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Effect of different levels of nitrogen and phosphorus on physico-chemical properties of soil in maize (*Zea mays* L.) Cv. K-64

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Abstract
A field study was conducted on the "Effect of different levels of nitrogen and phosphorus on physico-chemical properties of soil in maize (*Zea mays* L.) Cv. k-64" at the Soil Science & Agricultural Chemistry Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *Kharif* season 2018. The soil of experimental area falls in order *Inceptisol* and soil texture was sandy loam. The result showed that in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}), bulk density 1.57 (Mgm^{-3}), particle density 3.26 (Mgm^{-3}), pore space 65.55 (%), water holding capacity 39.29 (%), pH 7.22, EC 0.16 (dSm^{-1}), organic carbon 0.74 (%), available nitrogen 303.63 (Kg ha^{-1}), available phosphorus 21.40 (Kg ha^{-1}), available potassium - 221.46 (Kg ha^{-1}) as compared to T_0 (control).

Keywords: Maize, NPK, physical chemical properties of soil

Introduction
Maize is an important cereal crop which ranks the third after wheat and rice in the world. Maize is grown widely in many countries of the world (Onasanya *et al*., 2009) [7]. Maize which is botanically called (*Zea mays* L) belongs to the family *Gramineae*. Maize is one of the world's leading crops cultivated over an area of 139 million hectares with the production of about 600 million tonnes of grain. USA leads the largest area, followed by Brazil, china, Mexico and India. It is grown in almost all states of India occupying an area of 6.3 million hectares with the production and productivity of 11.3 million tonnes and 1.9 million tonnes per hectares respectively (Kumar *et al*., 2007) [6]. Maize grain contains about 70% carbohydrate, 10% protein, 4% oil, 2.3% crude fiber, 10.4% albuminoides, 1.4% ash (Choudhary, 1993) [3]. Along with this, it is rich in vitamin A, vitamin E, nicotinic acid, riboflavin and contains fairly high phosphorus than rice and sorghum. Its fodder and hay contain 7-10% protein, 15-36% fiber, 2.09-2.62% ether extract, 0.42-0.70% calcium, 0.28-0.29% phosphorus, 0.45% magnesium, 1.34% potassium and 56% carbohydrate, therefore, it has very nutritive fodder and hay. Besides food grain, fodder and feed, it has prime importance in textile, starch and big industries (Rai, 2006) [9]. Maize is also known as "Queen of cereals" and kind of fodder maize has been usually considered as poor man's crop and occupying the place in the rich communities due to its multifarious use as industrial food and feed crops (Suke *et al*., 2011) [14]. Fertilizer plays an important role in increasing the maize yield and their contribution to economy is very high. Balanced and optimum use of nitrogen, phosphorus and potassium as well as sulphur fertilizer plays a pivotal role in increasing the yields of cereals. Though the yield potential of our present varieties is high enough, but it has not been explored fully due to some production constraints. Among the limiting factors; proper level and ratio of nitrogen and phosphorus are prime importance. Maize is a highly potential crop in Mudhol area (Ghataprabha Left Bank Canal) of Bagalkot district in North Karnataka. Nitrogen is a vital plant nutrient and a major determining factor required for maize production. It is very essential for plant growth and makes up 1-4% of dry matter of the plants. Nitrogen is essential constituent of protein and is present in many other compounds of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life (Singh *et al*., 2010) [12]. Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of maize. Phosphorus is a constituent of nucleic acid, phytin and phospho-lipid. Phosphorus compound acts as energy within plants.

Phosphorus is essential for transformation of energy, in carbohydrate metabolism, in fat metabolism, in respiration of plant and early maturity of maize.

Materials and methods

The present study entitled "Effect of different levels of nitrogen and phosphorus on physico-chemical properties of soil in maize (*Zea mays* L.) Cv. k-64" comprise of a field experiment which was carried out at the Soil Science & Agricultural Chemistry Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences Prayagraj during Kharif season 2018, which is located at $25^0 24' 30''$ N latitude, $81^0 51' 10''$ E longitude and 98 m above the mean sea level. The detail of the experimental site, soil and climate is described in this chapter together with the experimental design, layout plan, cultural practice and techniques employed for the parameters. The area of Prayagraj district comes under subtropical belt in the South East Uttar Pradesh, which experience extremely hot summer and fairly winter. The maximum temperature of the location reaches up to 46^0C-48^0C and seldom falls as 4^0C – 5^0C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. It comes under subtropical climate receiving the mean annual rainfall of about 1100 mm, major rainfall from July to end of September. However, occasional precipitation was also not uncommon during winter. The winter months were cold while summer months were very hot and dry. The minimum temperature during the crop season was to be 27.1 ^{0}C and the maximum is to be 39.94 ^{0}C. The minimum humidity was 57.70% and maximum was to be 75.37%.

Experiment will be laid out in 3x3 factorial randomized block design with three levels of Nitrogen and Phosphorus plot size was 2x2 m^2 for crop seed rate is 18-20 kg ha^{-1} (*Zea mays* L.) Cv. k-64. Maize sowing was done on in 12th July 2018 and the source of nitrogen and phosphorus were Urea and SSP, respectively. Basal dose of fertilizer was applied in respective plots according to treatment allocation uniform furrows opened by about 5 cm. All the agronomic practices were carried out uniformly to raise the crop. The crop was harvested on November 2018.

Table 1: The treatments consisted of nine combination of N and P source of fertilizer

	Treatment Rate of fertilizers application	Symbol
T_0	Control No fertilizer doses	(L_0F_0)
T_1	0 % N + 50 % P N@0 kg ha^{-1} + P@30 kg ha^{-1}	(L_0F_1)
T_2	0 % N + 100 % P N@0 kg ha^{-1} + P@60 kg ha^{-1}	(L_0F_2)
T_3	50 % N + 0 % P N@60 kg ha^{-1} + P@0 kg ha^{-1}	(L_1 F_0)
T_4	50 % N + 50 % P N@60 kg ha^{-1} + P@30 kg ha^{-1}	(L_1F_1)
T_5	50 % N + 100 % P N@60 kg ha^{-1} + P@60 kg ha^{-1}	(L_1F_2)
T_6	100% N + 0% P N@120 kg ha^{-1} + P@0 kg ha^{-1}	(L_2F_0)
T_7	100% N + 50% P N@120 kg ha^{-1} + P@30 kg ha^{-1}	(L_2F_1)
T_8	100% N + 100% P N@120 kg ha^{-1} + P@60 kg ha^{-1}	(L_2F_2)

Results and discussion

Bulk density (Mgm^{-3})

The result of data depicted table that's the maximum bulk density (Mgm^{-3}) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 1.57 Mgm^{-3} while the minimum values of the result were found in treatment T_0 (control) which was 1.27 Mgm^{-3} respectively. The mean value of bulk density of soil (Mgm^{-3}) was found significant different. It was also observed the bulk density of soil was gradually increased with an increase in dose of N and P. The effect of N and P on bulk density of soil was also found significantly. Because the presence of N and P in optimum amount increase bulk density of soil. It's contains higher amount of sand, silt and clay particle. As these indicated an enrichment of fine fractions i.e. silt and clay a part from the retention of dissolved O.M. leading to change in physical properties of soil. Awad *et al*., (2014) [1]

Particle density (Mgm^{-3})

The result of data depicted that's the maximum particle density (Mgm^{-3}) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 3.26 Mgm^{-3} while the minimum values of the result were found in treatment T_0 (control) which was 2.33 Mgm^{-3} respectively. The mean value of particle density of soil (Mgm^{-3}) was found significant different. It was also observed the particle density of soil was gradually increased with an increase in dose of N and P. The effect of N and P on particle density of soil was also found significantly. Zhong *et al*., (2014) [15]

Pore space (%)

The result of data depicted that's the maximum pore space (%) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 65.55 % while the minimum values of the result were found in treatment T_0 (control) which was 55.31 % respectively. Bulk density and pore space were recorded maximum in INM practice and recommended dose of N and P. Kannan *et al*., (2013) [5]

Water holding capacity (%)

The result of data depicted that's the maximum water holding capacity (%) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 39.29 % while the minimum values of the result were found in treatment T_0 (control) which was 29.57 % respectively. Water holding capacity of soil was found significant different. It was also observed the pore space of soil was gradually increased with an increase in dose of N and P. The effect of N and P on water holding capacity of soil was also found significantly. Similar findings had been reported. Singh *et al*., (2003) [13],

Table 2: Effect of different level of N and P on physical parameters of soil in maize

Treatment	Bulk density (Mgm^{-3})	Particle density (Mgm^{-3})	Pore space (%)	Water holding capacity (%)
T_0	1.27	2.33	55.31	29.57
T_1	1.29	2.56	56.72	31.18
T_2	1.32	2.65	57.75	31.74
T_3	1.35	2.7	58.28	32.42
T_4	1.39	2.78	60.09	34.08
T_5	1.42	2.88	61.85	34.53
T_6	1.45	2.93	63.23	36.42
T_7	1.48	3.11	64.86	37.2
T_8	1.51	3.26	65.55	39.29
F- test	S	S	NS	S
S. Em±	0.023	0.082	2.280	1.128
C.D. (P= 0.05)	0.068	0.241	6.688	3.308

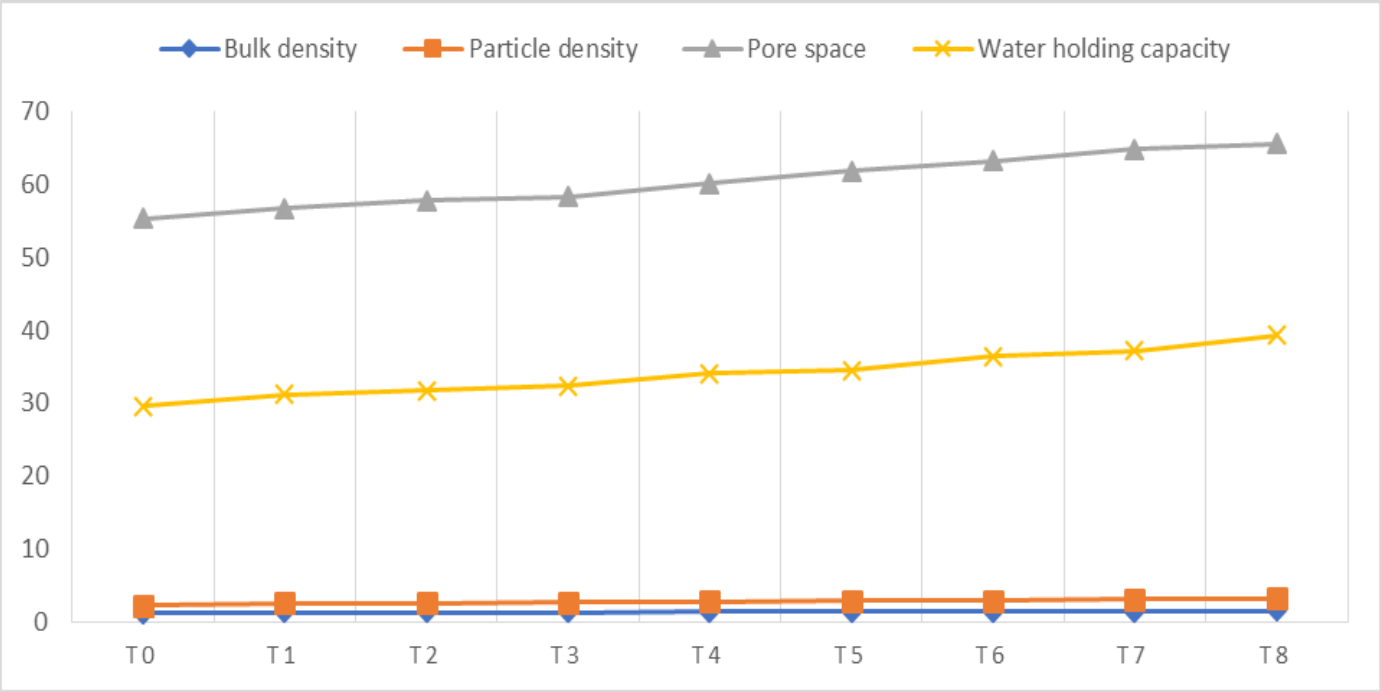

Fig 1: Effect of different level of N and P on physical parameters of soil in maize

Soil pH (1:2) w/v

The result of data depicted that's the maximum pH (1:2) w/v of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 7.22 while the minimum values of the result were found in treatment T_0 (control) which was 6.71 respectively. Application of nitrogen (N) fertilizer is one of the most important approaches on improving soil physical-chemical characters and maize grain using hybrid variety Zheng dam 958 in 2011 and 2012. These results indicated that the soil bulk densities were increased, whereas the soil porosity, field capacity and values pH were increased by N application at different stages. Heng *et al*., (2014) [4]

Soil electrical conductivity (dSm^{-1})

The result of data that's the maximum electrical Conductivity (dSm^{-1}) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 0.22 dSm^{-1} while the minimum values of the result were found in treatment T_0 (control) which was 0.16 dSm^{-1} respectively. The mean value of EC (dSm^{-1}) of soil was found non-significant of different levels of N and P. It was also observed the EC of soil were gradually increased with an increase dose of N and P. The interaction effect N and P on EC of soil was also found non-significantly. Similar result has been recorded by Bhattacharya *et al*., (2004) [2].

Organic carbon (%)

The result of data depicted that's the maximum organic carbon (%) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 0.59 % while the minimum values of the result were found in treatment T_0 (control) which was 0.74 % respectively. The mean value of organic carbon (%) of soil was found significant of different levels of N and P. It was also observed the organic carbon (%) of soil were gradually increased with an increase dose of N and P. The interaction effect N and P on organic carbon (%) of soil was also found significantly. Similar result has been recorded by Sharma *et al*., (2015) [11].

Available nitrogen (Kg ha^{-1})

The result of data depicted that's the maximum available nitrogen (Kg ha^{-1}) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 325.22 Kg ha^{-1} while the minimum values of the result were found in treatment T_0 (control) which was 303.63 Kg ha^{-1} respectively. It was also observed maximum nutrient use efficiency (NUE) obtained from the field. Where recommended dose of N and P fertilizer (90-60 Kg ha^{-1}) was added. The effect of hardpan and N and P fertilizers on nitrogen and phosphorus concentration was significant during the year 2003 while during the year 2004. This effect on nitrogen concentration in maize plants was

non-significant. While on phosphorus concentration was significant. Similar result has been recorded by Raza *et al*., (2005) [10].

Available phosphorus (Kg ha^{-1})

The result of data depicted that's the maximum available phosphorus (Kg ha^{-1}) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 32.30 Kg ha^{-1} while the minimum values of the result were found in treatment T_0 (control) which was 21.40 Kg ha^{-1} respectively. The statistical analysis of available phosphorus (Kg ha^{-1}) data indicates that there was a significant difference in available phosphorus (Kg ha^{-1}) interaction between nitrogen and phosphorus. Same result also found by Rai *et al*., (2006) [9].

Available potassium (Kg ha^{-1})

The result of data depicted that's the maximum available potassium (Kg ha^{-1}) of soil at were found in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) which was 221.46 Kg ha^{-1} while the minimum values of the result were found in treatment T_0 (control) which was 191.67 Kg ha^{-1} respectively. The mean value of available potassium (Kg ha^{-1}) was found significant different. Similarly, the maximum total P and K (73.82 and 206.50 Kg ha^{-1}) respectively was observed from the enhanced levels of P and K application (200-95-88-7.4 and 200-76-110-7.4 Kg N-P-K-Zn ha^{-1}). The trend of available N, P, K and Zn were also same as to that of uptake pattern due to the enhanced levels of nutrients at post-harvest soil. Paramasivan *et al*., (2012) [8]

Table 3: Effect of different level of N and P on chemical parameters of soil in maize

Treatment	pH (1:2) w/v	EC (dSm^{-1})	Organic carbon (%)	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})
T_0	6.71	0.16	0.59	303.63	21.40	191.67
T_1	6.74	0.17	0.61	304.76	22.25	202.69
T_2	6.8	0.19	0.64	307.36	23.97	206.87
T_3	6.89	0.23	0.68	309.74	25.57	210.92
T_4	6.95	0.21	0.7	312.56	27.12	211.78
T_5	7.07	0.22	0.71	316.31	28.22	212.02
T_6	7.11	0.23	0.72	317.69	29.14	216.12
T_7	7.16	0.25	0.73	321.03	30.40	217.68
T_8	7.22	0.27	0.74	325.22	32.30	221.46
F- test	NS	NS	S	S	S	S
S. Em±	0.262	0.021	0.019	4.570	0.575	5.119
C.D. (P= 0.05)	0.769	0.062	0.056	13.404	1.687	15.017

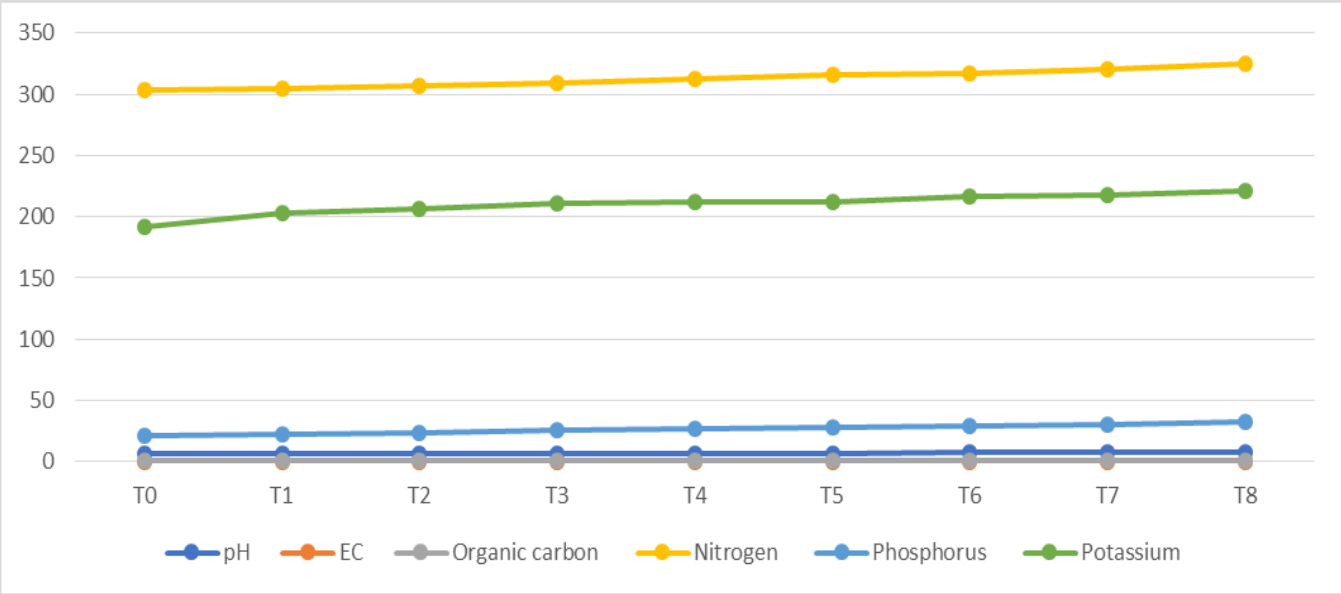

Fig 2: Effect of different level of N and P on chemical parameters of soil in maize

Conclusion

In the present investigation, it was apparent that application of N and P fertilizer in treatment T_8 (120 Kg N ha^{-1} and 60 Kg P ha^{-1}) was found on physical and chemical parameters of soil such as bulk density, particle density, % pore space, water holding capacity, EC, pH, organic carbon, available N, P and K than other treatment combinations. %pore space, pH and EC are non-significant. Thus it can be concluded that different levels of N and P fertilizer improved soil available nutrient, increased soil available nitrogen, phosphorus, potassium and electrical conductivity. However, pH of soil increased and also among the treatments T_8 recorded the best treatment which increased the availability of nutrient and influenced on physical properties of soil as well.

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