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Effect of different levels of NPK and Vermicompost on physico-chemical properties of soil, growth and yield of Okra [*Abelmoschus esculentus* L.] var. Kashi Kranti

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Abstract
A field experiment was carried out during *kharif* season of 2021 to evaluate the "Effect of Different Levels of NPK and Vermicompost on Physico-Chemical Properties of Soil, Growth and Yield of Okra [*Abelmoschus esculentus* L.] var. Kashi Kranti" in *inceptisol* soil. The experiment was laid down in 3x3 randomized block design having three factors with three levels of nitrogen, phosphorus, potassium through Urea, SSP, MOP 0, 50, 100% and also three levels of Vermicompost 0, 50 and 100% respectively. The result showed that in treatment T_9 has maximum yield 12.48 q ha^{-1} regarding, gave the best results with respect to plant height 114.54 cm, number of leaves plant^{-1} 49.31, number of branch plant^{-1} 47.27, number of fruit plant^{-1} (19.87), and yield of fruits q ha^{-1} (148.59) and T_9 provides highest cost benefit ratio 1: 2.82 and net profit ₹87535.43 ha^{-1} in okra were to found best treatment combination.

Keywords: Okra, nitrogen, phosphorus, potassium, Urea, SSP, MOP, Economic and yield

Introduction

Okra or lady's finger (*Abelmoschus esculentus*) is of old world origin, somewhere in the African continent. It has somatic chromosomes number 2n=130. It is an important vegetable crop grown in summer and rainy seasons throughout India. It is rich in vitamins, calcium, potassium and other mineral. Okra (*Abelmoschus esculentus* (L.) Moench) known in many English- speaking countries as lady's fingers, bhindi, bamila, ochro or gumbo, it belong *Malvaceae* family and it is valued for its edible green pods. It is widely cultivated in tropical, sub-tropical and warm temperate regions around the world. It is short duration vegetable. It is an important pan-tropical vegetable, particularly in West Africa, India, Brazil and Southern USA (Gloria *et al*., (2017). In India, okra is grown during pre-*kharif* (March to June) and *kharif* season (July to October). In India okra is cultivated in an area of 509 thousand ha with an annual production of 6095 thousand tonnes and productivity of 11.97 t ha^{-1}. In India, West Bengal leading okra production with an area of 77.5 thousand hectares with an annual production of 915 thousand tonnes and productivity of 11.8 t ha^{-1}. In Uttar Pradesh okra occupies an area of 22.93 thousand ha with annual production 307.29 thousand tonnes and productivity of 13.4 t ha^{-1} (Horti. Statistics at glance, 2018). Mature okra seeds are good source of protein and oil and it has been known to be very important in nutritional quality. Okra accounts for 60 percent of export of fresh vegetables. (Rani and jyoti, 2013) [6]

Organic manure contains all nutrients which are required for healthy growth of crop and help to improve physical, chemical and biological properties of soil (Ola *et al*., 2018) [5]. Nitrogen plays a vital role in chlorophyll, protein, nucleic acid, hormones and vitamins synthesis. Nitrogen also helps in cell division, cell elongation and linear increase in green pod yields of okra (Das *et al*., 2014) [1]. Nitrogen makes leafy vegetables and fodder more succulent. It also increases the protein content of food and feed (Lakra *et al*., 2017) [4]. Phosphorus is a key element in the formation of high energy compounds, such as AMP, ADP and ATP, which play essential role in photosynthesis and respiration. It is a vital component of nucleic acids and phospholipids (Meena *et al*., 2017). P increases crop resistance to diseases **(**Lakra *et al*., 2017) [4]. Potassium imparts vigour and disease resistance to the plant and plays an important role in crop productivity. Potassium contributes to stem growth, root growth and the synthesis of protein (Ginindza *et al*., 2015) [2].

Vermicompost is a mixture of worm castings, undigested organic wastes, microbes, vitamins, enzymes, hormones and antibiotics. It has less soluble salts, neutral pH, greater ion exchange

capacity, humic acid content, nitrates, calcium and magnesium. It improves water holding capacity of the soil. It contains plant hormones like auxins and gibberellins and enzymes which believed to stimulate plant growth and discourage plant pathogens. It also enriches the soil with useful microorganisms which add different enzymes like phosphatases and cellulases to the soil. It is rich in NPK and retain the nutrients for long time. (Tensingh *et al*., 2017) [7].

Materials and Methods

During the kharif season 2021-2022, an experiment was done at the crop Research farm of the Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, Uttar Pradesh, which is located on the outskirts of Prayagraj city. The area situated on the south of Prayagraj on right side of the river Yamuna on the south of Rewa road at distance of about 6 km from Prayagraj city. It is situated at 25°24'30" north latitude, 81°51'10" east longitude, and 98 meters above sea level. The location's highest temperature ranges from 46 to 48 ^{0}C, with lows of 40 to 50 ^{0}C. The relative humidity levels ranged from 20% to 94%. The average yearly rainfall in this area is roughly 1100 mm. Prayagraj has a sub-tropical and semi-arid climate, with rain falling primarily between July and September. The levels of N,P,K, @ 0%, 50% and 100%, and vermicompost @ 0%, 50%, and 100%, respectively, were used to control the treatments. The soil was Sandy loam. The recommended fertilizer dosage Nitrogen 100 kg ha^{-1}, Phosphorus 60 kg ha^{-1}, Potassium 50 kg ha^{-1}, Vermicompost 6t ha^{-1} at 30, 60, and 90 days after seeding, the soil surface was scraped followed by weeding three times.

Results and Discussion

As depicted in table 2 shows that the maximum bulk density of soil (Mg m^{-3}), was found in T_1 (Control) which was 1.301 and minimum found in T_9 (NPK @100% +Vermicompost @ 100%) which was 1.013. This is show that the maximum particle density of soil (Mg m^{-3}), was found in T_1 (Control) which was 2.481 and minimum found in T_9 (NPK @100% + Vermicompost @ 100%) which was 2.311. The results shows that the maximum pore space (%) of soil, was found in T_9 (NPK @100% + Vermicompost @ 100%) which was 51.02 and minimum found in T_1 (Control) which was 44.82. The results shows that the maximum water holding capacity (%) of soil, was found in T_9 (NPK @100% +Vermicompost @ 100%) which was 49.92 and minimum found in T_1 (Control) which was 34.13.This shows that the maximum pH of soil, was found in T_9 (NPK @100% +Vermicompost @ 100%) which was 7.700 and minimum found in T_1 (Control) which was 7.202. The results shows that the electrical conductivity (dS m^{-1}) of soil, was found in T_9 (NPK @100% +Vermicompost @ 100%) which was 0.388 and minimum found in T_1 (Control) which was 0.213. This is show that the maximum organic carbon of soil (%), was found in T_9 (NPK @100% +Vermicompost @ 100%)) which was 0.534 and minimum found in T_1 (control) which was 0.361. The results shows that the maximum N of soil (kg ha^{-1}) was found in T9 (NPK @100% +Vermicompost @ 100%) which was 308.15 kg ha^{-1} and minimum found in T_1 (Control) which was 0.361 kg ha^{-1}. The result shows that the maximum P of soil (kg ha^{-1}) was found in T_9 (NPK @100% + Vermicompost @ 100%) which was 33.12 kg ha^{-1} and minimum found in T_1 (Control) which was 23.3 kg ha^{-1}. The result shows that the maximum K of soil (kg ha^{-1}) was found in T9 (NPK @100% + Vermicompost @ 100%) which was 185.56 kg ha^{-1} and minimum found in T_1 (Control) which was 140.25 kg ha^{-1}.. The maximum plant height (cm) reported in T_9 (NPK @100% +Vermicompost @ 100%) 114.54 and minimum in T_1 (Control) 104.74 at harvest. The maximum number of leaves plant^{-1}, number of branches plant^{-1} and number of fruit plant^{-1} in T_9 (NPK @100% + Vermicompost @ 100%) 49.31, 47.27, 19.87 and minimum in T_1 (Control) 38.76, 39.13, 14.21. This is shows that the maximum yield (kg ha^{-1}) was found in (NPK @100% + Vermicompost @ 100%) 135.59 and minimum found in T_1 (Control) which was 47.56.

Table 1: Physical – chemical properties

Particulars	Results
Physical properties	
Sand (%)	61.32
Silt (%)	23.20
Clay (%)	15.6
Texture Class	Sandy loam
Soil Colour	Dry soil-Pale Brown Wet soil-Olive brown
Bulk Density (Mg m^{-3})	1.32
Particle Density (Mg m^{-3})	2.61
Pore space (%)	46.98
Water Holding Capacity (%)	47.12
Chemical properties	
Soil pH	7.3
Electrical Conductivity (dS m^{-1})	0.27
Organic Carbon (%)	0.42
Available Nitrogen (kg ha^{-1})	276.43
Available Phosphorus (kg ha^{-1})	16.51
Available Potassium (kg ha^{-1})	169.11

Table 2: Effect of NPK and Vermicompost on soil properties

Treatment	BD (Mg m^{-3})	PD (Mg m^{-3})	WHC (%)	PS (%)	pH (w/v)	EC (dS m^{-1})	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T_1	1.301	2.481	55.22	44.82	7.202	0.213	0.361	251.12	23.3	140.25
T_2	1.252	2.470	54.70	45.01	7.241	0.231	0.392	262.09	24.11	144.61
T_3	1.143	2.384	56.85	48.07	7.262	0.356	0.481	288.12	27.34	170.32
T_4	1.181	2.433	54.33	46.22	7.453	0.327	0.440	270.63	25.98	160.74
T_5	1.174	2.413	54.52	47.33	7.381	0.318	0.464	278.57	26.64	166.34
T_6	1.105	2.362	56.58	48.97	7.334	0.364	0.493	295.87	29.74	177.87
T_7	1.212	2.454	55.70	45.89	7.631	0.287	0.424	266.74	25.49	153.87
T_8	1.070	2.342	56.52	50.11	7.632	0.373	0.513	301.42	31.66	180.12
T_9	1.013	2.311	56.91	51.02	7.700	0.388	0.534	308.15	33.12	185.56
S.Em (±)			1.04	0.03		0.23	0.01	1.09	0.67	0.90
C.D.			3.11	2.59		0.41	0.02	2.32	1.42	1.90

Note: BD- Bulk Density, PD- Particle Density, WHC- Water Holding Capacity, PS- Pore Space, EC- Electrical Conductivity, OC- Organic Carbon, N-Nitrogen, P- Phosphorus, K- Potassium

Table 3: Effect of NPK and Vermicompost morphological parameters and yield attributes of okra

Treatment	Plant height (cm)	No. of leaves plant^{-1}	No. of branches plant^{-1}	No. of Fruit plant^{-1}	Yield of Fruits (q ha^{-1})
T_1	104.74	38.76	39.13	39.13	47.56
T_2	105.28	39.64	40.2	40.2	52.06
T_3	107.75	40.53	42.9	42.9	73.71
T_4	108.97	41.48	41.87	41.87	61.46
T_5	110.28	42.31	44.4	44.4	107.34
T_6	111.54	44.57	45.31	45.31	115.91
T_7	112.36	46.49	43.81	43.81	87.53
T_8	113.65	47.64	46.51	46.51	118.74
T_9	114.54	49.31	47.27	47.27	135.59
S.Em (±)	0.57	0.69	0.71	1.81	0.91
C.D.	1.67	2.12	2.01	2.69	1.78

Summary

The soil parameter such as Bulk density (Mg m^{-3}), Particle density **(**Mg m^{-3}), Porosity (%), Water holding capacity (%), Soil pH, Electrical conductivity (dS m^{-1}), Organic carbon (%), available Nitrogen (kg ha^{-1}), available Phosphorus (kg ha^{-1}), and available Potassium (kg ha^{-1}). The Growth and yield parameters were significantly influenced by application of different combination NPK and vermicompost such as Plant height (cm)**,** Number of leaves plant^{-1}, No. of branches plant^{-1}, No. of fruit plant^{-1}, yield (q ha^{-1}). However maximum Plant height (cm) (26.2, 91.67 and 114.54 at 30 DAS**,** at 60 DAS and at harvesting respectively)**,** number of leaves per plant (49.31), No. of branches per plant (47.27), No. of fruit per plant (19.87), yield (135.59 q ha^{-1}).

Conclusion

It is concluded from the trail that the effect of different levels NPK and Vermicompost in the experiments, The treatment T_9 [NPK 100% + Vermicompost 100%] was best treatment combinations with respect to Bulk density, particle density, pore space, water holding capacity, pH, EC, Organic Carbon, available N, P, K on soil. The significant improve in plant height, number of leaves, number of branches, number of fruits per plant, uptake of nutrients which was reflected into significantly highest yield with improved quality

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