cv. Camarosa, it is concluded that plants treated with Vermicompost (50%) + *Azotobacter* (25%) + AM (25%) significantly increased the height of the plant, plant spread, number of runners, fruit size, fruit weight, fruit volume, number of fruits per plant and yield per plant. Whereas number of leaves per plant and leaf area was maximum in Vermicompost (75%) + *Azotobacter* (50%) treated plants. Based on the above findings it may be concluded that to get substantially better growth and higher yield of berries with more propagating materials, the plants of strawberry may be treated with Vermicompost (50%) + *Azotobacter* (25%) + AM (25%) under Dehradun conditions of Uttarakhand.

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