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Effect of nano phosphorus fertilizers on uptake of nitrogen, phosphorus and potassium by maize

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Abstract
A field experiment was conducted during *Kharif* 2021 in farmer's field at Halavarthy village, Davanagere (Dst.), Karnataka, which comes under Central Dry Zone of Karnataka (Zone 4), using RCBD design with eleven treatments which were replicated three times to evaluate the impact of three different nano phosphorus fertilizers on uptake of N, P and K by maize. Treatments included T_1: Absolute control, T_2: 100% recommended package of practice (RPP), T_3 to T_5: 75% RDP (75% recommended dose of P) through SSP + 5% RDP through NP1(hydroxyapatite nano fertilizer), NP2 (nano rock phosphate) and NP3 (hydroxyapatite nanoparticles coated with CMC), T_6 to T_8 : 75% RDP + 1% RDP through foliar spray of NP1,NP2 and NP3, T_9 to T_{11}: 75% RDP + 5% RDP through soil application of NP1, NP2 and NP3, and 1% RDP through foliar spray of NP1, NP2 and NP3, respectively. Results revealed that application of phosphorus in nano form had significant effect on uptake of nutrients in maize. Treatment with 75% RDP through SSP + 5% RDP through soil application of NP1 + 1% RDP through foliar spray of NP1 recorded higher values of total uptake of N (166.34 kg ha^{-1}), P (32.38 kg ha^{-1}) and K (183.45 kg ha^{-1}), by maize compared to rest of the treatments.

Keywords: Hydroxyapatite nanoparticles, nano rock phosphate, coated hydroxyapatite nanoparticles, carboxy methyl cellulose, nitrogen, phosphorus, potassium

Introduction
In recent years, advancement in nanotechnology has improved ways for large-scale production of nanoparticles of physiologically important metals, which are now used to improve fertilizer formulations for increased uptake by plants and thereby minimizing nutrient loss to the environment (Solanki *et al*., 2015 and Liu and Lal, 2015) [11, 6]. Nanoparticles have high surface area, sorption capacity and controlled release kinetics to targeted sites making them "smart delivery system". The nano fertilizers are smaller in size and nano size of fertilizers are achieved either through physical or chemical means. Smaller (nano) size enhances their surface area in order to allow an increase in absorption of nutrients by roots and may be absorbed with different dynamics than those in bulk particles or ionic salts, which has significant benefits in improving morphological, physiological, biochemical and yield attributes (Chugh *et al.*, 2021) [1].

In recent investigations, it has been reported that nano fertilizers can improve crop productivity by enhancing the rate of seed germination, seedling growth, photosynthetic activity, metabolism in plant, carbohydrate and protein synthesis (Solanki *et al.*, 2015) [11]. Scientists all over the world synthesized different types of nano fertilizer materials like hydroxyapatite nano particles by Widiyastuti *et al.* (2011) [14]; Wijesinghe *et al.* (2017) [15]; Taskin *et al*. (2018) [13] and Marchiol *et al.* (2019), hydroxyapatite ($Ca_5(PO_4)_3OH$) nanoparticles coated with carboxy methyl cellulose was synthesized by Liu and Lal, (2014) [5], nano-diammonium phosphate by Singh *et al.* (2021) [10], hybrid nanostructures by associating humic substances with nano hydroxyapatite particles by Yoon *et al*. (2020) [16] calcium phosphate nanoparticles by Rane *et al*. (2015) [9], While, Kottegoda *et al.* (2017) [4] and Taskin *et al.* (2018) [13] synthesized and evaluated urea modified hydroxyapatite nano particles. Nano structured slow release phosphatic and potash fertilizers were synthesized and evaluated by Rajendran *et al*. (2017) [8] and chitosan nano particles loaded with NPK were synthesized by Corradini *et al.* (2010) [2].

Nano structured fertilizers can increase the nutrient use efficiency through mechanisms such as targeted delivery, slow or controlled release. They could precisely release their active ingredients in responding to environmental triggers and biological demands (Solanki *et al*., 2015) [11].

In this regard an experiment was conducted with the objective to study the effect of nano P fertilizers on uptake of nitrogen, phosphorus and potassium by maize.

Material and Methods

A field experiment was conducted during *Kharif* 2021 at farmer's field, Halavarthy village, Davanagere (Dst.), Karnataka, which comes under Agro Climatic Zone – 4, Central Dry Zone of Karnataka and the experimental details are as follows.

Central Dry Zone of Karnataka and the experimental details are as follows

Crop	Maize
Variety	MAH-14-5
Statistical design	RCBD
Number of treatments	Eleven
Number of replications	Three
Season	*Kharif* 2021
Spacing	60 × 30 cm
RDF	150:75:40 Kg ha^{-1} N:P_2O_5:K_2O
Nano fertilizers used	NP1- Hydroxyapatite nanoparticles (NHA), NP2- Nano Rockphosphate (NRP) and NP3-Coated hydroxyapatite nanoparticles with CMC (NHA+CMC)

Treatment details

Treatments	Details
T_1	Control
T_2	100% RPP
T_3	75% RDP + 5% RDP - NP1
T_4	75% RDP + 5% RDP - NP2
T_5	75% RDP + 5% RDP -NP3
T_6	75% RDP + FS of 1% RDP - NP1
T_7	75% RDP + FS of 1% RDP – NP2
T_8	75% RDP + FS of 1% RDP – NP3
T_9	T_3 + FS of 1% RDP - NP1
T_{10}	T_4 + FS of 1% RDP – NP2
T_{11}	T_5 + FS of 1% RDP – NP3

Note

NP 1: Hydroxyapatite nanoparticles
NP 2: Nano rock phosphate
NP 3: Coated Hydroxyapatite nanoparticles with CMC
RDP: Recommended dose of P
FS: Foliar spray

- RPP – Recommended package of practices as per the UAS B package of practices includes application of Recommended dose of NPK for Maize is 150:75:40 kg ha^{-1} + 10 kg ha^{-1} $ZnSO_4$, with farm yard manure (FYM) at the rate of 10 t ha^{-1}.
- 100% Recommended dose of N, K, Zn and FYM is common for the treatments T_3 to T_{11}
- Foliar spray of Nano P fertilizers carried out at 30 and 45 DAS.

Collection and analysis of plant samples

The plant samples which were disease, pest free and healthy were collected, washed with distilled water 2-3 times and kept for air dry. The air dried samples are further kept in hot air oven at 65-70°C for 48 hrs to remove the moisture and to inactivate the enzymes. Once dried, the samples were grounded using a mixer (stainless steel blades). The samples were analysed for different nutrient content by adopting standard analytical methods as given in Table 1.

Table 1: Methods employed for the analysis of plant samples

1	Total nitrogen	Micro Kjedahl method	Tandon (1998) [12]
2	Total phosphorous	Vandomolybdo phosphoric yellow colour method	
3	Total potassium	Flame photometer method	

The uptake of nutrients at harvest was worked out using the formula,

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient concentration (\%)}}{100} \times \text{Yield of grain/stover (g plant}^{-1}\text{)}$$

Total uptake = uptake by kernel + uptake by stover

Results and Discussion

N uptake

Data presented in Table 2 indicated that nitrogen uptake by kernel, stover and its total varied significantly due to application of nano phosphorus fertilizers.

N uptake by kernel, stover and its total uptake was significantly higher in T_9 treatment which received T_3 + FS of 1% RDP - NP1 (89.43, 76.91 and 166.34 kg ha^{-1}, respectively) which was on par with treatments T_{10} (84.76, 73.72 and 158.48 kg ha^{-1}, respectively) and T_{11} (86.74, 75.36 and 162.09 kg ha^{-1}, respectively) which received 75 per cent RDP through SSP + 5% RDP through NP2 + FS of 1% RDP through NP2 and 75 per cent RDP through SSP + 5% RDP through NP3 + FS of 1% RDP through NP3, respectively. Lower uptake was recorded in control (38.48, 35.36 and 73.84 kg ha^{-1}, respectively).

P uptake

Phosphorus uptake varied significantly due to application of nano phosphorus fertilizers (Table 2).

Phosphorous uptake by kernel and total uptake was higher in T_9 treatment (16.93 and 32.38 per cent, respectively) and the higher value of P uptake in stover was recorded in T_{11} (15.69 kg ha^{-1}) treatment which was statistically at par with T_9 (15.45 kg ha^{-1}) treatment.

K uptake

The data with respect to the potassium uptake by kernel, stover and its total as influenced by application of nano P fertilizers are presented in Table 2.

Data indicated that, lower uptake of K by kernel, stover and total was recorded in control (47.97, 53.53 and 101.50 kg ha^{-1}, respectively) which increased significantly to 83.40, 99.33 and 183.45 kg ha^{-1}, respectively in treatment T_9 (T_3 + FS of 1% RDP - NP1) and it was on par with T_{10} (78.46, 95.99 and 174.45 kg ha^{-1}, respectively) and T_{11} (79.88, 97.53 and 177.41 kg ha^{-1}, respectively).

Nutrient uptake is the product of nutrient content and yield. Data presented in Table 2 indicated that nutrient uptake was increased in all the treatments which received phosphorus (conventional and/or nano sources) along with recommended dose of N and K compared to control. Among them significantly higher values of nutrient uptake (N, p and K) were recorded with the application of 75% RDP (SSP) + 5%

RDP (NP1) + FS of 1% RDP (NP1) compared to control and 100% RPP applied treatment. This might be due to application of P in nano form increased uptake of nutrients by plants as they are small in size and have high rate of penetration through plant cell membrane (Liu and Lal., 2015; Khanm *et al*., 2018) [6, 3]. The higher uptake recorded with soil and foliar application of nano hydroxyapatite fertilizer might be attributed to higher nutrient content and yields (both kernel and stover) due to enhanced absorption of nutrients because, higher availability of nutrients in soil coinciding with plant demand as nano hydroxyapatite particles released nutrient slowly in a sustained manner.

Table 2: N, P and K uptake (kg ha^{-1}) in maize kernel and stover as influenced by the application of nano phosphorus fertilizers

Treatments	N (kg ha^{-1})			P (kg ha^{-1})			K (kg ha^{-1})		
	Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total
T_1 : Control	38.48	35.36	73.84	5.00	3.89	8.89	47.97	53.53	101.50
T_2 : 100% RPP	64.29	53.59	117.88	9.42	7.53	16.95	63.83	80.00	143.83
T_3 : 75% RDP + 5% RDP - NP1	80.69	67.65	148.34	13.71	13.03	26.74	74.73	88.72	163.45
T_4 : 75% RDP + 5% RDP - NP2	77.93	64.45	142.37	12.62	11.96	24.58	70.64	84.11	154.75
T_5 : 75% RDP + 5% RDP -NP3	78.69	65.43	144.12	12.81	12.13	24.94	72.35	85.93	158.28
T_6 : 75% RDP + FS of 1% RDP - NP1	77.07	64.13	141.20	11.97	10.64	22.62	70.95	83.93	154.88
T_7 : 75% RDP + FS of 1% RDP –NP2	75.04	61.75	136.79	11.49	10.83	22.31	68.91	81.07	149.98
T_8 : 75% RDP + FS of 1% RDP –NP3	75.73	63.12	138.86	11.68	11.02	22.69	69.31	82.27	151.58
T_9 : T_3 + FS of 1% RDP - NP1	89.43	76.91	166.34	16.93	15.45	32.38	83.40	99.33	183.45
T_{10}: T_4 + FS of 1% RDP – NP2	84.76	73.72	158.48	15.64	14.22	29.87	78.46	95.99	174.45
T_{11}: T_5 + FS of 1% RDP – NP3	86.74	75.36	162.09	16.41	15.69	32.09	79.88	97.53	177.41
S.Em ±	3.15	2.52	4.95	0.30	0.40	0.68	2.74	3.42	06.08
CD @ 5%	9.31	7.44	14.62	0.91	1.19	2.01	08.08	10.09	17.95

RPP: UASB Recommended package of practices NP1: Nano hydroxyapatite particles
RDP: Recommended Dose of Phosphorus NP2: Nano Rock Phosphate
FS: Folair spray NP3: Coated hydroxyapatite nanoparticles with CMC

Conclusion

From this investigation it is confirmed that soil application of 5% RDP through nano fertilizers or foliar application of 1% RDP through nano fertilizers or both can replace 25% RDP application through conventional phosphorus fertilizer (SSP), which saves nearly 25% of conventional P fertilizer application in maize. So, application of phosphorus in nano form will increases the uptake of N, P and K in maize.

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References

1. Chugh G, Siddique K, Solaiman Z. Nanobiotechnology for agriculture: smart technology for combating nutrient deficiencies with nanotoxicity challenges. Sustainability. 2021;13:1769-1781.
2. Corradini E, Moura MR, Mattoso LHC. A preliminary study of the incorporation of NPK fertilizer into chitosan nanoparticles. Express Polymer Letters. 2010;4:8-15.
3. Khanm H, Vaishnavi BA, Shankar AG. Raise of Nano-Fertilizer Era: Effect of Nano Scale Zinc Oxide Particles on the Germination, Growth and Yield of Tomato (*Solanum lycopersicum*). Int. J Curr. Microbiol. App. Sci. 2018;7(5):1861-1871.
4. Kottegoda N, Sandaruwan C, Priyadarshan G, Siriwardhana A, Rathnayake U, Arachchige D, *et al*. Urea-hydroxyapatite nano hybrids for slow release of nitrogen. J. Am. Chem. Soc. 2017;11:1214-1221.
5. Liu R, Lal R. Synthetic apatite nanoparticles as a phosphorus fertilizer for soybean (*Glycine max*). Scientific Reports. 2014;4:5686.
6. Liu R, Lal R. Potentials of engineered nanoparticles as fertilizers for increasing agronomic productions. Sci. Total Environ. 2015;514:131-139.
7. Marchiol L, Filippi A, Adamiano A, Iafisco M, Degli Esposti L, Mattiello A, *et al*., Influence of hydroxyapatite nanoparticles on germination and plant metabolism of tomato (*Solanum lycopersicum* L.): Preliminary evidence. Agron. 2019;9:161-175.
8. Rajendran M, Selvaraj RCA, Sundaram VB. Evaluation of nanostructured slow release fertilizer on soil fertility, yield and nutritional profile of *Vigna radiata*. Recent patents on nanotechnol. 2017;11(1):1-13.
9. Rane M, Bawskar M, Rathod D, Nagaonkar D, Rai M. Influence of calcium phosphate nanoparticles, *Piriformospora indica* and *Glomus mosseae* on growth of *Zea mays*. Adv. Nat. Sci.: Nano Sci. Nanotechnol., 2015;6(4):045014.
10. Singh H, Sharma A, Bhardwaj SK, Arya SK, Bhardwaj N, Khatri M. Recent advances in the applications of nano- agrochemicals for sustainable agricultural development. Environ. Sci. Process Impacts. 2021;23:213–239.
11. Solanki P, Bhargava A, Chhipa H, Jain N, Panwar J. Nano-fertilizers and their smart delivery system. In Nanotechnologies in food and agriculture. Springer, Cham; 2015 p. 81-101.
12. Tandon HLS. Methods of Analysis of Soils, Plants, Water and Fertilizers. Fertilizer Development and Consultation Organization. 1998;1:9-16.
13. Taskin MB, Sahin O, Taskin H, Atakol O, Inal A, Gunes A. Effect of synthetic nano-hydroxyapatite as an alternative phosphorus source on growth and phosphorus nutrition of lettuce (*Lactuca sativa* L.) plant. J Plant Nutr. 2018;41(9):1148-1154.
14. Widiyastuti, Setiawan A, Setyawan H, Kusdianto, Nurtono T, Nia SM, Winardi S. Diffusion flame synthesis

of hydroxyapatite nanoparticles using urea assisted precursor solution. The 4Th Nano science and nanotechnology symposium, AIP Conf. Proc. 2011;1415:152-154.
15. Wijesinghe WPSL, Mantilaka MMMGPG, Rajapakse RMG, Pitawala HMTGA, Premachandra TN, Herath HMTU, *et al*. Urea-assisted synthesis of hydroxyapatite nano rods from naturally occurring impure apatite rocks for biomedical applications. Res. Adv. 2017;7:24806-24812.
16. Korber B, Fischer WM, Gnanakaran S, Yoon H, Theiler J, Abfalterer W, *et al*. Tracking changes in SARS-CoV-2 spike: evidence that D614G increases infectivity of the COVID-19 virus. Cell. 2020 Aug 20;182(4):812-827.