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Effect of nitrogen level and nano-urea spray on productivity and quality of maize (*Zea mays* L.)

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Abstract

An field experiment conducted during *Kharif* 2022 on effect of Nitrogen levels and Nano urea spray on productivity and quality of maize at research farm, Vivekanand Global University, Jaipur. This experiment was done in FRBD consisting 9 treatments with their respective symbols. The data of experiment revealed that the among all the treatment combinations, application of 100 percent RDN with two foliar sprays of Nano-urea @ 4 ml/L showing highest Plant height (cm), number of cobs (plant⁻¹), length of cobs (cm) and no. of grains cob-1 over all the treatments. Significantly higher grains, straw and biological yield was recorded in combination of 100 percent RDN with two foliar sprays of Nano-Urea @ 4 ml/L. Highest Nitrogen (percent) and Phosphorus content in grain and straw was recorded in combination 100 percent RDN along with two foliar sprays of Nano-urea @ 4 ml L-1 which was significantly superior rest of treatment combinations.

Keywords: Maize, grain yield, harvest index, nitrogen, nano-urea, economics

Introduction

A record amount of strain is being placed on the present agriculture and natural resources to fulfill the rising food demand due to the growing population and consumption, the shrinking amount of arable land, and other productive units. In the developing world, achieving food security within a sustainable system is very difficult yet essential for reducing poverty. To get around this problem, agricultural growers resorted to utilize excessive amounts of specific inputs like chemical fertilizers and pesticides, which have already started harming the ecosystem and soil. To meet the world's future food security and sustainability needs, food production must grow substantially, while the negative impact of agriculture on environment must shrink dramatically at the same time (Foley *et al.*, 2011) ^[1]. In India, maize is the third most important cereal crop after rice and wheat. It is cultivated over 9.86 m ha with a production and productivity of 31.51 million tons & 3195 kg ha⁻¹, respectively (Anonymous, 2022) ^[1]. Special corn *viz.*, sweet corn, quality protein maize, popcorn, baby corn, high oil corn etc. assume tremendous market potential not only in India but in international market and perfectly suitable for peri-urban agriculture.

Maize grain has elevated nutritive value as it contains about 72 percent starch, 10 percent protein, 4.8 percent oil, 5.8 percent fiber and 3 percent sugar (Rafiq *et al.*, 2010) ^[12]. In India, the maize is used as human food (23 percent), poultry feed (51 percent), animal feed (12 percent), industrial (starch) products (12 percent), beverages and seed (1 percent). Nitrogen (N) occupies a conspicuous place in plant metabolic system. Being a primary source of nutrition for plants, nitrogen is a crucial component of the protein and chlorophyll found in many important parts of the plant's body. According to Leghari *et al.* (2016) ^[2], nitrogen is crucial to several physiological processes. Materials with a single unit between 1 and 100 nm in at least one dimension are referred to be nanomaterials. (Liu and Lal, 2014) ^[3] and having a both positive and negative charge on same particle that led to improve uptake of other nutrient by holding those- nutrient in soil against the different losses. Nano fertilizers are crucial instruments in agriculture for enhancing crop development, yield, and quality metrics while lowering fertilizer waste and cultivation costs. By increasing the availability of fertilizer nutrients to plants and lowering the rate at which they are lost through leaching, nanotechnology can Reduce water and soil pollution. Present day's nano fertilizers are emerging as an alternative to conventional fertilizers (Veronica *et al.*, 2014) ^[13].

Material and Methods

The experiment was conducted during *kharif* 2022 at experimental station of Vivekanand

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Global University, Jaipur. Soil of the experimental plot was found loamy sand in texture, low in organic carbon (0.20 percent), low in available nitrogen (136.23 kg ha⁻¹), high in available phosphorus (21.52 kg ha⁻¹), medium in available potassium (237.21 kg ha⁻¹), slightly alkaline in pH (8.22) and EC 0.32 d Sm⁻¹. The experiment was conducted in Factorial Randomized Block Design with 9 treatment combinations; treatments-A Nitrogen level (kg ha⁻¹), N0 (50 percent), N1 (75 percent), N2 (100 percent) and foliar sprays of Nano-urea-Control (NU0), Nano-urea (4 ml/L) one spray (NU1) and Nano-urea (4 ml/L) two sprays (NU2). The fertilizer used urea, DAP, MOP and nano-urea. Nano-urea sprayed at different growth stage of maize.

Results and Discussion

Effect of nitrogen level and Nano-Urea on yield attributes and yield

Number of cobs plant⁻¹ Effect of nitrogen levels

The data present in table 1 revealed that the application of 100 percent RDN gave significantly highest number of cobs /plant which was superior as compared to 50 percent and 75 percent RDN. The increase in number of cobs in maize due to 100 percent RDN was 29.78 percent and 9.86 percent over 50 percent and 75 percent RDN, respectively.

Effect of Nano-Urea

Maximum number of cobs was observed with two sprays of Nano urea (4 ml L⁻¹ water) which was significantly higher than control and one spray of Nano urea (4 ml/l water). The increase in number of cobs due to two sprays of Nano urea (4 ml/l water) was 24.05 percent and 9.61 percent over control and one spray of Nano urea, respectively.

Number of grains cob-1 Effect of nitrogen levels

The data presented in table 1 revealed that the application of 100 percent RDN produced maximum number of grains cob-1 which was significantly higher than 50 percent and 75 percent RDN. The increase in number of grains cob-1 due to 100 percent RDN was 32.37 percent and 12.81 percent, respectively over 50 percent and 75 percent RDN.

Effect of Nano-Urea

Enhancement in number of grains cob-1 due to two sprays of Nano urea was 26.55 percent and 10.48 percent, respectively over control and one spray of Nano urea. This may be as a result of the parameters for vegetative growth being increased, which would raise the source's efficiency and, in turn, enhance the efficiency of photosynthesis. This would increase the accumulation of dry matter in the sink, which would increase the yield components. Due to the size of the nanoparticle fertilizer's simple absorption, enhanced growth, and increased crop output, the aforementioned attributes may have improved more with Nano nitrogen than with the other treatment. (Liu and Lal, 2015) [3].

Interaction effect

Interaction effect of nitrogen and Nano-Urea was found significant in respect of number of grains cobs-1 (Table 2). Application of 75 percent RDN with two sprays of Nano urea, being at par with 100 percent RDN with two sprays of Nano

urea and application of 100 percent RDN with one spray of Nano urea and gave maximum number of grains cobs-1 over other combinations of nitrogen and Nano-Urea.

Cob length (cm) Effect of nitrogen levels

A critical scrutiny of data given in table 1 showed that different nitrogen levels significantly increased the cob length in maize. Application of 100 percent RDN recorded significantly maximum cob length as compared to 50 percent RDN and 75 percent RDN. The corresponding improvement in cob length due to application 100 percent RDN was 28.69 and 10.87 percent, respectively over 50 percent and 75 percent RDN. Due to an increase in tillers in conditions of high nitrogen levels, the rise in yield characteristics may be explained. Higher nitrogen applications may have increased meristematic activity, tissue differentiation (from somatic to reproductive), and the formation of floral precursors, leading to more flowers that later evolved into umbels. Greater photosynthesis was transferred from leaves to sink sites via stem at higher nitrogen levels. The cumulative impact of the growth in cobs (plant⁻¹), length of cob (cm), and number of grains cob-1 may be responsible for the rise in yield brought on by the application of nitrogen. The results of the present investigation corroborate the findings of Paramasivan *et al.* (2012) [14], Golada *et al.* (2013) [15], Jena *et al.* (2013) [16], Jena *et al.* (2016) [17],

Effect of Nano-Urea

Two sprays of Nano urea (4 ml/l water) recorded maximum cob length which was significantly higher than all other treatments. The increase in cob length due to two sprays of Nano urea was 23.11 percent and 9.29 percent over control and one spray of Nano urea, respectively. It was shown that applying nano-N to leaves promoted growth characteristics because it was easier for the nano-N to enter the leaves' stomata through gas absorption, which improved the availability of nutrients. (Rajaseker *et al.*, 2017) [8].

Test weight (g) Effect of nitrogen levels

A perusal of data depicted in table 1 indicated that the test weight of maize was not affected significantly due to different nitrogen levels.

Effect of Nano-Urea

The experimental findings showed in table 1 revealed that the foliar spray of Nano-Urea did not bring any significant variation in test weight of maize.

Effect of nitrogen levels

It is evident from the data presented in table 3 that grain yield of maize was significantly increased due to successive increase in nitrogen levels. The highest grain yield (3229 kg ha⁻¹) was recorded under the treatment of 100 percent RDN which was significantly higher over 50 percent and 75 percent RDN.

Effect of Nano-Urea

The significantly highest grain yield (3353 kg ha⁻¹) was recorded with two sprays of Nano urea (4 ml/l water) over control and one spray of Nano urea (4 ml/l water).

Table 1: Effect of nitrogen level and Nano-urea on yield attributes.

Treatments				
Number of cobs plant ⁻¹		Number of grains cob-1	Cob length (cm)	Test weight (g)
Nitrogen levels				
50 percent RDN	1.03	274.53	14.32	152.16
75 percent RDN	1.22	322.13	16.62	155.45
100 percent RDN	1.34	363.40	18.43	158.51
SEm ±	0.03	9.85	0.46	5.15
CD (P=0.05)	0.10	29.53	1.38	NS
Nano-urea				
Control	1.06	281.47	14.70	149.53
Nano urea (4 ml/l water) one spray	1.20	322.40	16.56	156.19
Nano urea (4 ml/l water) two spray	1.32	356.20	18.10	160.40
SEm ±	0.03	9.85	0.46	5.15
CD (P=0.05)	0.10	29.53	1.38	NS
N x NU	SIG	NS	NS	NS

Table 2: Interaction effect of nitrogen level and nano-urea on number of cobs (plant⁻¹)

N X NU	NU0 (Control)	NU1	NU2
N1	0.89	1.04	1.16
N2	1.09	1.22	1.34
N3	1.21	1.35	1.46
SEm± (N x NU)		0.06	
CD (p= 0.05) (N x NU)		0.18	

Interaction effect

The data in table 4 revealed that interaction effect of nitrogen levels and foliar spray of Nano-Urea on grain yield of maize was also found significant. Application of 75 percent RDN with two sprays of Nano urea (4 ml/l water) recorded higher grain yield which was significantly superior over other combinations of nitrogen levels and Nano-Urea except application of 100 percent RDN with two sprays of Nano urea (4 ml/l water) and application of 100 percent RDN with one spray of Nano urea.

Straw yield (kg ha⁻¹) Effect of nitrogen levels

A critical examination of data given in table 3 revealed that the straw yield of maize was affected significantly with the application of various nitrogen levels. The application of 100 percent RDN recorded highest straw yield (5151 kg ha⁻¹) of maize which was proved superior over 50 percent and 75 percent RDN.

Effect of Nano-Urea

Among different treatments, two sprays of Nano urea (4 ml/l water) gave significantly highest straw yield (5114 kg ha⁻¹) of maize which was significantly higher over control and one spray of Nano urea (4 ml/l water).

Interaction effect

The data (Table 5) revealed that interaction effect of nitrogen levels and foliar spray of Nano-Urea on straw yield was found significant. Application of 75 percent RDN with two sprays of Nano urea (4 ml/l water) produced significantly higher straw yield of maize which was remained at par with application of 100 percent RDN with two sprays of Nano urea (4 ml/l water) and application of 100 percent RDN with one spray of Nano urea (4 ml/l water) and found statistically superior to other

combinations of nitrogen levels and foliar spray of Nano-Urea. Role of nano nitrogen in stimulating enzymes involved in the influence of these traits by increasing the activity of chemical reactions and reduce the impact of free radicals that negatively affect the efficiency of the work of some organelles in the plant (Sorooshzadah *et al.*, 2012 and Morteza *et al.*, 2013) [10, 5].

Biological yield Effect of nitrogen levels

The findings presented in table 3 revealed that application of nitrogen levels had significant influence on biological yield of maize. Application of 100 percent RDN produced highest biological yield (8380 kg ha⁻¹) of maize which was significantly superior to application of 50 percent and 75 percent RDN.

Effect of Nano-Urea

Data presented in table 4.3 further revealed that biological yield of maize was significantly increased due to foliar spray of Nano-Urea in the comparison of control. Two sprays of Nano urea (4 ml/l water) produced maximum biological yield (8467 kg ha⁻¹) of maize which was significantly higher than control and one spray of Nano urea (4 ml/l water).

Interaction effect

The data presented in table 4 revealed that interaction effect of nitrogen levels and foliar spray of Nano-Urea on biological yield of maize was also found significant. Among the all the treatment combinations, the highest biological yield of maize was produced by application of 75 percent RDN with two sprays of Nano urea (4 ml/l water), followed by application of 100 percent RDN with Two sprays of Nano urea (4 ml/l water) and found statistically superior to other combinations of nitrogen levels and foliar spray of Nano-Urea. Further, biological yield of maize decreased significantly with decreasing in nitrogen levels and foliar spray of Nano-Urea. This increment in crop productivity with application of nano nitrogen might be a result of higher plant growth, dry matter accumulation and yield attributes due to optimum availability of water compared to other treatments. Our results are in close agreement with the results of earlier researchers *i.e.* Astanah *et al.* (2018) [7], Mehta and Bharat (2019) [4], Rani *et al.* (2019) [9].

Table 3: Effect of nitrogen levels and nano-urea on yields of maize

Treatments	Yield (kg ha ⁻¹)		Harvest index	
Grain yield	Stover yield	Biological yield		
Nitrogen levels				
50 percent RDN	2614	3777	6391	40.92
75 percent RDN	2928	4512	7439	39.37
100 percent RDN	3229	5151	8380	38.52
SEm ±	69	101	145	0.65
CD (P=0.05)	208	302	435	NS
Nano-Urea				
Control	2431	3723	6154	39.68
Nano urea (4 ml/l water) one spray	2986	4603	7589	39.41
Nano urea (4 ml/l water) two spray	3353	5114	8467	39.71
SEm ±	69	101	145	0.65
CD (P=0.05)	208	302	435	NS
N x NU	SIG	SIG	SIG	NS

Table 4: Interaction effect of nitrogen levels and Nano-Urea on grain yield (kg ha⁻¹)

N X NU	NU0 (Control)	NU1	NU2
N1	1932	2730	3181
N2	2368	2995	3420
N3	2995	3234	3458
SEm± (N x NU)		120	
CD (p= 0.05) (N x NU)		360	

Table 5: Interaction effect of nitrogen levels and Nano-Urea on straw yield (kg ha⁻¹)

N X NU	NU0 (Control)	NU1	NU2
N1	2789	3963	4578
N2	3587	4692	5256
N3	4792	5153	5508
SEm± (N x NU)		175	
CD (p= 0.05) (N x NU)		523	

Table 6: Interaction effect of nitrogen level and Nano-Urea on biological yield (kg ha⁻¹)

N X NU	NU0 (Control)	NU1	NU2
N1	4721	6692	7759
N2	5955	7688	8676
N3	7787	8386	8966
SEm± (N x NU)		251	
CD (p= 0.05) (N x NU)		754	

Conclusion

It was concluded from the above results that application of different nitrogen levels and foliar spray of Nano-Urea significantly enhanced the growth, yield attributes and yields of maize. The application of 100 percent RDN gave significantly highest grain yield along with higher net returns as compared to 50 percent and 75 percent RDN. Two sprays of Nano urea (4 ml l⁻¹ water) gave significantly higher grain yield and net returns over control and one spray of Nano urea (4 ml/l water) in maize crop. As interaction effect of nitrogen levels and Nano-Urea on yield and net returns of maize was found significant, therefore, application of 75 percent RDN with two sprays of Nano urea (4 ml/l water), followed by application of 100 percent RDN with two sprays of Nano urea (4 ml/l water) may be recommended for higher productivity of maize.

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