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

Basant Fageria [a++*], Ram Bharose [a#], Arun Alfred David [a†], Tarence Thomas [a‡] and A. K. S. Pratihar [b^]

[a] Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (211007), Uttar Pradesh, India.
[b] Department of Entomology, Rajasthan College of Agriculture, Udaipur, 313001, India.

Authors' contributions

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

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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

[++]M.Sc. Scholar;
[#]Assistant Professor;
[†]Associate Professor;
[‡]Professor;
^Research Scholar;
**Corresponding author: E-mail: basantfageria8@gmail.com;*

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 NPK_0FYM_0, 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 $NPK_{100}FYM_{100}$. 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 $NPK_{100}FYM_{100}$, 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 and18.46 kg ha^{-1}) and potassium (273.32 and 189.67 kg ha^{-1}) were recorded in NPK_0FYM_0. However, the physico-chemical characteristics of the soil were significantly influenced by the application of NPK with FYM.

Keywords: FYM; NPK; maize; soil health.

1. 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 [1-7].

Soil is essential in maize production because it provides nutrients, water, and physical support for growth [8]. Maize requires well-drained, healthy soil with enough water retention and aeration [9]. Organic and inorganic fertilizers can be used to improve soil fertility and increase maize output [10]. Alkaline soil of Prayagraj can benefit from acidifying fertilizers or amendments to improve nutrient uptake by maize [11]. 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 [12].

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 [13]. However, maize production is often limited by poor soil health, particularly in regions where soil fertility is low [14]. Therefore, there is a need to explore sustainable agricultural practices that can improve soil health and enhance maize productivity.

2. 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 $25^0$47'69" N and $81^0$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 NPK_0FYM_0 (absolute control), NPK_0FYM_{50} (0% NPK + 50% FYM), NPK_0FYM_{100} (0% NPK + 100% FYM), $NPK_{50}FYM_0$(50% NPK + 0% FYM), $NPK_{50}FYM_{50}$ (50% NPK + 50% FYM), $NPK_{50}FYM_{100}$ (50% NPK + 100% FYM),

$NPK_{100}FYM_0$ (100% NPK + 0% FYM), $NPK_{100}FYM_{50}$ (100% NPK + 50% FYM) and $NPK_{100}FYM_{100}$ (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^oC (dS m^{-1}), available nitrogen, phosphorus and potassium (kg ha^{-1}): Muthuvel et al. [15], Jackson [16], Wilcox [17], Walkley and Black [18], Subbiah and Asija [19], Olsen et al. [20], Toth and Prince [21].

3. RESULTS AND DISCUSSION

The statistically analyzed data is presented in Tables 1, 2 and Figs. 1, 2, 3 and 4 show the impacts of NPK and FYM on soil health metrics.

3.1 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 FYM_0 and lower bulk density 1.21 and 1.30 Mg m^{-3} were found in FYM_{100}. 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 NPK_0FYM_0 and the minimum bulk densities 1.19 and 1.24 Mg m^{-3} were found in $NPK_{100}FYM_{100}$.

3.2 Particle Density (Mg m^{-3})

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

3.3 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 FYM_{100}, and the minimum percentage pore space 45.32 and 41.61% were found in FYM_0. 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 $NPK_{100}FYM_{100}$ and the minimum percentage pore space 44.76 and 40.79% were found in NPK_0FYM_0.

3.4 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 FYM_{100} and the minimum water holding capacity 43.24 and 40.18% were found in FYM_0. 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 $NPK_{100}FYM_{100}$ and the minimum water holding capacity 42.18 and 39.57% were found in NPK_0FYM_0.

3.5 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 FYM_0 and the minimum pH 6.90 and 7.11 were found in FYM_{100}. 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 NPK_0 and the minimum pH 6.99 and 7.10 were found in NPK_{100}. 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 NPK_0FYM_0 and the minimum pH 6.74 and 6.89 were found in $NPK_{100}FYM_{100}$.

3.6 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 FYM_{100} and the minimum EC 0.32 and 0.22 dS m^{-1} were found in FYM_0. 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 NPK_{100} and the minimum EC 0.33 and 0.23 dS m^{-1} were found in NPK_0. 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 $NPK_{100}FYM_{100}$ and the minimum EC 0.31 and 0.21 dS m^{-1} were found in NPK_0FYM_0.

3.7 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 FYM_{100} and the minimum percentage organic carbon 0.36 and 0.35% were found in FYM_0. 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 NPK_{100} and the minimum percentage organic carbon 0.40 and 0.38% were found in NPK_0. 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 $NPK_{100}FYM_{100}$ and the minimum percentage organic carbon 0.34 and 0.33% were found in NPK_0FYM_0.

3.8 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 FYM_{100} and the minimum available nitrogen 264.60 and 232.51 kg ha^{-1} were found in FYM_0. 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 NPK_{100} and the minimum available nitrogen 262.17 and 229.11 kg ha^{-1} were found in NPK_0. 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 $NPK_{100}FYM_{100}$ and the minimum available nitrogen 255.23 and 224.52 kg ha^{-1} were found in NPK_0FYM_0.

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. (±)	-	-	-	-	-	-	-	-
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. (±)	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_0FYM_0	1.26	1.37	2.65	2.71	44.76	40.79	39.41	36.47
NPK_0FYM_{50}	1.21	1.33	2.63	2.68	46.46	42.69	40.73	38.13
NPK_0FYM_{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. (±)	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

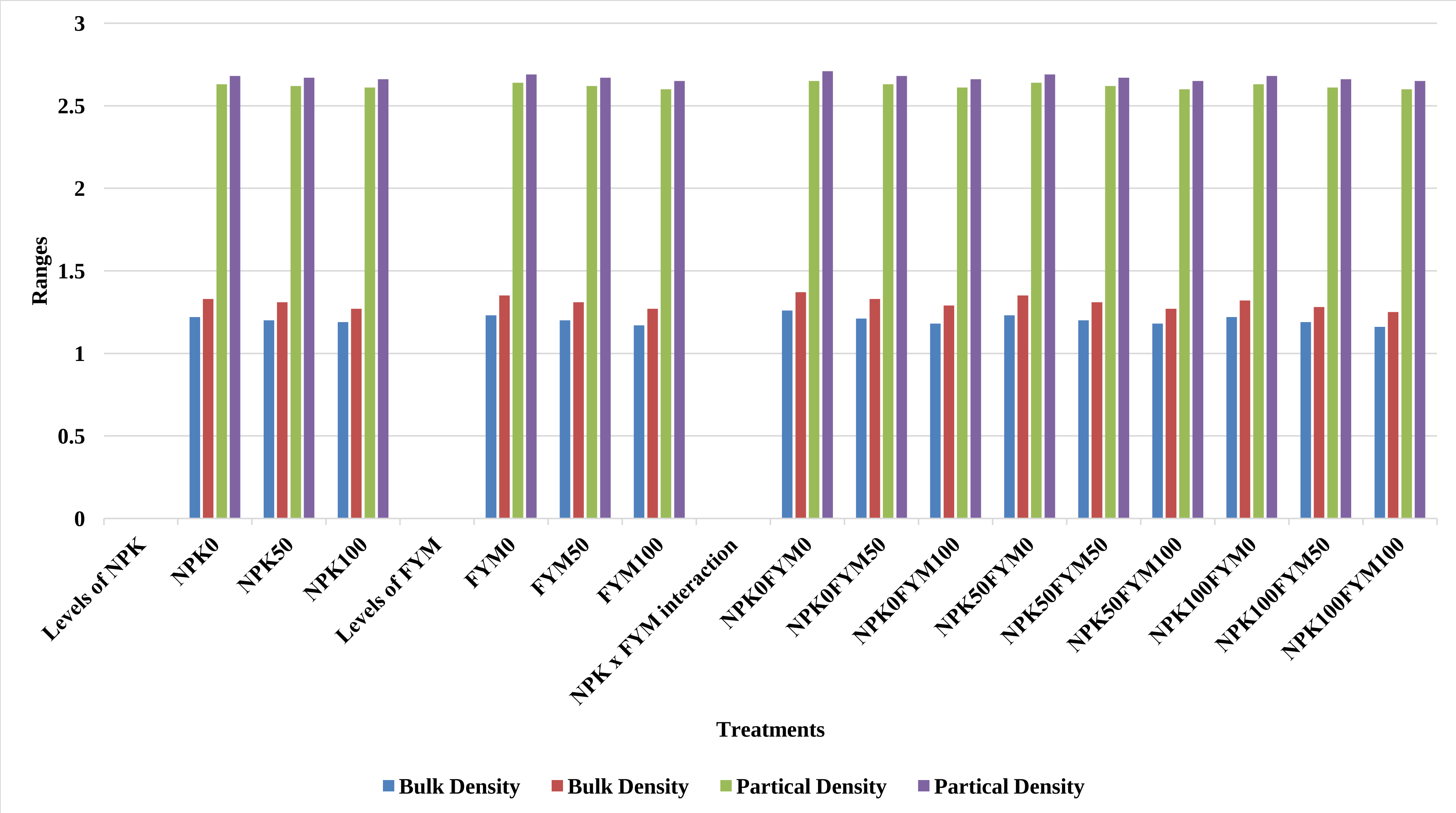

Fig. 1. Effect of NPK and FYM on Bulk density and Particle density of soil

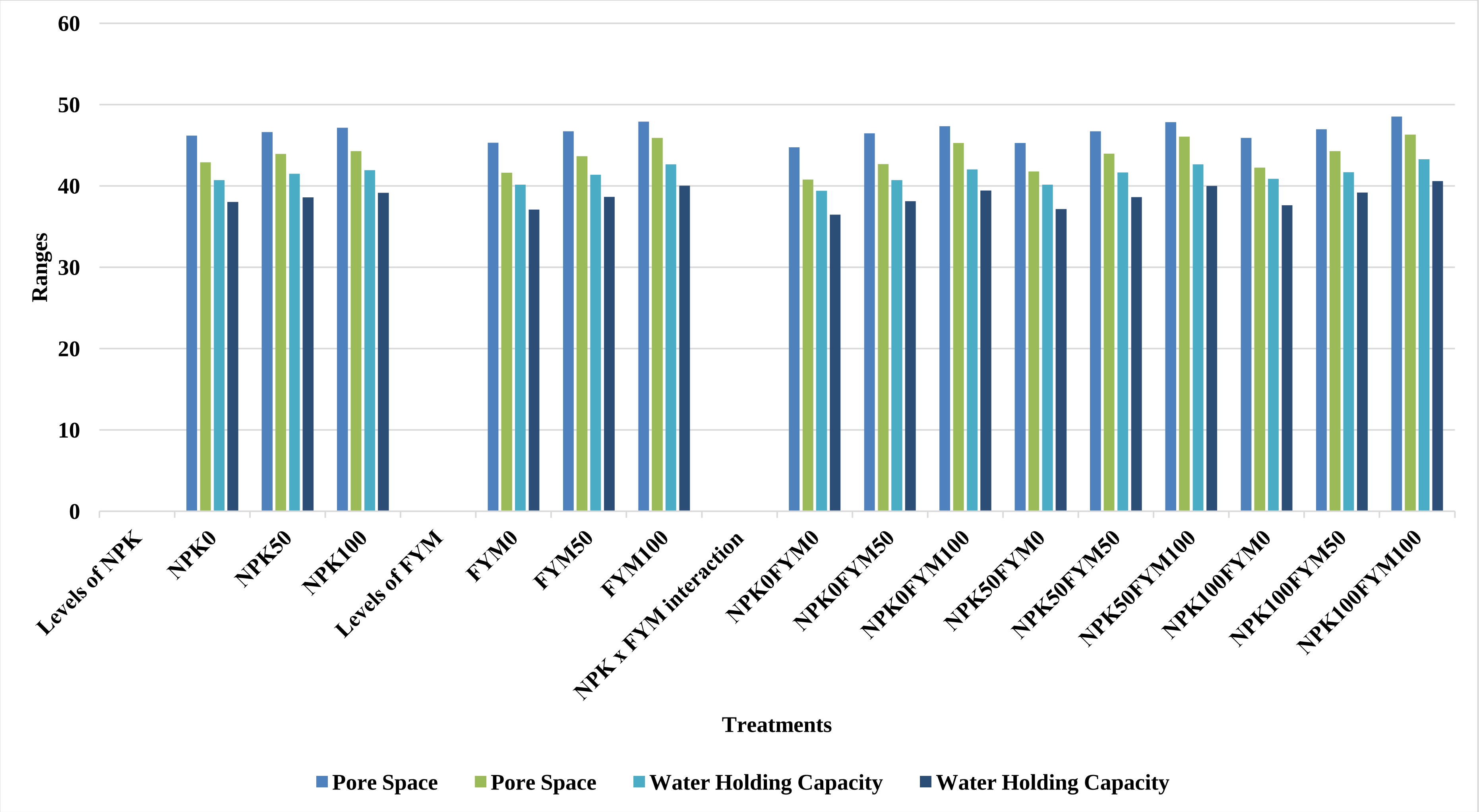

Fig. 2. Effect of NPK and FYM on pore space and water holding capacity of soil

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_0FYM_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_0FYM_{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_0FYM_{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

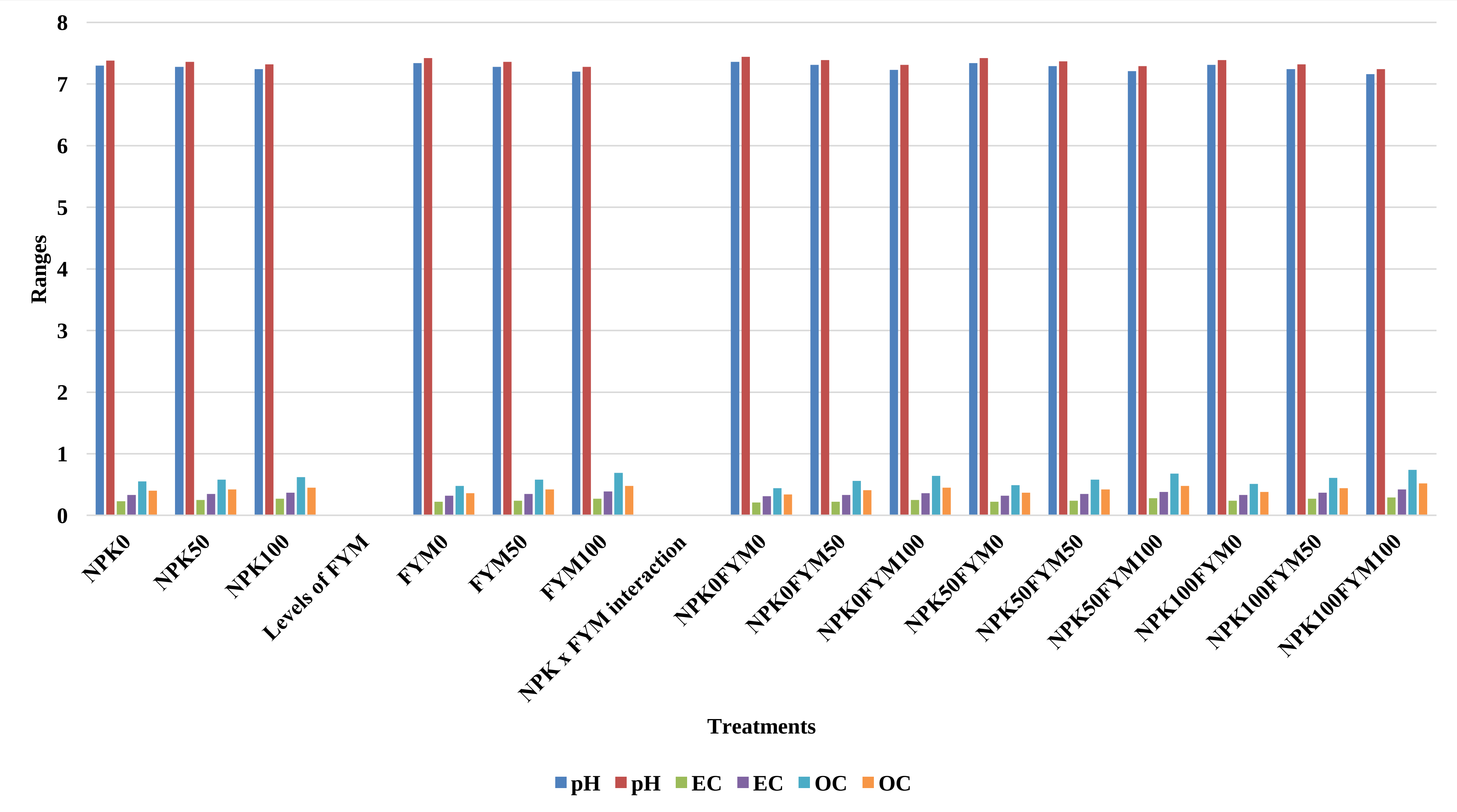

Fig. 3. Effect of NPK and FYM on pH, EC and organic carbon of soil

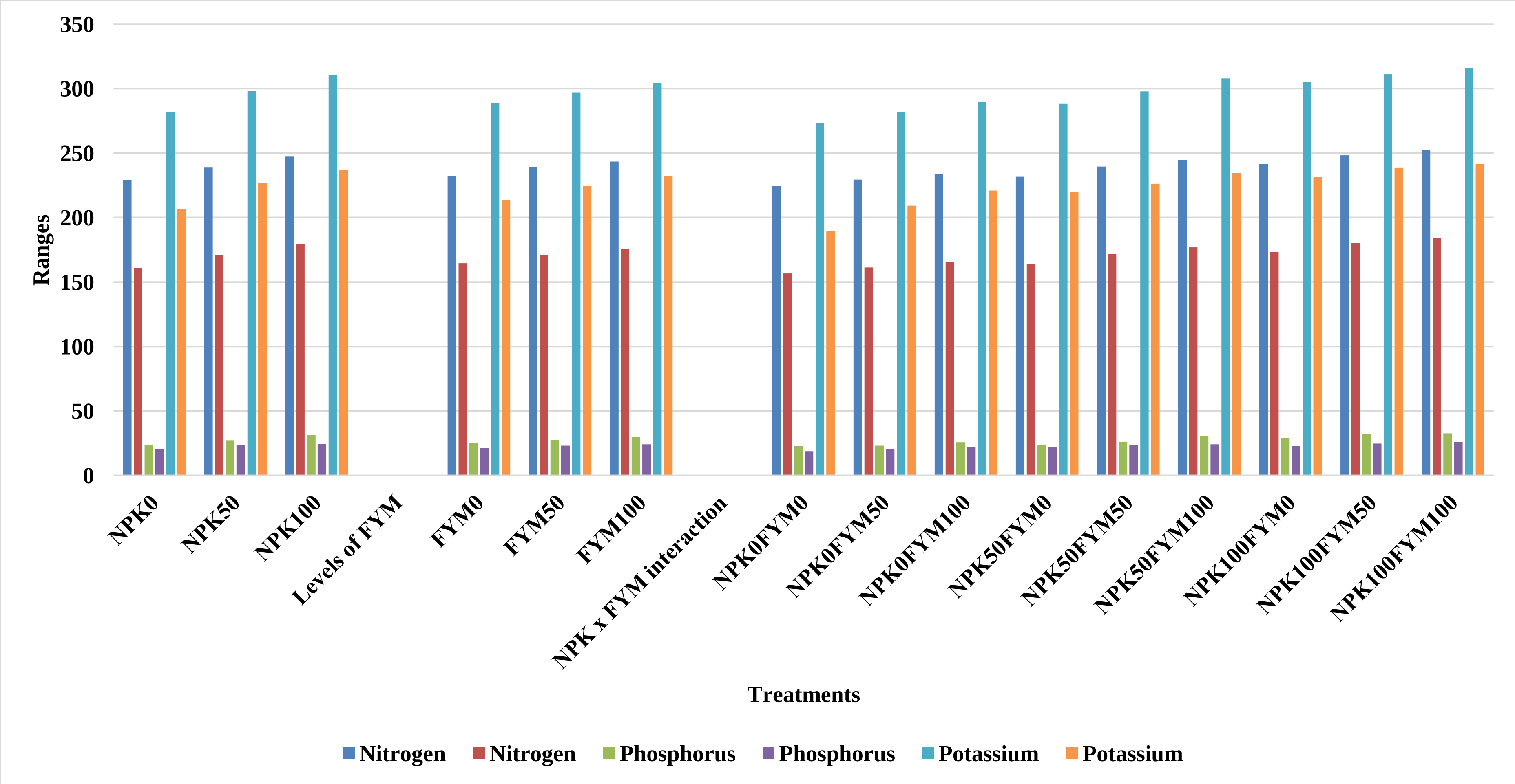

Fig. 4. Effect of NPK and FYM on available nitrogen, phosphorus and potassium of soil

3.9 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 FYM_{100} and the minimum available phosphorus 25.05 and 23.02 kg ha^{-1} were found in FYM_0. 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 NPK_{100} and the minimum available phosphorus 23.81 and 22.42 kg ha^{-1} were found in NPK_0. 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 $NPK_{100}FYM_{100}$ and the minimum available phosphorus 22.62 and 20.46 kg ha^{-1} were found in NPK_0FYM_0.

3.10 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 FYM_{100} and the minimum available potassium 215.89 and 193.66 kg ha^{-1} were found in FYM_0. 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 NPK_{100} and the minimum available potassium 208.54 and 186.62 kg ha^{-1} were found in NPK_0. 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 $NPK_{100}FYM_{100}$ and the minimum available potassium 200.32 and 169.67 kg ha^{-1} were found in NPK_0FYM_0.

4. 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 kg N, 60 kg P2O5, and 40 kg K2O per hectare (120-60-40 kg ha^{-1}) of NPK was used in conjunction with 10 tonnes per hectare (10 t ha^{-1}) of farmyard manure (FYM) in treatment $NPK_{100}FYM_{100}$. This is also the recommended dose of fertilizer in maize crop. 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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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Doran JW, Zeiss S. Soil health and sustainability: A key to global food security. American Journal of Alternative Agriculture. 2000;15(2):87-95.
2. Singh JP, Singh RK, Singh RK. Soil management practices for enhancing Maize production in alluvial soils of eastern Uttar Pradesh. Journal of Pharmacognosy and Phytochemistry. 2017;6(5):1199-1203.
3. Khaliq A, Ali S, Hameed S, Farooq M. Soil Fertility status and maize yield as affected by integrated use of farm yard manure and chemical fertilizers under different soil types. Journal of Soil Science and Plant Nutrition. 2015;15(3):619-634.
4. Kumar M, Kumar V, Singh AK. Soil suitability evaluation for Maize crop in Prayagraj district of Uttar Pradesh, India. Journal of Pharmacognosy and Phytochemistry. 2018;7(1):3019-3023.
5. Munsell AH. Munsell's description of his colour system, from a lecture to the American Psychological Association. American Journal of Psychology. 1971; 23(2):236-244.
6. Fisher RA. The underworld of probability, The Indian Journal of Statistics. 1960; 18(3/4):201- 210.
7. Bouyoucos GJ. The hydrometer as a new method for the mechanical analysis of soils. Soil Science. 1972;23(6):343-353.
8. Ncube B, Dimes JP, van Wijk MT, Twomlow SJ, Giller KE. Productivity and

residual benefits of grain legumes to sorghum and cotton in rotation with mucuna on Alfisols in the semi-arid tropics. Field Crops Research. 2011; 124(3):332-342.
9. Gbegbelegbe SD, Tollenaar M, Lee EA, Hunter RB. Impact of early and late planting on maize growth and yield in contrasting soil moisture conditions. Field Crops Research. 2009;112(3):201-206.
10. Kanyanjua SM, Karanja NK, Wachira PM, Mwangi WM. Combined use of organic and inorganic fertilizers for increased maize yields in Central Kenya. Agriculture, Ecosystems and Environment. 2007;119(1-2):40-48.
11. Mandal BK, Singh DK, Pathak H. Soil fertility status, nutrient uptake and yield of Maize as influenced by nutrient management practices in a Typic Haplustept of eastern Uttar Pradesh. Indian Journal of Agricultural Sciences. 2015;85(2):232-238.
12. Sharma P, Shukla AK. Maize production technology for enhancing farmers' income in Uttar Pradesh. International Journal of Current Microbiology and Applied Sciences. 2017;6(8):2193-2199.
13. Ahmad M, Hussain M, Farooq M, Ali A, Hussain S, Bharwana SA, Nawaz A. Response of maize to different levels of FYM and NPK fertilizer. Pure and Applied Biology. 2019;8(2):911-917.
14. Kumar P, Kumar V, Kumar R. Sustainable agricultural practices for maize productivity improvement in India. Environmental challenges and solutions in South Asia. 2019;51-65.
15. Muthuvel P, Udayasoorian C, Natesan R, Ramaswamy PP. Introduction to Soil Analysis, Tamil Nadu Agricultural University Coimbatore-64$_{100}$2; 1992.
16. Jackson ML. Soil chemical analysis Prentice Hall of India Ltd. New Delhi. 1958;219-221.
17. Wilcox LV. Electrical conductivity. American Water Work Association. J. 1950;42:775-776.
18. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science. 1934;63(3):251-263.
19. Subbiah BV, Asiija EC. A rapid procedure for estimation of available nitrogen in soil. Current Science. 1956;25(8):259-260.
20. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available Phosphorus in soils by extraction with sodium bicarbonate ($NaHCO_3$), U.S.D.A. Circular. 1954;939:1-19.
21. Toth SJ, Prince AL. Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. Soil Science. 1949;67:439-445.

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