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Effect of Bio-fertilizers, Vermicompost and *Trichoderma* on Fruit Quality and Residual of NPK in Soil of Strawberry Field (*Fragaria x annanasa* Duch.) cv. Sweet Charlie

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ABSTRACT

The present study was conducted at SHUATS, Allahabad during 2013-14 and 2014-15 to study the effect of bio-fertilizers, vermicompost and *Trichoderma* on fruit quality and NPK residual in field of strawberry (*Fragaria x annanasa* Duch.) cv. Sweet Charlie. The experiment was laid out in randomized block design with twelve treatments and three replications. The maximum total soluble solids (6.69°Brix) was recorded in T_{11} (5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 7 kg ha^{-1} *Azotobactor* + 6 kg ha^{-1} PSB + 10 kg ha^{-1} VAM) followed by (6.28°Brix) with T_{10} (5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 6 kg ha^{-1} PSB + 10 kg ha^{-1} VAM). The maximum acidity (0.72%) was also observed with T_{11} followed by T_7 and T_{10} while the least (0.58) was observed with T_0 (RDF through chemical fertilizers). The ascorbic acid and total sugars were also found maximum in T_{11} (55.96mg and 8.12% respectively). In 2013-14 the maximum residual NPK among the treatments was noticed 267.41 kg ha^{-1} with T_{11} among the treatments.

Key words: Strawberry, Bio-Fertilizer, Vermicompost, Trichoderma, fruit Quality

Strawberry (*Fragaria × ananassa* Duch.) belongs to the family Rosaceae. Strawberry plant is a surface feeder therefore fertility, moisture, drainage and microbial status of the upper layer of soil have great impact on its growth, development of fruit, fruit yield and quality and production of runners. The berries of strawberry are good source of ascorbic acid (30-120 mg/100 g), Vitamin-A (60 IU/100 g), potassium, calcium and phosphorus (Sharma 2002). The presence of ellagic acid, which prevents cancer and occurrence of heart diseases and abundance of anthocyanins have made it a more valuable fruit (Nazir *et al.* 2012). 100g of edible portion of strawberry contents 87.8% moisture, 0.7% protein, 0.2% fat, 1.1% fiber, 9.8% carbohydrate, 0.4 % minerals, 30 IU Vitamin A, 0.03 mg Thimine, 0.07 mg Riboflovin, 0.2 mg and Nicotinic acid.

Azotobacter is known to synthesis biologically active growth promoting substance like Indol Acetic Acid (IAA), Gibrellic Acid (GA) and Vitamin B. The use of Phosphate Solubilizing Bacteria as inoculants simultaneously increases phosphorus uptake by the plant and crop yield. Vesicular Arvescular Mycorrhizae plays a vital role in establishment, growth and productivity of strawberry plants. Vermicompost when applied to soil improve the soil physico-chemical properties. *Trichoderma* is used as a successful bio-control agent to suppress soil borne pathogens. Now days, Fruit quality in strawberry is an important aspect of marketing of fruits which mainly govern by nutrient and microbial status of soil. Hence the present experiment was carried out for to study effect of bio-fertilizers, vermicompost and *Trichoderma* on fruit quality and residual of NPK in soil of strawberry field (*Fragaria x annanasa* Duch.) cv. Sweet Charlie.

MATERIALS AND METHODS

The present investigation was carried out under Allahabad Agro-climatic Conditions at the Experimental Field of Department of Horticulture, SHIATS, Allahabad U.P. during 2013-14 and 2014-15. The experiment was laid out in randomized block design with 12 treatments which were replicated thrice. The 12 treatment were as follows T_0: Control; T_1: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost; T_2: 5 kg ha^{-1} *Trichoderma* + 7 kg ha^{-1} *Azotobacter*; T_3: 5 kg ha^{-1} *Trichoderma* + 6 kg ha^{-1} PSB; T_4: 5 kg ha^{-1} *Trichoderma* + 10 kg ha^{-1} VAM; T_5: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 7 kg ha^{-1} *Azotobactor*; T_6: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1}

Vermicompost + 6 kg ha^{-1} PSB; T_7: 5 kg ha^{-1} *Trichoderma*; + 2.5 t ha^{-1} Vermicompost; + 10 kg ha^{-1} VAM; T_8: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 7 kg ha^{-1} *Azotobactor* + 6 kg ha^{-1} PSB; T_9: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 7 kg ha^{-1} *Azotobactor* + 10 kg ha^{-1} VAM; T_{10}: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 6 kg ha^{-1} PSB + 10 kg ha^{-1} VAM and T_{11}: 5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 7 kg ha^{-1} *Azotobactor* + 6 kg ha^{-1} PSB + 10 kg ha^{-1} VAM. The total soluble solids (°Brix) of fruits were recorded by using a hand refractometer (0-32°B range). The values were corrected at 20°C and expressed as °Brix. The total titratable acidity of strawberry pulp was determined by visual titration method (Ranganna 1986). Ascorbic acid (mg 100 g^{-1}) was determined by 2, 6-dichlorophenol indophenols visual titration method described by Ranganna (1986). Total sugars of fruit present in the fruit pulp were estimated by method of Lane and Eynon described by Ranganna (1986). Available nitrogen (kg ha^{-1}) content was determined by using alkaline potassium permanganate method (Subbaiah and Asija 1956) by digestion, distillation and collection of NH_3 in 4% boric acid and then titrating against standard sulphuric acid. Available Phosphorous (kg ha^{-1}) was estimated by using 2.5 g of prepared soil sample and 50 ml of 0.5 m Bray's NH4 solution by following Olsen's method as out lined by (Jackson 1973). Available potassium (kg ha^{-1}) was determined photo-metrically from the neutral normal ammonium acetate extract (Jackson 1973). The data recorded during the course of investigation was subjected to statistical analysis described by Panse and Sukhatme (1985). The significance and non-significance of treatment effect was judge with the help of 'F' (variance ratio) table. The significance differences between the mean were tested against the critical difference at 5% probability level.

RESULTS AND DISCUSSION

The data on fruits yield plant^{-1} of strawberry cv. Sweet Charlie has significantly influenced by biofertilizers, vermicompost and *Trichoderma* is given in the (Table 1). The table revealed that there are significant differences among the treatments in first year, second year and their pooled data. The maximum total soluble solids (6.69) was recorded in T_{11} (5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1} Vermicompost + 7 kg ha^{-1} *Azotobactor* + 6 kg ha^{-1} PSB + 10 kg ha^{-1} VAM) followed by T_{10} (6.28) and T_7 and least was recorded in T_0 (Control) in pooled data analysis. The maximum acidity per cent (0.72) was estimated in T_{11} followed by T_{10} and T_7 and minimum was recorded in T_0 (0.58). The maximum ascorbic acid (55.96mg) was observed in T_{11} followed by T_7, T_9 and T_{10} and least was observed with T_0 (0.58). The maximum total sugar (8.12%) was observed in T_{11} followed by T_8 (7.82%) and T_9 (7.74) and T_{10} (7.62) while the least (5.04%) was observed with T_0. Similar findings also reported by Karma-Beer *et al.* (2017), Kumar *et al.* (2015), Dadashpour and Jouki (2012), Tripathi *et al.* (2010), Umar *et al.* (2009) in strawberry.

Table 1 Effect of bio-fertilizers, vermicompost and *Trichoderma* on fruit quality of Strawberry cv. Sweet charlie

Treatments	Total Soluble Solids (T.S.S.°Brix)			Acidity (%)			Ascorbic Acid (mg/100g of fruit pulp)			Total Sugars		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
T_0	4.83	5.00	4.92	0.58	0.58	0.58	48.51	48.61	48.56	4.95	5.12	5.04
T_1	4.95	5.13	5.04	0.68	0.67	0.68	48.70	48.72	48.71	5.23	5.35	5.29
T_2	5.19	5.28	5.24	0.67	0.67	0.67	50.71	51.02	50.86	5.70	5.92	5.81
T_3	5.85	5.95	5.90	0.68	0.68	0.68	50.28	50.32	50.30	5.78	5.91	5.85
T_4	5.46	5.60	5.53	0.70	0.65	0.68	51.83	51.55	51.69	7.20	6.45	6.82
T_5	6.20	6.02	6.11	0.69	0.67	0.68	51.10	52.15	51.63	7.28	7.19	7.23
T_6	5.46	5.49	5.47	0.67	0.64	0.66	50.49	54.63	52.56	6.83	7.19	7.01
T_7	6.36	6.14	6.25	0.69	0.70	0.70	54.59	55.36	54.98	6.99	7.14	7.06
T_8	5.58	6.24	5.91	0.65	0.71	0.68	52.48	51.70	52.09	8.00	7.65	7.82
T_9	6.02	6.09	6.06	0.67	0.67	0.67	54.00	54.50	54.25	7.41	8.07	7.74
T_{10}	6.27	6.28	6.28	0.68	0.71	0.69	52.58	54.89	53.74	7.74	7.49	7.62
T_{11}	6.50	6.88	6.69	0.72	0.73	0.72	56.30	55.62	55.96	8.09	8.15	8.12
SE.m (±)	0.34	0.36	0.35	0.02	0.03	0.02	1.36	1.53	1.45	0.37	0.33	0.35
C.D 0.5%	1.01	1.07	1.00	0.06	0.08	0.07	3.99	4.48	4.12	1.07	0.98	0.99

The data on residual available NPK during 2013-14 and 2014-15 before and after experimentation are given in (Table 2). In 2013-14 the maximum residual nitrogen among the treatments was estimated 267.41 kg ha^{-1} in T_{11}. Similarly in 2014-15 the maximum residual nitrogen among the treatments was recorded 291.04 kg ha^{-1} in T_{11} while in 2014-15 it was recorded 206.03 kg ha^{-1} in T_0. In 2013-14 the maximum residual phosphorous among the treatments was noticed 34.99 kg ha^{-1} with T_{11}. In 2014-15 the maximum residual potassium among the treatments was recorded 276.05 kg ha^{-1} with T_{11}. Similarly in 2014-15 the maximum residual potash among the treatments was noticed 243.70 kg ha^{-1} with T_{11} while the minimum residual potash was recorded 207.73 kg ha^{-1} in T_0. The increased residual nitrogen content in T_{11} might be attributed to nitrogen fixation by the biofertilizers specially Azotobacter as well as nitrogen retention capacity of Vermicompost (Hussain *et al.* 2017, Yavari *et al.* 2008, Singh and Singh 2009).

On the basis of results obtained, it can be concluded that the treatment T_{11} (5 kg ha^{-1} *Trichoderma* + 2.5 t ha^{-1}

rmicompost + 7 kg ha^{-1} *Azotobactor* + 6 kg ha^{-1} PSB + 10 ha^{-1} VAM) was found superior in terms of fruit quality of awberry and on residual effect of NPK in the strawberry among the different treatment.

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Table 1 Effect of bio-fertilizers, vermicompost and *Trichoderma* on fruit quality of strawberry cv. Sweet charlie

Treatments	Nitrogen kg ha^{-1}				Phosphorus kg ha^{-1}				Potassium kg ha^{-1}			
	2013-14		2014-15		2013-14		2014-15		2013-14		2014-15	
	Before planting	After harvesting	Before planting	After harvesting	Before planting	After harvesting	Before planting	After harvesting	Before planting	After harvesting	Before planting	After harvesting
T_0	199.17	198.53	198.53	206.03	16.56	16.57	16.57	16.57	222.20	189.95	189.95	207.73
T_1	199.17	217.78	217.78	215.56	16.56	16.99	16.77	16.77	221.20	225.50	225.50	214.62
T_2	199.17	201.58	201.58	211.40	16.56	20.06	18.31	18.31	222.20	223.74	223.74	216.57
T_3	199.17	215.13	215.13	210.85	16.56	22.95	19.76	19.76	221.20	230.52	230.52	227.84
T_4	199.17	222.22	222.22	216.95	16.56	21.83	19.20	19.20	222.20	225.94	225.94	224.59
T_5	199.17	223.84	223.84	232.32	16.56	20.95	18.76	18.76	221.20	220.85	220.85	218.45
T_6	199.17	233.65	233.65	230.45	16.56	22.88	19.72	19.72	221.20	264.33	264.33	218.96
T_7	199.17	237.22	237.22	234.78	16.56	22.22	19.39	19.39	222.20	230.51	230.51	231.30
T_8	199.17	247.67	247.67	231.80	16.56	24.90	20.73	20.73	221.20	234.31	234.31	238.70
T_9	199.17	231.55	231.55	265.28	16.56	26.36	21.46	21.46	221.20	264.29	264.29	216.66
T_{10}	199.17	256.42	256.42	272.78	16.56	28.47	22.52	22.52	221.20	235.92	235.92	225.91
T_{11}	199.17	267.41	267.41	291.04	16.56	34.99	25.78	25.78	222.20	276.05	276.05	243.70
SE.m (±)	5.23	9.61	9.61	16.10	0.46	2.59	2.59	2.03	5.99	15.28	15.28	14.75
C.D 0.5%	15.33	28.19	28.19	47.22	1.35	7.60	7.60	5.94	17.56	44.81	44.81	43.25

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