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Effect of chemical and nano nitrogenous fertilizers on availability of major nutrients (N, P, K) in soil after harvest of the sorghum crop

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Abstract
A pot culture experiment was conducted during summer 2017 at Department of Agril. Chemistry & Soil Science, College of Agriculture, JAU, Junagadh to study the effect of chemical and nano nitrogenous fertilizer on availability of major nutrients (N, P, K) in soil after harvest of sorghum (*Sorghum bicolor* L.) crop. The investigation was carried out in CRD design three replication with seven different treatments. The treatments included T_1 = Absolute control (No fertilizer), T_2 = Nano polymer, T_3 = RDN dose of sorghum crop through chemical fertilizer, T_4 = $NN_{2.5}$-2.5 times reduction of RDN through nano fertilizer, T_5 = NN_5-5 times reduction of RDN through nano fertilizer, T_6= NN_{10}-10 times reduction of RDN through nano fertilizer, T_7 = RDN through nano fertilizer. The results revealed that the application of RDN through nano fertilizer significantly improved the availability of nitrogen, phosphorus and potassium in post-harvest soil.

Keywords: Nano fertilizer, nano polymer, crotonylidiene urea

Introduction
Nitrogen deficiency was widely spread during green revolution due to introduction of high yielding varieties and imbalanced use of fertilizers. The applied N through fertilizers undergo transformation processes such as biological nitrogen fixation, immobilization, denitrification, volatilization in slightly alkaline calcareous soils. These transformation processes make N management very complex and quite difficult to improve the N use efficiency. Fertilizers have an axial role in enhancing the food production in developing countries especially after the introduction of high yielding and fertilizer responsive crop varieties. In spite of this, it is known that yields of many crops have begun to depression as a result of imbalanced fertilization and decrease in soil organic matter (Zahoor *et al.*, 2014) [9]. Nano fertilizers are the important tools in agriculture to improve crop growth, yield and quality parameters, reduce wastage of fertilizers and cost of cultivation. Nano fertilizers are very effective for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrient throughout the crop growth period. Fertilizer particles can be coated with nano membranes that facilitate slow and steady release of nutrients. Coating and cementing of nano and sub nano-composites are capable of regulating the release of nutrients from the fertilizer capsule. 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.

Materials and Method
To determine the effect of nitrogen nano fertilizer on nutrient availability of soil after harvest of sorghum (*Sorghum bicolor* L.) crop, a pot study was conducted in summer season of 2017 with 7 treatments replicated in thrice under net house condition at Department of Biotechnology, JAU, Junagadh. The experimental soil was *Vertic haplustepts*, medium black calcareous clayey in nature and slightly alkaline in reaction. Earthen pots having an upper diameter of 30 cm and lower diameter of 15 cm with 25 cm height were used in investigation. The pots were filled with 15 kg of soil. The required quantity of nitrogen was calculated as per treatment of different sources of nitrogen product on the basis of 15 kg bulk of soil and applied

as basal dose. The pot culture experiment was conducted with seven levels of nitrogen and two different source of nitrogen (Urea and Nano N Fertilizer) in completely randomized block design. The required quantity of potassium and phosphorus was applied as basal dose through KCl and SSP were also mixed with the soil. The treated soil was filled in polythene lined earthenware pots.

The pot culture experiment was conducted with seven levels of nitrogen and two different source of nitrogen in completely randomized block design.

S. No.	Treatments	Nitrogen (g per 15 kg soil)	Source
1	T_1	0	No fertilizer
2	T_2	0 g urea in 2.90 liter nano polymer	Nano polymer
3	T_3	3.48	Urea
4	T_4	1.38 g urea in 1.15 liter nano polymer	Nano N fertilizer
5	T_5	0.68 g urea in 0.56 liter nano polymer	Nano N fertilizer
6	T_6	0.34 g urea in 0.28 liter nano polymer	Nano N fertilizer
7	T_7	3.48 g urea in 2.90 liter nano polymer	Nano N fertilizer

Note: SSP (2.51gm) and MOP (0.66gm) was applied as basal dose

Result and Discussion

Effect of different levels of chemical and nano nitrogenous fertilizers on availability of nitrogen, phosphorus and potassium in soil.

The availability of nitrogen in post-harvest soil was significantly affected by different levels of chemical and nano nitrogenous fertilizers (Table 1) The maximum available N content (245.17 kg ha^{-1}) was recorded with the application of 2.5 times reduction of RDN through nano fertilizer and minimum (212.90 kg ha^{-1}) with T_1 (control) treatment, but it was statistically at par with T_7 (235.53 kg ha^{-1}) treatment. There was gradual increase in available N content up to T_4, beyond this level, it caused decreasing effect on available N content in post-harvest soil. While the treatment T_3 (RDN through chemical) produced significantly higher N content in soil (229.20 kg ha^{-1}) followed by T_5 (223.53 kg ha^{-1}) T_6 (221.13 kg ha^{-1}) treatments but lower than T_4 (245.17 kg ha^{-1}) and T_7 (235.53 kg ha^{-1}) treatments. The different levels of chemical and nano nitrogenous fertilizers showed positive effect on available nitrogen availability in post-harvest soil. These results are supported with the findings of Rajonee *et al.* (2016) [7] who reported that the available nitrogen content in soil after harvest is much higher than their respective initial. Available nitrogen was significantly higher in nano fertilizer treatment than the others. This may be due to the leftover fertilizer in soil and nano fertilizer holds higher amount of inorganic nitrogen than the conventional one. Mala *et al*. (2017) revealed that nanofertilizer treated soil showed higher nitrogen content in soil after harvesting of mungbean crop. The increase in the nitrogen concentration is attributed to the slow release, as well as the fixing of nitrogen by the root nodule inhabiting Rhizobium. This is confirmed by the increase in the number of root nodules and the number of Rhizobia/root nodules. The data clearly showed that the treatment of T_4 (2.5 times reduction of RDN through nano fertilizer) significantly increased the available phosphorus content in post-harvest soil. The maximum availability of P (39.53 kg ha^{-1}) was observed with 2.5 times reduction of RDN through nano fertilizer and it was statistically at par with treatment T_7 (RDN through nano fertilizer). The lowest phosphorus content in soil was (30.67 kg ha^{-1}) observed under control treatment followed by T_2 (31.50 kg ha^{-1}).The increasing magnitude of available P content from T_1 to T_4 (30.67 to 39.53 kg ha^{-1}) treatments in post-harvest soil, beyond this level, it caused decreasing effect on available P content in post-harvest soil. The other treatments T_5 (35.60 kg ha^{-1}) and T_6 (34.40 kg ha^{-1}) were remained statistically at par with each. Rajonee *et al.* (2017) reported that the available phosphorous is much higher in soil after harvest of the crop. This might be due to left-over fertilizer in soil and nano fertilizer holds higher amount of inorganic phosphorous than conventional one. Thus, nano fertilizer has significant positive effect on available phosphorous. These results are in agreement with that earlier work of Prathyusha *et al*. (2014) [5], Han *et al*. (2016) [1] and Pawar *et al*. (2017) [6]. The availability of K_2O in soil was significantly affected by different levels of chemical and nano nitrogenous fertilizers (Table 1). It was maximum with 2.5 times reduction of RDN through nano fertilizer (302 kg ha^{-1}). But it was statistically at par with treatment T_7 (RDN through nano fertilizer) and the minimum potassium content in post-harvest soil was observed under control treatment (269.20 kg ha^{-1}) followed by T_2 (273.73 kg ha^{-1}). In soil, the available K significantly increased with increasing nitrogen levels up to T_4 and beyond it significantly decreased under T_5 and T_6 treatments. While the treatment T_3 (RDN through chemical fertilizer) produced significantly higher (279.67 kg ha^{-1}) K content in soil followed by T_5 (278.10 kg ha^{-1}) and T_6 (275.97 kg ha^{-1}) treatments but lower than T_4 (302.50 kg ha^{-1}) and T_7 (308.07 kg ha^{-1}) treatments. But the treatments T_5 and T_6 were statistically at par with each other. It might be due to nutrients are released at a slower rate throughout the crop growth. Nano fertilizer particles coated with nano membranes that facilitate slow and steady release of nutrients. These results are in agreement with the earlier work of Pawar *et al*. (2017) [6] revealed that the soil available K was significantly influenced by GRDN and nitrogen application through CDU. It might be due to slow release nature of coated fertilizer. Saha *et al* (2017) reported that the availability of Potassium after harvesting of rice was varied significantly with the nitrogen levels.

The highest amount of available K was observed in the plot of 90 kg N/ha was applied. The significant increase in available nutrient status in soil due to application of fertilizer may be attributed to the fact that addition of nutrients brought about remarkable improvement in the soil fertility. These observation support the work reported Sood and Sharma (2002) [8], Rajonee *et al.* (2016) [7] Pooja *et al*. (2017) [4] and Kumar *et al*. (2017) [2].

Table 1: Effect of different levels of chemical and nano nitrogenous fertilizes on availability of major nutrients (NPK) in soils after harvest of sorghum crop.

Treatments	Available nutrients (kg ha^{-1})		
	N	**P_2O_5**	**K_2O**
T_1 - Absolute Control	212.90	30.67	269.20
T_2 - Nano polymer	219.63	31.50	273.73
T_3 -RDN through chemical fertilizer	229.20	36.37	279.67
T_4 - $NN_{2.5}$ -2.5 time reduction of RDN through nano fertilizer	245.17	40.20	296.63
T_5 - NN_5 -5 time reduction of RDN through nano fertilizer	223.53	35.60	278.10
T_6 - NN_{10} -10 time reduction of RDN through nano fertilizer	221.13	34.40	275.97
T_7 - RDN through nano fertilizer	235.53	38.47	291.40
S.Em.±	5.11	1.05	5.41
C.D. (P=0.05)	15.51	3.17	16.41
C.V.%	3.91	5.13	3.33

Conclusion

Based on the results summarized above, it can be concluded that the application of RDN through nano fertilizer significantly improved the availability of nitrogen, phosphorus and potassium in post-harvest soil. This study clearly indicated that the application of nano fertilizer can save about 40% dose of recommended nitrogenous fertilizer dose in sorghum crop. Thus, use of nitrogenous nano fertilizer increased nitrogen availability to considerable extent. This might be due to it control the release of nitrogen steadily for longer time as per the requirement of the crop.

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