Original Research Article

INFLUENCE OF SUPER NANO UREA AND NANO DAP ON GROWTH PARAMETERS OF RICE FALLOW COTTON UNDER HIGH DENSITY PLANTING SYSTEM

ABSTRACT

The experiment was carried out at wetlands farm, Tamil Nadu Agricultural University, Coimbatore, during summer, 2022 in a Randomized block design with ten treatments and replicated thrice. The main objective of this study is to find out the effect of varied dose of basal nitrogen & phosphorus and foliar application of conventional urea, super nano urea and nano DAP on rice fallow cotton under High Density Planting System (HDPS) on growth parameters. Cotton variety CO 17 was taken up for the study with RDF of 150:50:50 NPK Kg ha^{-1}. The experimental details viz., T_1- control (without N&P) K alone, T_2- RDF (150:50:50 NPK Kg ha^{-1}), T_3- 50% RDN&P,100% K+ conventional urea @ 1% and nano DAP @ 0.5% at 25 DAS, T_4- 50% RDN&P,100% K+ conventional urea @ 1% and nano DAP @ 0.5% at 25 DAS and 45 DAS, T_5- 50% RDN&P,100% K+ SNU(Super Nano Urea) @ 0.25% and nano DAP @ 0.5% at 25 DAS (Days After Sowing) and 45 DAS, T_6- 50% RDN&P,100% K+ SNU @ 0.25% and nano DAP @ 0.5% at 25 DAS, 45 DAS and 65 DAS, T_7- 50% RDN&P,100% K+ SNU @ 0.5% and nano DAP @ 0.5% at 25 DAS and 45 DAS, T_8- 25% RDN&P,100% K+ SNU @ 0.5% and nano DAP @ 0.5% at 25 DAS 45 DAS and 65 DAS, T_9- 50% RDN&P,100% K+ SNU @ 1% and nano DAP @ 0.5% at 25 DAS, T_{10}- 50% RDN&P,100% K+ SNU @ 1% and nano DAP @ 0.5% at 25 DAS and 45 DAS. The experimental results revealed that, among all the treatments, T_{10} significantly registered the increased plant height and highest leaf area index (3.5) and enhanced light interception (91%). Based on the experimental results, it is concluded T_{10} i.e., reduced application of basal nitrogen and phosphorus (50% RDN&P + 100% K) with super nano urea foliar spray @ 1% and nano DAP foliar spray @ 0.5% at 25 DAS and 45 DAS found to be the optimal dosage for increased growth parameters under high density planting system in rice fallow cotton.

Keywords: Conventional urea, Super Nano urea, Nano DAP, High density planting system.

1. INTRODUCTION

Cotton is a unique natural fiber and regarded as the 'white gold 'producing the most common fiber crop of the world. Cotton is grown on around 32–36 million-hectares area of tropical and northernmost agricultural latitudes in over 80 countries of the world to meet out the current global needs of human for the natural fiber (PIB Delhi, 2022).Gujarat, Maharashtra and Telangana are the major cotton producing states which produce about 65% of total cotton production in the country. In recent years, Tamil Nadu experienced a significant decline in cotton production, causing concerns about the sustainability of the industry and its impact on the economy. The reasons for this decline are complex, with factors ranging from weather conditions to government policies and market forces.

Nano-fertilizers are a new concept of nutrient management in crop and it is in its belonging stage there is a great thrust area in agriculture for sustainable crop improvement with major importance of nano-nitrogen and phosphorus. Nano-fertilizers cause an increase in plant nutritional efficiency, lowers their toxicity to soil organisms, and also it reduces the effects of potential stress due to excess application of fertilizer and reduces the amounts of fertilizers used (Kantwa *et al.,* 2022).

Phosphorus (P) is an essential element in plants, required for vital structural and metabolic functions. A shortage of P will lead to a breakdown of plant membranes and reduce energy transfer within the plant.

Application of 125 % RDF (125:62.5:62.5 NPK Kgha-1) with foliar spray of Mepiquat Chloride @ 150 ppm (F2S1) could be considered as a better package for higher productivity and profitability on rice fallow cotton under high density planting system (Kavin *et al.,*2022). High density cotton requires

higher dose of fertilization which results in enhanced production of bolls and increased yield. Rice fallow condition creates difficulty in germination of cotton seed. Hence seed treatment with inorganic compounds like, liquid nano DAP enhance the cotton seedling germination. Since cotton is an indeterminate crop, under high density planting this indeterminate property affects the yield by reducing boll numbers. Combined foliar application of nano urea and nano DAP brings down detrimental property in cotton.

2. MATERIAL AND METHODS

Field experiment is carried out at wetlands farm, Tamil Nadu Agricultural University, to evaluate the influence of nano urea and nano DAP on high density planting system of cotton under rice fallow condition, during summer 2022. Experimental field sited at 11o N latitude and 77o E longitude and altitude of 426.7 m above mean sea level coming under the category of Southern agro-climatic zone of India and Western agro-climatic zone of Tamil Nadu. The soil type is clay loam, which has pH of 8.5 (1:2 soil: water suspension solution), EC of 0.50 dSm-1. The availability of the primary nutrients *viz*., nitrogen, phosphorus and potassium in the soil are 216.0 kg ha-1, 40.3 kg ha-1 and 373.0 kg ha-1 respectively. This field experiment was laid out in Randomized Block Design (RBD) involving ten treatments and three replication with, varied dose of basal nitrogen & phosphorus, foliar spray of super nano urea, nano DAP and conventional urea. The experimental details viz.,

List 1 : Details of the experiment.

T_1	Control without N and P (K alone)
T_2	Recommended Dose of Fertilizer (RDF) 150:50:50 NPK kg ha^{-1}
T_3	50 % RDN&P + 1 spray of Conventional Urea @ 1.0 % +1 Spray of Nano DAP
T_4	50 % RDN&P + 2 sprays of Conventional Urea@ 1.0 %+ 2 Sprays of Nano DAP
T_5	50 % RDN&P + 2 sprays of SNU @ 0.25 % + 2 Sprays of Nano DAP
T_6	25 % RDN&P + 3 sprays of SNU @ 0.25 % + 3 Sprays of Nano DAP
T_7	50 % RDN&P + 2 sprays of SNU @ 0.5 %+ 2 Sprays of Nano DAP
T_8	25 % RDN&P + 3 sprays of SNU @ 0.5 %+ 3 Sprays of Nano DAP
T_9	50 % RDN&P + 1 sprays of SNU @ 1.0 %+ 1 Spray of Nano DAP
T_{10}	50 % RDN&P + 2sprays of SNU @ 1.0 %+ 2 Sprays of Nano DAP

Note: Nano DAP @0.5%

Besides the experimental treatments, recommended dose of potassium nutrient (83kg ha^{-1}) applied through muriate of potash fertilizer as basal nutrients in all the experimental plots, which has a net plot measurement of 8 m x 2 m.

Cotton seeds of variety CO 17 were used in this field experiment which is acid delinted seeds were sown in lines by adopting the recommended row and plant spacing of 100 cm and 10 cm respectively, with a seed rate of 1kg ha^{-1}. According to the treatment schedule, required quantity of urea and phosphorus was calculated and applied as a basal fertilizer for implementing on treatments, and for adopting foliar spray of SNU, nano DAP and conventional urea at 25 DAS, 45 DAS and 90 DAS. Required quantity of nano urea, nano DAP and conventional urea were measured and thoroughly mixed with required spray solution @ 500litres ha^{-1}. For better absorption of applied nutrients on cotton, foliar application was executed during morning hours (before 10 AM). Foliar applications should be made either early morning or late evening for maximum efficiency, and no foliar applications should be made to water-stressed plants Oosterhuis *et al*.,(2009). Plant height were measured using measuring scale 25 DAS, 45 DAS and at the time of harvest. The light interception

was measured from above, below, across and along the canopy and reflectance was measured using the instrument line quantum sensor. It is expressed in percentage. The crop was irrigated nine times during the cropping period. The data on growth attributes of cotton *viz*., plant height, leaf area index and light interception were calculated from 5 randomly tagged plants at 45 DAS, 90 DAS and at harvest stage in each experimental plot and average values were computed. Leaf area index and light interception were calculated using the following formula respectively,

$$\textbf{LAI} = \frac{\text{Leaf area x Number of leaves}}{\text{Spacing (cm)}}$$

$$\textbf{LI} = \frac{\text{PAR above canopy xPAR below canopy}}{\text{PAR above canopy}} \text{x}100$$

Significance of the difference observed in growth attributes of cotton of high density planting system under different basal nitrogen and phosphorous dose and various concentration of foliar nutrition of super nano urea, nano DAP and normal urea were statistically analysed.

3. RESULTS AND DISCUSSION

3.1 GROWTH ATTRIBUTES

Adoption of varied dose of basal nitrogen, phosphorus and several concentrations of super nano urea, nano DAP and conventional urea foliar spray significantly influenced the growth attributes *viz*., plant height, leaf area index and light interception of the cotton crop. Among the basal dose of nitrogen and phosphorus, maximal plant height (112.33 cm) was recorded on T_{10} (50% RDN&P and 100% K + two sprays of 1% SNU with 0.5% nano DAP) which was on par with T_9 (50% RDN&P and 100% K +one spray of 1% SNU with 0.5% nano DAP) which is significantly higher than the application of 100% RDF. In general, increased supply of nitrogen increases the growth and enhances the physiological activities of the plant. Among the foliar nutrition, T_{10} (50% RDN&F and 100% K + 1% of SNU with 0.5% nano DAP) recorded the highest leaf area index (4.11) and high leaf interception percentage (91%).

Adoption of 75% RDN + foliar spray of nano urea @ 4ml/L at knee stage and tasseling stage was significantly at par with 100% RDN this might be a most appropriate managerial alternative to achieve sustainability Samui *et al*.,(2022).

Bondada *et al*.,(1999) revealed that foliar-N significantly increased nodes above white flower (NAWF) over the control with no significant differences.

The highest number of panicles m^{-2} in rice might be due to sufficient amount of nitrogen through nano urea at critical stage which would have maintained continuous supply of nitrogen, led to the meristematic activity and stimulation of cell elongation in plants which resulted in higher number of panicles m^{-2} Sahu *et al*.,(2022).

According to Rajendran *et al*., (2011) higher seed cotton yield (19.29 q ha-1) was obtained in cotton receiving RDF and sprayed with NAA 40 ppm and DAP 2% either at square formation and peak flowering or peak flowering and boll development stage. Quality characters of cotton like seed index, lint index, ginning percentage, Bartlett's index, bundle strength and fibre finess were not influenced.

Addition of basal fertilizer to the soil and as foliar application had a positive influence on PN,E,gs and yield, whereas Ci and membrane leakage was reduced simultaneously. The increase in photosynthetic capacity and stomatal conductance under B-nutrition enhanced WUE and, combined with the increase in cell membrane stability, resulted in more retention of fruits and increased yield Ahmad *et al*., (2019).

3.2 LIGHT INTERCEPTION

Gwathmey *et al*.,(1998) revealed that foliar K did not affect canopy light interception in 1993, and it increased interception in 1994 only with no soil-applied K. In short-season environments, optimum K fertilization needs to be accompanied by cultivar selection and management that promote earliness of maturity

The increase in growth attributes in the treatment combination of 50% RDN&P with foliar application of SNU @ 1% and nano DAP @ 0.5% at emergence and square formation thereafter was due to the superiority of growth attributing characters of this combination over other treatment combinations because of satisfactory application of nitrogen during initial stages of crop growth which effectively nourished the crop up to square formation stage, and at the time of flowering, spraying of SNU and

nano DAP enhanced the production of yield attributing characters through their smart delivery nutrient supply system thus subsequently maximizing the uptake of nutrients and its use efficiency and accordingly contributing for maximizing growth attributes of cotton.

Table 1. Influence of Super nano urea, nano DAP on plant height (cm), leaf area index and light interception (%) of cotton at different days after sowing

	PLANT HEIGHT (cm)				LEAF AREA INDEX				LIGHT INTERCEPTION (%)	
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	45 DAS	90 DAS
T_1	26.50	53.50	64.33	79.83	0.83	1.29	1.79	1.92	55	66
T_2	29.00	57.83	59.33	85.14	0.96	1.39	2.03	2.09	59	64
T_3	31.66	61.00	68.00	89.00	1.02	1.58	2.39	2.56	55	65
T_4	32.16	61.66	70.33	91.57	1.03	1.53	2.69	2.70	58	68
T_5	31.00	61.00	73.33	99.15	1.03	1.68	3.00	2.95	61	74
T_6	30.66	60.50	80.66	91.30	1.01	1.53	3.20	3.25	55	72
T_7	31.66	63.66	84.00	99.33	1.04	1.67	3.69	3.40	64	85
T_8	30.83	60.66	89.66	92.33	1.01	1.51	3.03	3.12	71	78
T_9	34.00	65.00	90.33	107.26	1.06	1.75	3.55	3.89	73	77
T_{10}	34.00	67.16	98.91	112.33	1.06	1.77	3.84	4.11	79	91
SEd	1.63	2.77	4.72	5.45	0.05	0.08	0.18	0.19	4.10	4.61
CD(*P* = .05)	3.42	5.82	7.50	11.46	0.10	0.17	0.38	0.41	8.61	9.69

T_1 *Control without N and P (K alone)*

T_2 *Recommended Dose of Fertilizer (RDF) 150:50:50 NPK kg ha^{-1}*

T_3 *50 % RDN&P + 1 spray of Conventional Urea @ 1.0 % +1 Spray of Nano DAP@ 0.5%*

T_4 *50 % RDN&P + 2 sprays of Conventional Urea@ 1.0 % + 2 Sprays of Nano DAP@ 0.5%*

T_5 *50 % RDN&P + 2 sprays of SNU @ 0.25 % + 2 Sprays of Nano DAP@ 0.5%*

T_6 *25 % RDN&P + 3 sprays of SNU @ 0.25 % + 3 Sprays of Nano DAP@ 0.5%*

T_7 *50 % RDN&P + 2 sprays of SNU @ 0.5 % + 2 Sprays of Nano DAP@ 0.5%*

T_8 *25 % RDN&P + 3 sprays of SNU @ 0.5 % + 3 Sprays of Nano DAP@ 0.5%*

T_9 *50 % RDN&P + 1 sprays of SNU @ 1.0 % + 1 Spray of Nano DAP@ 0.5%*

T_{10} *50 % RDN&P + 2sprays of SNU @ 1.0 % + 2 Sprays of Nano DAP@ 0.5%*

4. CONCLUSION

From the experiment, it was concluded that, 50% RDN&P (326kg N ha^{-1} and 312kg P ha^{-1}) in combination with foliar nutrition of super nano urea @ 10ml litre-1 of water with nano DAP @ 5ml litre-1 of water sprayed at emergence and square formation and before flowering stage found to be a viable option in terms of growth attributes of rice fallow cotton under high density planting system. Since, the treatment combinations produced higher growth attributes which was on par with50% RDN&P (326kg N ha^{-1} and 312kg P ha^{-1}) in combination with foliar nutrition of super nano urea @ 5ml litre^{-1} of water with nano DAP @ 5ml litre^{-1} of water sprayed at emergence and square formation, the adoption of reduced dose of basal nitrogen and phosphorus i.e., 50% which is economically viable option for increasing the growth.

REFERENCES

Ahmad, S. A. G. H. E. E. R., Hussain, N. A. Z. I. M., Ahmed, N. I. A. Z., & Zaka, S. M. (2019). Influence of boron nutrition on physiological parameters and productivity of cotton (Gossypium hirsutum L.) crop. *Pak. J. Bot*, *51*(2), 401-408.

Bondada, B. R., Oosterhuis, D. M., & Tugwell, N. P. (1999). Cotton growth and yield as influenced by different timing of late-season foliar nitrogen fertilization. *Nutrient Cycling in Agroecosystems*, *54*, 1-8.

Gerik, T. J., Oosterhuis, D. M., & Torbert, H. A. (1998). Managing cotton nitrogen. *Adv Agron*, *64*, 115-147.

Gwathmey, C. O., & Howard, D. D. (1998). Potassium effects on canopy light interception and earliness of no-tillage cotton. *Agronomy Journal*, *90*(2), 144-149.

Harifi, T., & Montazer, M. (2012). Past, present and future prospects of cotton cross-linking: New insight into nano particles. *Carbohydrate polymers*, *88*(4), 1125-1140.

Kantwa, S., & Yadav, L. R. (2022). Nano urea: Applications and significance. *Just Agriculture*, *2*, 1-6.

Kumar, R. K., Thirukumaran, K., Karthikeyan, R., & Latha, M. R. (2022). Effect of Seed Priming with Various Organic and Inorganic Compounds on Cotton Seed Germination and Seedling Development. *International Journal of Plant & Soil Science*, *34*(22), 1-10.

Oosterhuis, D. M., Bibi, A. C., Gonias, E. D., & Mozaffari, M. (2007). Effect of phosphorus deficiency on cotton physiology. *AAES Research Series*, *562*, 35-38.

Oosterhuis, D. (2009, February). Foliar fertilization: mechanisms and magnitude of nutrient uptake. In *Proceedings of the fluid forum* (pp. 15-17).

Radin, J. W., & Matthews, M. A. (1989). Water transport properties of cortical cells in roots of nitrogen-and phosphorus-deficient cotton seedlings. *Plant Physiology*, *89*(1), 264-268.

Rathnayaka, R. M. N. N., Iqbal, Y. B., & Rifnas, L. M. (2018). Influence of Urea and Nano-Nitrogen Fertilizers on the Growth and Yield of Rice (Oryza sativa L.) Cultivar? Bg 250?. *Influence of Urea and Nano-Nitrogen Fertilizers on the Growth and Yield of Rice (Oryza sativa L.) Cultivar? Bg 250?*, *5*(2), 7-7.

Rajendran, K., Palchamy, A., Sankaranarayanan, K., Prabakaran, K., & Bhararhi, K. (2011). Enhancing Productivity of Summer Irrigated Cotton Through Plant Growth Regulator and Foliar Nutrition 248. *Madras Agricultural Journal*, *98*(jul-sep), 1.

Samui, S., Sagar, L., Sankar, T., Manohar, A., Adhikary, R., Maitra, S., & Praharaj, S. (2022). Growth and productivity of rabi maize as influenced by foliar application of urea and nano-urea. *Crop Research*, *57*(3), 136-140.

Sahu, T. K., Kumar, M., Kumar, N., Chandrakar, T., & Singh, D. P. (2022). Effect of nano urea application on growth and productivity of rice (Oryza sativa L.) under mid land situation of Bastar region. *Pharma innov*, *11*, 185-87.

Wang, X., Tang, C., Guppy, C. N., & Sale, P. W. G. (2008). Phosphorus acquisition characteristics of cotton (Gossypium hirsutum L.), wheat (Triticum aestivum L.) and white lupin (Lupinus albus L.) under P deficient conditions. *Plant and Soil*, *312*, 117-128.

WA Al-juthery, H., & Hilal Obaid Al-Maamouri, E. (2020). Effect of urea and nano-nitrogen fertigation and foliar application of nano-boron and molybdenum on some growth and yield parameters of potato. *Al-Qadisiyah Journal For Agriculture Sciences*, *10*(1), 253-263.