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Effect of different levels of nano urea and conventional fertilizer on soil health of maize (*Zea mays* L.) Var, P3544 in an Inceptisols of Prayagraj, (U.P) India

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Abstract
The experiment was laid down in randomized block design with three levels of conventional fertilizer (0% N, 50% N and 100% N) and foliar spray of nano urea fertilizer at three concentrations (0%,50% and 100%) respectively. The result shows that the application of different levels combination of conventional fertilizer and nano urea increased growth, yield of Maize and improved soil chemical properties. However some parameters of soil physical properties decreased. The results showed that the application of conventional fertilizer and nano urea in treatment T_9 ($N_{100,}$ 100%P and K fertilizers + 2 sprays of Nano nitrogen (4ml/l) minimum bulk density 1.200 Mg m^{-3} in 0-15 cm depth and 1.407 Mg m^{-3} in 15-30 cm depth, particle density 2.359 Mg m^{-3} in 0-15 cm depth and 2.669 Mg m^{-3} in 15-30 cm depth, water holding capacity 59.09% in 0-15 cm depth and 49.57% 15-30 cm depth , pH 7.105 in 0-15 cm depth and 7.309 in 15-30 cm depth, EC 0.222 dS m^{-1} in 0-15 cm depth and 0.148 dS m^{-1} in 15-30 cm depth,% organic carbon 0.487 % in 0-15 cm depth and 0.387% in 15-30 cm depth, Available Nitrogen (kg ha^{-1}) 247.12 in 0-15 cm depth and 199.2 in 15-30 cm depth , Available Phosphorous (kg ha^{-1}) 39.36 in 0-15 cm depth and 31.63 in 15-30 cm depth, Available Potassium (kg ha^{-1}) 4.34 in 0-15 cm depth and 9.37 in 15-30 cm depth was found Significant.

Keywords: IFFCO nanofertilizers, growth and yield parameters, maize, soil physic-chemical properties

Introduction
Maize (*Zea mays* L.) is the world's most widely cultivated food crop providing ample food calories and protein for more than one thousand million human beings in the world. It is a member of family Gramineae (*Poaeceae*) sub family *Panicoideae.* It ranks 3rd among the cereals in India after wheat and rice. The term corn refers as "to sustain life" that provides nutrients for human and animals worldwide (Elamin and Elagib, 2001).

It is cultivated throughout the year in all the seasons and grown around the globe. The nutritional value of maize is high as it contains 72% starch, 10% protein, 8.5% fibre, 4.8% oil, 3.0% sugar and 1.7% ash (Hokmalipour *et al*., 2010) [8]. Comparatively maize gives more yield than the other cereals such as rice, wheat etc., hence it is known as the "Queen of Cereals". It is an important staple food and also used as a fodder crop in India. Starch, cooking oil and gluten are also extracted from maize. The starch in maize can be hydrolysed and enzymatically treated to produce syrups, particularly high fructose corn syrup, a sweetener and also as fermented and distilled to produce grain alcohol. Grain alcohol from maize is traditionally the source of Bourbon whiskey (Ahmad *et al.,* 2012) [2]. Maize is an exhaustible crop that demands high nutrition for their growth and development. The productivity of the crop depends on nutrient management system. Inorganic fertilizers are most widely used all over the world as it gives higher yield and the end result is also much appreciable. Efficient use of nitrogen is important for maize production as it increases the yield and maximize economic return and minimize NO3 leaching to ground (Ahmad *et al.,* 2012) [2]. Bio fertilizers are also a good source of nutrients as it binds the atmospheric nitrogen which is inaccessible to plants and ammonium ion and is released into the soil. It also enhanced the fertility of the soil. Sustainable agriculture with a high productivity is crucial to alleviate the perils of hunger and increase food security. Food production and distribution are under an increased and continuous stress at a global scale due to climate change, an increased human population, decreased fertile lands and freshwater resources. This challenge could be addressed with technological advancements coupled with significant modifications to existing global food production systems (Achiri *et al*., 2017) [1].

Currently, modern agriculture is heavily supported by the use of high rates of agrochemicals. Synthetic chemical fertilizers are used for the optimal growth and productivity of crops, but they are not successful to enhance plant nutrient use efficiency (NUE) and crop productivity (Alemayehu and Shewarega, 2015) [4]. (Ajithkumar *et al*., 2021) [3]

Soils of India are deficient in nitrogen which are essential for plant growth. The main reason of this loss of nutrients is leaching, denitrification and volatilization. It is occurring when we apply fertilizers and nutrient in soil, so to avoid these losses we can apply fertilizers through foliar application. Foliar application is the application of fertilizer directly on the leaves of a plant. Plants are able to absorb nutrient through foliage. Field crops normally absorb the majority of nutrients from the soil through root absorption, but above ground plant structures, especially leaves, are capable of absorbing limited amounts of some nutrients. Foliar fertilization of crops offer specific advantages over soil- applied fertilizers, because the nutrients are applied and taken-up directly by their target organs, providing a specific and rapid response. There is also evidence that utilization of nutrient is better by foliar application as compare to soil application. Often the soil with its chemical, physical and biological complexity acts as a barrier and a buffering medium. We can also use nano fertilizers over traditional fertilizers for foliar application. Nano fertilizers are synthesized or modified form of traditional fertilizer materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical, or biological methods with the help of nanotechnology used to improve soil. There are lots of advantages of nano fertilizers, like they increase three- times in nutrient use efficiency. 55-60 times less requirement to chemical fertilizer, 10-12 times more stress tolerant by the crops, complete bio-source so eco-friendly, 30-35% more nutrient mobilization by the plants, 18-54% improvement in the crop yield. Present time IFFCO has introduced three types of nano fertilizers nano nitrogen, nano zinc and nano copper at Kalol unit in Gujarat. These products have been researched and developed indigenously at the IFFCO Nano Biotechnology Research Centre (NBRC).

Materials and Methods

The current study entitled "Effect of Different Levels of Nano Urea and Conventional Fertilizer on Soil Health, Crop Growth and Yield Attributes of Maize (*Zea mays.* L) Includes field research conducted in Soil Science and Agricultural Chemistry Research. The farm, SHUATS, Prayagraj during Kharif Season 2020, was 25º24'30"N latitude, 81º51'10"E longitude, and 98 m above sea level. Details of the test site, soil and climate are described in the chapter as well as the exploration design, building plan, cultural practices and techniques used in the boundaries. The Prayagraj region is below the subtropical belt in South East Uttar Pradesh, experiencing extreme summer temperatures and inclement winters. The maximum local temperature is 46 ℃ - 48 ℃ and is rarely as low as 4 ℃ - 5 ℃. The relative humidity was between 20-94%. The average rainfall in this area is approximately 1100mm. It comes under a tropical climate receiving an average annual rainfall of 1100mm, the heaviest rainfall from July to the end of October. Occasionally, however, the rain was rare in winter. The winter months were cold and the summer months were very hot and dry. The minimum temperature during the growing season was 27.1 ℃ and the minimum was 39.94 ℃. Humidity minimum was 57.70% and maximum was 75.37%.

Two different factors were considered: (i) Urea levels (0%, 50%, and 100%). (ii) Nano urea (0%, 50% and 100%). The trial consisted of 9 treatments and the field was placed in a Randomized Block Design with three duplicates and the treatment assigned accordingly. The size of each building was 2 x 2 m^2. Seeds were sown in the fields at intervals of 50 cm x 20 cm. Nitrogen was applied in separate doses, the first after 35 days of sowing and the second dose 42 days after sowing similar to the RDF. Different activities of cultural integration such as irrigation, cultivation, pest control and so on are performed as required. The amount of harvest was recorded in each plot after harvest. Soil at a depth of 0-15cm and 15-30cm is taken both before and after harvesting to determine soil boundaries. The various parameters analysed were Bulk density, particle density, % Pore Space, pH, E.C, % Organic Carbon, Nitrogen, Phosphorus and Potassium. Inorganic fertilizer was given through Urea (N), SSP (P) and MOP (K) in each plot as per treatment. Nano urea was applied as foliar application. 1st spray at active growth stage (30-35 days after germination) and 2nd spray 20-25 days after 1st spray or before flowering in the crop.

Table 1: Treatment Combinations

Treatment	Treatment Combinations	Symbol
T_1	Absolute control (no fertilizer)	C_0N_0
T_2	C_0,100%P&Kfertilizers + 2 sprays of Nano nitrogen (2ml/l) at 25-30 DAS and 45-50 DAS	C_0N_1
T_3	C_0,100%P&Kfertilizers + 2 sprays of Nano nitrogen (4ml/l) at 25-30 DAS and 45-50 DAS	C_0N_2
T_4	C_{50},100%P&Kfertilizers + 0 sprays of Nano nitrogen	C_1N_0
T_5	C_{50},100%P&Kfertilizers + 2 sprays of Nano nitrogen (2ml/l) at 25-30 DAS and 45-50 DAS	C_1N_1
T_6	C_{50},100%P&Kfertilizers + 2 sprays of Nano nitrogen (4ml/l) at 25-30 DAS and 45-50 DAS	C_1N_2
T_7	C_{100},100%P&Kfertilizers + 0 sprays of Nano nitrogen	C_2N_0
T_8	C_{100},100%P&Kfertilizers + 2 sprays of Nano nitrogen(2ml/l) at 25-30 DAS and 45-50 DAS	C_2N_1
T_9	C_{100},100%P&Kfertilizers + 2 sprays of Nano nitrogen (4ml/l) at 25-30 DAS and 45-50 DAS	C_2N_2

Table 2: Mechanical analysis of soil

Ingredients	Percentage	Method employed
Sand	70.4	Bouyoucous hydrometer method
Silt	12.0	Bouyoucous hydrometer method
Clay	17.6	Bouyoucous hydrometer method
Textural class	Sandy loam	

Table 3: Physical and chemical analysis of soil sample before sowing of crop

Particular	Rating	Method used	Scientist(year)
Bulk density (Mg $m^{-3)}$	1.190	Graduated measuring cylinder	(Muthuaval *et al*., 1992) [14]
Particle density (Mg $m^{-3)}$	2.192	Graduated measuring cylinder	(Muthuaval *et al*., 1992) [14]
Pore space (%)	45.71	Graduated measuring cylinder	(Muthuaval *et al*., 1992) [14]
Water holding capacity (%)	51.26	Volumetric flask method	(Muthuaval *et al*., 1992) [14]
Soil pH(1:2)	7.03	Digital, pH meter	(Jackson 1958)
Soil EC. (ds/m)	0.211	Digital conductivity meter	(Wilcox 1950) [22]
Organic carbon (%)	0.202	Wet oxidation Method	(Walkley and Black's method 1934) [21]
Available nitrogen (Kg $ha^{-1)}$	178.12	Kjeldhal Method	(subbaih and Asija, 1956)
Available phosphorous (Kg $ha^{-1)}$	20.12	Colorimetric method	(olsen *et al.*, 1954) [15]
Available potassium (Kg $ha^{-1)}$	215.36	Flame photometric method	(Toth and prince, 1949) [20]

Results and Discussion

Mechanical Properties of Soil: Table 2 indicate the estimated value by a depth of 0-15cm and 15-30cm. The maximum Bulk density (Mg m^3) was recorded in T_1 which was 1.238 in 0-15 cm and 1.471 in 15-30 cm and minimum was found in T_9 which was 1.200 Mg m^{-3} in 0-15 cm and 1.407 Mg m^{-3} in 15-30 cm respectively. The maximum Particle density (Mg m^3) 2.397 in 0-15 cm and 2.690 in 15-30 cm was recorded in T_1 and minimum was found in T_9 which was 2.359 in 0-15 cm and 2.669 in 15-30 cm. The maximum (%) pore space of soil was found in T_9 which was 49.12 in 0-15 cm and 47.27 in 15-30 cm and minimum (%) pore space values result was found in T_1 which was 48.24 in 0-15 cm and 44.88 in 15-30 cm. The maximum % Water holding capacity was found in T_9 which was 59.09 in 0-15 cm and 49.57 in 15-30 cm and minimum % water holding capacity was found in T_1 which was 53.17 in 0-15 cm and 45.12 in 15-30 cm.

Table 4: Response of Nano urea and Conventional fertilizer on Bulk density, Particle density and pore space of maize of post-harvest soil.

Treatment	Bulk density (Mg $m^{-3)}$		Particle density (Mg $m^{-3)}$		Pore density (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T1	1.238	1.471	2.397	2.690	48.24	44.88
T2	1.230	1.443	2.394	2.680	48.62	46.12
T3	1.229	1.435	2.396	2.677	48.70	46.37
T4	1.224	1.433	2.388	2.680	48.73	46.48
T5	1.218	1.432	2.379	2.677	48.78	46.47
T6	1.214	1.427	2.374	2.674	48.87	46.59
T7	1.212	1.422	2.371	2.676	48.90	46.83
T8	1.206	1.418	2.364	2.674	48.98	46.95
T9	1.200	1.407	2.359	2.669	49.12	47.27
F- test	NS	NS	NS	NS	NS	NS
S.Em (±)	0.012	0.015	0.024	0.077	0.91	1.30
CD at (5%)	0.036	0.045	0.072	0.231	2.72	3.90

Table 5: Response of Nano urea and Conventional fertilizer on pH, EC and Organic carbon of maize of post-harvest soil.

Treatment	pH (W/V)		EC (ds $m^{-1)}$		Organic carbon (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T1	7.337	7.545	0.200	0.130	0.408	0.238
T2	7.294	7.511	0.206	0.135	0.422	0.260
T3	7.285	7.494	0.211	0.137	0.426	0.265
T4	7.252	7.484	0.212	0.142	0.429	0.266
T5	7.242	7.475	0.215	0.143	0.432	0.271
T6	7.151	7.451	0.214	0.143	0.437	0.280
T7	7.134	7.425	0.215	0.144	0.441	0.283
T8	7.112	7.392	0.217	0.145	0.447	0.288
T9	7.105	7.389	0.222	0.148	0.487	0.327
F- test	NS	NS	NS	NS	SIG	SIG
S.Em (±)	0.058	0.062	0.005	0.004	0.012	0.014
CD at (5%)	0.175	0.186	0.27	0.011	0.037	0.042

Table 6: Response of Nano urea and Conventional fertilizer on Nitrogen, Phosphorous and Potassium of maize of post-harvest soil.

Treatment	Nitrogen		Phosphorous		Potassium	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T1	176.20	141.11	23.62	15.29	202.17	174.78
T2	188.65	148.69	24.25	18.61	218.89	175.46
T3	192.65	149.70	26.64	18.64	221.87	178.39
T4	197.65	161.53	28.32	21.73	222.32	178.89
T5	200.98	165.52	29.99	22.97	223.45	180.09
T6	203.65	168.64	31.58	25.08	225.75	182.69

T7	240.92	193.43	33.68	26.75	225.24	183.55
T8	243.32	196.48	36.20	28.50	228.76	185.65
T9	247.12	199.21	39.36	31.63	231.23	189.65
F- test	SIG	SIG	SIG	SIG	SIG	SIG
S.Em (±)	1.11	2.61	0.42	0.83	1.45	3.12
CD at (5%)	3.32	7.82	1.27	2.48	4.34	9.37

Conclusion

On the basis of above finding, it is concluded that Recommended dose of fertilizer of Nitrogen @ 120 kg ha^{-1}, Phosphorus @ 60 kg ha^{-1}, Potassium @ 40 kg ha^{-1} and nano urea @ 4 ml per l in T_9 was found best. Also, T_9 (N_{120} P_{60} K_{40} Kg ha^{-1} + nano urea @ 4 ml) gave the best physico-chemical properties of soil, yield (5330.04 kg ha^{-1}) As it is result of only one year study, further experimentation is required for its recommendation which will help in enhancing yield per unit area for sustaining productivity and fertility of soil.

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