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Effect of nitrogen management on growth, yield attributes and yield of lowland rice-ADT 43 (*Oryza sativa* L.)

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Abstract

A Field experiment was conducted at Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during the year 2021- 2022 to study the effect of different levels and split application of nitrogen on growth and yield of lowland rice. The experiments were laid out in randomized block design (RBD) with three replications. The treatments details are T_1 – Control, T_2 – 100% RDN through Urea (120 kg/ha), T_3 – 75% RDN through Urea (90 kg/ha), T_4 – 125% RDN through Urea (150 kg/ha), T_5 – 100% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea), T_6 – 75% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea), T_7 – 125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea), T_8 – 100% RDN (50% N basal through Urea + LCC4 @ Nano urea 600 ml/ha), T_9 – 75% RDN (50% N basal through Urea + LCC4 @ Nano urea 600 ml/ha) and T_{10} – 125% RDN (50% N basal through Urea + LCC4 @ Nano urea 600 ml/ha). Among the different treatments tried, T_7 treatment [125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea)] recorded the higher plant height (103.21 cm), LAI (5.62), CGR (7.40 g m^{-2} day^{-1}), DMP (11940 kg ha^{-1}), number of tillers m^{-2} (530.19), number of panicles m^{-2} (377.87), number of filled grains $panicle^{-1}$ (108.26), grain yield (5450 kg ha^{-1}) and straw yield (7125 kg ha^{-1}).

Key words : Nitrogen, rice, Nano urea, LCC.

Rice (*Oryza sativa* L.) is one of the most important cereal crops of the world, grown in wide range of agro-climatic zones, to nourish the mankind. More than 90 per cent of the World's rice is grown and consumed in Asia. Rice is an important crop in India because

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it provides a staple food for approximately 800 million people and it is extremely important for country's food and livelihood security. Globally, the output of paddy (rice) increased by more than thrice between 1961 and 2019, from 215 million tonnes to 755 million tonnes, with Asia accounting for most of the growth. More than 80% of the world's rice is produced in seven Asian nations: China, India, Indonesia, Bangladesh, Vietnam, Myanmar, and Thailand[2]. In India, the area, production and productivity of rice cultivation is 46.38 Mha, 130.29 Mt (million tons) and 2.8 tons ha^{-1} respectively. In Tamil Nadu, the area, production and productivity under rice cultivation is 2.21 Mha, 8.07 Mt (million tons) and 3.6 tons ha^{-1} respectively[1].

With the growing population, the food demand has also increases year by year. The challenge for agriculture in the future decades will be to meet the world's increasing food demand in a sustainable manner. This effort has become more difficult due to declining soil fertility, mishandling of added plant nutrients and rising input prices[14]. Therefore, here comes the need for increasing production with proper utilization of fertilizers which in return will benefit the farmer's economy too.

Rice yields are declining due to deteriorating soil health, imbalance in fertilizer use, lack of suitable rice varieties, pest infestation, frequent flood and drought[3]. Among them, inadequate supply of nutrients affects the growth and yield of rice. Nitrogen (N) is essential to all biological systems since it is required for all organisms to exist and flourish. Nitrogen is an important factor in affecting crop productivity. In India, around 67% of rice soils are believed to be nitrogen deficient, and as a result, rice crop has become a major user of nitrogen fertilizer. The efficacy of nitrogen fertilizer applied to rice crops ranges from 25 to 50%. Rice accounts for over 40% of total nitrogen fertilizer consumption in India[17].

Nitrogen nutrition is an important agronomic practice that influences rice crop productivity and quality. Even though improved rice varieties respond effectively to N fertilization, the recovery of applied N is quite low. N application in three to four splits at the sowing, active tillering, late tillering, and panicle-initiation stages resulted in greater yield with less N loss. As a result, one of the essential agronomic approaches for increasing rice production and N uptake is to apply the proper amount of fertilizer N at the appropriate time[4]. Many researchers discovered that applying nitrogen at appropriate physiological growth stages enhanced the uptake compared to applying all the fertilizer N at sowing[9,11]. Keeping in view of the above facts, the present investigation was carried out to study the effect of nitrogen management on growth, yield attributes and yield of lowland rice.

Field experiment was conducted at Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during the year 2021- 2022 to study the effect of different levels and split application of nitrogen on growth and yield of lowland rice. The experiments were laid out in randomized block design (RBD) with three replications. The treatments details are T_1 – Control, T_2 – 100% RDN through Urea (120 kg/ha), T_3 – 75% RDN through Urea (90 kg/ ha), T_4 – 125% RDN through Urea (150 kg/

ha), T_5 – 100% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea), T_6 – 75% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea), T_7 – 125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea), T_8 – 100% RDN (50% N basal through Urea + LCC4 @ Nano urea 600 ml/ha), T_9 – 75% RDN (50% N basal through Urea + LCC4 @ Nano urea 600 ml/ ha) and T_{10}–125% RDN (50% N basal through Urea + LCC4 @ Nano urea 600 ml/ha)

The climate of Annamalai Nagar was moderately warm with hot summer months. The maximum temperature ranges from 28.1°C to 38.3°C with a mean maximum of 33.2°C, while the minimum temperature fluctuates between 18.9°C and 27.5°C with a mean of 23.2°C. The maximum humidity was 96 per cent during November and the minimum was 79 per cent during April to May with a mean of 87.5 per cent. The mean annual rainfall received was 1500 mm with a distribution of 1000 mm during Northeast monsoon, 400 mm during the Southwest monsoon and 100 mm during hot weather period spread over 60 rainy days. The mean hours of bright sunshine per day was 9.5.

The experimental field was clay loam in texture, low in available nitrogen (228 kg ha^{-1}), medium in available phosphorus (16.4 kg ha^{-1}) and high in available potassium (292 kg ha^{-1}). The fertilizers were applied to the experimental field as per the recommended manurial schedule of 120:40:40 kg N, P_2O_5 and K_2O ha^{-1}. Urea (46 % N), DAP (46% P_2O_5 and 18% N) and Muriate of potash (60 % K_2O) fertilizers were used to supply N, P and K nutrients. Nitrogen dose was increased or decreased as per the treatment schedule. Half dose of nitrogen and full dose of phosphorus and potassium were applied basally just before transplanting. For T_2, T_3, T_4 treatments, remaining nitrogen was top dressed in two equal splits during active tillering stage and panicle primordial initiation. For T_5, T_6, T_7 treatments, 25kg N/ha supplied through urea according to Leaf Colour Chart (LCC4) reading. For T_8, T_9, T_{10} treatments, according to Leaf Colour Chart (LCC4) reading nitrogen supplied through nano urea (600 ml/ha).

Randomly five plants are tagged in each treatment in order to record the difference in plant height at different growth stages, number of tillers m^{-2}, leaf area index (LAI) and dry matter production (DMP). Yield attributes like number of panicles per m^{-2} and number of filled grains $panicle^{-1}$ were also recorded from the tagged plants. After harvesting 1000 grain weight, grain yield and straw yield were recorded separately for each plot. The experimental data were statistically analyzed as suggested by Panse and Sukhatme[10].

Growth characters :

Growth characters were greatly influenced by the different levels and split application of nitrogen (table-1). Among the different treatments tried, T_7 [125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea)] recorded the higher plant height (103.21 cm). Increased level and split application of nitrogen might have increased nitrogen availability to the crop which might have enhanced cell division and cell elongation resulting in taller plants. Such a favourable effect of nitrogen on increase in plant height of rice has been reported by many researchers[7,12].

It is observed that T_7 treatment [125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea)] recorded the maximum LAI (5.62), CGR (7.40 g m^{-2} day^{-1}), DMP (11940 kg ha^{-1}) and number of tillers m^{-2} (530.19) Table-1. Increased N translocation to the leaves causes a higher leaf area index at higher levels of N. The main effect of N fertilizers is to accelerate leaf expansion, which enhances canopy absorption of daily solar energy and thus increases dry matter production. Increasing dose and split application of nitrogen consistently raise the soil nitrogen availability during crop growth, which may have supported for increase in number of tillers m^{-2}. Similar results were also reported by Meena *et al.*,[6] and Ramana *et al.*,[13].

Yield attributes and yield :

The yield attributes and yield of lowland rice noticeably influenced by different levels and split application of nitrogen (table 2). Application of 125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea) (T_7) recorded the maximum number of panicles m^{-2} (377.87) and number of filled grains $panicle^{-1}$ (108.26). The improvement in yield-attributing traits can be attributed to improved vegetative growth as a result of N fertilization, which facilitates photosynthesis and thus increases translocation of food materials towards reproductive organs, resulting in the formation of more panicles with fertile grains. A similar findings were reported earlier by Malav *et al.*,[5] and Sorour *et al.*,[16]. Nitrogen increases grain filling and sink size by decreasing the number of defective spikelets and increasing hull size[15].

The maximum grain yield (5450 kg

Table-1. Effect of different levels and split application of nitrogen on growth characters of rice

Treat-ments	Plant height (cm) at harvest	LAI at flowering stage	CGR (g m^{-2} day^{-1}) atflowering to harvest	DMP (kg ha^{-1}) at harvest	No. of tillers m^{-2}
T_1	80.11	3.33	4.48	5585	420.56
T_2	92.61	4.68	6.53	9994	485.45
T_3	89.21	4.38	6.25	9285	471.23
T_4	95.81	4.98	6.94	10772	503.22
T_5	101.71	5.53	7.38	11749	525.8
T_6	97.01	5.12	7.01	10997	505.38
T_7	103.21	5.62	7.40	11940	530.19
T_8	93.71	4.79	6.70	10291	490.25
T_9	90.51	4.50	6.32	9515	475.71
T_{10}	98.71	5.23	7.17	11285	510.11
S.Ed	0.89	0.08	0.08	183	3.60
CD (P= 0.05)	1.81	0.17	0.18	369	7.28

Table-2: Effect of different levels and split application of nitrogen on yield attributes and yield of rice

Treat-ments	No. of panicles m^{-2}	No. of filled grains $panicle^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1	245.98	70.98	2550	3950	39.23
T_2	335.97	93.82	4332	5989	41.97
T_3	322.22	88.53	3952	5583	41.44
T_4	352.28	98.91	4792	6444	42.64
T_5	374.12	106.41	5336	7001	43.25
T_6	357.84	101.42	4922	6572	42.82
T_7	377.87	108.26	5450	7125	43.33
T_8	341.21	95.63	4512	6173	42.22
T_9	327.27	90.44	4076	5730	41.56
T_{10}	360.83	103.14	5102	6757	43.02
S.Ed	3.38	1.54	103	119	0.06
CD (P= 0.05)	6.83	3.12	210	241	0.21

ha^{-1}), straw yield (7125 kg ha^{-1}) and harvest index (43.33) was recorded by T_7 treatment [125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea)]. The increase in grain yield might be due to nitrogen application enhancing the dry matter production, improving rice growth rate. Different levels and split application of nitrogen had profound effect to increase the yield attributing characters which ultimately reflected on grain yield (Table-2). These results are in conformity with the findings of Ombir & Sandeep[8] and Subramanian *et al.*,[17]. The increase in harvest index with increasing levels of nitrogen might be due to better translocation of assimilates from source to sink[18,19].

The results indicated that, the lowland rice well responded to the increased nitrogen dose and split application based on LCC. Therefore application of 125% RDN (50% N basal + LCC4 @ 25kg N/ha through Urea) is the most beneficial practice for augmenting higher rice yield. Also, this practice is found to be agronomically sound, economically viable and can be recommended to the rice growers for realizing better yield and returns.

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