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Effect of bio capsules, FYM and vermicompost on growth, yield and fruit quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. winter dawn

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Abstract
The present investigation entitled "Effect of Bio Capsules, FYM and Vermicompost on Growth, Yield and Quality of Strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn" was conducted during October-February 2023-24 at the Central Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (Uttar Pradesh) Which was carried out in Statistical Design adopted for the experiment was Randomized Block Design (RBD) with three replications ten treatments combinations. The result of present investigation shows that the treatment T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) outstands in all the aspects with significant results in Growth, Yield and Quality parameters. Quality parameters like Plant height (27.52 cm), Petiole length (14.81 cm), Number of leaves (16.33), Plant spread East-West (23.53 cm), Plant spread North-South (23.63 cm), Flowering period (46.77 days), Number of flowers per plant (29.93), Number of fruits per plant (15.67), Fresh weight of fruit (23.11 gm), Fruit yield per plant (309.57 gm), Fruit yield per plot (1.86 kg), Polar diameter (4.90 cm), Radial diameter (3.59 cm), TSS (9.99 ^{o}Brix), Ph (3.43), Specific gravity (1.71), Ascorbic acid (54.92) which was followed by T_7 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The lowest observation was recorded in T_0 Control. Treatment with FYM, Vermicompost and Bio Capsule improves growth, yield and quality to a lesser extent as compared to the control.

Keywords: FYM, vermicompost, bio capsules, quality, winter dawn, strawberry

Introduction
Strawberry (*Fragaria* × *ananassa* Duch.) is a member of the Rosaceae family. One of the most well-known fruits, it is grown in both dry and wet climates on plains and hillsides as high as 3000 meters. With a maximum daytime temperature of 22-25 °C and a maximum nighttime temperature of 7-13 °C, it is commonly grown in both temperate and subtropical regions in both sheltered and open conditions. This delightful fruit is primarily utilized in processed form and to enhance the flavor of other products. It is a plant that grows around the world. In the first century of the common era, the Roman poets Virgil and Ovid described it, and by the sixteenth century, English gardeners were growing strawberries. (Boriss *et al*. 2006) [6]. Due to their great nutritional content and potential medical benefits, strawberries are one of the best natural sources of antioxidants and have grown in popularity in recent years. They are thought to be a fair source of vitamin A, vitamin B1, and vitamin C. They are high in proteins, minerals (Calcium, Phosphate, and K), niacin, and vitamin Strawberry (*Fragaria* × *ananassa* Duch.) is a member of the Rosaceae family. One of the most well-known fruits, it is grown in both dry and wet climates on plains and hillsides as high as 3000 meters. With a maximum daytime temperature of 22-25 °C and a maximum nighttime temperature of 7-13 °C, it is commonly grown in both temperate and subtropical regions in both sheltered and open conditions. This delightful fruit is primarily utilized in processed form and to enhance the flavor of other products. It is a plant that grows around the world. In the first century of the common era, the Roman poets Virgil and Ovid described it, and by the sixteenth century, English gardeners were growing strawberries. (Boriss *et al*. 2006) [6]. Due to their great nutritional content and potential medical benefits, strawberries are one of the best natural sources of antioxidants and have grown in popularity in recent years.

They are thought to be a fair source of vitamin A, vitamin B1, and vitamin C. They are high in proteins, minerals (Calcium, Phosphate, and K), niacin, and vitamin
C. Strawberries can also be processed to create a variety of products, including ice cream, wine, jelly, jam, and soft drinks. According to the most recent research, eating more strawberries may help postpone the age-related decline in brain activity and behavioral deficiencies. It may also significantly lessen the damaging effects of free radicals on the mucosa of the stomach. Strawberry fruit is rich in bioflavonoids and phenol acids. (Wang, Lin, 2000) [18].
In strawberry production, environmental contamination has recently been caused by illegal fertilizers, pesticides, and biological monitoring results (Zargar *et al*., 2017) [20]. Chemical fertilizers boost crop yields but leave behind toxic residues that damage the environment, endanger people, and contaminate water supplies (Al-Mamun *et al*., 2021) [2]. Growing the cultivation of strawberries is therefore practically impossible (Abdel-Aziz *et al*., 2021) [1].
The use of biocapsules to influence various fruit crops' development, flowering, fruit output, fruit quality, and growth has drawn more interest recently. Numerous researches looked at the effects of Biocapsule on the weight, diameter, and consistency parameters of strawberries, i.e., ascorbic acid, acidity, sugar content, and gross soluble solids. Naturally small and biodegradable, bio capsules are designed to precisely and precisely distribute nutrients, insecticides, or other components to plants. Bio capsules might be used to gradually add new components, enhance existing ones, or even introduce beneficial bacteria to strawberries after a certain amount of time. (Lokesh *et al.* 2020) [9].
Farm yard manure (FYM), or premium organic manure, is highly prized. In order to maintain crop yield, long-term agricultural research conducted in various locales has shown the benefits of an integrated nutrient supply system over chemical fertilizers alone. (Gaur, 1991). Through a number of mechanisms, such as rapid respiration, enhanced cell permeability, hormone growth action, or a combination of all of these, Farm Yard Manure (FYM) typically has a direct impact on crop yields. It gives the plants readily available types of nitrogen, phosphorus, potassium, and sulfur through biological breakdown. It enhances the physical characteristics of soil, including aggregation, permeability, and water-holding capacity, in an indirect manner. Farm animal feces is used to make FYM, which is complete with all necessary elements.
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them physiologically available when applied to seed, soil, or growing plants. (ICAR, Indian Institute of Spices Research, Kozhikode). The application of biocapsules to strawberries has, however, received less research. Aiming to investigate the "Effects of bio capsules, FYM, and vermicompost on the growth, yield, and fruit quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn" this experiment was designed and executed with the aforementioned facts in mind.

Materials and Methods

Location of research

The present investigation entitled "Effect of Bio Capsules, FYM and Vermicompost on growth, Yield and fruit Quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn" was conducted during October to February in 2023-24 at the Central Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India. The details of the materials used and methodology adopted during the 2023-24 period of investigation are presented below. Three randomly chosen plants from various treatments were used for the observations in order to evaluate the effect of Bio Capsule, FYM and Vermicompost on strawberry growth, yield, and fruit quality. The study used a Randomized Block Design with three replications for each of the ten treatments, *viz* T_0 (control), T_1 (100% RDF), T_2 (100% FYM (6 t/ha)), T_3 (100% Vermicompost (2 t/ha)), T_4 (Bio Capsule (400 ppm)), T_5 (100% RDF + Bio Capsule (400 ppm)), T_6 (100% RDF + 40% FYM (2.4 t/ha) + 60% Vermicompost (1.2 t/ha)), T_7 (100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha)), T_8 (100% RDF + 80% FYM (4.8 t/ha) + 20% Vermicompost (0.4 t/ha)), T_9 (100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% Vermicompost (0.4 t/ha)

Vegetative characters

Plant height

Plant height was measured at 30, 60, and 90 days after transplanting, using a measuring scale that went from the plant's crown to the tip of its primary leaf. The results were stated in centimeters.

Petiole length

The petiole is the stalk of the whole leaf, however for the purpose of this key's operation, the leaflet stalk of complex leaves is also included. At 30, 60, and 90, it is measured. They computed and statistically analyzed their average.

Number of Leaves Plant^{-1}

At 30, 60, and 90 DAP, the total number of leaves on tagged plants in each replication was counted and the average number of leaves per plant was reported.

Details of Treatment

Treatment no.	Treatment Combinations
T_0	Control
T_1	100% RDF
T_2	100% FYM (6 t/ha)
T_3	100% Vermicompost (2 t/ha)
T_4	Bio Capsule (400 ppm)
T_5	100% RDF + Bio Capsule (400 ppm)
T_6	100% RDF + 40% FYM (2.4 t/ha) + 60% Vermicompost (1.2 t/ha)
T_7	100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha)
T_8	100% RDF + 80% FYM (4.8 t/ha) + 20% Vermicompost (0.4 t/ha)
T_9	100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% Vermicompost (0.4 t/ha)

Plant Spread cm (East - West and North - South)
Using a meter scale, the spread of the tagged plants was measured at 30, 60, and 90 DAP in both east-west and north-south directions, and the average for each direction was computed.

Flowering Parameters
Days Taken to First Flowering
Three to four plants in each replication began to blossom after transplantation. To make the observation, the average number of days from the planting date was computed.

Number of Flowers Plant^{-1}
The average number of flowers per plant was calculated by counting the flowers on the representative plants.

Yield Parameters
Number of Fruits Plant^{-1}
On the same three tagged plants where fruit set was examined, the number of fruits per plant was noted. At each harvest, the quantity of fruits that reached harvestable maturity was counted, and the result was expressed as the number of fruits per plant.

Fresh Weight of Fruit (g)
To determine the fruit weight, a subset of the fruit was taken out of each replication. The weight was recorded using an electronic balance, and the average weight of the berries was determined and reported in grams (g).

Fruit Yield Plant^{-1} (g)
For every treatment, the weight of the whole fruits that were taken from every plant was noted.

Fruit Yield Plot^{-1} (Kg)
For every treatment, the weight of the whole fruits that were taken from every plot was noted. After calculation, the yield per hectare was given as quintal per hectare.

Polar Diameter (cm)
Ten fruits from each treatment were measured for polar diameter using a digital vernier calliper. The data was then recorded by calculating the average length.

Radial Diameter (cm)
On the same ten fruits, the radial diameter was measured using a digital vernier, while the polar diameter was measured manually. The data was recorded using the average width.

Quality Parameters
Total Soluble Solids (°Brix)
With the use of a digital refractometer, the total soluble solids (TSS) were measured. individually treatment's fully ripe fruits were selected, and three to five fruits' worth of juice were individually extracted and dropped over the refractometer's prism in little amounts. The TSS (°Brix) was calculated by averaging the measured value.

pH of Fruit
Fruit juice's pH was determined using a pH meter. The pH electrode is first calibrated using a reference buffer solution whose pH readings are known to fall within the measurement range. The electrode is submerged in the sample solution until a stable reading is obtained in order to measure pH.

Acidity (%)
With a small modification, Hortwitz's (1980) standard technique was used to assess titratable acidity (% malic acid). In order to do this, a known weight of crushed fruit was placed in a 100 ml volumetric flask, and the remaining volume was created by adding distilled water. After filtering, 10 milliliters of the filtrate were placed in a different conical flask and titrated against 0.1 N NaOH while employing phenolphthalein dye as a reference. The arrival of a light pink color served as the finish point indicator.

Ascorbic acid (mg/100g of fresh fruits)
Using 30% metaphosphoric acid as a buffer, 5-gram fruit pulp was ground to measure the ascorbic acid level. A muslin cloth was used to filter the extract, and the right volume was created. A appropriate aliquot was titrated up to the appearance of light pink color using a dichlorophenol dye solution (2–6). The result was expressed as milligrams of ascorbic acid per 100 grams of fruit pulp and was computed using the following formula. (AOAC, 1975)

Results and Discussion
Plant height, petiole length, number of leaves and plant spread all showed a consistent increase, according to the data (Table 1). Height of plant at 30 days after transplanting was maximum (9.16 cm) recorded in T9 100% RDF+35% FYM (2 t/ha)+Bio Capsule (400 ppm)+20% vermicompost (0.4 t/ha) was followed by T7 (8.63 cm) 100% RDF+60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum height (5.22 cm) was recorded in T0.
Height of plant at 60 days after transplanting was maximum (16.88 cm) recorded in T9 100% RDF+35% FYM (2 t/ha)+Bio Capsule (400 ppm)+20% vermicompost (0.4 t/ha) was followed by T7 (16.76 cm) 100% RDF +6 0% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum height (8.65 cm) was recorded in T0.

Height of plant at 90 days after transplanting was maximum (27.52 cm) recorded in T9 100% RDF+35% FYM (2 t/ha)+Bio Capsule (400 ppm)+20% vermicompost (0.4 t/ha) was followed by T7 (25.90 cm) 100% RDF+60% FYM (3.6 t/ha)+40% Vermicompost (0.8 t/ha). Whereas, the minimum height (16.15 cm) was recorded in T0.

Petiole length of plant at 30 days after transplanting was maximum (5.93 cm) recorded in T9 100% RDF+35% FYM (2 t/ha)+Bio Capsule (400 ppm)+20% vermicompost (0.4 t/ha) was followed by T7 (5.79 cm) 100% RDF+60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum petiole length (2.29 cm) was recorded in T0.

Petiole length of plant at 60 days after transplanting was maximum (13.02 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (12.83 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum petiole length (6.53 cm) was recorded in T_0.

Petiole length of plant at 90 days after transplanting was maximum (14.81 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (14.30 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha) Whereas, the minimum petiole length (7.81 cm) was recorded in T_0.

Number of leaves of plant at 30 days after transplanting was maximum (5.44) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (5.33) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of leaves (3.33) was recorded in T_0.

Number of leaves of plant at 60 days after transplanting was maximum (7.6) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (7.11) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of leaves (4.2) was recorded in T_0.

Number of leaves of plant at 90 days after transplanting was maximum (16.3) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (16.00) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of leaves (8.00) was recorded in T_0.

Plant spread in east-west at 30 days after transplanting was maximum (14.04 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (13.78 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum plant spread (8.33 cm) was recorded in T_0.

Plant spread in east-west at 60 days after transplanting was maximum (19.17 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (19.10 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum plant spread (10.30 cm) was recorded in T_0.

Plant spread in east-west at 90 days after transplanting was maximum (23.53 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (22.67 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum plant spread (14.40 cm) was recorded in T_0.

Plant spread in North-South at 30 days after transplanting was maximum (14.79 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (14.08 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum plant spread (9.17 cm) was recorded in T_0.

Plant spread in North-South at 60 days after transplanting was maximum (19.20 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (19.10 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum plant spread (10.27 cm) was recorded in T_0.

Plant spread in North-South at 90 days after transplanting was maximum (23.63 cm) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (22.83 cm) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum plant spread (14.50 cm) was recorded in T_0.

Table 1: Effect of Bio Capsule, FYM and Vermicompost on plant height, Petiole length, number of leaves per plant, plant spread in Strawberry cv. Winter Dawn

Treatments	Plant Height (cm)			Petiole length (cm)			No. of leaves plant^{-1}			Plant spread (cm)					
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT (E-W)	30 DAT (N-S)	60 DAT (E-W)	60 DAT (N-S)	90 DAT (E-W)	90 DAT (N-S)
T_0	5.22	8.65	16.15	2.29	6.53	7.81	3.33	4.22	8.00	8.33	9.17	10.30	10.27	14.40	14.50
T_1	5.87	9.66	17.86	2.69	7.88	9.05	3.89	5.00	8.22	8.71	10.14	12.93	12.87	15.97	16.10
T_2	5.80	10.60	19.58	2.97	8.75	9.92	4.22	5.44	9.22	9.22	10.24	13.23	13.17	17.23	17.50
T_3	5.93	11.84	20.63	3.67	9.65	10.72	4.78	5.55	12.78	10.06	11.15	13.37	13.47	17.80	18.13
T_4	5.97	12.81	21.77	4.11	10.83	11.72	4.78	6.00	14.11	10.74	11.67	14.80	14.70	18.97	19.20
T_5	6.58	13.68	22.91	4.73	11.28	12.60	5.00	6.33	14.44	12.04	12.18	16.23	16.27	19.30	19.27
T_6	7.87	14.63	23.88	5.13	11.77	12.75	5.11	6.33	14.67	12.55	13.14	17.23	17.17	20.60	20.50
T_7	8.63	16.76	25.90	5.79	12.83	14.30	5.33	7.11	16.00	13.78	14.08	19.10	19.10	22.67	22.83
T_8	8.59	15.82	24.57	5.58	12.42	13.70	5.22	6.78	15.33	13.10	13.72	18.07	18.00	20.87	20.77
T_9	9.16	16.88	27.52	5.93	13.02	14.81	5.44	7.66	16.33	14.04	14.79	19.17	19.20	23.53	23.63
S. Ed. (+)	0.39	0.18	0.25	0.20	0.15	0.19	0.31	0.36	0.46	0.17	0.33	0.31	0.31	0.45	0.47
CD at 5%	0.82	0.39	0.54	0.41	0.31	0.39	0.66	0.76	0.96	0.37	0.69	0.64	0.65	0.96	0.99

Days to first flowering and number of flowers per plant all showed a consistent increase, according to the data (Table 2). The minimum days (46.77) of first flowering was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (48.89) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The maximum days (59.44) of flowering was recorded in T_0.

Number of flowers / plant at 60 days after transplanting was maximum (6.33) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (6.10) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of flowers / plant (3.10) was recorded in T_0.

Number of flowers / plant at 80 days after transplanting was maximum (8.37) recorded in T_9 100% RDF + 35% FYM (2

t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (8.33) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of flowers / plant (4.90) was recorded in T_0.

Number of flowers / plant at 100 days after transplanting was maximum (8.00) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (7.90) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of flowers / plant (4.87) was recorded in T_0.

Number of flowers / plant at 120 days after transplanting was maximum (7.23) recorded in T_9 100% RDF + 100% FYM (6 t/ha) + Bio Capsule (400 ppm) + 100% vermicompost (2 t/ha) was followed by T_7 (6.30) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of flowers / plant (3.10) was recorded in T_0.

Total Number of flowers / plant after transplanting was maximum (29.93) recorded in T_9 100% RDF + 100% FYM (6 t/ha) + Bio Capsule (400 ppm) + 100% vermicompost (2 t/ha) was followed by T_7 (6.30) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of flowers / plant (15.97) was recorded in T_0. Similar findings were also recorded by (Shilpi *et al.* 2014) [14], the maximum number of flowers was noted in brinjal with application of 75% of RDF + 25% vermicompost.

Table 2: Effect of Bio Capsule, FYM and Vermicompost on Days to first flowering and Number of flowers per plant in Strawberry cv. Winter Dawn

Treatments	Days To First Flowering	Number of Flowers Plant^{-1}				
		60 DAT	80 DAT	100 DAT	120 DAT	Total
T_0	59.44	3.10	4.90	4.87	3.10	15.97
T_1	57.00	3.90	5.43	5.43	3.57	18.33
T_2	55.55	4.30	5.43	5.47	4.23	19.43
T_3	54.22	4.30	5.57	6.13	4.57	20.57
T_4	53.22	4.57	6.00	6.23	4.57	21.37
T_5	52.33	5.23	6.77	6.33	4.90	23.23
T_6	51.33	5.67	6.80	7.00	5.53	25.00
T_7	48.89	6.10	8.33	7.90	6.30	28.63
T_8	50.66	5.67	7.90	7.57	6.10	27.24
T_9	46.77	6.33	8.37	8.00	7.23	29.93
S. Ed. (+)	0.86	0.35	0.36	0.38	0.32	0.12
CD at 5%	1.80	0.73	0.76	0.80	0.68	0.25

Number of fruits plant^{-1}, Fresh weight of fruit, Fruit yield plant^{-1}, Fruit yield plot^{-1}, Polar diameter, Radial diameter all showed a consistent increase, according to the data (Table 3).

Number of fruits / plant at 70 days after transplanting was maximum (3.20) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (3.00) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of fruits / plant (1.57) was recorded in T_0.

Number of fruits / plant at 90 days after transplanting was maximum (4.33) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (4.10) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of fruits / plant (2.87) was recorded in T_0.

Number of fruits / plant at 110 days after transplanting was maximum (4.47) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (4.33) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of fruits / plant (2.67) was recorded in T_0.

Number of fruits / plant at 130 days after transplanting was maximum (3.67) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (3.33) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of fruits / plant (1.90) was recorded in T_0.

Total Number of fruits / plant after transplanting was maximum (15.67) recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (3.33) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). Whereas, the minimum number of fruits / plant (9.01) was recorded in T_0.

The maximum Fruit Weight (23.11 g) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (22.36 g) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum fruit weight (10.07 g) was recorded in T_0.

The maximum Fruit Yield / Plant (309.57 g) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (286.45 g) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum Fruit Yield / Plant (88.84 g) was recorded in T_0.

The maximum Fruit Yield / Plot (1.86 kg) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (1.72 kg) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum Fruit Yield / Plot (0.53 kg) was recorded in T_0.

The maximum Polar Diameter (4.90 cm) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (4.84) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum Polar diameter (3.70 cm) was recorded in T_0.

The maximum Radial Diameter (3.59 cm) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (3.53) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum Radial Diameter (2.97 cm) was recorded in T_0.

Table 3: Effect of Bio Capsule, FYM and Vermicompost on Number of Fruits per plant, Fresh weight of fruit, Fruit yield per plant, Fruit yield per plot, Polar diameter, Radial diameter in Strawberry cv. Winter Dawn

Treatments	Number of Fruits Plant^{-1}					Fresh Weight of Fruit (g)	Fruit Yield Plant^{-1} (g)	Fruit Yield Plot^{-1} (Kg)	Polar Diameter (cm)	Radial Diameter (cm)
	70 DAT	90 DAT	110 DAT	130 DAT	Total					
T_0	1.57	2.87	2.67	1.90	09.01	10.07	88.84	0.99	3.70	2.97
T_1	1.80	3.00	3.10	2.10	10.00	15.30	169.97	1.02	3.99	3.05
T_2	2.20	3.10	3.23	2.43	10.96	16.51	177.50	1.07	4.25	3.11
T_3	2.20	3.30	3.43	2.43	11.36	16.85	187.87	1.13	4.41	3.16
T_4	2.47	3.33	3.47	2.57	11.84	18.85	189.20	1.14	4.42	3.23
T_5	2.67	3.43	4.00	2.67	12.77	20.80	232.40	1.39	4.52	3.25
T_6	2.77	3.47	4.10	3.20	13.54	20.93	258.27	1.55	4.55	3.38
T_7	3.00	4.10	4.33	3.33	14.76	22.36	286.45	1.72	4.84	3.53
T_8	2.90	3.90	4.10	3.00	13.90	21.45	266.10	1.60	4.69	3.45
T_9	3.20	4.33	4.47	3.67	15.67	23.11	309.57	1.86	4.90	3.59
S. Ed. (+)	0.24	0.23	0.31	0.22	0.08	0.91	12.07	0.07	0.14	0.04
CD at 5%	0.51	0.48	0.64	0.47	0.17	1.92	25.35	0.15	0.30	0.08

According to the data (Table 4). The maximum T.S.S. (9.99) was recorded in T_9 100% RDF + 100% FYM (6 t/ha) + Bio Capsule (400 ppm) + 100% vermicompost (2 t/ha) was followed by T_7 (9.89) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum T.S.S. (9.08) was recorded in T_0.

The minimum pH of Fruit (3.43) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (3.46) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The maximum pH of Fruit (3.91) was recorded in T_0.

The maximum Acidity (%) of Fruit (1.29%) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (1.16) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha).

The minimum Acidity (%) of Fruit (0.55%) was recorded in T_0. The maximum Ascorbic acid (54.92) was recorded in T_9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) was followed by T_7 (54.52) 100% RDF + 60% FYM (3.6 t/ha) + 40% Vermicompost (0.8 t/ha). The minimum Ascorbic acid (48.49) was recorded in T_0.

Table 4: Effect of Bio Capsule, FYM and Vermicompost on T.S.S., pH, Acidity, Ascorbic acid in Strawberry cv. Winter Dawn

Treatments	T.S.S. (°Brix)	pH of Fruit	Acidity (%)	Ascorbic acid (mg/100 g of Fresh Fruit)
T_0	9.08	3.91	0.55	48.49
T_1	9.30	3.87	0.65	49.56
T_2	9.47	3.82	0.67	50.57
T_3	9.57	3.71	0.73	51.56
T_4	9.64	3.63	0.82	52.05
T_5	9.80	3.52	0.91	52.14
T_6	9.82	3.51	1.02	53.15
T_7	9.89	3.46	1.16	54.52
T_8	9.87	3.50	1.12	53.62
T_9	9.99	3.43	1.29	54.92
S. Ed. (+)	0.11	0.03	0.42	0.73
CD at 5%	0.23	0.06	0.09	1.53

Discussion

The effective production cycle, from the first planting stage to the last harvest, depends on the application of appropriate agronomic practices in the strawberry farming process. Important production decisions are made starting at the seedling stage and continue for the duration of the harvest season, which usually lasts two to three months. In order to produce berries of superior quality within this short growing season, it is imperative to apply a suitable fertilization schedule that preserves macro- and micronutrients and meets the physiological and photosynthetic needs of the plant (Mamun *et al.* 2021) [2].

Treatment T9 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% Vermicompost (0.4 t/ha) had the greatest effect and was the most significant in increasing strawberry growth and its flowering and fruiting attributes. This could be due to the application of bio capsule. It may have enhanced essential nutrients to the plants that increases physical attributes of the fruit (Singh *et al.* 2023) [16].

Vermicompost application increased total fruit yield. Substitution of vermicompost drastically reduced the incidence of physiological disorders like albinism, fruit malformation and occurance of grey mould (Singh *et al.* 2008) [15]. Similar patterns were observed in the next Growth phases. By adding essential nutrients to the soil, organic manures like FYM not only enhance the physical characteristics, pH, and water-holding capacity of the soil, but also boost nutrient availability and plant absorption.

Vermicompost is a rich source of macro and micronutrients; it may have increased vegetative development because Fe and Zn may have improved the microflora and enzymatic activity. Vermicompost has also been shown to positively impact plant growth in previous studies by (Aroncon *et al.* 2003, 2004, Singh *et al.* 2008, Yadav *et al.* 2010) [3, 4, 17, 19].

The development and flowering characteristics of strawberries have also been enhanced by the use of bio capsules. They contain advantageous bacteria that can colonize the rhizosphere, plant roots, or both, which promotes plant growth. These microorganisms are used as bio-fertilizers or biostimulants (Lingua *et al.* 2013 and Lovaisa *et al.* 2015) [11, 12].

Application of Vermicompost also increases number of flowers as reported by (Shilpi *et al* 2014) [14], the maximum number of flowers in brinjal with the application of 75% RDF + 25% Vermicompost.

Conclusion

The present investigation's results, when presented and discussed, indicate that the most effective combination for strawberry fruit yield, quality, flowering, and vegetative parameters was 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha). For the simple reason that vermicompost and FYM (farm yard manure) both serve as growth enhancers and contribute to the increased fruit yield of strawberries. It might therefore be advised to increase strawberry fruit output. Therefore, for increased strawberry production, the use of 100% RDF + 35% FYM (2 t/ha) + Bio Capsule (400 ppm) + 20% vermicompost (0.4 t/ha) can be advised.

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