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Effect of nano nitrogen fertilizer in conjunction with urea on dry matter production and yield of cotton crop

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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 dry matter production and yield of cotton crop. The significantly highest dry matter production (6236.36 kg ha^{-1}) and seed cotton yield (2235.8 kg ha^{-1}) was registered with application of 100% 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). The rate of increase of dry matter production and seed cotton yield with application of 100% RDF (120 kg ha^{-1}) over control (No nitrogen application) was 57.2% and 59.4% respectively.

Keywords: Nano nitrogen fertilizer, conjunction, dry matter production, yield, 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).

Fertilizers play a critical role in increasing food production in developing countries, particularly after the introduction of high yielding and fertilizer responsive varieties. Despite of this, it is well known that yields of many crops have begun to decline as a result of imbalanced fertilization and a decrease in soil organic matter content. The use efficiencies of N, P, and K fertilizers have remained constant over the last few decades, at 30-35 per cent, 15-20 per cent, and 35-40 per cent, respectively, leaving a large percentage of applied fertilizer to accumulate in the soil or enter aquatic systems, causing eutrophication (NAAS, 2013) [6].

Nitrogen plays very important role in various physiological process (Leghari *et al.*, 2016) [4] Nitrogenous fertilizers, particularly urea accounts for more than 82 per cent of the nitrogenous fertilizers used for most of the crops. Every year, around 33 million tons of urea is applied to various crops. Nitrogen deficiency in cotton reduces vegetative and reproductive growth and induces premature senescence, there by potentially reduces the yields (Tewiodle and Fernandez 1997) [7], whereas high nitrogen availability may shift the balance between vegetative and reproductive growth towards excessive vegetative development thus delaying maturity. Since nitrogen input is costly, judicious and efficient utilisation of nitrogen is essential for higher productivity of *Bt* cotton.

Materials and Methods
The, present investigation was carried out at college farm, college of Agriculture, Rajendranagar. The farm is geographically located at 17° 32'N Latitude, 78° 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), 100% RDF (120:60:60 kg ha^{-1}) in 4- splits at 20, 40, 60 and 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.

Two rows on either side width wise and two plants on either side length wise were considered as borders was utilized for estimating dry matter accumulation by destructive sampling at 20 DAS, 40 DAS, 60 DAS, 80 DAS and harvest by cutting at the base. The plants were initially dried in the shade, then cut into pieces and transferred to labelled brown paper bags and later dried in a hot air oven at 65 °C. The weight of the oven dried plants samples was recorded using electrical balance and the mean value was recorded as the dry matter accumulation and expressed in kg ha^{-1}. Three pickings of seed cotton were done when the bolls have fully burst and the yield from net plot was weighted separately and then converted to kg per hectare.

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 (1985). 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

Dry matter production

Dry matter accumulation is a key index reflecting the efficiency of photosynthesis which eventually determines the yield of the crop. A progressive increment in the accumulation of dry matter was observed with the advancement of the crop. A noticeable increment recorded at different stages is presented in Table 1. No significant difference was observed among the treatments with regards to dry matter production at 20 DAS. At 40, 60, 80 DAS and at harvest stage the crop fertilized with 100% 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) maintained its superiority and accumulated significantly higher dry matter production over all other treatments and it was followed by 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) and 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). The crop fertilized with 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 @ 750 mL ha^{-1} each time at 40 and 80 DAS (T_9) registered significantly higher dry matter production over 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). The lowest dry matter production was recorded with Control (T_1). Highest dry matter production in plots fertilized with recommended dose of N: P_2O_5: K_2O @ 120:60:60 kg ha^{-1} (RDFN in 4-splits @ 20, 40, 60, 80 DAS) the reason behind might be due to adequate supply of nitrogen increases the growth characters which in turn increases the dry matter production. This finding was similar as that of Udikeri and Shashidhara (2017) [8] reported that increase in application of fertilizer dose increases the dry matter production.

Seed cotton yield (kg ha^{-1})

The data pertaining to seed cotton yield (kg ha^{-1}) as influenced by the treatments is presented in the Table 2. There was significant differences seen among the treatments regarding seed cotton yield, the treatment receiving recommended dose of N: P_2O_5: K_2O @ 120:60:60 kg ha^{-1} (RDFN in 4-splits @ 20, 40, 60, 80 DAS) recorded the significantly highest seed cotton yield (2235.81 kg ha^{-1}) over all other treatments and it was followed by 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 (1972.80 kg ha^{-1}), 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 (1967.71 kg ha^{-1}) which were on par with each other. The treatment receiving 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 (1704.60 kg ha^{-1}), ¼th of 100% N as urea each time at 20 and 40 DAS + Nano- N sprays @ 750 mL ha^{-1} each time at 60 and 80 DAS (1699.45 kg ha^{-1}) which were on par with each other. While, significantly lower seed cotton yield of (905.84 kg ha^{-1}) was recorded with control (T_1). The substantial increase in seed cotton yield due to application of recommended dose of nitrogen might be due to favourable effect of nitrogen on growth parameters like plant height, increased number of bolls $plant^{-1}$, dry matter accumulation $plant^{-1}$ and its subsequent translocations towards sink improved the seed cotton yield. The results are in conformity with Dadgale *et al.* (2014) [2]. Similar positive response of nitrogen on seed cotton yield was observed by Basavanneppa (2005) and Meena *et al.* (2007) [1, 5].

Table 1: Effect of treatments Dry matter accumulation (kg ha^{-1}) at 20, 40, 60, 80 DAS and at harvest stage

S. No	Treatments	20 DAS	40 DAS	60 DAS	80 DAS	At harvest
T_1	Control (no fertilizers were applied)	16.12	55.00	394.80	753.70	2668.17
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	17.30	121.98	864.50	2030.22	6236.36
T_3	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	16.30	81.50	587.08	1263.16	4123.71
T_4	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	16.30	79.00	584.00	1258.87	4112.00
T_5	1/4th of 100% N as urea at 20 DAS + 3 urea sprays @ 2% each time at 40, 60 and 80 DAS	16.20	67.00	485.90	1003.76	3404.06
T_6	1/4th 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	17.10	108.50	773.88	1774.01	5529.08
T_7	1/4th 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	17.17	110.02	770.81	1778.24	5534.21
T_8	1/4th of 100% N as urea each time at 20 and 40 DAS + Nano- N sprays @ 750 mL ha^{-1} each time at 60 and 80 DAS	16.60	94.00	683.14	1517.16	4819.87
T_9	1/4th of 100% N as urea each time at 20 and 60 DAS + Nano- N spray @ 750 mL ha^{-1} each time at 40 and 80 DAS	16.90	95.99	679.13	1523.31	4824.84
	SE(m) ±	0.38	3.59	28.14	78.95	230.98
	CD (P= 0.05)	NS	10.86	85.08	238.75	698.44

Table 2: Effect of treatments on Seed cotton yield (kg ha^{-1})

S. No	Treatments	Seed cotton yield (kg ha^{-1})
T_1	Control (no fertilizers were applied)	905.84
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	2235.81
T_3	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	1436.33
T_4	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	1428.44
T_5	1/4th of 100% N as urea at 20 DAS + 3 urea sprays @ 2% each time at 40, 60 and 80 DAS	1166.81
T_6	1/4th 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	1967.71
T_7	1/4th 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	1972.80
T_8	1/4th of 100% N as urea each time at 20 and 40 DAS + Nano- N sprays @ 750 mL ha^{-1} each time at 60 and 80 DAS	1699.45
T_9	1/4th of 100% N as urea each time at 20 and 60 DAS + Nano- N spray @ 750 mL ha^{-1} each time at 40 and 80 DAS	1704.60
	SE(m) ±	85.97
	CD (P= 0.05)	259.97

Conclusion

It can be concluded that, significantly higher dry matter production and higher seed cotton yield obtained with application of nitrogen at 120 kg ha^{-1} through urea compared to application of nitrogen in combination of urea and nano urea.

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