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Effect of vermicompost and biofertilizers on soil health, flowering and yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler in central plain region of Punjab.

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ABSTRACT
The experiment was conducted at the research farm, Department of Agriculture, Mata Gujri College, Sri Fatehgarh Sahib, Punjab during 2017-18 to study the effect of vermicompost and biofertilizers on soil health, flowering and yield of strawberry (Fragaria × ananassa Duch.) cv. Chandler in central plain region of Punjab. The Experiment was laid out in Randomized Block Design with 9 treatments replicated thrice. Treatments consisted of vermicompost and biofertilizers (Arka Microbial Consortium, phosphate solubilizing bacteria and Azospirillum). Each treatment alone and their combination has shown significant effects on most of the parameters, but the combination of vermicompost, Arka Microbial Consortium, PSB and Azospirillum showed maximum number of flowers plant^{-1}, number of fruits plant^{-1}, yield plant^{-1} and yield ha^{-1}. However, minimum number of days taken to produce first flowering was recorded in the plants which were treated with T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + Azospirillum @ 7 kg/ha). The maximum total microbial population in soil, soil pH (7.08), soil EC (0.380 dSm^{-1}), organic carbon (0.65 %), nitrogen content (307 kg/ha^{-1}), phosphorus content (16.03 kg/ha^{-1}) and potassium content (180.00 kg/ha^{-1}) was recorded in treatment T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + Azospirillum @ 7 kg/ha). Hence, on the basis of overall findings of present investigation, T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + Azospirillum @ 7 kg/ha) significantly exhibited the maximum effect on higher flowering, yield and soil health.
Key words: *Strawberry, Vermicompost (VC), AMC (Arka Microbial Consortium), Azospirillum, PSB, Biofertilizer, flowering, yield and total microbial population.*

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INTRODUCTION

The modern cultivated strawberry (*Fragaria* × *ananassa* Duch.) is a manmade hybrid crop that was originated from the hybridization of two American species *Fragaria chiloensis* and *Fragaria virginiana* in France in seventeen century. The strawberry is a monoecious octoploid hybrid with chromosome number 2n = 56 and belongs to the family Rosaceae. It is an aggregate fruit, has attained the status of being one of the most important soft fruits of the world after grapes [21]. Strawberry is generally grown in hilly as well as cool climatic zones of India [8]. Its successful cultivation requires an optimum day temperature of 22-23°C and night temperature of 7-13°C in India [10]. In India it is being widely cultivated in the states of Punjab, Haryana, Maharashtra, Himachal Pradesh, Jammu and Kashmir besides some hilly regions of Uttar Pradesh with Maharashtra is a leading state in its production [4]. The area and production of strawberry in India is 500 Ha and 3800 MT, respectively [1].

Strawberry is used as fresh fruit being rich in vitamin C and ellagic acid, which has anti cancerous property. Fruits are attractive with distinct pleasant aroma and flavour, consumed as dessert and also have a special demand by the fruit processing units for the preparation of jams, ice cream, syrups etc. [17]. It is a profitable fruit crop in the shortest possible time as compared to the other fruits. It is the most popular and early paying back fruit in the world.

Among various aspect that contributed on growth, development and quality of strawberry, nutrition is one of the important element of crop production. Organic and microbial sources of nutrients have advantage of consistent and slow release of nutrients, maintaining idea C: N ratio, improvement of water holding capacity and microbial biomass of soil profile without having any residual effects [23]. Vermicompost significantly enhance the growth, development and productivity of plant [21]. It is gaining popularity and preference over farmyard manure as a richer source of available plant nutrients, growth regulators, enzymes, antifungal and antibacterial compounds [2, 3]. It improves the yield of strawberry due to their essential elements, vitamins, enzymes and hormone [11].

Biofertilizers are organic products containing living cells of different type of microorganisms, which have the capability to convert nutritionally important elements from unavailable to available form through biological processes [22]. Biofertilizers play a very significant role in atmospheric nitrogen fixation and phosphorus solubilization, these also help in stimulating the plant growth hormone providing better nutrient uptake and increased tolerance towards drought and moisture stress. A small dose of biofertilizers contains at least 10 million viable cells of specific strains [15].

Arka Microbial Consortium is a carrier based product which contains N-fixing, P & Zn solubilizing and plant growth promoting microbes as a single formulation. The novelty of this technology is that farmers need not apply N-fixing, phosphorous solubilizing and growth promoting bacterial inoculants individually. Phosphorus solubilizing bacteria and fungi play a vital role in persuading the insoluble phosphatic compound such as rock phosphate, bone meal and basic slag and particularly the chemically fixed soil phosphorus into available form [13]. *Azospirillum* species are free-living N2-fixing bacteria commonly found in soil and in association with roots of different plant species. For their capacity to promote plant growth they are considered as plant growth-promoting bacteria [6]. Biofertilizers combined with organic manure influences the plant growth by enhancing root biomass, total root surface facilitates higher absorption of nutrients and increase in yield by reducing consumption of natural sources of energy [14].

MATERIAL AND METHODS

An experiment was conducted at the Agriculture Research Farm, Department of Agriculture, Mata Gujri College, Sri Fatehgarh Sahib, Punjab during the year 2017-18. The research farm is situated between 30° 56' 11.90"N latitudes and 76° 18' 13.18"E longitudes and at a mean height of 279 meter above sea level. The experimental plot was well prepared by repeated ploughing followed by planking to obtain a fine tilth. Raising of beds 25 cm in height, 3.0 m length and 0.8 m width were prepared. Strawberry runners were planted during the last week of October 2017, maintaining a spacing of 40 × 30 cm with black polyethylene mulch. The experiment was laid out in Randomized Block Design (RBD) having nine treatments with three replications. Treatments consisted of T_1 (Control), T_2 (Arka Microbial Consortium (AMC) @ 7 kg/ha), T_3 (Vermicompost (VC) @ 5 tones/ha), T_4 (Phosphate solubilizing bacteria (PSB)@ 7 kg/ha), T_5 (*Azospirillum* @ 7 kg/ha), T_6 (AMC @ 7 kg/ha + VC @ 5 tones/ha), T_7 (PSB @ 7 kg/ha + VC @ 5 tones/ha), T_8 (*Azospirillum* @ 7 kg/ha + VC @ 5 tones/ha), T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha). The result revealed that plants treated with T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha). Fertilizers like water soluble N:P:K (19:19:19), (0:0:50) and Urea were used in experimental field to fulfil the recommended dose of fertilizers in strawberry crop. The recommended dose of fertilizers (RDF) 150:100:120 kg/ha was followed. Calculated amount of vermicompost are applied before 7 days of planting in single dose according to various treatment combination. It was mixed in the soil after beds were prepared. Calculated amount of biofertilizers are applied after 40 days of planting in single dose according to various treatment combinations. Before

application of biofertilizers, the amount to be applied was calculated. They were applied by mixing in soil and were directly applied near the rootzone of runners.
Observations were recorded on number of days taken to produce first flowering, number of flowers plant^{-1}, number of fruits plant^{-1}, yield plant^{-1} and yield ha^{-1} total amount of fruits produced per plants were weighed and then calculated on per hectare basis in tons. The soil biological properties were determined by serial dilution method. The soil samples were collected, processed and analyzed for available nitrogen content, phosphorus, potassium, organic carbon, soil pH and soil EC. The statistical analysis was done as per design of the experiment as suggested by Panse and Sukhatme [12].

RESULT AND DISCUSSION

Floral parameters

Different alone and combinations of vermicompost and biofertilizers exhibit significant and promotive influence on the growth characters in strawberry plants (Table 1). The minimum number of days taken to produce first flowering (66.04 days) was recorded in the plants which were recorded with the application of T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) however, the maximum number of days taken to produce first flowering (81.42 days) were recorded with the application of T_1 (Control) and maximum number of flowers per plant (21.14) was recorded in T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) however, minimum number of flowers per plant (16.22) were recorded in T_1 (Control). The earliness may be due to an optimum supply of plant nutrients and growth hormones in right amount during the entire crop period which induces the vegetative development of plant and ultimately more photosynthesis [7]. Minimum number of days taken to produce first flower may be due to balanced application of vermicompost and biofertilizers which supplies the all essential elements to plant to get early flowering and maximum number of flowers in strawberry plant. Similar observations were also reported by Kumar *et al.* [10].

Yield attributes

The maximum number of fruits per plant (16.22), yield per plant (150.53 g) and yield per hectare (8.49 t/ha) were recorded in the application T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) however, minimum number of fruits per plant (11.94), yield per plant (111.97 g) and yield per hectare (5.82 t/ha) was recorded in the plant treated T_1 (Control). The increase in yield might be due to increased fruit set per plant, increased berry size and weight and may also be due to the fact that nitrogen fixers and phosphorous solubulizers not only increased the availability of nitrogen and phosphorous to the plants but also increased their translocation from root to flower through plant foliage [16]. The increased yield might also be due to more absorption and utilization of nutrients due to integrated use of organic and inorganic fertilizers along with bio-fertilizers [9].

Soil health attributes

The minimum soil pH (7.08) and maximum soil EC (0.380) and organic carbon (0.65) were recorded with the application of T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) however maximum soil pH (7.63) and minimum soil EC (0.310) and organic carbon (0.51) were recorded with the application of T_1 (Control). Zahir *et al.* (2003)[24] opined that micro-organisms are important component of soil environment and their large number is indicative for better soil health which improves more nutrient availability from source to sink. Application of organic and inorganic fertilizers with and without inoculation of biofertilizers significantly improved the organic carbon. Similar observations were also reported by Singh *et al.* [19].
The maximum available nitrogen content (307.00 kg/ha^{-1}), phosphorus content (16.03 kg/ha^{-1}) and potassium content (180.00 kg/ha^{-1}) were recorded in treatment T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) however, minimum available nitrogen content (268 kg/ha^{-1}) , phosphorus content (12.07 kg/ha^{-1}) and potassium content (172.33 kg/ha^{-1}) were recorded in treatment T_1 (Control). Bala *et al.* (2011)[5] studied that the effect of organic manure and biofertilizers with graded dose of NPK on soil and leaf nutrient status of aonla (*Emblica officinalis* Gaertn.). It was observed that maximum results for soil properties like available N, P and K were recorded from trees treated with different combination of inorganic + organic manure + biofertilizers. The

increase in available nitrogen and phosphorus content may be due to increased biological nitrogen fixation and phosphate solubilization by micro-organisms. Singh *et al.* (2012)[18] who also stated that biofertilizers helped the plant to grow better and had direct effect on the nitrogen fixation and phosphorous mobilization in the strawberry plants.

In the present investigation it is reported that the maximum microbial population were recorded in treatment T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) in all colony forming unit such as 1563.00 × 10^6, 762.67 × 10^7, 82.33 × 10^8 per gram of soil however, minimum microbial population 108.00 × 10^6, 63.67 × 10^7, 2.33 × 10^8 were recorded in treatment T_1 (Control). Biofertilizers and organic manure proved more beneficial then inorganic fertilizers. These results are in accordance with the findings of Singh *et al.* [18] who also stated that biofertilizers helped improve the soil health and the plant to grow better and had direct effect on the nitrogen fixation and phosphorous mobilization in the strawberry plants.

Table 1:- Effect of vermicompost and biofertilizers on flowering and yield of strawberry

Treatments	Days taken to first flowering	NO. of flower per plant	NO. of fruit /plant	Yield/plant (g)	Yield/ha (t/ha)
T_1	81.42	16.22	11.94	111.97	5.82
T_2	74.92	19.02	13.86	142.24	7.72
T_3	78.79	17.91	12.83	126.94	6.59
T_4	79.26	17.60	12.37	120.25	6.58
T_5	73.63	18.61	13.54	138.72	7.54
T_6	68.23	20.21	15.65	148.99	8.08
T_7	72.22	19.04	14.20	145.39	7.89
T_8	67.76	20.01	15.20	148.46	8.05
T_9	66.04	21.14	16.22	150.53	8.49
S. Em. ±	0.80	0.65	0.47	1.43	0.28
CD (0.05)	2.40	1.96	1.41	4.29	0.85

Table 2:- Effect of vermicompost and biofertilizers on soil health

Treatments	Soil pH	Soil EC (dSm^{-1})	Organic carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Total bacterial count on nutrient agar (x 10^6 cfu g/soil)	Total bacterial count on nutrient agar (x 10^7 cfu g/soil)	Total bacterial count on nutrient agar (x 10^8cfu g/soil)
T_1	7.63	0.31	0.51	268.00	12.07	172.33	108.00	63.67	2.33
T_2	7.53	0.34	0.58	282.00	12.77	174.37	281.67	126.00	4.33
T_3	7.45	0.33	0.56	275.33	12.83	173.33	276.33	130.33	5.33
T_4	7.56	0.32	0.56	268.67	14.00	173.00	266.00	114.67	4.00
T_5	7.49	0.34	0.57	277.33	13.17	173.67	314.00	124.67	5.00
T_6	7.18	0.37	0.63	305.33	15.03	178.67	1316.00	615.67	62.00
T_7	7.44	0.34	0.60	289.00	15.23	175.00	729.00	354.33	9.67
T_8	7.27	0.36	0.62	303.00	13.67	178.17	1515.00	715.33	72.33
T_9	7.08	0.38	0.65	307.00	16.03	180.00	1563.00	762.67	82.33
S. Em. ±	0.11	0.01	0.01	1.36	0.34	0.76	2.09	0.67	1.02
CD (0.05)	0.34	0.02	0.04	4.08	1.03	2.27	6.27	2.00	3.05

CONCLUSION

From the results obtained during the present investigation with different treatment combinations of vermicompost and biofertilizers on soil health, flowering and yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler, it is concluded that plants treated with T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha) significantly increased the flowering and higher yield as compare to control and other

treatment. On the basis of above findings it may be concluded that Soil biological properties was higher in treatment T_9 (AMC @ 7 kg/ha + VC @ 5 tones/ha + PSB @ 7 kg/ha + *Azospirillum* @ 7 kg/ha)as compare to control.

REFERENCES

1. Anonymous (2017). *Indian Horticulture Data Base.* National Horticulture Board, Ministry of Agriculture, Government of India. www.nhb.gov.in.
2. Arancon N Q, Edward C A, Bierman P, Welch C and Metzger J D. (2004). Influences of vermicompost on field strawberry: Effect on growth and yields. *Bioresource Technology* **93**: 143-153.
3. Arancon N Q, Galvis P, Edward C and Yardim E. (2002). The tropic diversity of nematode communities in soil treated with vermicompost. *Pedobiologia* **47**: 736-40.
4. Baba Z A, Sheikh T A, Hassan A, Mustafa I, Seher T, Hussain G and Hamid B. (2018). Integrated Effect of Inorganic and Biofertilizers on Macro and Micro Nutrient Uptake in Strawberry (*Fragaria × ananassa*, Duch). *International Journal of Current Microbiology and Applied Sciences* **7**(3): 2146-2152.
5. Bala S, Chaudhary V R and Shukla H S. (2011). Effect of organic manure and biofertilizers with graded dose of NPK on soil and leaf nutrient status of aonla (Emblica officinalis Gaertn.) cv. Banarasi. *Journal of Agricultural Science* **2**(5): 709-711.
6. Bashan Y, de-Bashan L E. (2005). Plant growth-promoting. In: Hillel D (editor -in-chief) Encyclopedia of soils in the environment, vol 1. Oxford: Elsevier, p 2200.
7. Beer K, Kumar S, Gupta A K. and Syamal M M. (2017). Effect of Organic, Inorganic and Bio-Fertilizer on Growth, Flowering, Yield and Quality of Strawberry (Fragaria × ananassa Duch.) cv. Chandler. *International Journal of Current Microbiology and Applied Sciences* **6**(5): 2932-2939.
8. Changotra P, Bashir D, Hussain S. and Kaur A. (2017).Cultivation on strawberry *(Fragaria × ananassa* Duch.) cv. chandler as affected by bio and inorganic fertilizers under open conditions. *Global Journal of Bio science and Biotechnology* **6**(2): 332-343.
9. Hazarika T K, Ralte Z, Nautiyal B P and Shukla A C. (2015). Influence of bio-fertilizers and bio - regulators on growth, yield and quality of strawberry (Fragaria × ananassa Duch.). *Indian Journal of Agricultural Sciences* **85**(9): 1201-1205.
10. Kumar N, Singh H K and Mishra P K. (2015). Impact of Organic Manures and Biofertilizers on Growth and Quality Parameters of Strawberry cv. Chandler. *Indian Journal of Science and Technology* **8**(15): 1-6.
11. Makulec G. (2002). The role of Lumbricus rubellus Hoffmeister in determining biotic and abiotic properties of peat soil. *Polish Journal of Ecology* **50**(3): 301-39.
12. Panse V G and Sukhatme P V. 1985. Statistical Methods for Agricultural Workers. *Indian Council of Agricultural Research Publication* **2**(7): 87-89.
13. Pindi P K, Satyanarayana S D V. (2012). Liquid Microbial Consortium- A Potential Tool for Sustainable Soil Health. *Journal of Biofertilizers & Biopesticides* **3**: 124.
14. Prasad H, Sajwan P, Kumari M and Solanki S P S. (2017). Effect of organic manures and biofertilizers on plant growth, yield and quality of horticultural crop. *International Journal of Chemical Studies* **5**(1): 217-221.
15. Rao K M, Singh P K, Ryingkhum H B K and Maying B. (2014). Use of biofertilizers in vegetable production. *Indian Horticulture Journal* **4**(1): 73-76.
16. Singh A. and Singh J N. (2009). Effect of biofertilizers and bioregulators on growth, yield and nutrient status of strawberry cv. Sweet Charlie. *Indian Journal of Horticulture* **66**(2): 220-224.
17. Singh A K, Beer K and Pal A K. 2015. Effect of vermicompost and biofertilizers on strawberry growth, flowering and yield. *Annals of Plant and Soil Research* **17**(2): 196-199.
18. Singh S K and Saravanan S. (2012). Effect of bio-fertilizers and micronutrients on yield and quality of strawberry (Fragaria × ananassa Duch) cv. Chandler. *Asian Journal of Horticulture* **7**(2): 533-536.
19. Singh S R, Zargar M Y, Najar G R, Ishaq M L and Hakeem S A. (2012). Effect of integrated nutrient supply on yield, fertility and quality of strawberry under rainfed temperate conditions. *Journal of the Indian Society of Soil Science* **60**(1): 79-82.
20. Sinha R K, Herat S, Valani D, Chauhan K. (2009). Vermiculture and sustainable agriculture. *American-Eurasian Journal of Agriculture and Environmental Sciences* **5**(5): 01-55.
21. Umar I, Wali V K, Kher R and Sharma A. (2008). Impact of integrated nutrient management on strawberry yield and soil nutrient status. *Applied Biological Research* **10**: 22-25.
22. Vessey J K. 2003. Plant growth promoting rhizobacteria as biofertilizers. *Plant and soil* **255**: 571-586.
23. Yadav S K, Khokhar UV and Yadav R P. (2010). Integrated nutrient management for strawberry cultivation. *India Journal of Horticulture* **67**(4): 445-449.
24. Zahir Z A, Arshad M and Frankenberger W T. (2003). Plant growth promoting rhizobacteria: applications and perspectives in agriculture. *Advances in Agronomy* **81**: 97-168.