International Journal of Plant & Soil Science

Volume 36, Issue 6, Page 570-576, 2024; Article no.IJPSS.116781
ISSN: 2320-7035

Effect of Recommended dose of Fertilizer, Vermicompost and Zinc on Physico-chemical Properties of Soil, Growth and Yield of Okra (*Abelmoschus esculentus* L.) var. Supper Green

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2024/v36i64660

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers,peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/116781

Original Research Article

Received: 07/03/2024
Accepted: 11/05/2024
Published: 14/05/2024

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Cite as: *Chowdhury, B., Swaroop, N., Thomas, T., Kumar, K., & Thomas, A. (2024). Effect of Recommended dose of Fertilizer, Vermicompost and Zinc on Physico-chemical Properties of Soil, Growth and Yield of Okra (Abelmoschus esculentus L.) var. Supper Green. International Journal of Plant & Soil Science, 36(6), 570–576. https://doi.org/10.9734/ijpss/2024/v36i64660*

ABSTRACT

The experiment's goal was to demonstrate how zinc and vermicompost along with recommended dose of fertilizer effected the yield characteristics of okra and the health of the soil. Three levels of vermicompost at 0, 50, and 100% ha^{-1}, N,P,K at 100% ha^{-1} and three levels of zinc at 0, 50, and 100% ha^{-1}, respectively, were applied in the 3x3 RBD design. Vermicompost in combination produced a small decrease in soil pH 7.00 and negligible change in EC 0.19 dS m^{-1}, decrease in bulk density 1.40 Mg m^{-1}, increase in particle density 2.64 Mg m^{-1}, according to treatment T9 (Vermicompost @ 100% + Zn @ 100%+ Recommended dose of fertilizer). Following fertilizer application, observations showed a significant increase in pore space (48.83%), water holding capacity (43.22%), organic carbon (0.52%), and available Phosphorous 24.67 kg ha^{-1}, Potassium 182.86 kg ha^{-1}, and Zn 0.53mg $kg^{-1}$and T7 has highest at Nitrogen content with 292.33 kg h^{-1}. Among other treatments for okra cultivation, nitrogen kg ha^{-1} phosphorus kg ha^{-1}, potassium kg ha^{-1}, and zinc mg kg-^{1} were also found to be significant. With regard to plant height of 120.70 cm, number of fruit plants-^{1} 30.33, and fruit yield of 141.33 q ha^{-1}, the maximum yield exhibited the best qualities. At 141.33q ha^{-1}, it produced the highest yield. Applying zinc along with organic manures was also found to be a superior source of fertilization than using fertilizers alone.

Keywords: Okra; vermicompost; zinc; physico-chemical properties of soil; growth; yield.

1. INTRODUCTION

"Okra is a popular vegetable which is cultivated in the tropical and sub-tropical region of the world. Okra belongs to the Malvaceae family and semi pollinated in nature which plays an important role to the demand of vegetables in the country where they are scanty in the market. The nutritional constituents of okra include calcium, protein, oil and carbohydrates; others are Iron, Magnesium and Phosphorus. Most okra is eaten in cooked or processed form. Young fruits may be eaten raw, the oil could be as high as in poultry eggs and soyabean" Adesida et al. [1].

Okra is most popular in India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Berlin, Saudi Arabia, Mexico and Cameron Largest area and production is in India followed by Nigeria. Total area under okra in India reported to be 528.37thousand hectare, production 6145.97 thousand tonnes and productive highest in 2018-19. West Bengal is the leading state of area and production of okra, way has area 77.40 thousand hectare and production 913:32 thousand tonnes. Highest production is 17.40 t ha of Andhra Pradesh. Uttar Pradesh climate is good for okra that in total 22.64 thousand hectare and production is 303,05 thousand tonnes in 2018-19 National Horticulture Board data, [2].

"Use of Vermicompost has been advocated in integrated nutrient management (INM) system in vegetable crops. Vermicompost helps in reducing C:N ratio, increased humic acid content, cation exchange capacity and water-soluble carbohydrate. Vermicompost is a source of micro and macro nutrients and acts as a chelating agent. Vermicompost is greatly humified through the fragmentation of parent organic materials by earthworms and colonization by micro-organisms" Singh et al. [3].

"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 4 enzymes like phosphatases and cellulases to the soil. It enhances germination, plant growth and thus over all crop yield, It is rich in NPK and retain the nutrients for long time" Tensingh et al. [4].

"Zinc mainly functions as the metal component of a series of enzymes. The most important enzymes activate by this element are carbonic anhydrase and a number of dehydrogenases. Zinc deficiency is thought to restrict RNA synthesis, which in turn inhibits protein synthesis. Zinc is also involved in auxin production as well as flower and fruit setting. Shoots and buds of zinc deficient plants contain very low auxin, which causes dwarfism and growth reproduction" Nusrat et al. [5].

2. MATERIALS AND METHODS

The central research farm of the department of soil science and agricultural chemistry at the Naini Agricultural Institute, Prayagraj (Allahabad) 211 007, (U.P.), situated at 25°24'30" North latitude, 81°51'10" East longitude, and 98 meters above mean sea level, is where the field experiment will be carried out during the Zaid season in 2023 [6]. standing in for the Agro- climatic zone (Upper Gangetic Plain Region) and the Agro-ecological subregion (North Alluvium Plain Zone, 0-1% Slope).

Argo The Prayagraj district's climate, which features a scorching summer and a chilly winter, is representative of the subtropical belt that runs through the southeast of the United Province. The location's maximum temperature is 46°C, with rare dips below 4°C or 5°C. There is a 20–94% relative humidity range. This location receives approximately 1100 mm of rain on average each year.

Prior to plowing, a single site in the trial plot will have random soil samples taken from depths of 0–15 cm and 15–30 cm. The soil sample will be reduced in volume by being cinned and quartered [7,8]. The sample will then be air dried and put through a 2 mm sieve in order to prepare it for chemical analysis (PH: Jackson, [9]; EC: Wilcox [10]); organic carbon: Walkley and Black [11]; available nitrogen: Subbaih and Asija, [12], phosphorus: Olsen et al. [13]; potassium: Toth and Prince, [14]; zinc: Lindsay and Norvell, [15]).

3. RESULTS AND DISCUSSION

3.1 Soil Parameters

The soil parameters exhibit a notable rise in the composition of vermicompost and zinc. Table 2. shows that applying varying amounts of vermicompost and zinc with RDF has the following effects on soil: it increases pore space, water holding capacity, organic carbon, accessible nitrogen, phosphorus, potassium, and zinc. The lowest measurements for particle density in treatment T1 were 2.61 and 2.63 mg m^{-1}. pore space 42.1 and 40.99%, water holding capacity 38.35 and 36.16% and T9 shows the highest particle density 2.64 and 2.66 Mg m^{-1}, pore space 48.42% and 45.89 %, water holding capacity 43.22% and 41.98% respectively in 0-15cm and 15-30cm depth of soil. Also in Table 2. shown bulk density with highest in T1 1.4 and 1.49 with lowest in T9 1.40 and 1.41 respectively in 0-15cm and 15- 30cm depth of soil. Table 3. shown that in Treatment T1 have highest pH 7.60 and 7.63 , EC 0.28 and 0.29 dS m^{-1}, organic carbon 0.37 and 0.30%, nitrogen 264 and 261.89 kg ha^{-1}, phosphorus 17.96 and 13.67 kg ha^{-1}, Potassium 139.89 and 132.59 kg h^{-1}, zinc 0.38 and 0.20 mg kg^{-1} and T9 have lowest pH 7.00 and 7.08, EC 0.19 and 0.20 dS m^{-1}, organic carbon 0.52% and 0.45 , Phosphrous 24.67and 22.33 kg ha^{-1}, potassium 182.86 and 175.60 kg ha^{-1}, zinc 0.53 and 0.32 mg kg^{-1} respectively in 0-15cm and 15-30cm depth of soil.T7 has highest nitrogen recorded with 292.33and289.00kgh^{-1} . Physical and Chemical properties respectively are shown where its clear that the T9 treatment is better followed by T8 and T7. It eventually shows that the vermicompost and Zn application with RDF is the beneficial effect on the soil, that will maintain the soil. T1 shows that lowest effect on the soil parameters.

Table 1. List of Treatment combinations used for the study

S. No.	Treatment combination
T_1	(RDF, Vermicompost @ 0 t ha^{-1} and Zinc @ 0kg ha^{-1})
T_2	(RDF,Vermicompost @ 0 t ha^{-1} and Zinc @ 2.5kg ha^{-1}),
T_3	(RDF, Vermicompost @ 0 t ha^{-1} and Zinc @ 5kg ha^{-1}),
T_4	(RDF,Vermicompost @ 2.5 t ha^{-1} and Zinc @ 0kg ha^{-1}),
T_5	(RDF, Vermicompost @ 2.5 t ha^{-1} and Zinc @ 2.5kg ha^{-1}),
T_6	(RDF,Vermicompost @ 2.5 t ha^{-1} and Zinc @ 5kg ha^{-1}),
T_7	(RDF,Vermicompost @ 5 t ha^{-1} and Zinc @ 0kg ha^{-1}),
T_8	(RDF,Vermicompost @ 5 t ha^{-1} and Zinc @ 2.5kg ha^{-1}),
T_9	(RDF,Vermicompost @ 5 t ha^{-1} and Zinc @ 5kg ha^{-1}).

[RDF= Recommended dose of Fertilizer =N,P,K @ 100 ,60,50 Kg ha^{-1} respectively]

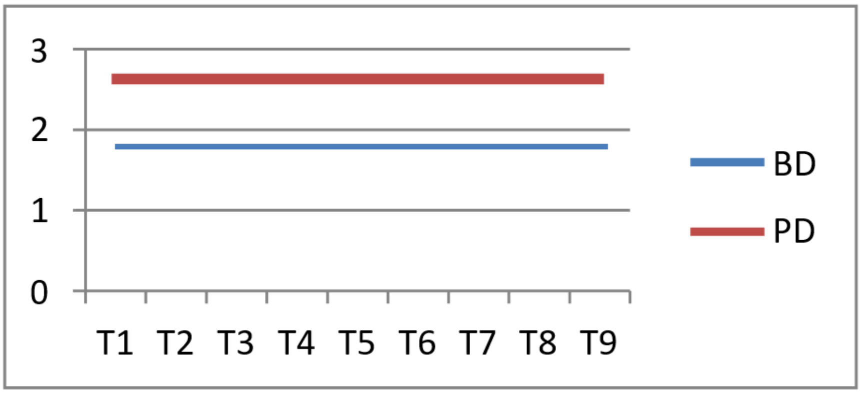

Fig. 1. Treatment Combination VS Bulk Density and Particle Density

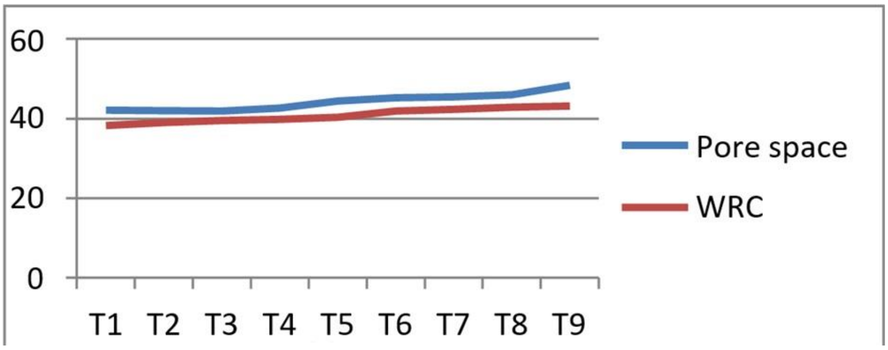

Fig. 2. Treatment Combination VS Pore Space and Water Holding Capacity

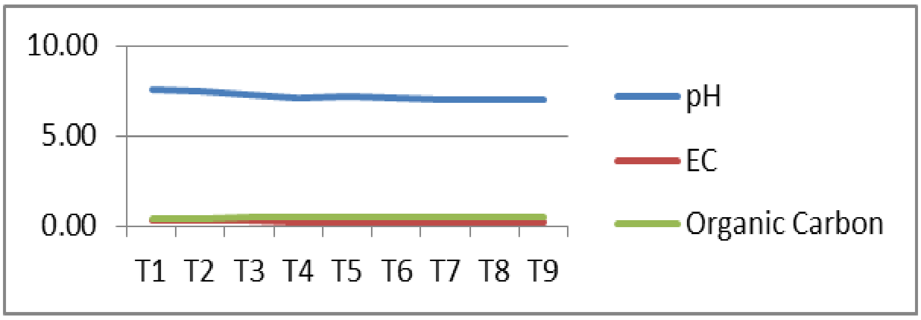

Fig. 3. Treatment Combination VS pH,EC, Organic

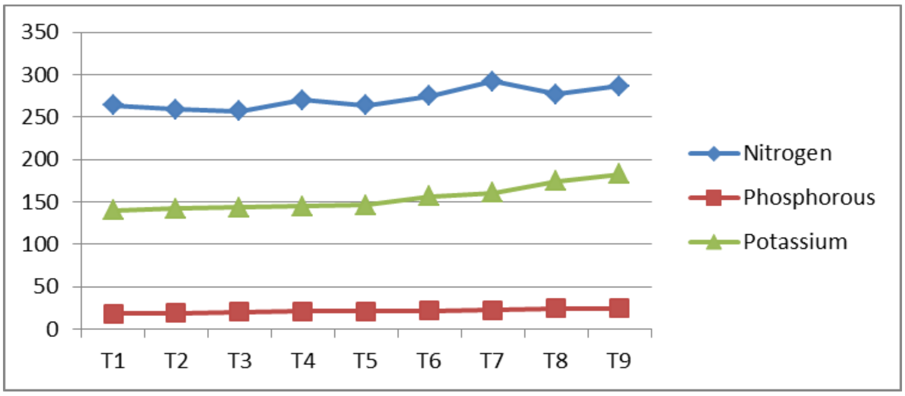

Fig. 4. Treatment combination vs amount of nitrogen phosphorous and potassium in soil

Table 2. Effect of RDF and different levels of Vermicompost and Zn on physical properties of soil

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	1.47	1.49	2.61	2.63	41.97	40.99	38.35	36.16
T_2	1.46	1.47	2.62	2.64	42.01	41.51	38.99	36.87
T_3	1.46	1.47	2.61	2.63	42.1	42.28	39.51	37.23
T_4	1.45	1.46	2.63	2.64	42.62	43.28	39.87	37.95
T_5	1.45	1.44	2.62	2.64	44.43	44.16	40.33	38.52
T_6	1.44	1.42	2.63	2.66	45.24	44.5	41.96	40.26
T_7	1.43	1.44	2.62	2.65	45.51	44.98	42.32	40.93
T_8	1.42	1.42	2.64	2.66	46.03	46.27	42.84	41.31
T_9	1.40	1.41	2.64	2.66	48.43	45.89	43.22	41.98
F-test	S	S	NS	NS	S	S	S	S
S.Em. (±)	0.01	0.01	-	-	0.64	0.58	0.87	0.76
C.D.@5%	0.02	0.02	-	-	1.36	1.23	1.87	1.62

Table 3. Effect of RDF and different levels of Vermicompost and Zn on Chemical properties of soil

Treatments	pH		EC (dS m^{-1})		Organic Carbon (%)		Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})		Zinc (mg kg^{-1})	
	0-15 cm	15-30 cm	0-15cm	15-30cm	0-15 cm	15-30 cm	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	7.60	7.63	0.28	0.29	0.37	0.30	264.00	261.89	17.96	13.67	139.89	132.59	0.38	0.20
T_2	7.53	7.60	0.27	0.28	0.39	0.33	259.33	258.33	19.25	14.74	142.26	133.56	0.44	0.23
T_3	7.30	7.40	0.25	0.26	0.44	0.40	256.67	255.67	20.36	15.33	143.22	135.22	0.45	0.25
T_4	7.30	7.40	0.22	0.23	0.45	0.38	270.00	266.67	20.67	15.67	144.92	145.44	0.46	0.26
T_5	7.20	7.30	0.23	0.24	0.47	0.40	263.67	273.67	21.25	16.33	145.90	145.96	0.47	0.27
T_6	7.10	7.17	0.23	0.24	0.48	0.41	275.00	269.67	21.33	17.33	156.62	156.63	0.48	0.28
T_7	7.01	7.08	0.22	0.23	0.49	0.40	292.33	289.00	22.33	20.67	160.88	157.63	0.48	0.30
T_8	7.02	7.0 0	0.21	0.22	0.50	0.43	276.67	274.67	24.33	21.33	174.59	160.89	0.50	0.30
T_9	7.00	7.08	0.19	0.20	0.52	0.45	286.33	282.67	24.67	22.33	182.86	175.60	0.53	0.32
F-test	S	S	S	S	S	S	S	S	S	S	S	S	S	S
S.Em.(±)	0.07	0.07	0.02	0.01	0.01	0.03	8.11	11.95	21.33	17.33	1.26	1.14	0.01	0.01
C.D.@5%	0.15	0.16	0.01	0.02	0.02	0.07	17.205	25.35	22.33	20.67	2.66	2.42	0.02	0.02

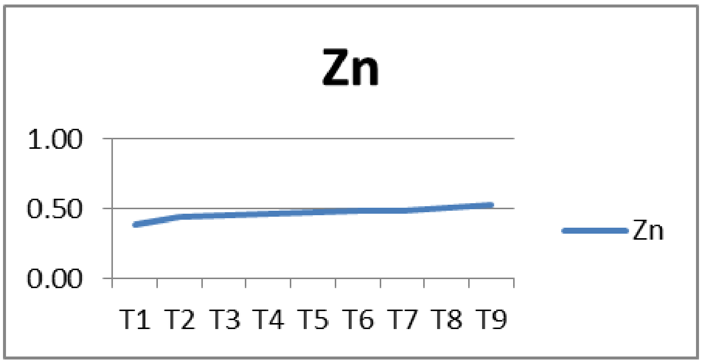

Fig. 5. Treatment combination vs amount zinc in soil

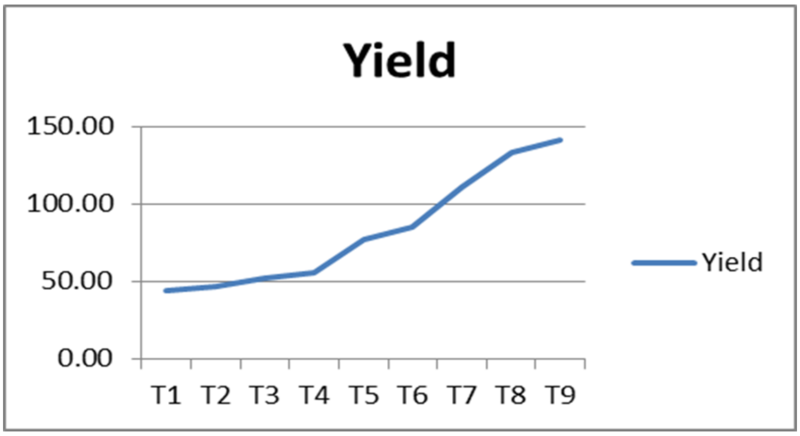

Fig 6. Treatment combination VS Yeild of Okra

Table 4. Effect of different treatment combination on cost benefit ratio (C: B) of Okra

Treatment	Selling Yield (q ha^{-1})	price (₹ q^{-1})	Gross return (₹ ha^{-1})	Total cost of cultivation (₹ ha^{-1})	Net Profit (₹ ha^{-1})	Cost Benefit ratio (C:B)
T1	44.67	1000	44670	36926.16	9743.84	1:1.20
T2	47.33	1000	47330	36927.66	12321.34	1:128
T3	52.33	1000	52330	36091.16	17238.84	1:1.44
T4	55.67	1000	55670	39092.91	16577.09	1:1.42
T5	77.00	1000	77000	39175.41	37824.59	1:1.96
T6	85.00	1000	85000	39257.91	45723.09	1:2.1
T7	111.67	1000	111670	43259.66	68410.34	1:2.5
T8	133.67	1000	133670	43442.16	90327.84	1:3.0
T9	141.33	1000	141330	43324.66	97905.34	1:3.2

3.2 Selling Price of Okra (Yield) = 1000 q^{-1}

According to following Table 4. The economy of different treatment concerned, the treatment T9 provides highest net profit of **₹ 97905.34**with cost benefit ratio1:3.2 however, the minimum net profit of **₹9743.84** was recorded in the treatment T1 with cost benefit ratio is1:1.2.

4. CONCLUSION

Based on the aforementioned data, it was determined that, when compared to alternative treatment combinations, the T9 therapy combination (Recommended dose of fertilizer+Vermicompost @ 100% + Zn @ 100%) produced the best outcomes. It yields a maximum profit of ₹97905.34 ha^{-1} and a maximum benefit-cost ratio of 1:3.2. Vermicompost and zinc are therefore beneficial to soil health and a profitable crop of okra. In case of soil T7 has highest at Nitrogen content with 292.33 kg h^{-1}.We can conclude the T9 gives the best result for production of Okra and T7 is best according to soil nutrient content.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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