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Effect of vermicompost on plant growth, fruit yield and quality of strawberries in irrigated arid region of northern plains

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ABSTRACT

Studies were conducted to determine the effect of vermicompost (VC) on plant growth, fruit yield and quality of 'Chandler' strawberry. Different graded levels of vermicompost (1.25, 2.50, 3.75, 5.00, 6.25, 7.50, 8.75 and 10.0 t ha^{-1}) were supplemented with inorganic fertilizers to balance fertilizer requirement of strawberry under semi-arid region of northern India. Our results revealed that with the increase in dose of VC, there was increasing trend for plant growth, yield and quality parameters of strawberry. However, vermicompost application @ 10 t ha^{-1} increased plant spread (16.1%), leaf area (31.4%) and dry matter (17.7%), and increased total fruit yield (29.1 %) over inorganic fertilizer. Fruit harvested from plant receiving vermicompost have higher TSS, ascorbic acid content and lower acidity. All these parameters were appeared dose dependent and best results were achieved @ 7.5 t ha^{-1}, however, beyond this dose of vermicompost, there was not significant influence on these parameters. Substitution of vermicompost drastically reduced the incidence of diseases, proportion fruits free from any physiological disorders indicating that application of vermicompost had significant role in producing healthy fruits and thereby increasing the marketable fruit yield with better quality parameters.

Key words: Vermicompost, plant growth, fruit yield, quality, strawberry.

INTRODUCTION

Vermicompost is a finely-divided, peat-like material, with high porosity, aeration, drainage, water holding capacity and microbial activity, which make it an excellent soil conditioner (Edwards, 4). There are many reports available in the literature, which indicate that vermicompost contains plant growth regulating materials, such as humic acids (Atiyeh *et al.*, 2; Muscolo *et al.*, 6) and plant growth regulators like auxins, gibberellins and cytokinins (Krishnamoorthy and Vajrabhiah, 5; Tomati *et al.*, 12), which are responsible for increased plant growth and yield of many crops (Atiyeh *et al.*, 2; Arancon *et al.*, 3). These plant growth regulating materials are produced by action of microbes, like fungi, bacteria, actinomycetes (Edwards, 4; Tomati *et al.*, 12) etc., and earthworms, as vermicompost provides large particulate surface areas that provide many microsites for microbial activities and for strong retention of nutrients as a result, most nutrients become in available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium (Edwards, 4; Orozco *et al.*, 7). Hence, vermicompost exhibits similar effects on growth and yield of plants as shown by soil-applied inorganic fertilizers or plant growth regulators or hormones (Muscolo *et al.*, 6). However, most research conducted on the use of vermicompost has only been in the greenhouse conditions, and only a few workers have reported its use and effects under field conditions.

Strawberry is one of the most important fruit crops of the world. It has become the most favourite fruit crop among the Indian growers near towns and cities, because of its remunerative prices and higher profitability (Sharma and Sharma, 9; Singh *et al.*, 11). Strawberry requires higher amount of nutrients for higher yield of quality fruit. Consequently, efforts have been made to determine the doses of inorganic nutrients for strawberry cultivation (Singh *et al.*, 11). Recently, some reports have appeared which clearly suggest that application of vermicompost along with chemical fertilizers result in increased yield and fruit quality (Arancon *et al.*, 3) mainly due to production of plant growth regulators by microorganisms during the process of vermicomposting (Atiyeh *et al.*, 2; Muscolo *et al.*, 6). Considering these points, experiment was conducted to determine the effect of different doses of vermicompost along with chemical fertilizers on growth, yield and fruit quality of 'Chandler' strawberry.

MATERIALS AND METHODS

The studies were conducted at research farm of Central Institute of Post Harvest Engineering and Technology, Abohar during 2004-05 and 2005-06. Soil of the experimental farm was sandy-loam (Ustic Haplocambid), having pH 8.42, which was low in organic carbon (0.42%), medium in available

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phosphorus, and high in potash. Soil was thoroughly ploughed and raised beds of 25 cm height, five metre in length and one-metre width were prepared at a distance of 50 cm. Healthy and disease-free runners of 'Chandler' strawberry were procured from Dr Y.S. Parmar University of Horticulture and Forestry, Solan and planted on raised beds at a spacing of 25 cm × 25 cm during first week of October. Irrigation was provided with micro-sprinkler system during early stage of plant establishment, which was replaced by drip system after 15 days of planting.

The graded dose of vermicompost (VC) was applied at 1.25, 2.50, 3.75, 5.00, 6.25, 7.5, 8.75 and 10.0 t ha^{-1}, and inorganic fertilizers (NPK) served as control. Vermicompost was first analyzed for major nutrients (N = 0.92%; P = 1.21% and K = 1.45%), and on the basis of available nutrients in it, vermicompost treated plots were supplemented with appropriate amount of inorganic fertilizers, to equalize the recommended rate/dose of nutrients among treatments. The required quantity of vermicompost (as per treatment) and the inorganic fertilizers were applied and incorporated to the top 10 cm layer of soil in experimental beds. Plastic mulch and drip irrigation systems were installed on beds after 15 days of planting of the runners. Each treatment combination consisted of 64 plants in a plot size of 4 cm × 1 cm. Treatments were replicated three times in a complete randomized block design. Observations on plant spread (cm), leaf area (cm^2) and plant dry weight (%) were recorded on five plants from each replication at 90, 120 and 150 days after planting (DAP). The plants were harvested for assessment of mean leaf area, fresh and dry weight. Total fruit yield was calculated by taking all the harvested fruit on each picking and thereafter, healthy fruits which were free from injury and diseases; and free from any disorders were sorted out to calculate the marketable fruit yield. The quality parameters were analysed as per AOAC (1). The data obtained was subjected to analysis, following standard procedures (Panse and Sukhatme, 8).

RESULTS AND DISCUSSION

Plant growth parameters like plant spread, leaf area and dry weight were significantly influenced in plots receiving vermicompost than those receiving inorganic fertilizers only (Table 1). In general, increase in vermicompost dose from 2.5 to 7.5 t ha^{-1} increased all growth parameters significantly, but further increase in vermicompost dose (10 t ha^{-1}) could not influence these parameters significantly. This influence of vermicompost on growth parameters was lesser effective at 90 days after planting but was more prominent at 120 and 150 days after planting (DAP). Further, all the plant growth parameters showed increasing trend with the duration of observations (90 to 150 DAP), and vermicompost amended treatments showed consistently better growth over plots receiving inorganic fertilizer only, indicating positive and significant influence of vermicompost ($p \leq 0.05$) on growth parameters of strawberry. It may be attributed to the positive effects of vermicompost on strawberry plant growth due to better availability of plant growth influencing materials, such as plant growth regulators and humic acids, produced by the increased activity of microbes (Arancon *et al.*, 3). It has been scientifically demonstrated that microbes like fungi, bacteria, yeasts, actinomycetes, algae etc., are capable of producing plant growth promoting substances such as auxins, gibberellins etc., in appreciable quantity during vermicomposting (Krishnamoorthy and Vajrabhiah, 5; Tomati *et al.*, 12), which might have affected the plant growth appreciably (Atiyeh *et al.*, 2; Arancon *et al.*, 3).

Further, plants responded differently to different doses of vermicompost, with significantly higher growth when VC was applied at 10.0 t ha^{-1}, and lower growth at 2.5 t ha^{-1}. Such differential response of plants to differed doses of vermicompost may be due to the fact that lower doses of vermicompost might have produced growth-promoting substances in lesser amount than higher doses. However, the growth of plants with vermicompost at 7.5 t ha^{-1} was significantly at par with that of 10 t ha^{-1} indicating that this dose of VC (7.5 t ha^{-1}) was enough for supplying the desirable amount of growth promoting substances for higher growth and fruit yield of strawberry.

Vermicompost has influenced the days taken to 1st flowering, fruit number/plant, individual berry weight and total fruit yield over inorganic fertilizers (Table 2). Plants took only 86.0 days to flower when vermicompost was applied @ 10 t ha^{-1} as compared to 96.4 days when plants received inorganic fertilizers only (Table 2). Similarly, fruit per plant (30.5), individual berry weight (13.4 g), and total fruit yield (387.5 g/plant) were maximum when strawberry plants received vermicompost @ 10 t ha^{-1}, whereas those, which received inorganic fertilizers only, have produced minimum fruits/plant (28.4), had the lowest berry weight (10.8 g) and total fruit yield (300.2 g/plant). Further, increasing the dose of vermicompost from 1.25 to 10 t ha^{-1}, has significantly reduced the number of days taken to flowering (94.1 to 86.0), but increased fruit number (28.6 to 30.5/plant), individual berry weight (11.4 to 13.4 g) and total fruit yield (304.6 to 387.5 g/plant), clearly indicating that plants from plots receiving inorganic amended vermicompost had taken significantly lesser days to flower and produced large-sized fruit with higher total yield/plant than those receiving inorganic fertilizers only (Table 2).

Table 1. Effect of different doses of vermicompost (vc) on growth parameters of 'Chandler' strawberry.

Treatment	Plant spread (cm)			Leaf area (cm^2)			Dry weight (g/pant)		
	Days after planting (DAS)			Days after planting (DAS)			Days after planting (DAS)		
	90	120	150	90	120	150	90	120	150
Inorganic fertilizers	10.4	16.9	21.1	80.5	247.1	387.5	12.7	17.1	25.9
VC @ 1.25 t/ha	10.1	17.2	21.5	78.2	251.5	392.5	12.5	16.9	26.7
VC @ 2.50 t/ha	11.3	17.6	22.4	81.2	268.3	398.1	12.9	17.9	27.5
VC @ 3.75 t/ha	11.8	18.0	22.5	83.6	281.4	423.6	13.2	18.3	28.0
VC @ 5.00 t/ha	12.0	18.4	22.9	84.6	293.5	461.0	13.5	19.1	28.4
VC @ 6.25 t/ha	12.2	19.2	23.4	86.1	304.2	484.1	14.0	19.6	29.2
VC @ 7.50 t/ha	12.8	19.7	23.8	87.5	318.6	513.8	13.8	20.7	29.6
VC @ 8.75 t/ha	13.4	20.6	24.3	88.6	334.5	519.6	14.2	21.2	30.1
VC @ 10.00 t/ha	13.0	20.2	24.5	88.1	323.5	509.2	14.3	21.4	30.5
CD at 5%	0.4	0.5	0.7	2.1	17.5	26.5	0.6	0.7	1.2

Table 2. Effect of different doses of vermicompost (vc) on days taken for flowering, yield attributing characters and total fruit yield of 'Chandler' strawberry.

Treatment	Days taken to 1st flowering	Fruits /plant	Fruit weight (g)	Total fruit yield (g/plant)
Inorganic fertilizers	96.4	28.4	10.8	300.2
VC @ 1.25 t/ha	94.1	28.6	11.4	304.6
VC @ 2.50 t/ha	92.3	29.0	11.8	311.7
VC @ 3.75 t/ha	90.2	29.4	12.0	339.1
VC @ 5.00 t/ha	88.6	29.1	12.4	351.5
VC @ 6.25 t/ha	87.1	30.2	12.9	362.7
VC @ 7.50 t/ha	86.5	31.0	13.2	376.7
VC @ 8.75 t/ha	85.7	30.8	13.5	381.4
VC @ 10.00 t/ha	86.0	30.5	13.4	387.5
CD at 5%	3.7	0.45	0.71	14.7

Application of different doses of vermicompost had influenced the fruit quality of 'Chandler' strawberry significantly over control (Table 4). Fruit harvested from plants receiving different doses of vermicompost were having significantly higher TSS, ascorbic acid, and had lower acidity than those harvested from plants receiving inorganic fertilizers only. Among different doses of vermicompost, plants receiving vermicompost @ 7.5 t ha^{-1} produced fruits with high TSS (7.42%), lower acidity (1.10%) and higher ascorbic acid content (50.8 mg/100 g pulp). Interestingly, plants receiving vermicompost have produced better fruit quality attributes which can be attributed due to better growth of plants under different doses of vermicompost, which might have favoured accumulation of higher sugars, less acidity and better ascorbic acid content. Although, there is no report in the literature to support this contention, however many authors have reported that strawberry plants with better growth produce fruit of better colour and quality (Singh *et al.*, 10). Recently, Singh *et al.* (11) have reported that strawberry plants under low plastic tunnels have better growth than those grown in open fields, and such plants produced fruit of better texture, colour and quality attributes. Further, differential response of strawberry to fruit texture, colour and quality may be attributed to variable growth attained by the plants, primarily due to differential rate of release of growth promoting substances owing to differed doses of vermicompost (Arancon *et al.*, 3; Tomatio *et al.*, 12). The present study revealed that addition of vermicompost with chemical fertilizers is quite useful in field-grown strawberries for better

Table 3. Effect of different doses of marketable fruit yield and quality parameters of 'Chandler' strawberry.

Treatment	Marketable fruit yield (g/plant)	TSS (%)	Acidity (%)	Ascorbic acid content (mg/100 g)
Inorganic fertilizers	214.6	7.17	1.23	46.9
VC @ 1.25 t/ha	220.5	7.21	1.21	47.4
VC @ 2.50 t/ha	232.7	7.26	1.20	47.8
VC @ 3.75 t/ha	262.5	7.29	1.20	48.2
VC @ 5.00 t/ha	282.6	7.31	1.18	48.8
VC @ 6.25 t/ha	298.7	7.37	1.15	49.7
VC @ 7.50 t/ha	317.5	7.42	1.11	50.7
VC @ 8.75 t/ha	321.7	7.40	1.09	50.8
VC @ 10.0 t/ha	324.6	7.36	1.09	51.1
CD at 5%	16.2	0.06	0.09	0.84

growth, and it helps in getting higher marketable fruit yield of firmer fruit with good quality attributes.

REFERENCES

1. AOAC. 1989. *Official Methods of Analysis,* 14th Edn. Association of Official Agricultural Chemists, Washington, DC.
2. Atiyeh, R.M., Lee, S.S., Edwards, C.A., Arancon, N.Q. and Metzger, J. 2002. The influence of humic acid derived from earthworm-processed organic waste on plant growth. *Biores. Tech.* **84**: 7-14.
3. Arancon, N.Q., Edwards, C.A., Bierman, P., Welch, C. and Metzer, J.D. 2004. Influence of vermicomposts on field strawberries: Effect on growth and yields. *Biores. Tech.* **93**: 145-53.
4. Edwards, C.A. 1998. The use of earthworm in the breakdown and management of organic waste. **In**: *Earthworm Ecology*. ACA Press LLC, Boca Raton, FI, pp. 327-54.
5. Krishnamoorthy, R.V. and Vajrabhiah, S.N. 1986. Biological activity of earthworm casts: an assessment of plant growth promoter levels in casts. *Proc. Indian Acad. Sci*. (*Animal Sci.*) **95**: 341-51.
6. Muscolo, A., Bovalo, F., Gionfriddo, F. and Nardi, F. 1999. Earthworm humic matter produces auxin-like effect on *Daucus carota* cell growth and nitrate metabolism. *Soil Biol. Biochem.* **31**: 1303-11.
7. Orozco, F.H., Cegarra, J., Trujillo, L.M. and Roig, A. 1996. Vermicomposting of coffee pulp using the earthworm *Eisenia fetida*: effect on C and N contents and the availability of nutrients. *Biol. Fert. Soils,* **22**: 162-66.
8. Panse, V.G. and Sukhatme, P.V. 1984. *Statistical Methods for Agricultural Workers*, (3rd edn.). ICAR, New Delhi, India.
9. Sharma, R.R. and Sharma, V.P. 2004. *The Strawberry.* ICAR, New Delhi, India.
10. Singh, R., Asrey, R. and Kumar, S. 2006. Effect of plastic tunnel and mulching on growth and yield of strawberry. *Indian J. Hort*. **63**: 18-21.
11. Singh, R., Sharma, R.R., Kumar, S. and Singh, D.B. 2009. Package of practices for strawberry cultivation with modern techniques under North Indian plains. *Acta Hort.* **842**: 607-11.
12. Tomati, U., Grappelli, A. and Galli, E. 1988. The harmone like effect of earthworm casts on plant growth. *Biol. Fert. Soils,* **5**: 288-94.

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