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Effect of nitrogen and phosphorus nano-fertilizers on growth and yield of maize (*Zea mays* L.)

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Abstract
The study entitled, **"**Effect of nitrogen & phosphorus nano-fertilizers on growth and yield of maize (*Zea mays* L.)" was undertaken by conducting a laboratory experiment of synthesis and characterization of nitrogen and phosphorus nano-fertilizer and a field experiment at Regional Research Station, Anand Agricultural University, Anand (Gujarat) during summer and *kharif* seasons of the year 2021. The field experiment was laid out in Randomized Block Design comprising fourteen treatments of T1[Control(No NPK)], T2[100% RDF (150 N-60 P-0 K kg ha-1)], T3[75% RDF + Nano N & P through foliar application (1000 ppm)], T4[75% RDF + Nano N & P through foliar application (2000 ppm)], T5[75% RDF + Nano N & P through foliar application (3000 ppm)], T6[50% RDF + Nano N & P through foliar application (1000 ppm)], T7[50% RDF + Nano N & P through foliar application (2000 ppm)], T8[50% RDF + Nano N & P through foliar application (3000 ppm)], T9[25% RDF + Nano N & P through foliar application (1000 ppm)] and T10[25% RDF + Nano N & P through foliar application (2000 ppm)], T11[25% RDF + Nano N & P through foliar application (3000 ppm)], T12[Seed treatment Nano N & P + Nano N & P through foliar application (1000 ppm)], T13 [Seed treatment Nano N & P + Nano N & P through foliar application (2000 ppm)], T14[Seed treatment Nano N & P + Nano N & P through foliar application (3000 ppm)]. The instrumental analysis results indicated that synthesized nitrogen and phosphorus nano-fertilizer were of 229.9 nm particle size with Poly-dispersity Index of 0.426, mono dispersed, pure, stable and showed characteristic absorption H-O bond at wave number of 3431.27 cm-1. Significantly higher plant height, cob length, grain yield and straw yield was achieved under application of T4- 75% RDF + Nano N & P through foliar application (2000 ppm) during the summer, *kharif* and pooled analysis.

Keywords: Nano-fertilizer, growth, yield and maize

Introduction
Nanotechnology is emerging as a rapidly growing field with its wide application in science and technology for manufacturing of new materials at nano scale level. It is observed that seed treatment by nanotechnology devices can promote the crop growth, increase the yield and improve the quality of many crop products, including cereal and cash crops. The nanotechnology application in food and agriculture is in its budding stage (Hong *et al.*, 2014) [3].

Nano-fertilizer mainly delays the release of the nutrients and extends the fertilizers effect period. Nano-fertilizers have higher surface area and particle size less than the pore size of root sand leaves of the plant which can increase penetration into the plant from applied surface and improve uptake and nutrient use efficiency of the nano fertilizer (Liscano *et al.*, 2000) [7]. The concept of nanotechnology is attributed to Nobel laureate Richard Fey men who gave a very famous visionary speech in 1959 during one of his lectures. Nano fertilizers are more beneficial as compared to chemical fertilizers three-times increase in Nutrient Use Efficiency (NUE), 80-100 times less requirement to chemical fertilizers, 10 times more stress tolerant by the crops, complete bio-source, so eco-friendly, 30% more nutrient mobilization by the plants, 17-54% improvement in the crop yield and improvement in soil aggregation, moisture retention and carbon build up. The yield per hectare is also much higher than conventional fertilizers, thus giving higher returns to the farmers (Rostami *et al.*, 2017) [9].

Nitrogen (N) occupies a conspicuous place in plant metabolic system. Nitrogen being a major food for plants is an essential constituent of protein and chlorophyll present in many major portions of the plant body. Nitrogen plays a most important role in various physiological processes. It imparts dark green color in plants, promotes leaves, stem and other vegetative parts' growth and development. Moreover, it also stimulates root growth.

Phosphorus (P) is part of nucleic acids, phospholipids and high-energy molecules such as adenosine triphosphate (ATP) in all living organisms. In plants, P is an essential element required for development and reproduction and it is one of the main components of the fertilizers necessary to sustain modern agriculture. In soils, the concentration of inorganic P (available to plants) ranges from 35 to 70% of the total P. Maize starch can be hydrolyzed and enzymatically treated to produce syrups, particularly high fructose corn syrup, and a sweetener; and also fermented and distilled to produce grain alcohol. Grain alcohol from maize is traditionally the source of Bourbon whiskey. In Gujarat, maize is an important traditionally grown crop of tribal areas comprising the districts of Panchamahals, Sabarkantha, Banaskantha and part of Vadodara and Kheda districts. Maize is having an area of 0.44 million ha with a production of 0.68 million tones and productivity of 1659 kg ha-1 in Gujarat (Anon., 2020). The pattern of consumption of maize in India is lower as compared to other developed countries. Maize ranking third in cereal production after rice and wheat.

Materials and Methods

The experiment comprised of synthesis of HAP modified urea nano particle (NPs) by direct precipitation method and subsequently characterization of HAP modified urea NPs for size and morphological characteristics was conducted in laboratory of the Department of Nanotechnology and Centre for Advanced Research in Plant Tissue Culture, Anand Agricultural University, Anand. The maize variety GAYMH 3 (Gujarat Anand Yellow Maize Hybrid 3) was used in the present investigation as a test crop which was released by Main Maize Research Station, Anand Agricultural University, Godhra during the year 2018 for middle Gujarat Agro-climatic zone. The experiment in field was conducted during summer and *kharif* season of the year 2021 at the Regional Research Station Farm, Anand Agricultural University, Anand to carry out study on "Effect of nitrogen and phosphorus nano-fertilizers on growth and yield of maize."

Full dose of phosphorus (60 kg P2O5 ha-1) and 50% of nitrogen in each plot (75 kg nitrogen ha-1) in the form of di-ammonium phosphate and urea were applied in furrows before sowing. Remaining 50% nitrogen (75 kg nitrogen ha 1) was applied in the form of urea in equal three split application at an interval of 15, 30 and 60 days after sowing as per treatment.

Result and Discussion

Characterization of Nitrogen and Phosphorus Nano-Fertilizers

Dynamic Light Scattering (DLS)

Average particle size and poly-dispersity index of the nitrogen and phosphorus NPs synthesized via direct precipitation method, was evaluated of 1000 ppm of suspensions prepared in deionized water for seed treatment and three spraying schedules using Malvern Zeta Sizer, ZS-90 instrument. Dynamic light scattering (DLS) analyze the velocity of particle movement by measuring dynamic fluctuations of light scattering intensity, caused by the random motion of the particle. This technique yields an average particle size, poly-dispersity index and counts rate of the particle present in the solution (Murdock *et al.*, 2008) [8].

Table 1: Characterization nitrogen and phosphorus (NPs) for particle size (nm), PDI and zeta potential (mV)

Sr. no.	Particle size (nm)	PDI	Zeta potential (mV)
1.	229.1	0.426	-63.7

Data presented in Table 1 and Fig. 1 revealed that the prepared nitrogen and phosphorus NPs for seed treatment and three spray schedules showed a particle size of 229.1 nm. The PdI (Poly-dispersity Index) scale in all the samples range of 0.426 indicates that the particles remain in disperse form in all the samples.

1.1.1

Zeta potential measurement

1.1.2

Surface charge of synthesized nitrogen and phosphorus (NPs) was measured following standard operating procedure using Malvern Zeta Sizer, ZS-90 instrument. Zeta potential measurement specifies the electro kinetic potential of a colloidal system (Garcia *et al.*, 1997) [1]. Magnitude of the zeta potential is an indicator of repulsive forces between particles and therefore it can provide a good estimate of the suspension stability (Hunter, 1981) [5].

The larger zeta potential values represent lower degree of aggregation that leads to lower degree of stability of nanoparticles and smaller z-averaged hydrodynamic diameter. At lower zeta values, the nanoparticles flocculate early and the stability in nano-suspension increase.

The common dividing line between unstable and stable suspensions is taken as + 30 or -30 mV; particles having zeta potentials beyond these limits are generally considered as stable.

Fourier-Transform Infrared Spectroscopy (FT-IR)

To determine the functional groups responsible for the synthesis of nitrogen and phosphorus NPs, FTIR analysis was performed. The FTIR spectrum of synthesized nitrogen and phosphorus NPs (pH 10.5) is shown in Fig. 2, which shows absorption bands at 3431.27, 3035.11, 1677.53, 1593.13, 1460.14, 1150.57, 1027.86, 787.07 and 555.81 cm 1.

The highest peak at 3431.27 cm-1 is the characteristic absorption of H-O bond and lowest pick at 555.81 cm-1. Other absorption peaks which corresponding the hydroxyl impurities in the material. Present findings are in close agreement with other works and Hong *et al.*, 2009) [4].

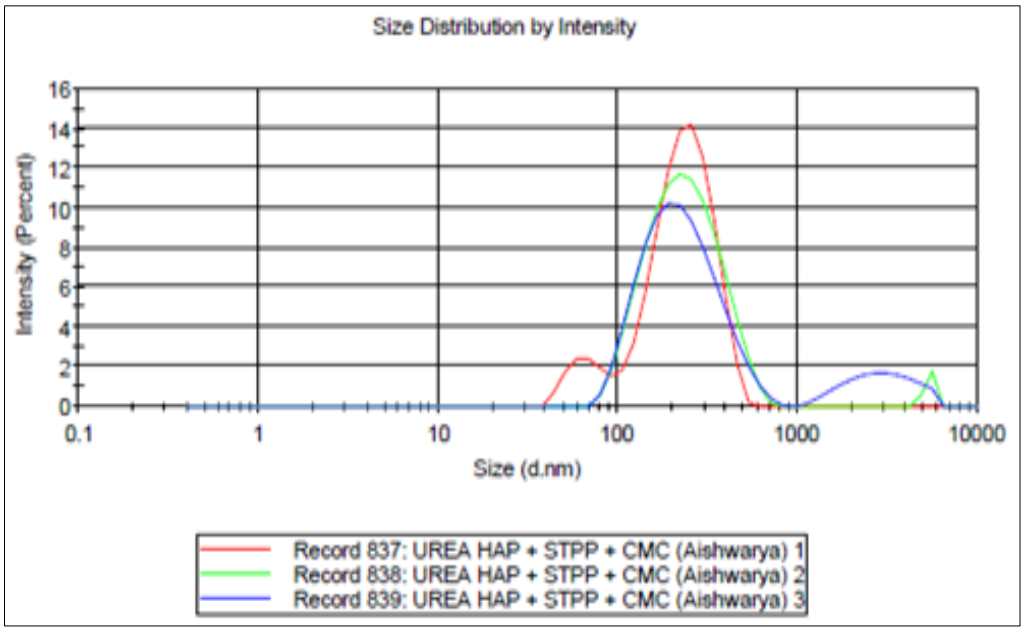

Fig 2: Particle size distribution of synthesized nitrogen and phosphorus NPs using dynamic light scattering

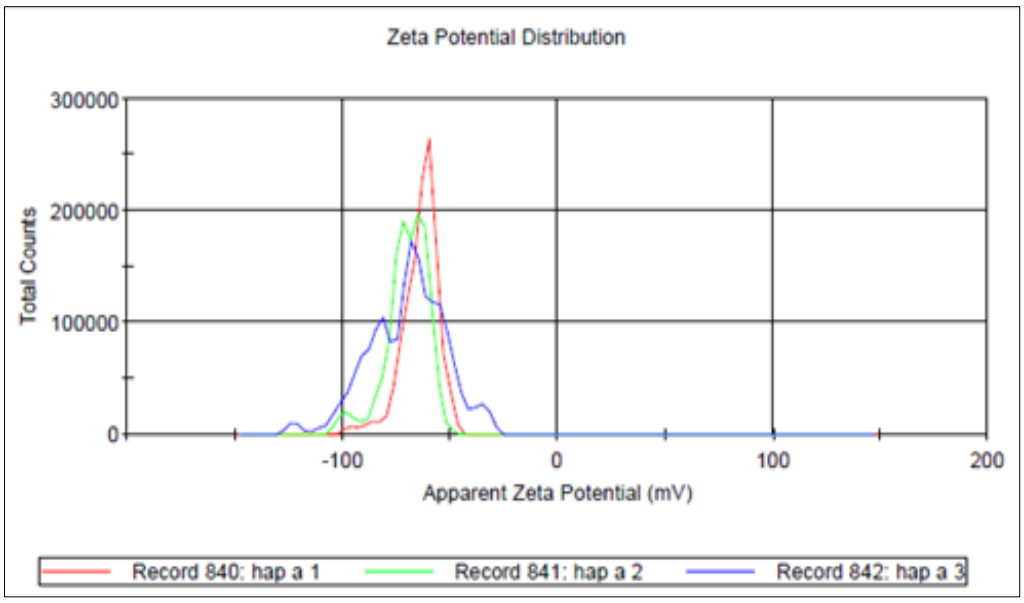

Fig 3: Zeta potential of synthesized nitrogen and phosphorus NPs

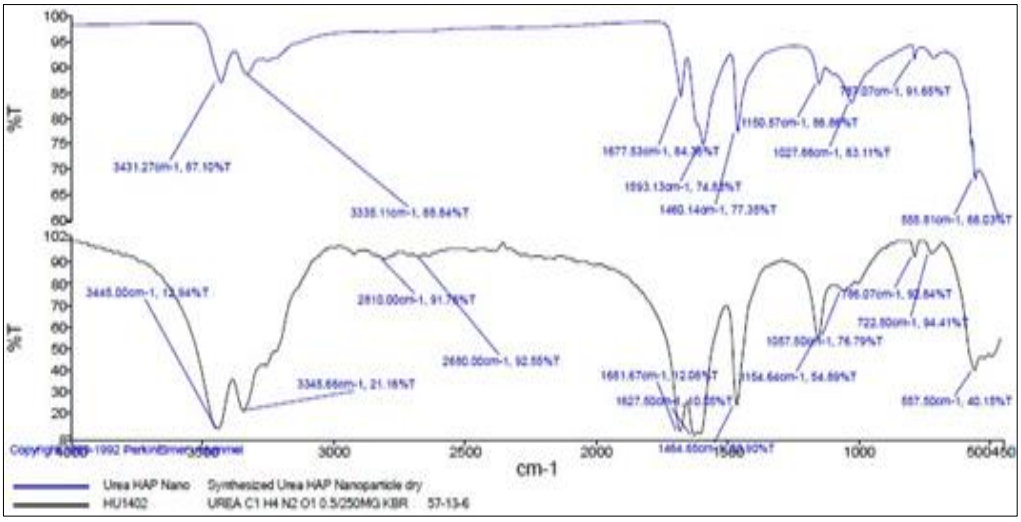

Fig 4: FTIR spectrum of nitrogen and phosphorus NPs

Plant height

Growth and development of any crop depend on the progressive initiation of cell differentiation, organ primordial and expansion of component cell until characteristics of the plant is realized. Plant height of maize increased progressively with advance in age of the crop up to harvest. The significant differences were observed in plant height at 45 DAS during both the seasons as well as in pooled results (Table 2).

Significantly higher plant height (83.97, 84.83 and 84.40 cm during the seasons summer, *kharif* 2021 and pooled analysis, respectively) was recorded under the application of 75% RDF + Nano N & P through foliar application (2000 ppm) at 45 DAS, but it was at par with all the treatments except T1, T11, T12, T13 and T14 treatments during summer season and at par with T2, T3, T5, T6, T7 and T8 during *kharif* season, while on pooled basis it was at par with T2, T3, T5, T6 and T7 treatments. A like above, data presented in Table 3 portrayed a significant difference among the treatments with response to different treatments of nano- fertilizers at harvest.

Application of 75% RDF + Nano N & P through foliar application (2000 ppm) (T4) reported significantly higher plant height of 195 cm during the summer season at harvest as compared to rest of the treatments barring T2, T3, T5, T7 and T8. In *kharif* season also same treatment gave significantly higher (196 cm) value of plant height than the rest except T2, T3, T5, T6, T7, T8 and T10 treatments. On pooled basis also same treatment registered significantly higher (196 cm) plant height than the rest barring T2, T3, T5 and T7 treatments.

Above findings indicate that foliar application of nano nitrogenous fertilizer gets absorbed and reduces nitrogen losses, improves nutrient use efficiency, minimize pollution and also provide balance crop nutrition as per requirement during the crop growth period. Such types of the beneficial effects of nano fertilizer were observed by Hasaneen *et al.* (2016) [2], Kaviani *et al.* (2016) [6] and Rostami *et al.* (2017) [9].

Cob length

Cob length is one of the important factors that affects grain yield. An increase in the cob length resulted in to increase in the grain yield. Data pertaining to the effect of different treatments on cob length of maize recorded at harvest during seasons summer, *kharif* 2021 and on pooled basis are presented in Table 4.

Table 2: Effect of different treatments on plant height (cm) of maize at 45 DAS

Treatments		Plant height at 45 DAS (cm)		
		Summer	*Kharif*	Pooled
T1: Control		70.50	70.83	70.67
T2: 100% RDF (150 N-60 P-0 K kg ha-1)		82.60	84.51	83.56
T3: 75% RDF + Nano N & P through foliar application (1000 ppm)		81.50	83.11	82.31
T4: 75% RDF + Nano N & P through foliar application (2000 ppm)		83.97	84.83	84.40
T5: 75% RDF + Nano N & P through foliar application (3000 ppm)		80.73	82.51	81.62
T6: 50% RDF + Nano N & P through foliar application (1000 ppm)		79.97	81.57	80.77
T7: 50% RDF + Nano N & P through foliar application (2000 ppm)		80.50	82.17	81.33
T8: 50% RDF + Nano N & P through foliar application (3000 ppm)		77.93	80.83	79.38
T9: 25% RDF + Nano N & P through foliar application (1000 ppm)		74.03	78.43	76.23
T10: 25% RDF + Nano N & P through foliar application (2000 ppm)		77.14	80.35	78.74
T11: 25% RDF + Nano N & P through foliar application (3000 ppm)		73.37	79.30	76.33
T12: Seed treatment Nano N & P + Nano N & P through foliar application (1000 ppm)		71.97	77.10	74.53
T13: Seed treatment Nano N & P Nano N & P through foliar application (2000 ppm)		72.13	75.27	73.70
T14: Seed treatment Nano N & P Nano N & P through foliar application (3000 ppm)		71.93	73.84	72.89
Mean		77.01	79.61	78.31
S.Em. ±	S			0.63
	T	2.69	2.00	1.68
	S X T			2.33
C. D. at 5%	S			1.80
	T	7.84	5.83	4.77
	S X T			NS
C.V.%		6.06	4.37	5.26

Table 3: Effect of different treatments on plant height (cm) of maize at harvest

Treatments	Plant height at harvest (cm)		
	Summer	*Kharif*	Pooled
T1: Control	156	160	158
T2: 100% RDF (150 N-60 P-0 K kg ha-1)	193	194	194
T3: 75% RDF + Nano N & P through foliar application (1000 ppm)	191	182	187
T4: 75% RDF + Nano N & P through foliar application (2000 ppm)	195	196	196
T5: 75% RDF + Nano N & P through foliar application (3000 ppm)	191	192	192
T6: 50% RDF + Nano N & P through foliar application (1000 ppm)	179	185	182
T7: 50% RDF + Nano N & P through foliar application (2000 ppm)	189	187	188
T8: 50% RDF + Nano N & P through foliar application (3000 ppm)	180	186	183
T9: 25% RDF + Nano N & P through foliar application (1000 ppm)	73	178	176
T10: 25% RDF + Nano N & P through foliar application (2000 ppm)	175	183	179
T11: 25% RDF + Nano N & P through foliar application (3000 ppm)	174	179	177
T12: Seed treatment Nano N & P + Nano N & P through foliar application (1000 ppm)	172	174	173
T13: Seed treatment Nano N & P Nano N & P through foliar application (2000 ppm)	173	176	175

T14: Seed treatment Nano N & P + Nano N & P through foliar application (3000 ppm)		171	171	171
Mean		179	181	180
S.Em. ±	S			1.36
	T	5.45	4.71	3.60
	S X T			5.09
C. D. at 5%	S			NS
	T	15.84	13.69	10.22
	S X T			NS
C.V.%		5.24	4.47	4.87

Significantly higher cob length of 25.68 cm was observed under treatment 75% RDF + Nano N & P through foliar application (2000 ppm) 3 spray at 15, 30 and 60 DAS of maize (T4) than rest of the treatments except T2 during the season summer. During the *kharif* season also same treatment recorded significantly higher cob length (25.82 cm) than other treatments barring treatments T2, T3, T5, T6, T7, T8, T9 and T11.

During pooled results significantly higher cob length (25.75 cm) was recorded under T4, but it was comparable with T2 and T5 treatments. On the contrary, lower cob length (17.69, 19.10 and 18.40 cm during seasons summer, *kharif* 2021 and pooled basis, respectively) was recorded with treatment T1 [no nitrogen and phosphorus application].

Grain yield

The data on grain yield of maize as influenced by different nitrogen and phosphorus nano- fertilizer treatments during both summer & *kharif* 2021 seasons as well as in pooled analysis are given in Table 3.

Data mentioned in Table 3 showed that different treatments significantly influenced the grain yield of maize during both the seasons (summer and *kharif* 2021) and in pooled analysis. Among all the treatments tested, treatment T4 (75% RDF + Nano N & P through foliar application (2000 ppm) at 15, 30 and 60 DAS after sowing of maize) gave significantly higher grain yield of 6037, 6456 and 6247 kg ha-1during summer, *kharif* and on pooled basis, respectively as compared to all the treatments, except treatments T2 and T3. The treatment T4 produced 66.46, 76.86 and 71.70% higher grain yield compared to control (T1) during the summer, *kharif* seasons and in pooled analysis, respectively. The increase over recommended dose (T4) was 3.2, 3.5 and 3.1 per cent, during summer, *kharif* and on pooled basis, respectively. The increase in grain yield is mainly due to increase in plant height (Tables 2 and 3) and cob length (Table 3) in the treatment T4 over rest of the treatments.

Conclusion

Based on two seasons research finding it is concluded that application of 75% RDF + Nano N & P through foliar application (2000 ppm) at 15, 30 and 60 days after sowing gave significantly higher growth and yield of maize.

References

1. Garcia AB, Cuesta A, Montes-Moran MA, Martinez-Alonso A, Tascon JMD. Zeta potential as a tool to characterize plasma oxidation of carbon fibers. Journal of colloid and interface science. 1997;192:363-367.
2. Hasaneen MN, Abdel-aziz, HM, Omer AM. Effect of foliar application of engineered nanomaterials carbon nanotubes and chitosan nanoparticles NPK fertilizer on the growth of French bean plant. Journal of Biochemistry and Biotechnology, Res. 2016;4(4):68-76.
3. Hong J, Peralta JR, Rico C, Sahi S, Gardea JL. Evidence of translocation and physiological impacts of foliar applied CeO2, Journal of Plant Nutrition. 2014;1:139-143.
4. Hong RY, Li JH, Chen LL, Liu DQ, Li HZ, Zheng Y, *et al*. Synthesis, surface modification and photocatalytic property of ZnO nanoparticles. Powder Technology. 2009;189:426-432.
5. Hunter RJ. Zeta Potential in Colloid Science: Principles and Applications. Academic Press; London; c1981.
6. Kaviani B, Ghaziani MVF, Negahdar N. Effect of application methods and different concentrations of biologic nano fertilizer, especial for ornamental plants on some morphological, physiological and proliferation traits and enhancing the quality of buxus hyrcana pojark. International Journal of Advance in Science Engineering and Technology. 2016;2(4):92-105.
7. Liscano JF, Wilson CE, Norman JRJ, Slaton NA. Zinc availability to rice from seven granular fertilizers. AAES Research Bulletin. 2000;963:1-31.
8. Murdock RC, Braydich-Stolle L, Schrand AM, Schlager JJ, Hussain SB. Characterization of nanomaterial dispersion in solution prior to *in vitro* exposure using dynamic light scattering technique. Toxicological Sciences. 2008;101(2):239-253.
9. Rostami M, Movahedi Z, Davari MZ, Siahpoosh S. Effect of foliar application of biofertilizer and nano-fertilizers on morpho-physiological characteristics of peppermint (*mentha piperita*). Department of Agronomy, Malayer University, Iran; c2017.