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Effect of nitrogen levels on growth, yield, nitrogen uptake and economics of rice variety BPT 2782-Bhavathi

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Abstract
A field experiment was conducted during *kharif*, 2018 and 2019 at Agricultural Research Station, Bapatla to evaluate the effect of different nitrogen levels on growth, yield attributes and yield of rice variety BPT 2782-Bhavathi. 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 200 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 (5688 and 5625 kg ha^{-1}) while lowest yield (4875 and 4860 kg ha^{-1}) 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 both the years 2018 and 2019. It can be indicated that application of 200 kg N ha^{-1} is more economical to the BPT 2782 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 200 kg ha^{-1}.

Keywords: Rice variety, BPT 2782, Bhavathi and nitrogen levels

Introduction
Rice is one of the most important cereal crops of the world which feeds half of the world's population providing 35-60% of the total calorie (Tayefe *et al.*, 2014) [12]. In recent years, rice farmers in India are extensively cultivating modern high yielding rice varieties. Therefore, nutrient management of the high yielding rice varieties is crucial to obtain the desired yield. Among the major nutrient elements, nitrogen (N) is the most limiting nutrient for rice crop growth and yield which is required in higher amounts compared to other nutrients. N influences rice yield by playing major role in the photosynthesis, biomass accumulation, effective tillering, and spikelets formation. Most of the agricultural soils in India are deficient in N (Sarkar *et al*., 2016) [10]. Therefore, N fertilization is imperative for modern rice varieties in order to exploit their full yield potential. High yielding modern rice varieties show a greater response to applied nitrogen, while they differ in N demand depending on their genotype and agronomic traits under different climatic conditions. On the other hand, excessive N application can lead to ground water pollution, increased production cost, reduced yield and environmental pollution (Djaman *et al.,* 2018) [2]. Therefore, variety-specific N fertilizer recommendation could be an effective option for better N management. Considering these, the present study was carried out to study the effect of different N rates on high yielding rice variety. The objectives of the investigation were to determine the optimum N rates of newly released high yielding rice variety.

Methods and Materials
Field experiment was carried out for two consecutive seasons of *kharif*, 2018 and 2019 at Agricultural Research Station, Bapatla. The soil is clay loam in texture. The soil is neutral (pH 7.49) in reaction with low electrical conductivity (0.24 dS m^{-1}). The soil is medium in organic carbon content, low in available nitrogen, medium in available phosphorus and potash. The experiment was laid out in 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 2782- Bhavathi was sown separately in nursery and 25 days old

seedlings were transplanted at 20 cm x 15 cm spacing @ two seedlings per hill in both the years. Nitrogen (Urea) was applied as per treatments in three equal splits (1/3 as basal, 1/3 at maximum tillering and 1/3 at panicle initiation stage). Phosphorus (60 kg ha^{-1}) and potassium (40 kg ha^{-1}) were supplied through single super phosphate and muriate of potash and were uniformly applied to all plots as basal during *kharif* 2018 and 2019. 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) [8] and wherever the results were calculated at 5 per cent level of significance.

Results and Discussions

Plant height (cm)

Plant height was affected significantly with different 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} (89.9 and 91.7 cm) and it was on par 280, 240, 200 and 160 kg N ha^{-1} in 2018 and 2019 when compared to all other treatments and the lowest plant height was recorded with 80 kg N ha^{-1} (83.3 and 85.1 cm). Increase in level of nitrogen application might have increased nitrogen availability to the crop which might have enhanced cell division, photosynthesis metabolism, assimilated production 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 (Prasad Rao *et al.*, 2011 and Contreras *et al.* 2017) [9, 1].

Table 1: Effect of nitrogen levels on growth of BPT 2782

Treatment	Plant height (cm)		No of tillers/plant	
	2018	2019	2018	2019
T1-80 kg N/ha	83.3	85.1	10.0	10.4
T2- 120 kg N/ha	85.3	86.7	12.8	12.5
T3- 160 kg N/ha	86.5	87.4	13.3	13.4
T4- 200 kg N/ha	87.4	88.0	13.3	13.5
T5-240 kg N/ha	86.6	89.6	13.4	13.8
T6-280 kg N/ha	88.3	90.9	13.4	13.6
T7-320 kg N/ha	89.9	91.7	13.4	13.7
S.Em+	1.3	1.4	0.3	0.2
CD (0.05)	3.9	4.3	2.4	0.6
CV (%)	5.4	5.1	7.3	6.7

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 (Table-1). At maturity significantly maximum number of productive tillers/plant were recorded with the application of 240 kg N ha^{-1} (13.4 and 13.8) where as the lowest number of tillers per plant was recorded with 80 kg N ha^{-1} (10 and 10.4) treatment. Nitrogen fertilization played a vital role in cell division and might have supported for increase in number of tillers m^{-2}. Similar results were also reported by Mamata Meena *et al.* (2013) [5].

Panicle length (cm)

Panicle length varied significantly due to N fertilizer in all the treatments as shown in Table-2. Significantly longest panicle length was obtained with 320 kg N ha^{-1} during both the years (22.2 and 22.5 cm) that was statistically similar with all other treatments except 80 120 kg N ha^{-1} applied treatment (21.0 and 21.3 cm). Panicle length increased significantly with increased levels of nitrogen. The increase in panicle length with N fertilization was reported by Yosef Tabar (2013) [15] and Gewaily *et al.* (2018) [4].

Table 2: Effect of nitrogen levels on yield attributes of BPT 2782

Treatment	Panicle length (cm)		No of filled grains/panicle		Test weight (g)	
	2018	2019	2018	2019	2018	2019
T1-80 kg N/ha	21.0	21.3	186	181	14.4	14.2
T2- 120 kg N/ha	21.1	21.2	198	194	14.5	14.3
T3- 160 kg N/ha	21.3	21.5	210	218	14.6	14.4
T4- 200 kg N/ha	21.4	21.6	216	215	14.7	14.5
T5-240 kg N/ha	21.6	21.8	220	224	14.8	14.6
T6-280 kg N/ha	21.8	21.9	225	228	14.8	14.8
T7-320 kg N/ha	22.2	22.5	234	232	14.9	14.9
S.Em+	0.3	0.3	5.8	6.6	0.1	0.2
CD (0.05)	0.9	1.0	17.4	19.9	0.3	0.6
CV (%)	5.3	5.6	8.8	7.1	4.2	5.6

Number of filled grains panicle^{-1}

Total number of filled grains panicle^{-1} was also affected significantly by the levels of nitrogen application. Total number of filled 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} (234 and 232) when compared to 80 and 120 kg N ha^{-1}. The increase in the number of filled grains with increase in N rates indicates that N fertilization is important for both source and sinks development (Yesuf & Balcha, 2014) [13].

1000 Grain weight (g)

Differences in 1000 grain weight among the treatments followed similar trend as that of total of filled grains panicle^{-1} (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 (14.9 and 14.9 g), which was significantly higher than the results obtained in 80 kg N ha^{-1}treatment during 2018 and 2019. 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 (Zaidi *et al.*, 2007 and Narendra Pandey *et al.*, 2008) [16, 6].

Grain Yield (kg ha^{-1})

Grain yield, also followed the same 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 during both the years of the study. Results showed that the maximum grain yield (5688 and 5625 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 yield 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. These results are in confirmation with the findings of Ombir Singh *et al.* (2012) [7] and Sunita Gaind and Lata Nain (2012) [11].

Table 3: Effect of nitrogen levels on grain yield, straw yield and Harvest index of BPT 2782

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)		Harvest Index (%)	
	2018	2019	2018	2019	2018	2019
T1-80 kg N/ha	4875	4860	5250	5265	43.0	42.9
T2- 120 kg N/ha	4950	5225	5800	5738	44.0	44.1
T3- 160 kg N/ha	5190	5230	5835	5970	44.4	44.4
T4- 200 kg N/ha	5325	5336	6175	6250	45.2	45.0
T5-240 kg N/ha	5400	5470	6260	6475	45.1	45.0
T6-280 kgN/ha	5575	5510	6385	6725	45.2	45.0
T7-320 kg N/ha	5688	5625	6480	6940	45.1	45.1
S.Em+	132	126	178	158	0.7	0.7
CD (0.05)	396	378	528	473	2.1	2.1
CV (%)	8.2	7.3	7.8	6.2	5.1	5.8

Straw Yield (kg ha^{-1})

Rice straw yields (Table-3) were affected by the levels of nitrogen application 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 2018 and 2019. 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) [14] and Zayed *et al.* (2011) [17].

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 2018 and 2019, 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) [17, 11].

Nitrogen content and uptake in rice grain and straw

Significant difference was observed in nitrogen content and uptake among different levels of nitrogen applied to rice crop. Maximum nitrogen content and uptake (Table 4) both in rice grain (1.42% and 79.87 kg/ha) and straw (1.44% and 99.93 kg/ha) was observed by the application of the 320 kg N ha^{-1}. While lower nitrogen content and uptake of both rice grain and straw was registered by applying 80 kg N/ ha^{-1} in 2018 and 2019.

Economics

Gross returns, net returns and benefit cost ratio were worked out for different nitrogen levels for BPT 2782-Bavathi variety. The data on economics presented in Table-4. Among the nitrogen levels 320 kg N ha^{-1} recorded maximum gross returns (95,932 and 96,392) 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) and Dushyant Mishra *et al.* (2015) [3].

Table 4: Effect of nitrogen levels on nitrogen content and nitrogen uptake in rice grain and straw of BPT 2782

Treatments	Nitrogen content in grain (%)	Nitrogen uptake in grain (kg/ha)	Nitrogen content in straw (%)	Nitrogen uptake in straw(kg/ha)
T1-80 kg N/ha	1.23	59.78	0.87	45.80
T2- 120 kg N/ha	1.28	66.88	1.02	58.52
T3- 160 kg N/ha	1.37	71.65	1.39	82.98
T4- 200 kg N/ha	1.40	74.70	1.42	88.75
T5-240 kg N/ha	1.40	76.58	1.43	92.59
T6-280 kg N/ha	1.41	77.69	1.44	96.84
T7-320 kg N/ha	1.42	79.87	1.44	99.93
S.Em±	0.04	2.23	0.02	5.53
CD (P=0.05)	0.11	6.69	0.06	16.59
CV (%)	9.5	10.9	4.9	9.7

Table 5: Effect of nitrogen levels on economics of BPT 2782

Treatment	Gross returns		Net returns		B:C Ratio	
	2018	2019	2018	2019	2018	2019
T1-80 kg N/ha	75664	75679	1481	1496	1.02	1.02
T2- 120 kg N/ha	84340	84278	9663	9601	1.13	1.13
T3- 160 kg N/ha	85059	84994	9882	9817	1.13	1.13
T4- 200 kg N/ha	95178	95053	19507	19382	1.25	1.25
T5-240 kg N/ha	94578	94593	18413	18428	1.24	1.24
T6-280 kg N/ha	95615	95955	18956	19296	1.24	1.24
T7-320 kg N/ha	95932	96392	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 2782- Bhavathi. It can be concluded that application of 200 kg N ha^{-1} to the BPT 2782-Bavathi variety is more appropriate when compared to other levels of nitrogen application.

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