The Pharma Innovation Journal 2020; 9(1): 442-446

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(1): 442-446

www.thepharmajournal.com
Received: 01-11-2019
Accepted: 05-12-2019

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Effect of bio-fertilizers on growth, yield and quality of strawberry (*Fragaria x ananassa* Duch.) cv. Nabila under net tunnel

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Abstract
The present investigation entitled as "Effect of bio-fertilizer on growth, yield and quality of strawberry (*Fragaria* x *ananassa* Duch) cv. Nabila under net tunnel" was carried out at the Research Farm of the Center of Excellence on Protected Cultivation and Precision Farming in Net Tunnel at IGKV, Raipur (C.G.) to assess the impact on bio-fertilizers on growth parameters, yield and quality of strawberries. The investigation was laid out with 12 treatments which replicates thrice under randomized complete block design. The trial had 12 different combinations of bio-fertilizers. Treatment T_5 RDF + *Azospirillum* (@7 kg / ha) + *Phosphate Solubilizing Bacteria* (@6 kg / ha) has been recorded best for growth parameters i.e. plant height, plant spreading in East-West and North-South directions and number of leaves per plant, whereas the lowest value for the same was noticed in treatment T_0: RDF (Contorl). Earliest flowering, fruiting and fruit maturity was seen under the treatment T_{11}: RDF + *Azospirillum* (@7 kg/ha) + *Phosphate Solublizing Bacteria* (@ 6kg/ha + VAM @10 kg/ha), while the late flowering, fruiting and fruit maturity was observed under control.
Flowering and physical parameters of fruit *i.e.* number of flowers, number of fruits per plant, fruit of length, diameter, volume and weight of fruit were significantly influenced under the treatment T_{11}: (RDF + Azospirillum (@7 kg / ha) + *Phosphate Solubilizing Bacteria* (@6 kg / ha) + VAM (@10 kg / ha) whereas, the minimum value for the same was observed under control (T_0). As regard yield, the yield (355.84 q/ha) was obtained under the treatment $T_{11,}$ which was found highest among rest of the other treatment. Moreover, control registered the lowest yield (196.23 q / ha). The treatment T_{11} (RDF + *Azospirillium @ 7 kg/ha* + *Phosphate Solubilizing bacteria (@* 6 kg/ha) + VAM (@10 kg/ha) registered highest benefit cost ratio (4.20:1), while the value (2.20:1) was observed in RDF + control.

Keywords: Bio-fertilizers, *Fragaria x ananassa*, glutathionine

Introduction
Strawberry (*Fragaria* ***x*** *ananassa* Duch.) is an aggregate fruit, has attained the status of being one of the most important soft fruit of the world after grapes Umar *et al*. (2008) [8]. Among the fruits, it is one of the most popular, delicate in flavour, rich in vitamins and minerals and gives quickest return in the shortest possible time Singh and Singh *et al*. (2009) [6]. The fruits are also good sources of natural antioxidants, including antioxidants, vitamins, phenols, acids, dietary glutathionine and endogenous metabolites, and are especially antioxidant toward free radical organisms Wang *et al*. (2000) [9] and Singh *et al*. (2008) [5]. Strawberry can be successfully grown in humid or dry areas in plains as well as hills up to 3000 meters above sea level. In India, commercial development is takes place in Punjab, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Maharashtra, Uttarakhand, Uttar Pradesh, Rajasthan, and West Bengal. Rana and Chandel *et al.* (2003) [4].
Northenless, the improper use of such chemical fertilizers has resulted in certain polluting effects o soil, plants and I addition, o human health. As a result, scientists look forward to replacing (partially) chemical fertilizers with bio-fertilizers and organic farming systems while using organic manures and bio-fertilizers and organic farming systems use organic fertilizers and bio-fertilizres.
The application of organic manures not only enhances soil physical properties and pH but also adds essential nutrients to the soil, thus increasing the supply of nutrients and their effective pl ant absorption Hazarika *et al.* (2014) [2]. Uses of organic manures are environmentally safe and viable alternatives of chemical fertilizers and it increases microbial bio-mass in the soil Selvamani *et al.* (2011) [7]. Bio-fertilizers can improve plant growth and productivity has been adopted generally as an alternative source of chemical fertilizers Mia *et al.* (2010) [8].

These were found to promote growth-promoting synthesis of substances such as auxins, gibberellins, cytokines and antibiotic metabolites, which in effect enhanced resistance to biotic and abiotic stress Awasthi *et al*. (1998) [1]. Inoculation of these N-fixing micro-organisms in the soil not only increases the yield but also save 20-40% nitrogen inputs. In addition to organic manures and bio-fertilizers, the bio-regulators also play an important role in growth and yield of fruit crops. A balanced application with bio-fertilizers of both organic and inorganic fertilizers appears to be an ideal proposal for most horticultural crops to meet nutrient requirements.

Strawberry cultivation in Chhattisgarh is not carried out commercially due to a lack of knowledge of its cultivation, since the crop is special in its climate, soil, fertilizer, mulching requirements and various cultural practices, but different thermo-intensive and low-cooling strawberry varieties are now available for cultivation that perform well under Chhattisgarh plain soil and climatic condition.

In recent years, emphasis has been put on the use of biofertiliz ers to influence the growth, flowering, fruit production, fruit q uality and yield of various fruit crops. Fruit yield, fruit number, several researchers analyzed the effect of strawberry bio-fertilizers on fruit weight, fruit diameter, and consistency parameter, i.e. gross soluble solids, ascorbic acid, acidity, and sugar content. The bio-fertilizer like *Azotobactor*, *Aspirillum*, VAM and PSB was found to be essential in altering strawberry fruit production, yield and quality parameters.

Farmers are currently growing small-scale strawberry fruit in different pockets of agro-climate regions in Chhattisgarh, but they do not get good size and quality fruit. Therefore, the current focus is on exploring the possibilities of supplementing chemical fertilizers with bio-fertilizers in order to increase the characteristics of strawberry growth, flowering, yield and quality.

Nabila is an important strawberry cultivar that performs well i n Chhattisgarh climate condition.For research work, the Nabil a variety was therefore chose. No research work was carried o ut in Chhattisgarh on the application of bio-fertilizer in strawberry.

Material and Methods

The present investigation was carried out during the year 2018-19 at Research Farm of Centre of Excellence on Protected Cultivation and Precision Farming in net tunnel under College of Agriculture, IGKV, Raipur (C.G.). Nabila is an important strawberry cultivar that performs very well in Chhattisgarh's climate. For the present investigation, therefore, Nabila cultivar was selected. The soil of experimental field is clay-loam, known locally in the area as "Dorsa. In order to get a fine tilth, the experimental plot was well prepared for a fine tilth by repeated ploughing and planking. Weeds, grasses / residues of plants and other materials were removed from the field. Elevated beds of 15-20 cm in height were prepared for the planting of the strawberry plants. Beds were mulched with silver-black polythene sheets to manage weeds in the row, to maintain soil temperature, to prevent rotting, to maintain moisture and to achieve better quality of fruit.

The investigation was laid out with 12 different combination of biofertilizer with replication thrice under randomized complete block design. Strawberry plants with 2-3 open leaves were planted on 2.0 m x 1.0 m raised beds. Mulching was conducted to test the weed density population and to preserve soil moisture. Strawberry planting was performed at a distance of 30 x 30 cm with the help of khurpi on 1st October 2018. Bio-fertilizers available in powder form were applied in the soil pit before the transplanting of strawberry plant. DAP (Di-ammonium phosphate) was used in the experimental field as basal dose of fertilizer. FYM @ 25 tones/ha was also added in the experimental field. During the crop periods, the water soluble fertilizers *i.e.* 19:19:19, 13:00:45, 12:61:00, 17:44:00 and 00:00:50 were applied through fertigation to meet out the fertilizer requirement of the crops. The harvesting was performed by hand picking at an interval of two days. Slightly earlier, fruits were picked at full maturity stages so they stayed solid enough to be able to handle.

Results and Discussion

The data recorded in the course of the investigation on various aspects revealed interesting facts that are as follows:

Effect on growth, flowering and fruiting parameters

The effect of application of bio-fertilizers showed significant variations in plant height observed after planting at 30, 60, 90 and 120 days. At 120 DAP, the superiority of treatment T_5 (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha), registered maximum plant height (31.20 cm) which was found at par with T_{11} having plant height of (30.41cm). Treatments T_{10}, T_8 & T_7 and T_7, T_6 & T_9 and T_6, T_9, T_1, T_4 & T_2 and T_9, T_1, T_4, T_2 & T_3 having respective plant heights of 28.22, 28.12 & 27.20 and 27.20, 26.53 & 26.21 and 26.53, 22.21, 25.90. 25.80 & 25.74 and 26.21, 25.90, 25.80, 25.74 & 25.00 cm were statistically at par with each other. Nevertheless, the minimum plant height (23.20 cm) was registered under the RDF + Control (T_0) treatment.

During plant growth at 30, 60, 90 and 120 days after transplantation, the effect of biofertilizers on the number of leaves per plant was reported. Similarly, at 120 DAP, the maximum number of leaves per plant (41.90) was observed under the same T5 (RDF + Azospirillum @ 7 kg / ha + Phosphate Solubilizing Bacteria @ 6 kg / ha) procedure, showing significant differences with the rest of the treatments. However, the treatments T_7, T_6 & T_9 and T_9, T_1 & T_4 and T_2 & T_3 having respective number of leaves 36.51, 36.50 & 35.81 and 35.81, 35.80 & 35.80 and 35.21 & 35.10 were found statistically at par with each other. Under T_0 (RDF + Control) the minimum number of leaves per plant (34.31) was reported.

Days of first flowering is greatly influenced by bio-fertilizer soil application. Treatment T11 (RDF + Azospirillum @ 7 kg / ha + Phosphate Solublizing Bacteria @ 6kg / ha + VAM @ 10 kg / ha) was noted among the different minimum days to first flowering treatments (40.33). The treatments T_5, T_8 & T_7 and T_8, T_7, T_6, T_9 & T_1 and T_7, T_6, T_9,T_1, T_4 & T_2 and T_6, T_9, T_1, T_4 & T_2 and T_1, T_4, T_2 & T_3 having respective days to first flowering 41.33, 42.66 & 43.00 and 42.66, 43.00, 43.89, 43.99 & 44.21 and 43.00, 43.89, 43.99, 44.21, 44.89 & 45.01 and 43.89, 43.99, 44.21, 44.89 & 45.01 and 44.21, 44.89. 45.01 & 46.23 were found statistically “at par with each other. Maximum days to first flowering (48.33) were observed under the treatment T_0 (control).

The maximum number of flowers per plant (43.41) was observed under treatment” T11 (RDF + Azospirillum (@ 7 kg / ha) + Phosphate Solublizing Bacteria (@ 6 kg / ha) + VAM (@10 kg / ha), which was found to be non-significant with treatments T10 & T5 having flower numbers 42.83 & 41.32

respectively. The treatment T_5, T_8 & T_7 and T_8, T_7 & T_5 and T_6, T_7 & T_8 and T_6 & T_9 having respective number of flower 41.32, 39.23 & 39.12 and 39.23, 39.12 & 41.32 and 38.33, 39.12 & 39.23 and 38.33 & 36.90 were found significance. The treatment T_3, T_2, T_4, T_1 & T_9 having respective number of flowers 35.13, 35.32, 35.73, 31.31 & 36.90 were also noticed "non-significant differences with each other, while the lowest number of flowers per plant (31.31) was observed under control.

The minimum days to first fruiting (52.16) was noted under the treatment T_{11} (RDF +" *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha). Moreover the treatments T_{10}, T_5, T_8, T_7, T_6, T_5 & T_9 (RDF + *Azotobacter* (@ 7 kg/ha) + VAM (@ 10 kg/ha) having days to first fruiting 53.33, 55, 55.23, 55.89, 56.14 & 56.21 respectively. Moreover, the treatments T_{10}, T_5, T_8, T_7, T_6, T_9, T_1 & T_4 and T_5, T_8, T_7, T_6, T_9, T_1, T_4, T_2 & T_3 having respective days to first fruiting 53.33, 55, 55.23, 55.89, 56.14, 56.21, 56.89 & 57.01 and 55, 55.23, 55.89, 56.14, 56.21, 56.89, 57.01, 57.99 & 58.23 were found "at par with each other. Treatment RDF + Control (T_0), which was equal to T2 (57.99) & T3 (58.23) days, observed the maximum days to first fruiting (61.75).

Yield and yield attributing characters

The maximum number of fruits per plant (41.80) was recorded under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha), which was found statistically at par with the treatments T_{10}" (RDF + *Azotobacter* @7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha) having average number of fruits per plant 41.00. Moreover, the treatments T_3, T_2 & T_4 and T_2, T_4 & T_1 and T_4, T_1, T_9, T_6, T_7 & T_8 having respective number of fruits 33.80, 33.87 & 34.67 and 33.87, 34.67 & 34.93 and 34.67, 34.93, 35.13, 35.47, 35.53 & 35.60 "were found non-significant differences with each other under present investigation. Under the treatment RDF + Control (T0), the minimum number of fruits per plant (32.67) was recorded." The number of fruits per plant under this investigation varied from 32.67 to 41.80.

Under the present study, the fruit weight ranged from 31.00 to 43.33 g. Treatment T11 (RDF + Azospirillum @ 7 kg / ha + Phosphate Solubilizing Bacteria @ 6 kg / ha + VAM @ 10 kg / ha) considered the average fruit weight (43.33) to be significantly different from all other treatments. All treatments are significantly different from each other. The minimum weight of fruit (31.00) was recorded in the RDF + Control (T_0) treatment.

"The maximum fruit diameter (4.85 cm) was observed under the treatment T_{11} (RDF + *Azospirillum* @7 kg/ha + *Phosphate Solublizing Bacteria* @ 6kg/ha + VAM @10 kg/ha), which was significantly different from rest of the treatments. The treatment T_4 & T_1 and T_9 & T_6 having respective fruit diameters 3.15 & 3.18 & 3.43 & 3.49 were found statistically at par with each other. The minimum fruit diameter (2.59) was observed under T_0 control.

The maximum fruit length (6.64 cm) was noticed under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha) which was found significantly differs from all other treatments. All the treatments were found significantly different with each other. The minimum fruit length (3.70) was recorded under the treatment RDF + Control (T_0)."

The maximum fruit volume (37.17 cc) was noticed under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha) which was found non-significant differences with the treatments T_{10} having fruit volume of 37.10cc. Similarly the T_2 & T_3 and T_1 & T_4 and T_6 & T_7 and T_7 & T_8 having respective fruit volumes of 31.80 & 30.70 and 33.50 & 33.00 and 35.40 & 36.00 and 36.00 & 36.77 cc "were found statistically at par each other. However the minimum fruit volume (30.60 cc) was recorded under the treatment RDF + Control (T_0)."

The maximum specific gravity (1.17g/ml) was noticed under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha) which was found non-significant differences with the treatment T_{10} having specific gravity of 1.13 g/ml. The treatments T_2 & T_3 and T_2 & T_4 and T_5 & T_8 and T_7 & T_8 having average specific gravity of 1.04 & 1.03 and 1.04 & 1.05 and 1.12 & 1.11 and 1.10 & 1.11 g/ml respectively were found statistically similar with each other. The minimum specific gravity (1.01g/ml) was recorded under the treatment RDF + Control (T_0).

Days to fruit maturity was recorded minimum (62.16) in the treatments T_{11} RDF + *Azospirillum* @7 kg/ha + *Phosphate Solublizing Bacteria* @ 6kg/ha + VAM @10 kg/ha), which was found non-significant differences with the treatments T_{10}, T_5 & T_8 having respective days to fruit maturity 65.33, 67.00 & 67.23. Similarly the treatments T_3, T_2, T_4, T_1, T_9, T_6, T_7, T_8 & T_5 having respective days to fruit maturity 70.23, 69.99, 69.01, 68.89, 68.21, 68.14, 67.89, 67.23 and 67.00 should non-significant differences with each other. "The Maximum days to fruit maturity (74.88) were recorded under the treatment RDF + Control (T_0)."

Yield (kg) per plant (1.03) was observed under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @10 kg/ha), which showed significant difference with other treatments. T_{10} (0.93) was also exhibiting significant differences with rest of the treatments. The treatment T_5 & T_8 and T_7, T_6, T_9, T_1, T_4, T_2 & T_3 and T_6, T_9, T_1, T_4, T_2 & T_3 having respective Fruit yields per plant 0.83 & 0.75 and 0.64, 0.62, 0.61, 0.61, 0.59 & 0.57 and 0.62, 0.61, 0.61, 0.59 and 0.57 kg were registered statistically at par with each other. The lowest Fruit yield per plant (0.54 kg) was observed under T_0 which was found non-significant differences with the treatments T_6, T_9, T_1, T_4, T_2 & T_3 having respective Fruit yield (kg) per plant 0.62, 0.61, 0.61, 0.59, 0.57 & 0.54 kg per plant.

Yield per hectare (qt) was ranged from 196.23 to 355.89 quintal under the different treatments. "The highest yield (355.84 q/ha) was recorded under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha)" followed by T_{10} (RDF + *Azotobacter* @7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @10 kg/ha) and T_5 (RDF + *Azospirillum* @7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha) having the average fruit yield of 348.45 and 323.58 q/ha respectively. The treatments T_2 & T_4 and T_5 & T_6 and T_6 & T_9 and T_7 & T_8 having average yields 233.89 & 253.65 and 323.58 & 292.35 and 292.35 & 284.59 and 306.89 & 311.58 quintals/ hectare were recorded statistically at par "with each other. However the minimum yield 196.23 q/ha was noticed under RDF + Control (T_0).

Benefit: Cost ratio

Different treatments under the present study influence the Benefit: Cost ratio. The data is presented in tabular form in

Table 1 and graphically depicted.

The highest Benefit: Cost ratio (4.20) was reported under the treatment T_{11} (RDF + *Azospirillum* @ 7 kg/ha + Phosphate solublizing Bacteria @ 6 kg/ha + VAM @10 kg/ha), which was found at par with the treatments T_{10} (RDF + *Azotobacter* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha), having benefit cost ratio of 4. Therefore, in the current investigation, the lowest benefit: cost ratio (2.20) was reported under T_0 (RDF + Control). The procedures in the current investigation T_{11}& T_{10} and T_5, & T_8 and T_6 &T_9 and T_2 & T_3 were found to be at par with each other. However, T_1 & T_4 treatments were found to be significantly different from each other.

Kumar *et al*. (2018) [8] recorded maximum benefit: cost ratio (1: 3.87) in strawberry with 5 kg/ha *Trichoderma* + 2.5 t/ha Vermi-compost + 7 kg/ha *Azotobacto*r + 6 kg/ha PSB + 10 kg/ha VAM. Rana *et al.* (2003) [4] & Yadav *et al.* (2010) also presented the higher cost benefit ratio with the application of bio-fertilizers.

Table 1: Effect of bio-fertilizers on growth of strawberry (*Fragaria x ananassa* duch.) cv. Nabila under net tunnel

Treatments	Plant height (cm)				Number of leaves per plant				Days to 1st flowering	Number of flowers per plant	Days to 1st fruiting
	30 DAP	60 DAP	90 DAP	120 DAP	30 DAP	60 DAP	90 DAP	120 DAP			
T_0: RDF (Control)	5.89	11.30 ^{a}	18.32 ^{a}	23.20 ^{a}	3.70 ^{a}	11.42^{a}	22.80^{a}	34.31^{a}	48.33 ^{g}	31.31 ^{a}	61.75 ^{d}
T_1: RDF + *Azospirillum* @7 kg/ha	6.16	13.82 ^{cde}	19.80 ^{b}	25.90 ^{bc}	4.90 ^{cd}	13.10^{c}	26.10^{c}	35.80^{c}	44.21 ^{cdef}	36.14 ^{bc}	56.89 ^{bc}
T_2: RDF + *Phosphate Solubilizing Bacteria* @6 kg/ha	6.10	13.21 ^{bc}	18.60 ^{a}	25.74 ^{bc}	4.22 ^{b}	12.31^{ab}	24.50^{b}	35.21^{b}	45.01 ^{def}	35.32 ^{b}	57.99 ^{cd}
T_3: RDF + VAM @10 kg/ha	5.91	12.51^{b}	18.52 ^{a}	25.00 ^{b}	4.00 ^{ab}	12.30^{ab}	23.50^{a}	35.10^{b}	46.23 ^{f}	35.13 ^{b}	58.23 ^{cd}
T_4: RDF + *Azotobacter* @7 kg/ha	6.16	13.30 ^{bcd}	19.51^{b}	25.80 ^{bc}	4.80 ^{c}	13.00^{c}	25.01^{b}	35.80^{c}	44.89^{def}	35.73 ^{b}	57.01 ^{bc}
T_5: RDF + *Azospirillum* @7 kg/ha + *Phosphate Solubilizing Bacteria* @6 kg/ha	7.01	15.6^{g}	23.60 ^{e}	31.20 ^{f}	6.30 ^{g}	16.30^{e}	31.10^{g}	41.90^{h}	41.33 ^{b}	41.32 ^{fg}	55.00 ^{abc}
T_6: RDF + *Azospirillum* @ 7 kg/ha + VAM @10 kg/ha	6.29	14.32^{def}	20.62 ^{c}	26.53 ^{cd}	5.31 ^{de}	13.50^{c}	27.13^{d}	36.50^{d}	43.89 ^{cde}	38.33 ^{cde}	56.14 ^{abc}
T_7: RDF + *Phosphate Solubilizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha	6.35	14.34^{def}	20.70 ^{cd}	27.20 ^{de}	5.71^{ef}	13.52^{c}	28.10^{e}	36.51^{b}	43.00 ^{bcd}	39.12 ^{def}	55.89 ^{abc}
T_8: RDF + *Phosphate Solubilizing Bacteria* @6 kg/ha + *Azotobacter* @ 7 kg/ha	6.55	14.74^{efg}	20.73 ^{cd}	28.12 ^{e}	5.80 ^{f}	13.82^{c}	28.71^{e}	38.20^{e}	42.66 ^{bc}	39.23 ^{ef}	55.23 ^{abc}
T_9: RDF + *Azotobacter* @7 kg/ha + VAM @10 kg/ha	6.21	14.00^{cde}	20.10 ^{bc}	26.21 ^{bcd}	5.31 ^{de}	13.31^{c}	27.02^{d}	35.81^{dc}	43.99 ^{cde}	36.90 ^{bcd}	56.21 ^{abc}
T_{10}: RDF + *Azotobacter* @7 kg/ha + *Phosphate Solubilizing Bacteria* @ 6 kg/ha + VAM @10kg/ha	6.55	14.90^{efg}	21.51 ^{d}	28.22 ^{e}	5.90 ^{fg}	14.81^{d}	28.71^{e}	39.10^{f}	40.67 ^{a}	42.83 ^{g}	53.33 ^{ab}
T_{11}: RDF + *Azospirillum* @7 kg/ha + *Phosphate Solubilizing Bacteria* @ 6kg/ha + VAM @10 kg/ha	6.95	15.30 ^{fg}	22.90 ^{e}	30.41^{f}	6.10 ^{fg}	16.10^{e}	30.10^{f}	39.80^{g}	40.33 ^{a}	43.41 ^{g}	52.16 ^{a}
SE(m) ±	0.25	0.37	0.27	0.44	0.16	0.33	0.26	0.21	0.70	0.77	1.55
C.D. at 5%	NS	1.10	0.81	1.29	0.47	0.99	0.76	0.63	2.05	2.28	4.54

Table 2: Effect of bio-fertilizers on yield of strawberry (*Fragaria x ananassa* Duch.) cv. Nabila under net tunnel

Treatments	Number of fruits per plant	Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	Fruit volume (cc)	Specific gravity (g/ml)	Days to fruit maturity	Fruit yield (kg/plant)	Yield (q/ha)	Benefit: Cost ratio
T_0: RDF (Control)	32.67 ^{a}	31.00^{a}	2.59^{a}	3.70^{a}	30.60 ^{a}	1.01 ^{a}	74.88 ^{c}	0.54 ^{a}	196.23 ^{a}	2.20 ^{a}
T_1: RDF + *Azospirillum* @ 7 kg/ha	34.93 ^{cd}	35.87^{e}	3.18^{d}	4.58^{e}	33.50 ^{d}	1.07 ^{d}	68.89 ^{b}	0.61 ^{ab}	268.22 ^{cd}	3.17 ^{d}
T_2: RDF + *Phosphate Solublizing Bacteria* @ 6 kg/ha	33.87 ^{bc}	33.07^{c}	2.99^{c}	4.19^{c}	31.80 ^{bc}	1.04 ^{bc}	69.99 ^{bc}	0.57 ^{ab}	233.89 ^{b}	2.76 ^{b}
T_3: RDF + VAM @ 10 kg/ha	33.80 ^{b}	31.60^{b}	2.83^{b}	4.09^{b}	30.70 ^{ab}	1.03 ^{ab}	70.23 ^{bc}	0.57 ^{ab}	225.56 ^{a}	2.66 ^{b}
T_4: RDF + *Azotobacter* @ 7 kg/ha	34.67 ^{bcd}	34.53^{d}	3.15^{d}	4.33^{d}	33.00 ^{cd}	1.05 ^{cd}	69.01 ^{bc}	0.59 ^{ab}	253.65 ^{b}	3.00 ^{c}
T_5: RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha	37.60 ^{e}	41.27^{i}	4.15^{h}	6.21^{j}	36.87 ^{ij}	1.12 ^{hi}	67.00 ^{ab}	0.83 ^{c}	323.58 ^{fgh}	3.82 ^{i}
T_6: RDF + *Azospirillum* @ 7 kg/ha + VAM @ 10 kg/ha	35.47 ^{d}	38.27^{f}	3.49^{e}	5.30^{g}	35.40 ^{fg}	1.09 ^{ef}	68.14 ^{b}	0.62 ^{ab}	292.35 ^{def}	3.45 ^{f}
T_7: RDF + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha	35.53 ^{d}	39.73^{g}	3.75^{f}	5.69^{h}	36.00 ^{gh}	1.10 ^{fg}	67.89 ^{b}	0.64 ^{b}	306.89 ^{ef}	3.63 ^{gh}
T_8: RDF + *Phosphate Solublizing Bacteria* @ 6 kg/ha + *Azotobacter* @ 7 kg/ha	35.60 ^{d}	40.67^{h}	3.85^{g}	5.99^{i}	36.77 ^{hi}	1.11 ^{gh}	67.23 ^{ab}	0.75 ^{c}	311.58 ^{efg}	3.68 ^{hi}
T_9: RDF + *Azotobacter* @7 kg/ha + VAM @ 10 kg/ha	35.13 ^{d}	37.73^{f}	3.43^{e}	4.84^{f}	35.00 ^{ef}	1.07 ^{de}	68.21 ^{b}	0.61 ^{ab}	284.59 ^{cde}	3.36 ^{ef}
T_{10}: RDF + *Azotobacter* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha +VAM @ 10kg/ha	41.00 ^{f}	41.87^{j}	4.65^{i}	6.36^{k}	37.10 ^{jk}	1.13 ^{ij}	65.33 ^{ab}	0.93 ^{d}	348.45 ^{h}	4.11 ^{jk}
T_{11}: RDF + *Azospirillum* @ 7 kg/ha + *Phosphate Solublizing Bacteria* @ 6 kg/ha + VAM @ 10 kg/ha	41.80 ^{f}	43.33^{k}	4.85^{j}	6.64^{l}	37.17 ^{k}	1.17 ^{j}	62.16 ^{a}	1.03 ^{e}	355.84 ^{h}	4.20 ^{k}
SE(m) ±	0.37	0.20	0.03	0.07	0.64	0.02	1.95	0.03	11.83	0.06
C.D. at 5%	1.11	0.58	0.08	0.20	1.88	0.05	5.71	0.09	34.71	0.17

Conclusion

The following conclusions were drawn from the present study are as under:

- Bio-fertilizer was found best for influencing growth characters like plant height and number of leaves as compared to control at all the stages of plant growth and development.
- The treatment T_{11} (RDF + *Azospirillum* (@ 7 kg/ha) + *Phosphate Solublizing Bacteria* (@ 6 kg/ha) + VAM (@10 kg/ha) takes minimum days to first flowering, fruiting and maturity duration as compared to control.
- The treatment T_{11} (RDF + *Azospirillum* (@ 7 kg/ha) + *Phosphate Solublizing Bacteria* (@ 6 kg/ha) + VAM (@10 kg/ha), reported 41.80% more fruits per plant in comparison to control.
- The application of treatment T_{11} (RDF + *Azospirillum* (@ 7 kg/ha) + *Phosphate Solublizing Bacteria* (@ 6 kg/ha) + VAM (@10 kg/ha) had considerable influence the physical parameters of fruit *i.e.* fruit length, diameter, fruit weight, volume, specific gravity.

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