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Assessment of organic and inorganic fertilizers on physico-chemical properties of soil of tomato (*Solanum lycopersicum* L.) *Var*. Pusa ruby

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Abstract
A field study was conducted on Assessment of Organic and Inorganic Fertilizers on Physico-Chemical Properties of Soil of Tomato (*Solanum lycopersicum* L.) *Var*. Pusa Ruby at the Soil Science & Agricultural Chemistry Research Farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during winter season 2020. The results obtained with highest Bulk Density, Particle Density, Percentage Pore Space, Water Retaining Capacity, pH, EC and there was significant increase in OC, Available Nitrogen, Phosphorus and Potassium in T_8 [NPK@ 100% + Vermicompost@ 50%] than other treatments. It was also revealed that the application of NPK with vermicompost is an excellent way of improving yield of quality tomato under field conditions with greater cost benefit ratio and it will also improve the fertility of the soil.

Keywords: Tomato, NPK and vermicompost, physico-chemical properties of soil

Introduction
Tomato, (*Solanum lycopersicum* L.), belongs to the family Solanaceae having chromosome number (2n=24). It is a self pollinated crop and its origin is Peru. Tomato has a significant role in human nutrition because of its rich source of lycopene, minerals and vitamins such as ascorbic acid and β- carotene which are anti oxidants and promote good health (Antonio *et al*., 2004) [2]. Tomato can be grown on a wide range of soil from sandy to heavy clay. However, well-drained, sandy or red loam soil rich in organic matter with a pH range of 6.0-7.0 are considered as ideal. The best fruit colour and quality is obtained at a temperature range of 21-24°C. Temperatures above 32ºC and below 10ºC adversely affect the fruit set and development. The plants cannot withstand frost and high humidity. It requires a low to medium rainfall.

Vermicompost is the product of the decomposition process. Vermicompost contains water-soluble nutrients and is an excellent, nutrient-rich organic fertilizer and soil conditioner. It is used in farming and small scale sustainable, organic farming. Vermicompost is an eco-friendly, cost effective and ecologically sound bio-fertilizer that also played a significant role in soil biology, chemistry and physics. It is an effective means for improving soil aggregation, structure, aeration and fertility; contains most of the nutrients in plant available form such as nitrates, phosphates, exchangeable calcium and soluble potassium; increases beneficial microbial population, diversity and activity; improves the soil moisture-holding capacity; enriched with valuable vitamins, enzymes and hormones; accelerates the population and activities of earthworms (Bhasker *et al.*, 1992) [3].

An inorganic fertilizer is any material of natural or synthetic origin (other than liming materials) that is applied to soil or to plant tissues to supply one or more plant nutrients essential to the growth of plants. Fertilizers enhance the growth of plants. Conventional production uses chemical fertilizers mainly urea, superphosphate and potash (Shimbo *et al*., 2001) [11].

Pusa Ruby an early and hardy variety evolved at IARI. The plants are medium and determinate. The fruits are medium-sized and uniformly red when ripe. It yields about 25-30 tonnes ha^{-1}. Plants are indeterminate with a height of 80-85 cm and spreading habit with hardy branches.

Materials and Methods

Study site

The field study was conducted in Prayagraj district which comes under subtropical belt with semi-arid climatic condition, with both extremes of temperature, i.e., winter and summer. The maximum temperature of the location reaches up to 46˚C-48˚C and seldom falls as 4˚C-5˚C. The relative humidity ranges between 20% to 94%. The average rainfall in this area is around 1100mm annually. The minimum temperature during the crop season was to be 5.9˚C and the maximum is to be 29.04˚C. The maximum humidity was to be 42.72% and maximum was to be 93.28%. Trasnsplanting was done from last week of November and *rabi* season starts from October and ends in March (winter).

Layout and treatment combination

Experiment was laid out in 2x2 randomized block design with organic (vermicompost) and inorganic (NPK) with three different levels of NPK@ 0, 50 and 100% ha^{-1} and three different levels of vermicompost@ 0, 50 and 100% ha^{-1}. Treatment were T_1 - control, T_2 - @$N_0P_0K_0$ kg ha^{-1} + VC @7.5 t ha^{-1}, T_3 - @$N_0P_0K_0$ kg ha^{-1} + VC @15 t ha^{-1}, T_4 - @$N_{60}P_{30}K_{30}$ kg ha^{-1} + VC @ 0 t ha^{-1}, T_5 - @$N_{60}P_{30}K_{30}$ kg ha^{-1} + VC @7.5 t ha^{-1}, T_6 - @$N_{60}P_{30}K_{30}$ kg ha^{-1} + VC @15 t ha^{-1}, T_7 - @$N_{120}P_{60}K_{60}$ kg ha^{-1} + VC @0 t ha^{-1}, T_8 - @$N_{120}P_{60}K_{60}$ kg ha^{-1} + VC @7.5 t ha^{-1}, T_9 - @$N_{120}P_{60}K_{60}$ kg ha^{-1} + VC @ 15 t ha^{-1}. Nitrogen was applied in two split doses. The source of NPK and Vermicompost were urea, SSP, MOP and vermicompost, respectively.

Methods for different parameters

The method used for the analysis of bulk density, particle density, percentage pore space and water holding capacity was Graduated measuring cylinder (Muthuvel *et al.*, 1992) [9], for the estimation of soil pH, digital p H meter was used (M.L. Jackson., 1958) [4], for the estimation of EC, digital EC meter was used (Wilcox., 1950) [18], forthe estimation of OC, wet oxidation method was used (Walkley and Black., 1947) [17], for the estimation of available nitrogen, alkaline potassium permanganate method was used (Subbiah and Asija., 1956) [13], for the estimation of available phosphorus, photoelectric colorimeter was used (Olsen *et al*., 1954) [10] and for the estimation of available potassium, flame photometer was used (Toth and Prince., 1949) [16].

Results and Discussion

Bulk Density (Mg m^{-3})

The maximum bulk density 1.44, 1.49 Mg m^{-3} was found in treatment T_8 (@ $N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 1.14, 1.16 Mg m^{-3} at 0-15 and 15-30cm depth respectively. The bulk density was increasing with the increase in depth. The bulk density was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Kumar *et al.*, (2013) [7].

Particle Density (Mg m^{-3})

The maximum particle density 2.71, 2.81 Mg m^{-3} was found in treatment T_8, T_2 (@ N_{120}, P_{60}, K_{60} kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}), (@$N_0P_0K_0$ kg ha^{-1} + VC @7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 2.4, 2.63 Mg m^{-3} at 0-15 and 15-30cm depth respectively. The particle density was increasing with the increase in depth. The particle density was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Kumar *et al.*, (2013) [7].

Pore space (%): The maximum Pore space 54%, 50.66% was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum Pore space was found in T_1 (Control) which was 41%, 38.33% at 0-15 and 15-30cm depth respectively. The pore space was decreasing with the increase in depth. The Pore space was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Kumar *et al.*, (2013) [7].

Water Holding Capacity (%)

The maximum water retaining capacity 67.7, 65.7% was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 51.1, 48.1(%) at 0-15 and 15-30cm depth respectively. The water holding capacity was decreasing with the increase in depth. The water retaining capacity was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Yadav *et al.*, (2019) [19].

Table 1: Effects of NPK and Vermicompost on Physical Properties of Soil in Tomato

Treatments	Bulk Density (Mg m^{-3})		Particle Density (Mg m^{-3})		Pore space (%)		Water Holding Capacity (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.14	1.16	2.40	2.63	41	38.33	51.16	48.1
T_2	1.30	1.41	2.60	2.81	47.33	44.33	52.25	50
T_3	1.30	1.42	2.55	2.57	47.66	44.66	52.88	50.45
T_4	1.32	1.36	2.61	2.66	47.33	45.33	57.75	55.30
T_5	1.35	1.38	2.54	2.58	47.66	45.66	61.50	60.20
T_6	1.35	1.40	2.47	2.53	41.66	39	62.83	60.80
T_7	1.36	1.42	2.38	2.44	47.33	45	61.10	59.67
T_8	1.44	1.49	2.71	2.75	54	50.66	67.70	65.70
T_9	1.40	1.42	2.61	2.64	48	46	65.91	62.39
F- test	S	S	S	S	S	S	S	S
S. Ed(±)	0.00471	0.01207	0.00583	0.01609	0.59317	0.73912	0.08701	0.27859
C.D. (P=0.05)	0.01003	0.02187	0.0124	0.03425	1.26262	1.57329	0.1852	0.593

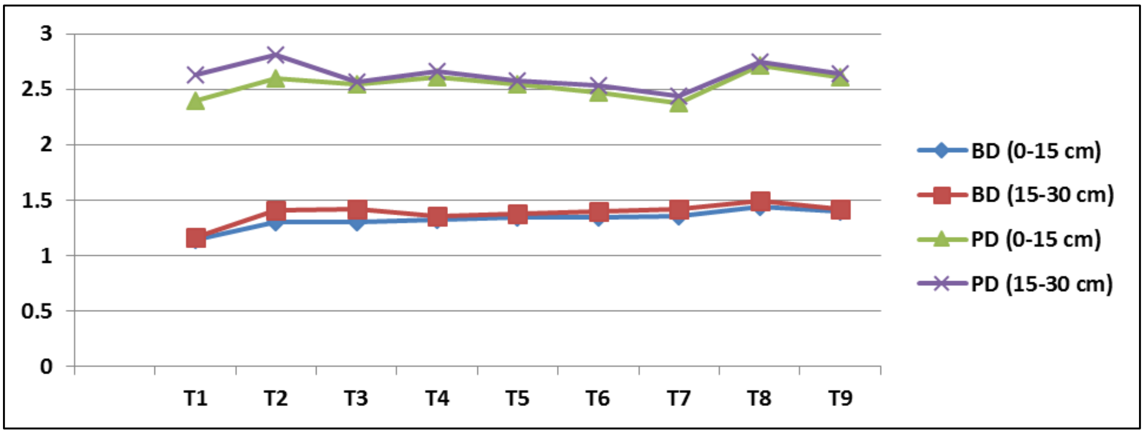

Fig 1: Effects of NPK and Vermicompost in Bulk density and Particle density at different depths

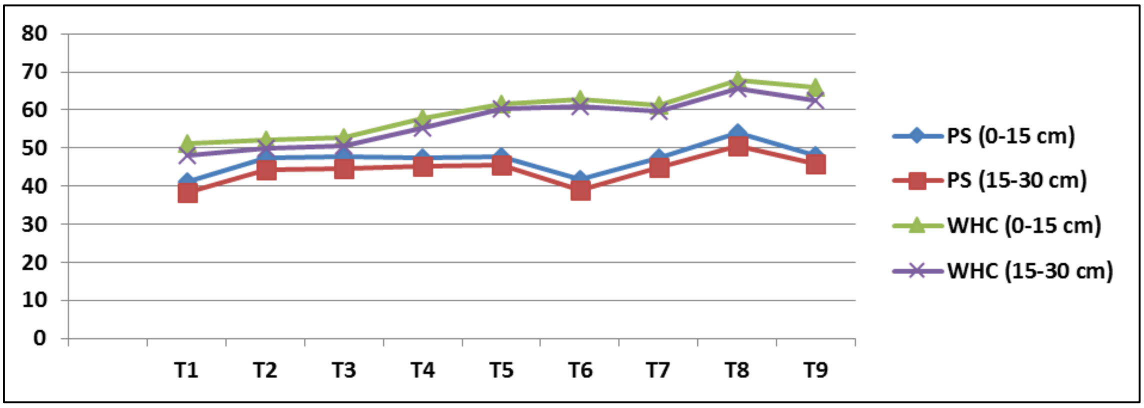

Fig 2: Effects of NPK and Vermicompost in % Pore space and WHC at different depths

pH

The maximum pH 7.37, 7.41 was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 7.06, 7.08 at 0-15 and 15-30cm depth respectively. The pH was increasing with the increase in depth. The pH was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Yadav *et al.*, (2019) [19].

Electrical conductivity (dS m^{-1})

The maximum EC 0.51, 0.49 dS m^{-1} was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 0.24, 0.20 dS m^{-1} at 0-15 and 15-30cm depth respectively. The EC was decreasing with the increase in depth. The EC was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Yadav *et al.*, (2019) [19].

Organic carbon (%)

The maximum OC 0.82, 0.49% was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 0.57, 0.20% at 0-15 and 15-30cm depth respectively. The OC was decreasing with the increase in depth. The OC was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Yadav *et al.*, (2019) [19].

Table 2: Effects of NPK and Vermicompost on Chemical Properties of Soil in Tomato

Treatments	pH		EC		OC	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	7.06	7.08	0.24	0.20	0.57	0.53
T_2	7.07	7.10	0.36	0.33	0.63	0.61
T_3	7.08	7.11	0.41	0.35	0.64	0.63
T_4	7.11	7.11	0.41	0.41	0.65	0.66
T_5	7.19	7.21	0.43	0.44	0.71	0.69
T_6	7.13	7.17	0.44	0.44	0.74	0.72
T_7	7.22	7.23	0.44	0.45	0.69	0.66
T_8	7.37	7.41	0.51	0.49	0.82	0.79
T_9	7.33	7.35	0.47	0.46	0.81	0.76
F- test	S	S	S	S	S	S
S. Ed(±)	0.00621	0.01506	0.00896	0.00864	0.00724	0.00553
C.D. (P=0.05)	0.01322	0.03206	0.01907	0.0184	0.01542	0.01177

Nitrogen (kg ha^{-1})

The maximum Nitrogen 228.3, 226.3 kg ha^{-1} was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 207, 204.1 kg ha^{-1} at 0-15 and 15-30cm depth respectively. The available Nitrogen was decreasing with the increase in depth. The Nitrogen was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Kumar *et al.*, (2013) [7].

Phosphorus (kg ha^{-1})

The maximum phosphorus 18.85, 17.64 kg ha^{-1} was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 13.92, 11.39 kg ha^{-1} at 0-15 and 15-30cm depth respectively. The Phosphorus was decreasing with the increase in depth. The Phosphorus was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Kumar *et al.*, (2013) [7].

Potassium (kg ha^{-1})

The maximum potassium 228.3, 226.3 kg ha^{-1} was found in treatment T_8 (@$N_{120}P_{60}K_{60}$ kg ha^{-1} + Vermicompost @ 7.5 t ha^{-1}) for 0-15 and 15-30 cm depth respectively and minimum was found in T_1 (Control) which was 207, 204.1 kg ha^{-1} at 0-15 and 15-30cm depth respectively. The Potassium was decreasing with the increase in depth. The Potassium was found significant in different depths at different levels of fertilizer and vermicompost. Similar findings also reported by Kumar *et al.*, (2013) [7].

Table 3: Effects of NPK and Vermicompost in Availability of Primary Nutrients of Soil in Tomato

Treatments	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	207.0	204.1	13.9	11.3	115.9	113.2
T_2	208.1	205.6	14.5	12.6	123.6	119.6
T_3	212.2	209.5	15.7	13.3	127.5	122.3
T_4	213.4	212.1	16.1	16.1	127.8	123.3
T_5	219.0	216.1	16.4	14.3	134.5	133.3
T_6	218.0	215.1	16.6	15.2	131.1	128
T_7	222.0	219.1	17.3	15.8	139.8	135.3
T_8	228.3	226.3	18.8	17.6	146.8	145
T_9	225.1	222.1	18.2	17.4	144.2	142.3
F- test	S	S	S	S	S	S
S. Ed(±)	0.17389	0.15901	0.082	0.06948	0.1596	0.65353
C.D. (P=0.05)	0.37015	0.33848	0.1745	0.1479	0.33972	1.3911

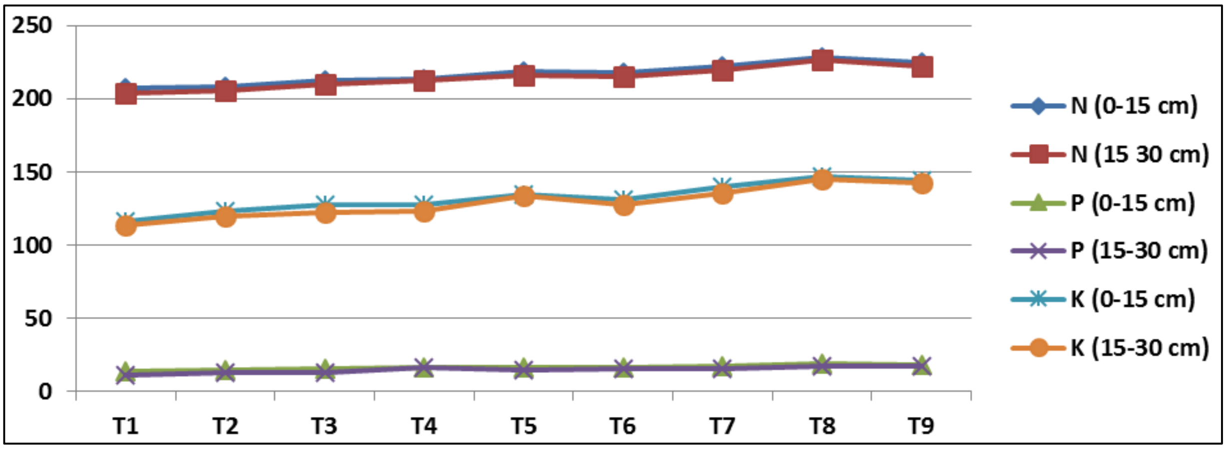

Fig 3: Effects of NPK and Vermicompost in Availability of Primary Nutrients at different depths

Conclusion

In the present investigation it can be concluded that the application of NPK and vermicompost in case of T_8-@$N_{120}P_{60}K_{60}$ kg ha^{-1} + VC @7.5 t ha^{-1} was found significant in Bulk Density, Particle Density, Percentage Pore Space, Water Holding Capacity, pH, EC, OC, Available NPK than the other treatments. Thus it can be concluded that different levels of NPK and vermicompost fertilizer improve soil available nutrients and physical properties of the soil as well as the yield and thus, this treatment will be beneficial for the farmers.

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