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P Hemanth
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar. Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

K Shailaja
Assistant Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

KPC Reddy
Associate Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

P Satish
Assistant Professor, Department of Agronomy, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

Corresponding Author:
P Hemanth
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar. Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

Effect of nano nitrogen fertilizer in conjunction with urea on apparent N use efficiency of cotton crop

P Hemanth, K Shailaja, KPC Reddy and P Satish

Abstract
A field experiment was conducted during *kharif* 2021-2022 at college farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad in randomized block design with nine treatments and three replications to study the effect of nano nitrogen fertilizer in conjunction with urea on apparent N use efficiency. The highest apparent N use efficiency (1.39) was registered with the application of treatment ¼th of 100% N as urea each time at 20 and 60 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 40 and 80 DAS which was on par with ¼th of 100% N as urea each time at 20 and 40 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 60 and 80 DAS (1.36), ¼th of 100% N as urea at 20 DAS + 3 Nano-N sprays @ 1250 mL ha^{-1} each time at 40, 60 and 80 DAS (1.27), ¼th of 100% N as urea at 20 DAS + 3 Nano-N sprays @ 750 mL ha^{-1} each time at 40, 60 and 80 DAS (1.24), ¼th of 100% N as urea each time at 20 and 60 DAS + Nano- N sprays @ 750 mL ha^{-1} each time at 40 and 80 DAS (1.04).

Keywords: Nano nitrogen fertilizer, conjunction, urea, cotton crop

Introduction
Cotton (*Gossypium hirsutum* L.), is one of the major cash crop of India, popularly known as 'White gold' and 'king of fibres' for its role in the national economy in terms of foreign exchange earnings and employment generation. In India, cotton cropping provides 60% of the fibre to textile industries, supplies more than one million metric ton of cooking oil, animal feed and 40 million metric tons of biomass in the form of cotton stalks. India accounts for around 37.5% of the global cotton area and contributes to 26% (*i.e.*, 6.20 million metric tons) of the global cotton produce of 23.92 million metric tons. The textile industry, which consumes the cotton, as its principal raw material, contributes about 4% to the GDP and is the major exchange earner for the country. Telangana ranks 3rd in area and production with 52.55 lakh acres and 68.58 lakh bales accounting for 16.65% and 19.02% of all India cotton area and production respectively. Among the districts in Telangana, Nalgonda stood first with (2.73 lakh ha) followed by Nagarkurnool (1.42 lakh ha), Adilabad (1.40 lakh ha), Sangareddy (1.40 lakh ha) and Komaram Bheem (1.24 lakh ha) in cotton area (www.agri.telangana.gov.in).
Nanotechnology with nanoscale inputs for production of Nano Agri-inputs (NAIPs) has emerged as an innovative solution for addressing issue of low or declining use efficiency of nutrients with minimum environment footprints. Nanotechnology is an interdisciplinary promising research field, opening a vast number of opportunities in fields like medicine, pharmaceuticals, electronics, and agriculture. The term nano-materials are generally used to describe the materials having a size between 1 and 100 nm. The small size and enormous surface area of such characteristics give unique properties for nano- materials like optical, physical, and biological. Nano-fertilizers are new generation of the synthetic fertilizers which contain readily available nutrients in Nano scale range. Nano fertilizers are preferred largely due to their efficiency and environment friendly nature compared to conventional chemical fertilizers (Pratima *et al.*, 2021) [6]. While conventional urea is effective just for 30-50 per cent in delivering nitrogen to plants, the effectiveness of the nano urea is over 80% Urea also forms 82% of the total nitrogenous fertilizers consumed in India, with an annual consumption of 33.6 million tons in 2019-20. Hence nano urea / nano N fertilizers would be a potential fertilizer to improve NUE and to reduce input cost of farmer. The productivity of current agricultural practices relies heavily on fertilizer use.

Material and Methods

The, present investigation was carried out at college farm, college of Agriculture, Rajendranagar. The farm is geographically located at 17º 32'N Latitude, 78º 41'E Longitude with an altitude of 542.6 m above mean sea level. The soil of the experiment field was sandy clay loam in texture with alkaline pH (8.20), Non saline (EC 0.85 dS m^{-1}), low in organic matter content (0.33%), low in available nitrogen (171.8 kg ha^{-1}), high in available phosphorus (30.5 kg P_2O_5 ha^{-1}), and high in available potassium (358 kg K_2O ha^{-1}). The experiment was laid out in randomized block design with nine treatments and replicated three times. Treatments include Control (No fertilizer were applied) (T_1), Recommended dose of N: P_2O_5: K_2O @ 120-60-60 kg ha^{-1} (RDFN in 4-splits @ 20, 40, 60, 80 DAS (T_2), 1/4th of 100% N as urea at 20 DAS + 3 Nano- N sprays @ 1250 mL ha^{-1} each time at 40, 60 and 80 DAS (T_3), 1/4th of 100% N as urea at 20 DAS + 3 Nano- N sprays @ 750 mL ha^{-1} each time at 40, 60 and 80 DAS (T_4), 1/4th of 100% N as urea at 20 DAS + 3 urea sprays @ 2% each time at 40, 60 and 80 DAS (T_5), 1/4th of 100% N as urea at 20 and 40 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 60 and 80 DAS (T_6), 1/4th of 100% N as urea at 20 and 60 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 40 and 80 DAS (T_7), 1/4th of 100% N as urea at 20 and 40 DAS + Nano- N sprays @ 750 mL ha^{-1} each time at 60 and 80 DAS (T_8), 1/4th of 100% N as urea at 20 and 60 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 40 and 80 DAS (T_9). Entire recommended dose of phosphorous and potassium was applied in the form of single super phosphate and muriate of potash as basal at the time of sowing to all plots except control. Nitrogen is applied as soil application and foliar application at 20, 40, 60 and 80 DAS.

Apparent N use efficiency calculation

$$= \frac{\text{(Total N uptake in N fertilized plot)} - \text{(Total N uptake in control plot)}}{\text{Quantity of N fertilizer applied}}$$

The statistical analysis of data recorded for different characters during the course of investigation was carried out through the procedure appropriate to the design of the experiment as described by Panse and Sukhatme (1978) [5]. The significance of difference was tested by 'F' test. Five percent level of significance was used to test the significance of results. The critical differences were calculated when the differences among treatments were found significant in 'F' test. In the remaining cases, only standard error of means was worked out. The co-efficient of variance (CV %) was also worked out.

Results and Discussion

The data pertaining to apparent N use efficiency presented in table 1.

The highest apparent N use efficiency (1.39) was registered with the application of treatment ¼th of 100% N as urea each time at 20 and 60 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 40 and 80 DAS which was on par with ¼th of 100% N as urea each time at 20 and 40 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 60 and 80 DAS (1.36), ¼th of 100% N as urea at 20 DAS + 3 Nano-N sprays @ 1250 mL ha^{-1} each time at 40, 60 and 80 DAS (1.27), ¼th of 100% N as urea at 20 DAS + 3 Nano-N sprays @ 750 mL ha^{-1} each time at 40, 60 and 80 DAS (1.24), ¼th of 100% N as urea each time at 20 and 60 DAS + Nano- N sprays @ 750 mL ha^{-1} each time at 40 and 80 DAS (1.04). This increase in apparent N use efficiency was mainly due to reduced nitrogen application. Nano-fertilizers have large surface area and particle size, less than the pore size of root and 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. Reduction of particle size results in increased specific surface area and number of particles per unit area of a fertilizer that provide more opportunity to contact of nano-fertilizer which leads to more penetration and uptake of the nutrient and thus results in high nutrient use efficiency (Liscano *et al.,* 2000) [4]. Below 100 nm nano-fertilizers makes plant use fertilizers more efficiently, reduces pollution, environmentally friendly, dissolve in water more effectively thus increase its metabolic activities (Joseph and Morrison, 2006) [2]. Similar findings were given by Qamar *et al.* (2015) [7] Kumar *et al.* (2021) [3].

Table 1: Effect of treatments on apparent N use efficiency

S. No	Treatments	Apparent N use efficiency
T_1	Control (no fertilizers were applied)	0
T_2	Recommended dose of N: P_2O_5: K_2O @ 120:60:40 kg ha^{-1} (RDFN in 4-splits @ 20, 40, 60, 80 DAS	0.93
T_3	1/4th of 100% N as urea at 20 DAS (30 kg N ha^{-1}) + 3 Nano- N sprays @ 1250 mL ha^{-1} each time at 40 (50 g), 60 (50 g), and 80 (50 g) DAS (Total 30.15 kg N ha^{-1})	1.27
T_4	1/4th of 100% N as urea at 20 DAS (30 kg N ha^{-1}) + 3 Nano- N sprays @ 750 mL ha^{-1} each time at 40 (30 g), 60 (30 g) and 80 (30 g) DAS (Total 30.09 kg N ha^{-1})	1.24
T_5	1/4th of 100% N as urea at 20 DAS (30 kg N ha^{-1}) + 3 urea sprays @ 2% each time at 40 (4.6 kg), 60 (4.6 kg) and 80 (4.6 kg) DAS (Total 43.8 kg N ha^{-1})	0.44
T_6	1/4th of 100% N as urea each time at 20 and 40 DAS (60 kg N ha^{-1}) + Nano- N sprays @ 1250 mL ha^{-1} each time at 60 (50 g) and 80 (50 g) DAS (Total 60.1 kg N ha^{-1})	1.36
T_7	1/4th of 100% N as urea each time at 20 and 60 DAS (60 kg N ha^{-1}) + Nano- N sprays @ 1250 mL ha^{-1} each time at 40 (50 g) and 80 (50g) DAS (Total 60.1 kg N ha^{-1})	1.39
T_8	1/4th of 100% N as urea each time at 20 and 40 DAS (60 kg N ha^{-1}) + Nano- N sprays @ 750 mL ha^{-1} each time at 60 (30 g) and 80 (30 g) DAS (Total 60.06 kg N ha^{-1})	0.97
T_9	1/4th of 100% N as urea each time at 20 and 60 DAS (60 kg N ha^{-1}) + Nano- N spray @ 750 mL ha^{-1} each time at 40 (30 g) and 80 (30 g) DAS (Total 60.06 kg N ha^{-1})	1.04
	SE(m) ±	0.12
	CD (P= 0.05)	0.38

Conclusion

It can be concluded that, highest apparent N use efficiency (1.39) was registered with the application of treatment ¼th of 100% N as urea each time at 20 and 60 DAS + Nano- N sprays @ 1250 mL ha^{-1} each time at 40 and 80 DAS (T_7).

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