



Influence of Super Nano Urea and Nano DAP on Growth Parameters of Rice Fallow Cotton under High Density Planting System

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out at wetlands farm, Tamil Nadu Agricultural University, Coimbatore, during summer, 2023 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., T₁- control (without N&P) K alone, T₂- RDF (150:50:50 NPK Kg ha⁻¹), T₃- 50% RDN&P,100% K+ conventional urea @ 1% and nano DAP @ 0.5% at 25 DAS, T₄- 50% RDN&P,100% K+ conventional urea @ 1% and nano DAP @ 0.5% at 25 DAS and 45 DAS, T₅- 50% RDN&P,100%

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K+ SNU(Super Nano Urea) @ 0.25% and nano DAP @ 0.5% at 25 DAS (Days After Sowing) and 45 DAS, T₆- 50% RDN&P,100% K+ SNU @ 0.25% and nano DAP @ 0.5% at 25 DAS, 45 DAS and 65 DAS, T₇- 50% RDN&P,100% K+ SNU @ 0.5% and nano DAP @ 0.5% at 25 DAS and 45 DAS, T₈- 25% RDN&P,100% K+ SNU @ 0.5% and nano DAP @ 0.5% at 25 DAS 45 DAS and 65 DAS, T₉- 50% RDN&P,100% K+ SNU @ 1% and nano DAP @ 0.5% at 25 DAS, T₁₀- 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, T₁₀ significantly registered the increased plant height (112.33 cm) and highest leaf area index (4.11) and enhanced light interception (91%). Based on the experimental results, it is concluded T₁₀ 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” [1]. “Gujarat, Maharashtra and Telangana are the major cotton producing states which produce about 65% of total cotton production in the country” [2]. 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” [3].

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 Kg ha⁻¹) with foliar spray of Mepiquat Chloride @

150 ppm could be considered as a better package for higher productivity and profitability on rice fallow cotton under high density planting system [4]. 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 this detrimental property in cotton. With all considerations the aim of the experiment to study the effect of nano urea and nano DAP spray on growth parameters of cotton in HDPS under rice fallow environment.

2. MATERIALS 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 2023. “Experimental field sited at 11°N latitude and 77° 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 which is given in Table 1. The average maximum and minimum temperature recorded were 37° C and 23.1° C respectively, and the mean morning and evening relative

humidity were 76.3% and 52.9% respectively. A cumulative rainfall of 60 mm was received in 5 rainy days during the cropping period” [2]. 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.

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 the field experiments which are 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 65 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 application should be made either early morning or late evening for maximum efficiency, and no foliar applications should be made to water-stressed plants” [5]. Plant height and leaf area index were measured using measuring scale and leaf area meter at 30 DAS, 60 DAS, 90 DAS and at the time of harvest which is given below (Table 2) respectively. 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,

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

$$LI = \frac{\text{PAR above canopy} \times \text{PAR below canopy}}{\text{PAR above canopy}} \times 100$$

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.

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%

Table 1. Initial soil status of the experimental site

Parameter	Value	Unit	comments
pH	8.07		Slightly alkaline
EC	0.50	ds/m	Non saline
Available N	216	Kg/ha	Low
Available P	40.3	Kg/ha	High
Available K	373	Kg/ha	High

Table 2. 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

- T₁ Control without N and P (K alone)
T₂ Recommended Dose of Fertilizer (RDF) 150:50:50 NPK kg ha⁻¹
T₃ 50 % RDN&P + 1 spray of Conventional Urea @ 1.0 % +1 Spray of Nano DAP@ 0.5%
T₄ 50 % RDN&P + 2 sprays of Conventional Urea@ 1.0 % + 2 Sprays of Nano DAP@ 0.5%
T₅ 50 % RDN&P + 2 sprays of SNU @ 0.25 % + 2 Sprays of Nano DAP@ 0.5%
T₆ 25 % RDN&P + 3 sprays of SNU @ 0.25 % + 3 Sprays of Nano DAP@ 0.5%
T₇ 50 % RDN&P + 2 sprays of SNU @ 0.5 % + 2 Sprays of Nano DAP@ 0.5%
T₈ 25 % RDN&P + 3 sprays of SNU @ 0.5 % + 3 Sprays of Nano DAP@ 0.5%
T₉ 50 % RDN&P + 1 sprays of SNU @ 1.0 % + 1 Spray of Nano DAP@ 0.5%
T₁₀ 50 % RDN&P + 2sprays of SNU @ 1.0 % + 2 Sprays of Nano DAP@ 0.5%

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 T₁₀ (50% RDN&P and 100% K + two sprays of 1% SNU with 0.5% nano DAP) which was on par with T₉ (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, T₁₀ (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” [6].

Bondada et al. [7] revealed that foliar-N significantly increased nodes above white flower (NAWF) over the control with no significant differences [8] observed that “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. ”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” [9].

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 [10].

3.2 Light Interception

Gwathmey and Howard [11] 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” [2].

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.

4. CONCLUSION

From the experiment, it was concluded that, 50% RDN&P (163kg N ha⁻¹ and 156kg 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 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 with 50% RDN&P (163kg N ha⁻¹ and 156kg 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, the adoption of reduced dose of basal nitrogen and phosphorus i.e., 50% which is economically viable option for increasing the growth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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