

Influence of NPK Levels in Conjugation with FYM on Soil Health properties at Maize field in Prayagraj District (*Zea mays* L.)

Abstract

This field experiment aimed to assess the "Influence of NPK Levels in Conjugation with FYM on Soil Health properties at Maize field in Prayagraj District (*Zea mays* L.)" at the Crop Research Farm of the Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (SHUATS), Prayagraj (U.P.) during the *Zaid* season 2022. The outcomes demonstrated a considerable impact of NPK and FYM application on the physico-chemical characteristics of the soil. At a depth of 0-15 cm and 15-30 cm, the maximum bulk density (1.26 and 1.37 Mg m⁻³), particle density (2.65 and 2.71 Mg m⁻³) and pH (7.36 and 7.44) were recorded in NPK₀FYM₀, while the minimum bulk density (1.16 and 1.25 Mg m⁻³), particle density (2.60 and 2.65 Mg m⁻³) and pH (7.16 and 7.24) were found in NPK₁₀₀FYM₁₀₀. Similarly, the maximum EC (0.29 and 0.42 dS m⁻¹), organic carbon (0.74 and 0.52%), percentage pore space (48.52 and 46.31%), water holding capacity (45.28 and 42.60%) and available nitrogen (252.03 and 184.03 kg ha⁻¹), phosphorus (32.65 and 25.83 kg ha⁻¹) and potassium (315.62 and 241.52 kg ha⁻¹) were recorded in NPK₁₀₀FYM₁₀₀, while the minimum EC (0.21 and 0.31 dS m⁻¹), organic carbon (0.44 and 0.34%), percentage pore space (44.76 and 40.79%), water holding capacity (39.41 and 36.47%) and available nitrogen (224.52 and 156.52 kg ha⁻¹), phosphorus (22.62 and 18.46 kg ha⁻¹) and potassium (273.32 and 189.67 kg ha⁻¹) were recorded in NPK₀FYM₀. However, the physico-chemical characteristics of the soil were significantly influenced by the application of NPK with FYM.

Keywords: FYM, NPK, Maize, Soil Health.

Introduction:

Soil health is the capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality and promote plant and animal health. NPK fertilizers are synthetic fertilizers

that provide nitrogen, phosphorus and potassium. These nutrients are essential for plant growth, but they can also have negative impacts on soil health if used excessively. FYM, on the other hand, is a type of organic fertilizer that is made from animal manure and plant materials. FYM provides a number of benefits for soil health, including: increased soil organic matter content, improved soil structure, enhanced water retention, reduced nutrient leaching and increased microbial activity. The use of NPK and FYM together can have a synergistic effect on soil health. For example, a study by the University of California, Davis found that the addition of FYM to NPK-fertilized soils increased the yield of corn by 15%. However, it is important to note that the use of NPK and FYM should be done in a balanced way. Too much of either can have negative consequences for soil health. (Doran *et al.*, 2000)

Soil is essential in maize production because it provides nutrients, water, and physical support for growth (Ncube *et al.*, 2011). Maize requires well-drained, healthy soil with enough water retention and aeration (Gbegbelegbe *et al.*, 2009). Organic and inorganic fertilizers can be used to improve soil fertility and increase maize output (Kanyanjua *et al.*, 2007). Alkaline soil of Prayagraj can benefit from acidifying fertilizers or amendments to improve nutrient uptake by maize (Manda *et al.*, 2015). Soil texture affects water-holding and nutrient retention. Maize grows best in loam soils, but alluvial soil in Prayagraj can be improved for maize cultivation by adding organic matter (Sharma and Shukla, 2017).

Maize (*Zea mays* L.) is an important cereal crop, widely grown for food, feed, and industrial purposes. It is the third most important cereal crop after wheat and rice. However, maize production is limited by various factors, including soil nutrient deficiencies. Therefore, the application of NPK fertilizers and FYM can enhance the soil properties and ultimately improve the growth and yield of maize (Ahmad *et al.*, 2019). However, maize production is often limited by poor soil health, particularly in regions where soil fertility is low (Kumar *et al.*, 2019). Therefore, there is a need to explore sustainable agricultural practices that can improve soil health and enhance maize productivity.

Materials and Methods:

The experiment was carried out during the *Zaid* season 2022 at the Crop Research Farm of the Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam

Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj (U.P.). The site, which is situated at latitudes 25°47'69" N and 81°85'74" E, has a humid subtropical climate with 900-1100 mm of annual rainfall on average. Three levels of FYM (0, 50 and 100%) and three levels of NPK fertilizer (0, 50 and 100%) were used in the experiment's Factorial Randomized Block Design (F-RBD). Treatments included NPK₀FYM₀ (absolute control), NPK₀FYM₅₀ (0% NPK + 50% FYM), NPK₀FYM₁₀₀ (0% NPK + 100% FYM), NPK₅₀FYM₀ (50% NPK + 0% FYM), NPK₅₀FYM₅₀ (50% NPK + 50% FYM), NPK₅₀FYM₁₀₀ (50% NPK + 100% FYM), NPK₁₀₀FYM₀ (100% NPK + 0% FYM), NPK₁₀₀FYM₅₀ (100% NPK + 50% FYM) and NPK₁₀₀FYM₁₀₀ (100% NPK + 100% FYM). All the treatments were randomly replicated three times. Soil samples were taken from each plot at a depth of 0-15 and 15-30 cm before and after the experimental crop was sown. The soil samples were dried in the shade at room temperature and passed through a 2 mm screen, and then had several soil properties analysis. The following accepted methods were used to determine the soil's B.D., P.D. (Mg m^{-3}), %PS, WHC (%), pH, EC at 25°C (dS m^{-1}), available nitrogen, phosphorus and potassium (kg ha^{-1}): Muthuvelet *et al.* (1992), Jackson (1958), Wilcox (1950), Walkley and Black (1934), Subbiah and Asija (1956), Olsen *et al.* (1954), Toth and Prince (1949).

Results and Discussion:

The statistically analyzed data is presented in Table and Figure 1 and 2 show the impacts of NPK and FYM on soil health metrics.

Bulk density (Mg m^{-3})

The effect of FYM on bulk density of soil after crop harvest was found significant, with higher bulk densities 1.28 and 1.45 Mg m^{-3} of soil were recorded at 0-15 and 15-30 cm depth respectively in FYM₀ and lower bulk density 1.21 and 1.30 Mg m^{-3} were found in FYM₁₀₀. The effect of NPK on bulk density was found non-significant. However, the interaction of NPK and FYM had a significant impact on bulk density, with the maximum bulk densities 1.30 and 1.47 Mg m^{-3} of soil were recorded at 0-15 and 15-30 cm depth respectively in NPK₀FYM₀ and the minimum bulk densities 1.19 and 1.24 Mg m^{-3} were found in NPK₁₀₀FYM₁₀₀.

Particle Density (Mg m^{-3})

Regarding particle density of soil after crop harvest, neither FYM, NPK, nor their interaction had a significant effect.

Pore space (%)

On the basis of soil samples taken from two different depths i.e. 0-15 and 15-30 cm it was found that FYM significantly influenced percentage pore space of soil after crop harvest, with the maximum percentage pore space 47.90 and 45.89% of soil were recorded at 0-15 and 15-30 cm depth respectively in FYM₁₀₀, and the minimum percentage pore space 45.32 and 41.61% were found in FYM₀. The effect of NPK on percentage pore space was found non-significant. However, the interaction of NPK and FYM showed a significant effect, with maximum percentage pore space 48.52 and 46.31% of soil were recorded at 0-15 and 15-30 cm depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum percentage pore space 44.76 and 40.79% were found in NPK₀FYM₀.

Water Holding Capacity (%)

Similarly at 0-15 and 15-30 cm soil depth FYM had a significant effect on water holding capacity of soil after crop harvest, with maximum water holding capacity 46.32 and 43.12% of soil were recorded at 0-15 and 15-30 cm depth of soil respectively in FYM₁₀₀ and the minimum water holding capacity 43.24 and 40.18% were found in FYM₀. The effect of NPK on water holding capacity was non-significant. The interaction of NPK and FYM had a significant impact, with the maximum water holding capacity 47.05 and 43.70% of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum water holding capacity 42.18 and 39.57% were found in NPK₀FYM₀.

Soil pH

FYM had a significant effect on soil pH after crop harvest, with the maximum pH 7.31 and 7.50 of soil were recorded at 0-15 and 15-30 cm soil depth respectively in FYM₀ and the minimum pH 6.90 and 7.11 were found in FYM₁₀₀. NPK also had a significant effect on soil pH, with the maximum pH 7.25 and 7.49 of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₀ and the minimum pH 6.99 and 7.10 were found in NPK₁₀₀. The interaction of NPK and FYM showed a significant effect, with the maximum pH 7.40 and 7.65 of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₀FYM₀ and the minimum pH 6.74 and 6.89 were found in NPK₁₀₀FYM₁₀₀.

Electrical conductivity (dS m⁻¹)

The effect of FYM on the EC of soil after crop harvest was found significant, with the maximum EC 0.39 and 0.27 dS m⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in FYM₁₀₀ and the minimum EC 0.32 and 0.22 dS m⁻¹ were found in FYM₀. Similarly, the effect of NPK on soil EC were significant, with the maximum EC 0.37 and 0.27 dS m⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀ and the minimum EC 0.33 and 0.23 dS m⁻¹ were found in NPK₀. The interaction of NPK and FYM had a significant impact on the EC of soil with the maximum EC 0.42 and 0.29 dS m⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum EC 0.31 and 0.21 dS m⁻¹ were found in NPK₀FYM₀.

Organic carbon (%)

FYM significantly influenced the percentage of organic carbon in soil after crop harvest, with the maximum percentage organic carbon 0.48 and 0.45% of soil were recorded at 0-15 and 15-30 cm soil depth respectively in FYM₁₀₀ and the minimum percentage organic carbon 0.36 and 0.35% were found in FYM₀. Similarly, NPK had a significant effect, with the maximum percentage organic carbon 0.45 and 0.42% of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀ and the minimum percentage organic carbon 0.40 and 0.38% were found in NPK₀. The interaction of NPK and FYM showed a significant effect, with the maximum percentage organic carbon 0.52 and 0.47% of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum percentage organic carbon 0.34 and 0.33% were found in NPK₀FYM₀.

Nitrogen (kg ha⁻¹)

The effect of FYM on available nitrogen in soil after crop harvest was significant, with maximum available nitrogen 276.72 and 243.43 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in FYM₁₀₀ and the minimum available nitrogen 264.60 and 232.51 kg ha⁻¹ were found in FYM₀. Similarly, NPK had a significant effect, with the maximum available nitrogen 278.55 and 247.17 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀ and the minimum available nitrogen 262.17 and 229.11 kg ha⁻¹ were found in NPK₀. The interaction of NPK and FYM had a significant impact, with the maximum available nitrogen 282.85 and 252.03 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum available nitrogen 255.23 and 224.52 kg ha⁻¹ were found in NPK₀FYM₀.

Phosphorus (kg ha⁻¹)

FYM significantly influenced the available phosphorus in soil after crop harvest, with the maximum available phosphorus 29.71 and 26.03 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in FYM₁₀₀ and the minimum available phosphorus 25.05 and 23.02 kg ha⁻¹ were found in FYM₀. Similarly, NPK had a significant effect, with the maximum available phosphorus 31.08 and 26.52 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀ and the minimum available phosphorus 23.81 and 22.42 kg ha⁻¹ were found in NPK₀. The interaction of NPK and FYM showed a significant effect, with the maximum available phosphorus 32.65 and 27.83 kg ha⁻¹ of soil were at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum available phosphorus 22.62 and 20.46 kg ha⁻¹ were found in NPK₀FYM₀.

Potassium (kg ha⁻¹)

The effect of FYM on the available potassium of soil after crop harvest was found significant, with the maximum available potassium 231.45 and 212.44 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in FYM₁₀₀ and the minimum available potassium 215.89 and 193.66 kg ha⁻¹ were found in FYM₀. Similarly, NPK had a significant effect, with the maximum available potassium 237.56 and 217.13 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀ and the minimum available potassium 208.54 and 186.62 kg ha⁻¹ were found in NPK₀. The interaction of NPK and FYM had a significant impact, with the maximum available potassium 242.62 and 221.52 kg ha⁻¹ of soil were recorded at 0-15 and 15-30 cm soil depth respectively in NPK₁₀₀FYM₁₀₀ and the minimum available potassium 200.32 and 169.67 kg ha⁻¹ were found in NPK₀FYM₀.

Table 1: Effect of NPK and FYM on some 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
Levels of NPK								
NPK ₀	1.22	1.33	2.63	2.68	46.18	42.92	40.73	38.02
NPK ₅₀	1.20	1.31	2.62	2.67	46.61	43.94	41.49	38.58
NPK ₁₀₀	1.19	1.27	2.61	2.66	47.14	44.28	41.95	39.14
S.Em. (\pm)	-	-	-	-	-	-	-	-
C.D. at 5%	-	-	-	-	-	-	-	-
Levels of FYM								
FYM ₀	1.23	1.35	2.64	2.69	45.32	41.61	40.14	37.08
FYM ₅₀	1.20	1.31	2.62	2.67	46.72	43.65	41.36	38.64
FYM ₁₀₀	1.17	1.27	2.60	2.65	47.90	45.89	42.66	40.02
S.Em. (\pm)	0.01	0.01	-	-	0.39	0.48	0.34	0.26
C.D. at 5%	0.03	0.04	-	-	1.17	1.44	1.01	0.79
NPK x FYM interaction								
NPK ₀ FYM ₀	1.26	1.37	2.65	2.71	44.76	40.79	39.41	36.47
NPK ₀ FYM ₅₀	1.21	1.33	2.63	2.68	46.46	42.69	40.73	38.13
NPK ₀ FYM ₁₀₀	1.18	1.29	2.61	2.66	47.33	45.29	42.03	39.45
NPK ₅₀ FYM ₀	1.23	1.35	2.64	2.69	45.28	41.79	40.15	37.14
NPK ₅₀ FYM ₅₀	1.20	1.31	2.62	2.67	46.71	43.97	41.65	38.61
NPK ₅₀ FYM ₁₀₀	1.18	1.27	2.60	2.65	47.85	46.06	42.67	40.00
NPK ₁₀₀ FYM ₀	1.22	1.32	2.63	2.68	45.92	42.24	40.86	37.63
NPK ₁₀₀ FYM ₅₀	1.19	1.28	2.61	2.66	46.97	44.29	41.70	39.19
NPK ₁₀₀ FYM ₁₀₀	1.16	1.25	2.60	2.65	48.52	46.31	43.28	40.60
S.Em. (\pm)	0.02	0.02	-	-	0.67	0.83	0.58	0.46
C.D. at 5%	0.05	0.06	-	-	2.02	2.50	1.75	1.36

Table 2: Effect of NPK and FYM on some chemical properties of soil.

Treatments	pH (w/v)		EC (dS m ⁻¹)		OC (%)		Nitrogen (kg ha ⁻¹)		Phosphorus (kg ha ⁻¹)		Potassium (kg ha ⁻¹)	
	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	0-15 cm	15-30 cm
Levels of NPK												
NPK ₀	7.30	7.38	0.33	0.23	0.55	0.40	229.11	161.11	23.81	20.42	281.54	206.62
NPK ₅₀	7.28	7.36	0.35	0.25	0.58	0.42	238.66	170.66	26.97	23.22	298.09	227.00
NPK ₁₀₀	7.24	7.32	0.37	0.27	0.62	0.45	247.18	179.17	31.08	24.52	310.56	237.13
S.Em. (±)	-	-	0.004	0.002	0.006	0.003	1.65	1.58	0.27	0.10	2.74	2.24
C.D. at 5%	-	-	0.011	0.007	0.019	0.008	4.95	4.74	0.81	0.30	8.21	6.71
Levels of FYM												
FYM ₀	7.34	7.42	0.32	0.22	0.48	0.36	232.51	164.51	25.05	21.02	288.89	213.66
FYM ₅₀	7.28	7.36	0.35	0.24	0.58	0.42	239.01	171.00	27.10	23.10	296.85	224.66
FYM ₁₀₀	7.20	7.28	0.39	0.27	0.69	0.48	243.43	175.43	29.71	24.03	304.45	232.44
S.Em. (±)	-	-	0.004	0.002	0.006	0.003	1.65	1.58	0.27	0.10	2.74	2.24
C.D. at 5%	-	-	0.011	0.007	0.019	0.008	4.95	4.74	0.81	0.30	8.21	6.71
NPK x FYM interaction												
NPK ₀ FYM ₀	7.36	7.44	0.31	0.21	0.44	0.34	224.52	156.52	22.62	18.46	273.32	189.67
NPK ₀ FYM ₅₀	7.31	7.39	0.33	0.22	0.56	0.41	229.35	161.35	23.18	20.68	281.55	209.17
NPK ₀ FYM ₁₀₀	7.23	7.31	0.36	0.25	0.64	0.45	233.45	165.45	25.62	22.12	289.75	221.02
NPK ₅₀ FYM ₀	7.34	7.42	0.32	0.22	0.49	0.37	231.63	163.63	23.86	21.66	288.45	219.97
NPK ₅₀ FYM ₅₀	7.29	7.37	0.35	0.24	0.58	0.42	239.54	171.54	26.21	23.85	297.85	226.25
NPK ₅₀ FYM ₁₀₀	7.21	7.29	0.38	0.28	0.68	0.48	244.82	176.82	30.85	24.14	307.98	234.78
NPK ₁₀₀ FYM ₀	7.31	7.39	0.33	0.24	0.51	0.38	241.38	173.38	28.68	22.95	304.90	231.33
NPK ₁₀₀ FYM ₅₀	7.24	7.32	0.37	0.27	0.61	0.44	248.14	180.10	31.91	24.78	311.15	238.55
NPK ₁₀₀ FYM ₁₀₀	7.16	7.24	0.42	0.29	0.74	0.52	252.03	184.03	32.65	25.83	315.62	241.52
S.Em. (±)	-	-	0.006	0.004	0.01	0.004	2.86	2.74	0.47	0.18	4.74	3.88
C.D. at 5%	-	-	0.019	0.012	0.03	0.014	8.57	8.21	1.40	0.53	14.22	11.63

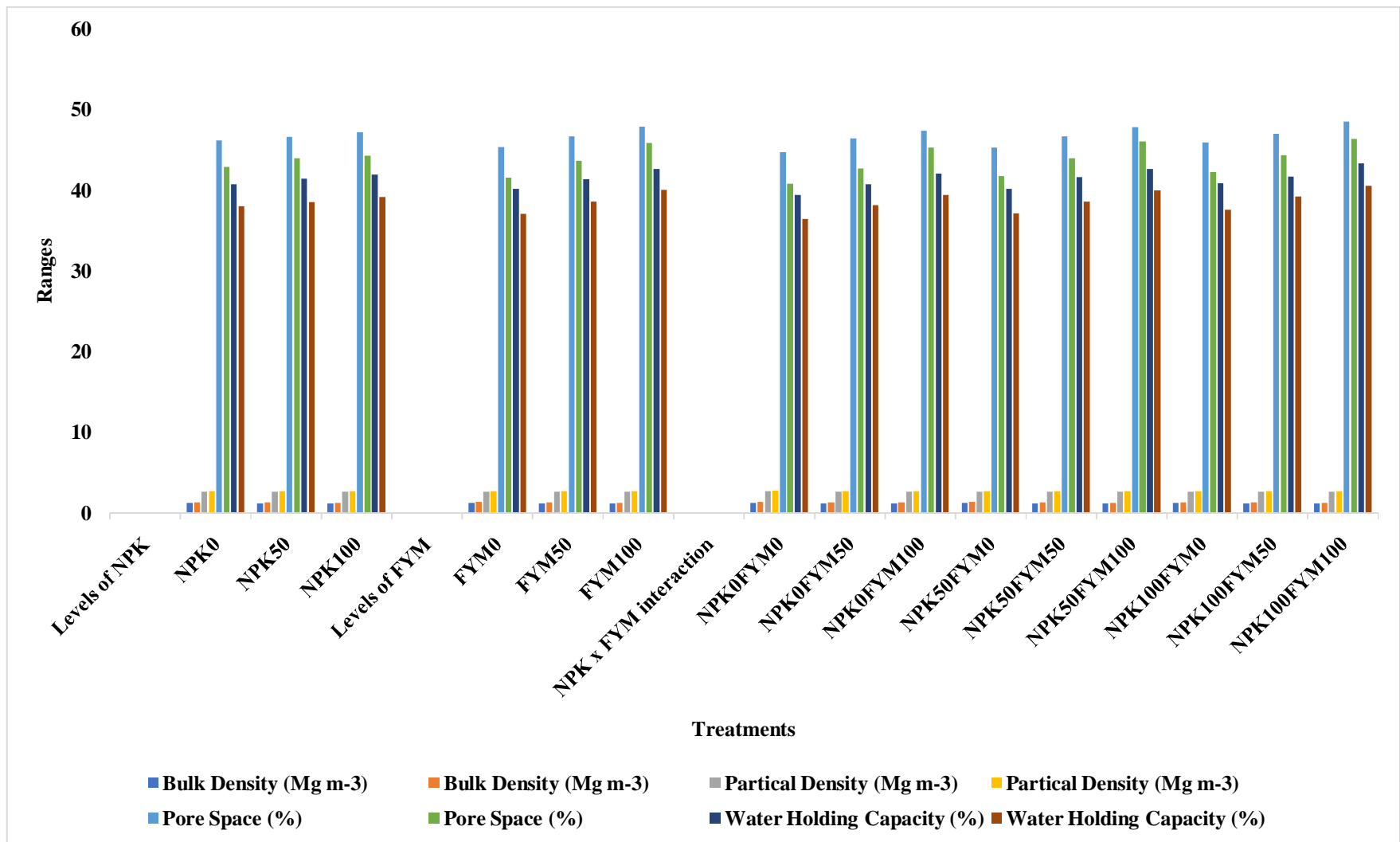


Fig. 1: Effect of NPK and FYM on Bulk Density, Particle Density, Pore Space and Water Holding Capacity.

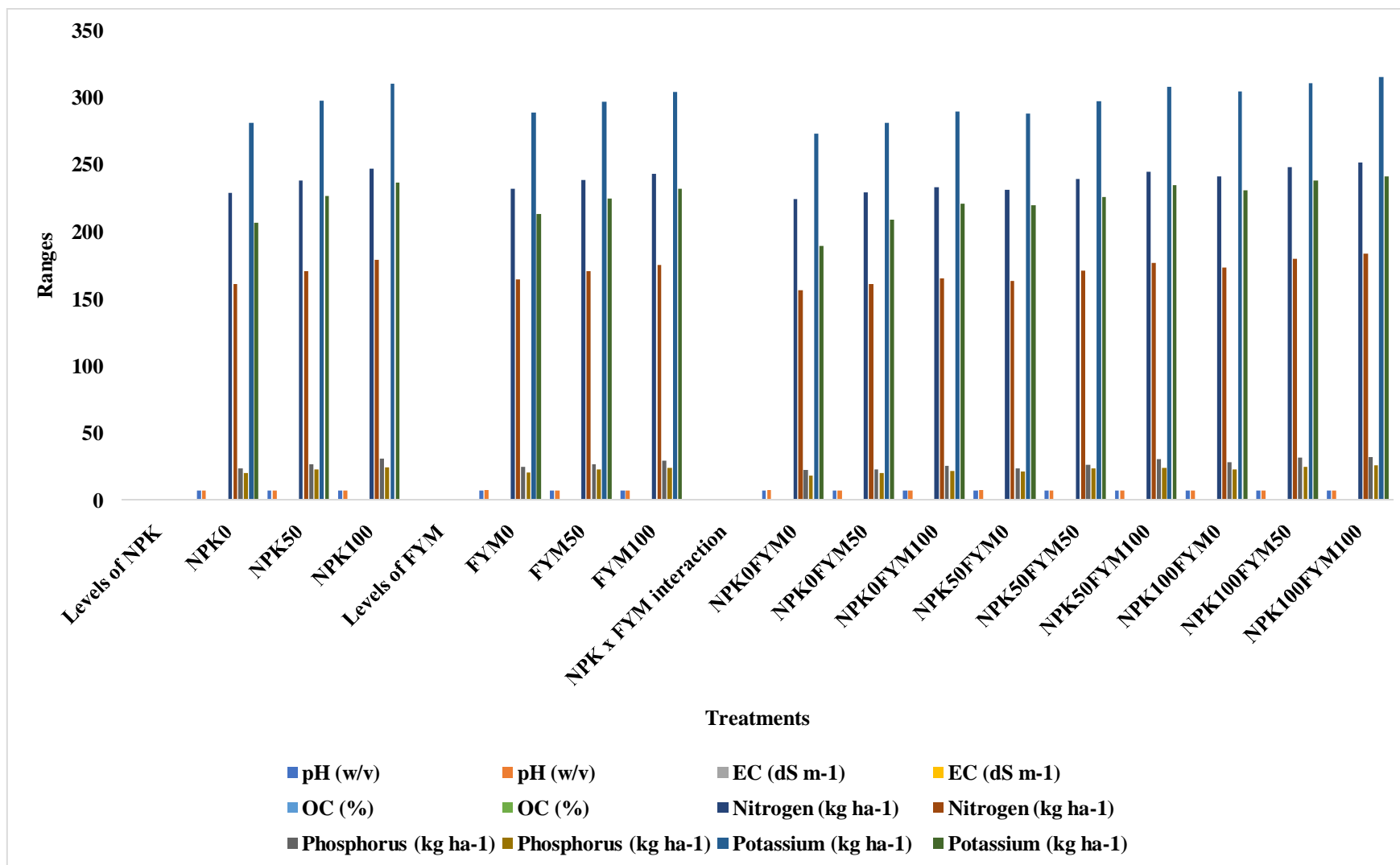


Fig. 2: Effect of NPK and FYM on pH, EC, OC, Nitrogen, Phosphorus and Potassium.

Conclusion:

The findings of this study show that NPK with FYM can improve soil health indices and maize output. The highest maize yield was obtained when 120-60-40 kg ha⁻¹ NPK was used in conjunction with 10 t ha⁻¹ FYM in treatment NPK₁₀₀FYM₁₀₀. The findings of this study emphasize the significance of controlling the use of chemical fertilizers and organic amendments in order to promote soil health and crop productivity. More research is needed to investigate the long-term impact of NPK and FYM treatment on soil health and crop productivity.

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