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K Anny Mrudhula
Agricultural Research Station, Bapatla, Andhra Pradesh, India

Y Suneetha
Agricultural Research Station, Bapatla, Andhra Pradesh, India

Corresponding Author:
K Anny Mrudhula
Agricultural Research Station, Bapatla, Andhra Pradesh, India

Effect of nitrogen levels on growth, yield attributes and yield of rice variety BPT 2231- Akshaya

K Anny Mrudhula and Y Suneetha

Abstract
A field experiment was conducted during *kharif*, 2014 and 2015 at Agricultural Research Station, Bapatla to evaluate the effect of different nitrogen levels on growth, yield attributes and yield rice variety BPT 2231- Akshaya. The experiment was laid out in a randomized block design with 7 treatments replicated thrice. Seven levels of nitrogen (80, 120, 160, 200, 240, 280 and 320 kg N ha^{-1}) were used as an experimental treatments. The results revealed that application of 320 kg N ha^{-1} recorded significantly the highest yield attributing characters like productive tillers $plant^{-1}$, panicle length, number of filled grains per panicle and grain yield (5288 and 5325 kg ha^{-1}) while lowest yield was recorded with 80 kg N ha^{-1} treatment. Highest net returns and benefit cost ratio was recorded with 200 kg N ha^{-1} during 2014 and 2015. It can be indicated that application of 200 kg N ha^{-1} is more economical to the BPT 2231 long duration variety in both the years of experimentation. A linear increase in grain yield was observed with continuous rate increase of nitrogen from 80 to 320 kg ha^{-1}.

Keywords: BPT 2231 rice variety, growth, nitrogen and yield

Introduction

Rice (*Oryza sativa* L.) is a staple food for more than half of the world's population. It is staple food for more than half of the global population in about 40 countries and more than 65 per cent of the population in India. Globally it is grown on acreage of 167 million hectares with total production of 769 million tonnes and productivity 4.8 ton per hectare (FAO, 2018) [3]. It has been supporting more people for many years than any other cereals and is one of the three most important food crops in the world, forms the stable diet of 2.7 billion people. In India, it is grown in an area of 43.79 M ha with a total production of 112.9 M t and a productivity of 2578 kg ha^{-1} (Agriculture Statistics, 2018) [1].

Nitrogen, an essential primary nutrient which promotes the growth and development and also influences the availability of other nutrients. It deserves a special status among the major nutrients and is the "mineral of life" for rice crop. It is the most critical input that limits rice productivity in irrigated ecosystem. It takes about 1 kg of nitrogen to produce 15 to 20 kg of grain, but the efficiency of nitrogen use in India is very low (Hegde and Sudhakar Babu, 2001) [5]. Nitrogen (N) is the indispensable nutrient to rice production and its uptakes is affected by rice varieties, environment, soil conditions, crop rotations etc. Managing nitrogen fertilization in rice fields is a challenging task for farmers because of various kinds of losses due to de - nitrification, deep percolation and run-off in flooded soils resulting in low nitrogen use efficiency. While excessive nitrogen promotes lodging and diseases and results in low nitrogen use efficiency, low application of nitrogen will often reduce rice. Among the various factors contributing for rice production, fertilizers play an important role. Use of adequate nitrogen rate is important not only for obtaining maximum economic returns, but also to reduce environmental pollution. Excessive nitrogen application can result in accumulation of large amounts of post-harvest residual soil nitrogen. Residual soil nitrate (NO^{-3}) may be available for subsequent crops in the next season, but such nitrogen is highly susceptible to leaching during non-crop periods. It is important to achieve efficient use of nitrogen in chemical fertilizers, not only through cultivation techniques, but also by breeding varieties with high nitrogen use efficiency and reducing nitrogen inputs from farming to the environment (Sachiko *et al.*, 2009) [15]. Rice varieties may respond differently to nitrogen application. Cultivars selected under high N fertilizer application may not be suitable for soils with low N status. Even after the application of high rates of fertilizer N to rice, expected yield levels might not be obtained. Rice varieties differ in their ability to extract soil and fertilizer N and in its distribution to different plant organs.

Understanding N uptake and assimilation is necessary in any attempt to optimize the efficiency of absorbed N for grain production. Hassan *et al*. (2007) [4] showed that vigorous biomass accumulation could lead to dilution of plant nitrogen content up to the panicle initiation stage, which could lead to inefficient use of N for spikelet formation. It is important to increase the efficiency of soil and fertilizer N by using nutrient efficient varieties. It is hypothesized that the N use efficiency of the rice plant can be optimized by critical leaf, stem and grain N content of rice varieties, which improves the efficiency of grain production. The present investigation was to assess variability in grain yield of rice varieties under optimal and suboptimal nitrogen levels.

Materials and Methods

A field experiment was conducted during *kharif*, 2014 and 2015 at Agricultural Research Station, Bapatla. The experiment was laid out in a randomized block design with 7 treatments replicated thrice. Seven nitrogen levels (80, 120, 160, 200, 240, 280 and 320 kg N ha^{-1}) were used as an experimental treatments. Rice variety BPT 2231- Akshaya was sown separately in nursery and twenty five days old seedlings were transplanted into main field by adopting a spacing of 20 cm between rows and 15 cm between plants with in a row. Nitrogen was applied as per the treatments in three equal splits in the form of urea. First split of nitrogen was applied as basal dose at the time of planting of the crop remaining two equal splits of nitrogen was broadcasted at maximum tillering and panicle initiation stages. Phosphorus was applied at the rate of 60 kg P_2O_5 ha^{-1} in the form of single super phosphate as basal and potassium 40 kg K_2O ha^{-1} in the form of muriate of potash was applied in two equal splits as basal dose at the time of transplanting and panicle initiation stage. Irrigation and weed management was done in time to time. The plant height was measured from ground level to the apex of last fully opened leaf during vegetative period and upto the tip of the panicle after flowering. Panicle length of ten randomly selected panicles from each plot was measured from neck node to the tip of panicle and then averaged and expressed in cm. Number of grains of 10 randomly selected panicles from each plot were counted and then averaged as grains $panicle^{-1}$. Samples of grain collected separately at the time of threshing from each plot were dried properly. 1000-grains from each of these samples were taken and their weights were recorded and expressed in grams. The border rows were harvested first and then, the net plot area was harvested and the produce was threshed by beating on a threshing bench, cleaned and sun dried to 14 per cent moisture level. Grain from net plot area was thoroughly sun dried, threshed, cleaned and weight of grains was recorded and expressed in yield per hectare. The data were analyzed statistically following the method given by Panse and Sukhatme (1978) [12] and wherever the results were calculated at 5 per cent level of significance.

Result and Discussion

Plant height (cm)

Plant height measured at maturity was affected significantly by levels of nitrogen application (Table-1). In general, plant height increased with increase in level of nitrogen application. At maturity significantly the highest plant height was recorded with 320 kg N ha^{-1} (100.8 and 98.3 cm) and it was on par 280 kg N ha^{-1} in 2014 and on par with 280 and 240 kg N ha^{-1} in 2015 when compared to all other treatments and the lowest plant height was recorded with 80 kg N ha^{-1} (91.6 and 87.3 cm) during both the years. Increase in level of nitrogen application 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 (Meena *et al.*, 2011 and Prasad Rao *et al.*, 2011) [8, 13].

Number of productive Tillers/plant

Number of productive tillers/plant recorded at maturity was significantly influenced by the application of nitrogen levels during both the years of study (Table-1). During both the years of study at maturity significantly maximum number of productive tillers/plant were recorded with the application of 240 kg N ha^{-1} (13) where as the lowest number of tillers per plant was recorded with 80 kg N ha^{-1} (10) treatment. Increased availability of nitrogen with increasing dose of nitrogen application might have supported for increase in number of tillers m^{-2}. Similar results were also reported by Latheef and Reddy (2007) [6] and Mamata Meena *et al.* (2013) [17].

Panicle length (cm)

Panicle length varied significantly due to N fertilizer in all the treatments as shown in Table-1. Significantly longest panicle length was obtained with 320 kg N ha^{-1} during both the years (22.7 and 24.5 cm) that was statistically similar with all other treatments except 80 kg N ha^{-1} applied treatment (21.1 and 22.7 cm). Panicle length increased significantly with increased levels of nitrogen. Metwally *et al.* (2017) [9] and Yosef Tabar (2013) [21] also reported the maximum panicle length at highest level of nitrogen application.

Table 1: Effect of nitrogen levels on growth of BPT 2231

Treatment	Plant height (cm)		No of tillers/plant	
	2014	2015	2014	2015
T1-80 kg N/ha	91.6	87.3	10	10
T2- 120 kg N/ha	92.4	87.5	11	11
T3- 160 kg N/ha	95.2	94.4	11	11
T4- 200 kg N/ha	96.6	94.5	12	12
T5-240 kg N/ha	97.6	96.4	13	13
T6-280 kg N/ha	99.0	98.3	12	12
T7-320 kg N/ha	100.8	98.3	12	12
SEm+	0.8	2.3	0.32	0.3
CD (0.05)	2.4	6.8	0.97	0.9
CV (%)	5.7	5.1	5.85	6.0

Number of filled grains $panicle^{-1}$

Total number of filled grains $panicle^{-1}$ was also affected significantly by levels of nitrogen application. Total number of grains $panicle^{-1}$ was increased significantly with increase in fertilizer up to 320 kg N ha^{-1}during both the years of the study. Significantly maximum number of filled grain panicle was recorded with 320 kg N ha^{-1} (239 and 248) when compared to 80 and 120 kg N ha^{-1}. Increased nitrogen application might have supported steady increase in soil nitrogen availability during crop growth which in turn might have increased the length of the panicle and spikelet number $panicle^{-1}$ by enhanced cell division and enlargement (Shekara *et al.*, 2011 and Ramana *et al.*, 2012) [16, 14].

1000 Grain weight (g)

Differences in 1000 grain weight across different treatments followed similar trend as that of total or filled grains panicle^{-1} during both the years of study (Table-2). During both the years of the study, there was a slight increase in 1000 grain weight with increasing nitrogen levels from 0 to 320 kg ha^{-1}. Application of nitrogen fertilizer @ 320 kg ha^{-1} produced maximum weight of 1000-grains (17.9 and 17.7 g), which was significantly higher than the results obtained in 80 kg N ha^{-1}treatment during 2014 and 2015. This might be due to increased translocation of photosynthates from source to sink. Such an increase in 1000 grain weight with the application of nitrogen was also noticed elsewhere (Srivastava *et al*., 2006, Zaidi *et al.*, 2007, Narendra Pandey *et al.*,2008) [18, 22, 10].

Grain Yield (kg ha^{-1})

Grain yield, also followed the trends noticed with that of yield attributing parameters increase in level of nitrogen application increased the yields of rice significantly up to the highest level of nitrogen application, 320 kg ha^{-1}during both the years of the study. Results showed that the maximum grain yield (5288 and 5325 kg N ha^{-1}) while, the minimum grain yield was obtained with 80 kg nitrogen application. The mean per cent increase in grain yield with 80, 120, 160, 200, 240 and 280 kg N ha^{-1} over that of no nitrogen application was 22%, 12.1%, 11.4%, 1.5%, 0.8% and 0.3% during the first and 21.9%, 15.1%, 11.2%, 4.3%, 2.9% and 2.2% in second year of the study, respectively, showing linear response to nitrogen application. The linear response observed in grain yields is also supported by the similar trend noticed with all growth and yield attributing characters studied. The increase in grain yield might be due to nitrogen application enhancing the drymatter production, improving rice growth rate. Fertilizer application with optimum quantity had profound effect to increase the yield attributing characters which ultimately reflected on grain yield. These results are in confirmation with the findings of Ombir Singh *et al.* (2012) [11] and Sunita Gaind and Lata Nain (2012) [19].

Straw Yield (kg ha^{-1})

Rice straw yields (Table-3) were affected by the levels of nitrogen application only unlike that of grain yields but followed similar trend as that of crop growth during both the years of the study. Rice straw yield found to increase with increasing rate of nitrogen application significantly up to 320 kg N ha^{-1} (6480 and 6980 kg ha^{-1}) and the lowest straw yield was recorded with 80 kg N ha^{-1} (5250 and 5265 kg ha^{-1}) in 2014 and 2015. Overall, the increase in straw yield with these treatments might be due to better growth reflected in these treatments in terms of plant height, drymatter accumulation and tillering. These results are in conformity with Yogeshwar Singh *et al.* (2006) [18] and Zayed *et al.* (2011) [23].

Harvest Index

Harvest index was significantly influenced by the nitrogen levels during both the years of the study. The highest harvest index of 45.2% and 45.0% was recorded with 200 kg N ha^{-1} in 2014 and 2015, respectively, but it was on a par with all other treatments except T1 treatment *i.e* 80 kg N ha^{-1}. The increase in harvest index with increasing levels of nitrogen might be due to better translocation of assimilates from source to sink as was observed with number of filled grains per panicle and 1000 grain weight. A few other researchers (Zayed *et al.*, 2011 and Sunita Gaind and Lata Nain, 2012) [23, 19].

Economics

Gross returns, net returns and benefit cost ratio were worked out for different nitrogen levels for BPT 2231 variety. The data on economics presented in Table-4. Among the nitrogen levels 320 kg N ha^{-1} recorded maximum gross returns (96,932 and 97,392) and 200 kg N ha^{-1} recorded highest net returns (19,507 and 19,382) and benefit cost ratio (1.25 and 1.25) during both the years of study. These results are in agreement with the findings of Singh *et al.* (1998) [17] and Dushyant Mishra *et al.* (2015) [2].

Table 2: Effect of nitrogen levels on yield attributes of BPT 2231

Treatment	Panicle length (cm)		No of grains/panicle		Test weight (g)	
	2014	2015	2014	2015	2014	2015
T1-80 kg N/ha	21.1	22.7	188	191	16.7	16.5
T2- 120 kg N/ha	21.5	23.0	201	208	17.2	17.2
T3- 160 kg N/ha	22.1	23.1	221	225	17.3	17.3
T4- 200 kg N/ha	22.3	23.9	230	232	17.9	18.2
T5-240 kg N/ha	22.4	24.4	232	236	17.7	18.8
T6-280 kg N/ha	22.6	24.2	236	240	17.6	18.6
T7-320 kg N/ha	22.7	24.5	239	248	17.9	18.7
SEm+	0.4	0.5	3.33	4.6	0.3	0.2
CD (0.05)	1.3	1.6	18.8	13.9	0.9	0.6
CV (%)	5.9	5.5	5.8	6.5	4.3	0.4

Table 3: Effect of nitrogen levels on grain yield, straw yield and harvest index of BPT 2231

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)		Harvest index (%)	
	2014	2015	2014	2015	2014	2015
T1-80 kg N/ha	4175	4160	5250	5265	44.3	44.1
T2- 120 kg N/ha	4650	4525	5800	5738	44.5	44.1
T3- 160 kg N/ha	4690	4730	5835	5770	44.6	44.4
T4- 200 kg N/ha	5250	5100	6375	6250	45.2	45.0
T5-240 kg N/ha	5260	5170	6460	6475	44.6	44.4
T6-280 kg N/ha	5275	5210	6385	6725	44.8	44.6
T7-320 kg N/ha	5288	5325	6480	6940	44.9	44.7
SEm+	132	126	178	158	0.2	0.2
CD (0.05)	396	378	528	473	0.7	0.6
CV (%)	8.2	7.3	7.8	6.2	5.1	5.8

Table 4: Effect of nitrogen levels on economics of BPT 2231

Treatment	Gross returns		Net returns		B:C Ratio	
	2014	2015	2014	2015	2014	2015
T1-80 kg N/ha	76664	76679	1481	1496	1.02	1.02
T2- 120 kg N/ha	85340	85278	9663	9601	1.13	1.13
T3- 160 kg N/ha	86059	85994	9882	9817	1.13	1.13
T4- 200 kg N/ha	96178	96053	19507	19382	1.25	1.25
T5-240 kg N/ha	95578	95593	18413	18428	1.24	1.24
T6-280 kg N/ha	96615	96955	18956	19296	1.24	1.24
T7-320 kg N/ha	96932	97392	18779	19239	1.24	1.24

Conclusion

Application of appropriate levels of nitrogen is one of important factor to increase the growth and yield of rice varieties. The results of this study indicated that the increased nitrogen levels up to 320 kg N ha^{-1} significantly enhanced the grain yield and the yield components. But application of 200 kg N ha^{-1} is recorded more economical yield when compared to other levels of nitrogen to the BPT 2231- Akshaya. It can be concluded that application of 200 kg N ha^{-1} to the BPT 2231-Akshaya variety is more appropriate when compared to other levels of nitrogen application.

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