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Effect of different levels of NPK and zinc on physico-chemical properties of soil, growth and yield attributes of maize (*Zea mays* L.) var. KM20

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Abstract
A field experiment conducted during summer seasons of 2021-22 at Agricultural Research Farm of Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj (UP). Effect of Different levels of NPK and Zn on Physico-Chemical Properties of soil, Growth and yield Attributes of Maize (*Zea Mays* L.) Keeping in this view experiment was conducted in RBD with three replications Treatments are T_1-0% NPK + 0% Zn, T_2-0% NPK + 50% Zn, T_3-0% NPK + 100% Zn, T_4-50% NPK + 0% Zn, T_5-50% NPK + 50% Zn, T_6-50% NPK + 100% Zn, T_7-100% NPK + 0% Zn, T_8-100% NPK + 50% Zn, T_9-100% NPK + 100% Zn Results showed that T_1 is superior in soil bulk density and pH with 1.302 Mg m^{-3}, and 7.73 respectively and T_9 is superior in particle density, pore space, water holding capacity Electric Conductivity, organic carbon available nitrogen, phosphorus and potassium with 2.483 Mg m^{-3}, 51.02%, 46.01%, 0.25dS m^{-1}, 0.248%, 271.15 kg ha^{-1}, 19.24 kg ha^{-1} and 148.45 kg ha^{-1} respectively and T_9 is inferior in bulk density, and pH with 1.253 Mg m^{-3}, and 7.73, respectively and T_1 is inferior in soil particle density, pore space, water holding capacity, Electric Conductivity, organic carbon and available nitrogen, phosphorus and potassium with 2.314 Mg m^{-3}, 44.82%, 37.90%, 0.16 dS m^{-1}, 0.231%, 251.12 kg ha^{-1}, 16.12 kg ha^{-1}, and 117.65 kg ha^{-1}, respectively.

Keywords: Soil physical properties and Soil chemical properties

Introduction
Food security has long been a major concern in India, with memories of serious famines and with a rapidly increasing population. The promotion of the production and use of fertilizers in order to increase crop yields has been a major objective of the Government of India for more than 30 years. The policy has succeeded and food production in India has kept pace with requirements. The forecast population of 140 million by 2025 will require 300 million tons of food grain compared with about 200 million tons of today. Little extra land is available and the increase in production will have to come from higher yields, for which there is ample scope.

Long term security of the global food supply requires a balance between increasing production and environment sustainability. Both nutrient scarcities and surpluses alike can threaten this balance. Integrated nutrient management for sustainable crop production examines this challenge of managing both organic and inorganic nutrient sources in agricultural systems where nutrients are deficient or in excess supply. The country's researchers and policy-makers have considered several soil and plant nutrient management options to sustain soil fertility in their continuing effort to close the food and population gaps, which primarily include the Integrated Nutrient Management and the balanced use of chemical based fertilizers.

Among the various cereals namely rice and wheat have been under the main focus for achieving food security. However, maize has emerged as the third most important cereal crop after rice and wheat. It is the staple food for vast rural population of our country. Maize, also called as the queen of cereals, occupies a pride place among the cereal crops of India. Maize (*Zea mays* L.) is an annual plant which belongs to family Gramineae. It is the American Indian word for corn which means 'to sustain life'. It is cultivated globally as one of the most important cereal crops. It is a versatile crop grown over a range of agro climatic zones and provides food, feed, fodder and serves as sources of basic raw material for the number of industrial products *viz*., starch, protein, oil, alcoholic beverages, food sweeteners, cosmetics, more recently as bio-fuel etc. No other cereal is being used in as many ways as maize. It occupies an important place as a source of human food (25%), animal feed (12%), poultry feed (49%), starch (12%) and 1% each in brewery and seed.

Materials and Methods

This experiment was conducted during kharif season 2021 on crop research farm of the department of Soil Science and Agricultural Chemistry. The right bank of the river Yamuna and about 6 km away from Prayagraj station. It is positioned at 25.570N Latitude and 81.50E latitude and about 98 meter above sea level

The details of the materials used and technologies adopted during the courses for present investigations entitled "Effect of Different levels of NPK and Zn on Physico-Chemical Properties of soil, Growth and yield Attributes of Maize (*Zea Mays* L.)" This chapter provides complete description of soil, planting materials used and climatic conditions prevalent in the locality during the experimental period.

The experiment is were carried out at the research farm of Soil Science and Agricultural chemistry department of Soil Science and Agricultural Chemistry, Naini, SHUATS. During *summer* season of 2021. The experiment is conducted in a randomized block design (RBD) with two levels of Inorganic fertilizers NPK (50, 100% dosage), Zn respectively, the treatments are replicated into three times dividing the experimental area into twenty seven plots.

Table 1: Treatment combination

	Treatment combination
T_1	0% NPK + 0% Zn
T_2	0% NPK + 50% Zn
T_3	0% NPK + 100% Zn
T_4	50% NPK + 0% Zn
T_5	50% NPK + 50% Zn
T_6	50% NPK + 100% Zn
T_7	100% NPK + 0% Zn
T_8	100% NPK + 50% Zn
T_9	100% NPK + 100% Zn

Results and Discussion

Soil Physical analysis

Bulk density (Mg m^{-3})

Data shows significant Effect of different treatment on Bulk density of soil properties. The maximum Bulk density of soil At depth 0 -15 cm maximum Bulk density (Mg m^{-3}) of soil was recorded 1.302 Mg m^{-3} in treatment T_1 (control) and minimum Bulk density (Mg m^{-3}) of soil was recorded 1.254 Mg m^{-3} in treatment T_9 (NPK @ 100% + @ Zn 100%). At depth 15-30 cm maximum Bulk density (Mg m^{-3}) of soil was recorded 1.317 Mg m^{-3} in treatment T_1 (control) and minimum Bulk density (Mg m-^{3}) of soil was recorded 1.263 Mg m^{-3} in treatment T_9 (NPK @ 100% + @ Zn 100%). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12], Das *et al.* (2013) [10], Singh *et al*. (2013) [33] and Nadeem *et al.* (2017) [34].

Partical density (Mg m^{-3})

Data shows significant Effect of different treatment on Particle density (Mg m^{-3}) of soil properties. The maximum Particle density of soil At depth 0-15 cm maximum particle density (Mg m^{-3}) of soil was recorded 2.483 Mg m^{-3} in treatment T_9 (NPK @ 100% + Zn @ 100%) and minimum particle density (Mg m^{-3}) of soil was recorded 2.314 mg m^{-3} in treatment T_1 (control). At depth 15 - 30 cm maximum particle density (Mg m^{-3}) of soil was recorded 2.664 Mg m^{-3} in treatment T_9 (NPK @ 100%+ Zn @ 100%) and minimum particle density (Mg m^{-3}) of soil was recorded 2.491 Mg m^{-3} in treatment T_1 (control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12], Das *et al*. (2013) [10], Singh *et al*. (2013) [33] and Nadeem *et al.* (2017) [34].

Pore space (%)

The data shows significant Effect of different treatment on pore space (%) of soil properties. The maximum pore space of soil at depth 0-15 cm response of soil pore space was found to be significant in Levels of NPK and Zn. The maximum soil pore space was recorded 51.02% in treatment (NPK @ 100%+ Zn @ 100%) and minimum soil pore space was recorded 44.82% in treatment T_1 (Control). At depth 15-30 cm response of soil pore space was found to be significant in Levels of NPK and Zn. The maximum soil pore space was recorded 50.84% in treatment (NPK @ 100% + Zn @ 100%) and minimum soil pore space was recorded 44.64% in treatment T_1 (Control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12], Das *et al*. (2013) [10], Singh *et al*. (2013) [33] and Nadeem *et al.* (2017) [34].

Water holding capacity (%)

The data shows significant Effect of different treatment on water holding capacity of soil properties. The maximum water holding capacity of soil at depth 0-15 cm response of soil water holding capacity was found to be significant in Levels of NPK and Zn. The maximum soil water holding capacity was recorded 46.01% in treatment (NPK @ 100%+Zn @ 100%) and minimum soil water holding capacity was recorded 37.90% in treatment T_1 (Control). At depth 15 -30 cm response of soil water holding capacity was found to be significant in Levels of NPK and Zn. The maximum soil water holding capacity was recorded 42.26% in treatment (NPK @ 100% + Zn @ 100%) and minimum soil water holding capacity was recorded 36.40% in treatment T_1 (Control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12].

Soil Chemical analysis

pH of soil

The data shows significant effect of different treatment on pH of soil properties. The maximum pH of soil at depth 0 - 15 maximum soil pH was recorded 7.784 in treatment T_1 (control) and minimum soil pH was recorded 7.73 in treatment T_9 (NPK @ 100% + Zn @ 100%). At depth 15 - 30 maximum soil pH was recorded 7.88 in treatment T_1 (control) and minimum soil pH was recorded 7.71 in treatment T_9 (NPK @ 100% + Zn @ 100%). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12], Das *et al*. (2013) [10], Singh *et al*. (2013) [33] and Nadeem *et al.* (2017) [34].

Electrical Conductivity (dS m^{-1})

The data shows significant Effect of different treatment on Electrical Conductivity of soil (dS m^{-1}) of soil properties. The maximum Electrical Conductivity (dS m^{-1}) of soil at depth 0-15 response of EC (dS m^{-1}) of soil was found to be significant in Levels of NPK and Zn. The maximum EC (dS m^{-1}) of soil was recorded 0.25 dS m^{-1} in treatment T_9 (NPK @ 100% + Zn @ 100%) and minimum EC (dS m^{-1}) of soil was recorded 0.16 dS m^{-1} in treatment T_1 (control). At depth 15-30 maximum EC (dS m^{-1}) of soil was recorded 0.33 dS m-1 in

treatment T_9 (NPK @ 100% + Zn @ 100%) and minimum EC (dS m-1) of soil was recorded 0.18 dS m-1 in treatment T_1 (control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12], Das *et al*. (2013) [10], Singh *et al*. (2013) [33] and Nadeem *et al.* (2017) [34].

Organic Carbon (%)

Data shows significant effect of different treatment on Organic Carbon of soil properties. The maximum Organic Carbon of soil at depth 0 - 15 maximum organic carbon in soil was recorded 0.248% in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum% Organic carbon in soil was recorded 0.231% in treatment T_1 (control). At depth 15-30 maximum % organic carbon in soil was recorded 0.243% in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum % Organic carbon in soil was recorded 0.228% in treatment T_1 (control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12].

Available Nitrogen (kg ha^{-1})

The data shows significant effect of different level treatment on Available Nitrogen of soil properties. The maximum Available Nitrogen of soil at depth 0 - 15 maximum available Nitrogen in soil was recorded 271.15 (kg ha^{-1}) in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum available Nitrogen in soil was recorded 251.12 (kg ha^{-1}) in treatment T1 (control). At depth 15 - 30 maximum available Nitrogen in soil was recorded 263.60 (kg ha^{-1}) in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum available Nitrogen in soil was recorded 242.95 (kg ha^{-1}) in treatment T_1 (control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12].

Available Phosphorus (kg ha^{-1})

The data shows significant Effect of different treatment on Available Phosphorus of soil properties. The maximum Available Phosphorus of soil at depth 0-15 maximum available Phosphorus in soil was recorded 19.24 (kg ha^{-1}) in treatment T_9 (NPK @ 100%+ Zn @ 100%) which was significantly higher than any other treatment combination and the minimum available Phosphorus in soil was recorded 16.12 (kg ha^{-1}) in treatment T_1 (control). At depth 15 - 30 maximum available Phosphorus in soil was recorded 17.90 (kg ha^{-1}) in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum available Phosphorus in soil was recorded 15.14 (kg ha^{-1}) in treatment T_1 (control). These results were in close conformity with the findings of Dekhane *et al.* (2011) [12].

Available Potassium (kg ha^{-1})

The data shows significant Effect of different treatment on Available Potassium of soil properties. The maximum Available Potassium of soil at depth 0-15 maximum available potassium in soil was recorded 198.45 (kg ha^{-1}) in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum available potassium in soil was recorded 117.65 (kg ha^{-1}) in treatment T1 (control). At depth 15 – 30 maximum available potassium in soil was recorded 190.28 (kg ha^{-1}) in treatment T_9 (NPK @ 100% + Zn @ 100%) which was significantly higher than any other treatment combination and the minimum available potassium in soil was recorded 109.48 (kg ha^{-1}) in treatment T_1 (control). These results were in close conformity with the findings of Dekhane *et al*. (2011) [12].

Table 2: Effect of different levels of NPK and Zinc on physical properties of soil

Treatments	BD (Mg m^{-3})		PD (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	1.302	1.317	2.314	2.491	44.82	44.64	37.90	36.34
T_2	1.296	1.307	2.342	2.523	45.01	44.83	41.60	48.34
T_3	1.274	1.296	2.434	2.616	48.07	47.89	42.01	39.42
T_4	1.281	1.305	2.382	2.563	46.22	46.04	43.25	40.82
T_5	1.279	1.293	2.414	2.597	47.33	47.15	42.10	38.40
T_6	1.265	1.286	2.456	2.635	48.97	48.79	43.57	41.90
T_7	1.274	1.291	2.368	2.547	45.89	45.71	40.52	38.51
T_8	1.268	1.281	2.477	2.659	50.11	49.93	42.52	42.23
T_9	1.254	1.263	2.483	2.664	51.02	50.84	46.01	42.26
F- test	NS	NS	NS	NS	S	S	S	S
S.Em.(±)	-	-	-	-	13.329	14.187	0.116	0.132
C.D.	-	-	-	-	6.288	7.223	0.055	0.051

Table 3: Effect of different levels of NPK and Zinc on chemical properties of soil

Treatment	pH (w/v)		EC (dS m^{-1})		Organic Carbon (%)		Nitrogen (Kg ha^{-1})		Phosphorus (Kg ha^{-1})		Potassium (Kg ha^{-1})	
	0-15cm	15-30cm	0-15cm	15 - 30cm	0-15cm	15-30cm	0-15 cm	15-30cm	0-15 cm	15-30cm	0-15cm	15-30cm
T_1	7.84	7.88	0.16	0.18	0.231	0.228	251.12	242.95	16.12	15.14	117.65	109.48
T_2	7.81	7.83	0.17	0.20	0.234	0.230	253.09	248.92	16.77	15.45	127.3	119.13
T_3	7.79	7.81	0.19	0.22	0.238	0.235	258.12	250.95	17.35	15.89	130.32	122.15
T_4	7.80	7.82	0.23	0.23	0.236	0.231	254.63	249.46	17.46	16.25	128.54	120.37
T_5	7.76	7.78	0.21	0.26	0.241	0.238	261.57	253.4	17.90	16.74	135.71	125.54
T_6	7.72	7.75	0.22	0.27	0.245	0.241	263.87	254.7	18.12	16.98	141.87	132.7
T_7	7.78	7.80	0.23	0.31	0.243	0.240	266.74	258.57	18.25	17.35	138.49	130.32
T_8	7.74	7.76	0.24	0.32	0.246	0.242	269.42	253.25	18.99	17.67	143.67	132.5
T_9	7.73	7.71	0.25	0.33	0.248	0.243	271.15	263.6	19.24	17.90	148.45	141.28
F- test	NS	NS	NS	NS	S	S	S	S	S	S	S	S
S.Em. (±)	-	-	-	-	0.020	0.024	12.03	10.53	6.993	5.254	0.90	1.08
C.D.	-	-	-	-	0.009	0.007	5.67	4.13	3.299	2.154	1.90	2.18

Conclusion

It was concluded from the trial that in treatment combination T_9 (NPK @ 100%+ Zn @ 100%) NPK and Zn found to be appropriate for maize (*Zea mays* L.)var. KM20 on Prayagraj. It was also found significant for getting maximum growth, yield, CBR of the crop and Physico-chemical properties of soil. Therefore, here it's a need for further investigation to confirm the results at various locations in Prayagraj.

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