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Growth, yield and nitrogen uptake of direct seeded rice varieties under variable nitrogen rates

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Abstract
A field experiment was carried out during *kharif* seasons of 2017 and 2018 at College farm, Agricultural College, Bapatla, Andhra Pradesh, India to evaluate the response of direct seeded rice varieties to different doses of nitrogen on growth, yield and uptake of nitrogen and were significantly influenced by varieties and nitrogen levels. The experiment was conducted in split plot design with main plot treatments three varieties *viz.*, NLR-145, BPT-5204 and NLR-34449 and sub plot treatments with four nitrogen levels *viz.*, 60 kg N ha^{-1}, 80 kg N ha^{-1}, 100 kg N ha^{-1} and 120 kg N ha^{-1} replicated thrice. The results revealed that among varieties, BPT-5204 recorded significantly highest plant height, number of tillers m^{-2}, drymatter accumulation, and yield and nitrogen uptake and was on par with the variety NLR-145 during both the years of study. Among nitrogen levels application of 120 kg N ha^{-1} showed significantly highest plant height, number of tillers m^{-2}, drymatter accumulation, yield and nitrogen uptake over other nitrogen levels *viz.*, 60 kg N ha^{-1}, 80 kg N ha^{-1} and 100 kg N ha^{-1} during two successive years.

Keywords: Direct seeded rice, varieties, nitrogen levels and nitrogen uptake

Introduction
Rice (*Oryza sativa* L.) is the most consumed cereal grain in the world, constituting the dietary staple food of more than half of the world population and referred to as “Global grain”. The theme on rice as “Rice is life” was used for international year of rice- 2004, denoting its overwhelming importance as an item of food and commerce by the United Nations. Globally, 1.4 billion ha of cultivable land is available. In rice growing countries, India has largest area under rice in the world *i.e.*, 44.11 million ha and ranks second in production with 108.92 million tonnes and productivity of 2391 kg ha^{-1}. Among states, Andhra Pradesh had an area of 2.39 million hectares under rice crop with a production of 7.23 million tonnes and productivity of 3022 kg ha^{-1} (www.Indiastat.com, 2016-17) [12]. Among the agronomic factors, fertilizer stands foremost and is one of the most productive inputs in agriculture. Nitrogen is the most critical element in crop production (Nachimuthu *et al*. 2007) [4]. It is vital for maintaining and improving rice crop growth and yield. Direct seeding is becoming an attractive alternate to transplanting of rice. Farmers are shifting to direct sowing to reduce labour input, drudgery and cost of cultivation. It is replacing the traditional planting in areas with good drainage and water control. Varieties respond differently to different nitrogen levels of nitrogen. Recently a few high yielding varieties suitable for cultivation have been released, but their responsiveness to different nitrogen levels have to be studied for suitable recommendations. Hence, the present investigation was undertaken to study the response of direct seeded rice varieties to different doses of nitrogen on growth, yield and uptake of nitrogen.

Material and Methods
A field experiment was carried out on clay loam soil of Agricultural College Farm, Bapatla during *kharif* seasons 2017 and 2018. The soil was slightly alkaline in reaction (pH 7.8) and medium in organic carbon (0.50%), low in available nitrogen (242 kg ha^{-1}), medium to high in available phosphorus (38 kg ha^{-1}) and high in available potassium (434 kg ha^{-1}).The experiment was laid out in split plot design and replicated thrice. Main plot treatments comprised of three varieties *viz.*, NLR-145, BPT-5204 and NLR-34449 and sub plot treatments with four nitrogen levels *viz.*, 60 kg N ha^{-1}, 80 kg N ha^{-1}, 100 kg N ha^{-1} and 120 kg N ha^{-1}.

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Rice Crop was sown on 2nd August in *kharif* 2017 and 6th August in *kharif* 2018. Nitrogen was applied as per the treatments in three splits (1/2 as basal, ¼ at maximum tillering stage and ¼ at panicle initiation stage). A recommended dose of phosphorus of 60 kg P_2O_5 ha^{-1} and potassium 40 kg K_2O ha^{-1} was applied uniformly to all plots as basal in form of Single Super Phosphate and Muriate of Potash, respectively. Other recommended agronomic practices and plant protection measures were taken up timely. Pre and post-harvest observations in respect to both growth and yield parameters were recorded following standard procedures

Results and discussion

Growth

Data pertaining to growth characters for both the years is presented in Table.1 and indicated that the variety BPT-5204 recorded significantly highest plant height (102.1 cm and 97.6cm during 2017 and 2018, respectively), number of tillers m^{-2} (316 and 298 during 2017 and 2018, respectively), drymatter accumulation (14192 and 13974 kg ha^{-1} during 2017 and 2018, respectively) which was significantly superior over NLR-34449 and was on parity with the variety NLR-145. The shortest plant height, less number of tillers m^{-2} and least drymatter accumulation was recorded with the variety NLR-34449 during both the years of experiment. This variation in growth characters of varieties could be due to difference in their genetic makeup, its adaptation to the environment. These findings corroborate with earlier findings of Kumar *et al.* (2017) [2] and Shukla *et al.* (2015) [10].

Among nitrogen levels, taller plants were recorded significantly with 120 kg N ha^{-1} (110.2 and 102.1 cm during 2017 and 2018, respectively) which was on par with the 100 kg N ha^{-1} and significantly superior over 80 and 60 kg N ha^{-1}. Paul *et al.* (2016) [6] who stated that nitrogen is the main growth promoter element and helps for more synthesis of food resulting into greater cell division and cell enlargement. The shorter plants were recorded with 60 kg N ha^{-1}.

Significantly higher number of tillers m^{-2} (348 and 330 during 2017 and 2018, respectively), drymatter accumulation (14171 and 14060 kg ha^{-1} during 2017 and 2018, respectively) was observed with 120 kg N ha^{-1} and was statistically superior over other levels. The lower number of tillers m^{-2} and drymatter accumulation was recorded with the application of 60 kg N ha^{-1}. The results are in line with Saha *et al.* (2017) [8] and Kumar *et al.* (2017) [2] who stated that the nitrogen seems to have played a vital role in the formation of new tissues which are dependent on the protoplasmic structure, cell division and cell elongation.

Table 1: Plant height, Number of tillers m^{-2} and Drymatter accumulation of direct seeded rice as influenced by varieties and nitrogen levels during *kharif* 2017 and 2018

Treatments	2017			2018		
	Plant height (cm)	Number of tillers m^{-2}	Drymatter accumulation (kg ha^{-1})	Plant height (cm)	Number of tillers m^{-2}	Drymatter accumulation (kg ha^{-1})
Varieties						
V_1- NLR-145	93.7	303	12824	90.3	290	12740
V_2- BPT-5204	102.1	316	14192	97.6	298	13974
V_3- NLR-34449	87.5	278	11247	82.2	259	11456
S.Em±	2.7	6.92	376.09	2.61	7.57	360.59
CD (p = 0.05)	10.7	27	1477	10.2	30	1416
CV (%)	10.0	8.0	10.2	10.0	9.3	9.8
Nitrogen levels						
N_1- 60 kg ha^{-1}	80.1	251	11216	77.8	238	11258
N_2- 80 kg ha^{-1}	89.9	284	12206	87.7	268	12213
N_3- 100 kg ha^{-1}	98.8	313	13423	93.6	295	13363
N_4- 120 kg ha^{-1}	110.2	348	14171	102.1	330	14060
S.Em±	3.82	9.07	404.14	2.84	7.28	359.14
CD (p = 0.05)	11.4	27	1201	8.5	22	1067
CV (%)	12.1	9.1	9.5	9.5	7.7	8.5
Interaction						
VX N	NS	NS	NS	NS	NS	NS
N X V	NS	NS	NS	NS	NS	NS

Yield Attributes and Yield

Data regarding yield attributes and yield for both the years is presented in Table 2 and Figure 1. During 2017, in case of varieties significantly highest number of filled grains $panicle^{-1}$ (149), grain yield (5962 kg ha^{-1}), straw yield (7076 kg ha^{-1}) and harvest index (46.0%) were recorded with BPT-5204 and was statistically comparable to NLR-145 and found significantly superior over the variety NLR-34449. Similar trend was observed during 2nd year of investigation. The increase in yield attributes and yield of rice might be due to higher availability of nutrients as evidenced from N content in grain and straw at harvest subscribes to the view that there was greater availability of growth inputs matching with formation and development of yield components as reported by Srilatha *et al.* (2013) [11].

With respect to nitrogen levels, significantly higher number of filled grains $panicle^{-1}$ (155), grain yield (5903 kg ha^{-1}) and straw yield (7637 kg ha^{-1}) was found to be higher with higher nitrogen doses. Lower number of filled grains $panicle^{-1}$, grain yield and straw yield was registered with 60 kg N ha^{-1} during 2017-18. Harvest index was not influenced by nitrogen levels. The results are in accordance with the Nayak *et al.* (2016) [5] and Meena *et al.* (2017) [3] who stated that increased nitrogen application makes better availability of nitrogen for the vegetative growth of crop and contributes carbohydrates from photosynthetic activity resulting in better partitioning and efficient translocation of photo-assimilates to sink (grain) thereby increased number of filled grains per panicle.

Interaction effect of varieties and nitrogen levels was significant with grain yield and presented in Table 4.3 reveals that the treatment combination variety BPT-5204 and application of higher dose of nitrogen (120 kg Nha^{-1}) registered highest grain yield. Variety BPT-5204 was on par with NLR-145 at same level of nitrogen (120 kg N ha^{-1})

during 2017-18. During 2018-19, variety BPT-5204 was on par with NLR-145 variety at same nitrogen levels (60, 80 and 100 kg N ha^{-1}). These results are in close conformity with those of Bhat *et al.* (2015) [1] who earlier reported that higher growth and yield attributes together with increased photosynthetic efficiency under high level of nitrogen in the long duration variety BPT-5204 and lead to enhanced photosynthetic accumulation and translocation together contributed for higher grain yield.

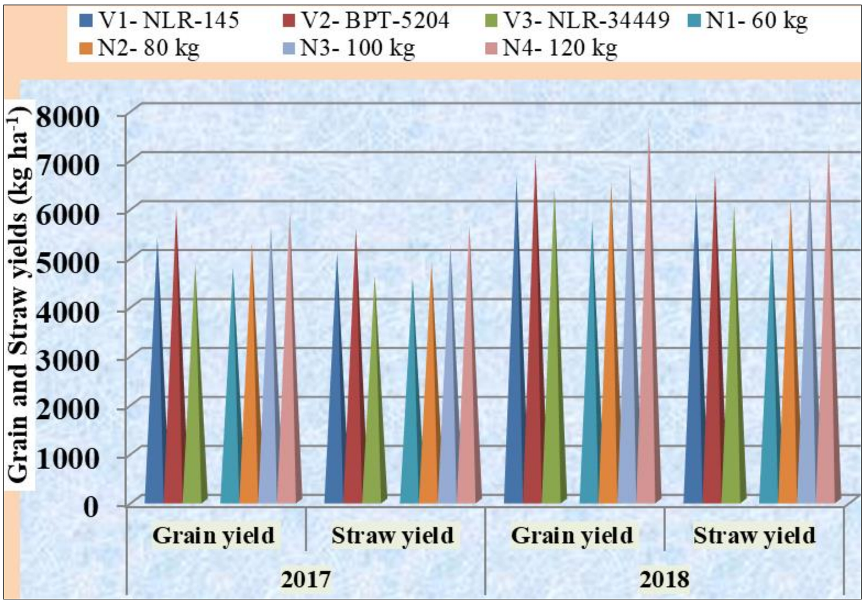

Fig 1: Grain and Straw yields (kg ha^{-1}) of direct seeded rice as influenced by varieties and nitrogen levels during *kharif* 2017 and 2018

Nitrogen Uptake

A perusal of data (Table. 2) on nitrogen uptake at harvest separately by grain and straw was highest (68.0 and 65.8 kg ha^{-1} by grain and 29.5 and 28.0 kg ha^{-1} by straw during 2017 and 2018, respectively) with the variety BPT-5204 which was significantly superior over NLR-34449 and was on parity to NLR-145. The least nitrogen uptake by grain and straw was observed with NLR-34449 variety. The highest uptake might be due to the fact that the drymatter accumulation was relatively higher and it was multiplied with the nitrogen contents. Similar results were also reported by earlier scientists Rao *et al.* (2013) [7].

With regards, nitrogen levels, highest nitrogen uptake was recorded with 120 kg ha^{-1} (69.8 and 67.8 by grain and 29.4 and 28.1 kg ha^{-1} by straw during 2017 and 2018, respectively) and showed significantly superior over 100, 80 and 60 kg N ha^{-1}. The lowest nitrogen uptake was recorded with the application of lower dose of nitrogen level. It could be attributed due to higher supply and availability of nitrogen at higher nitrogen level and also due to highest grain yield coupled with highest nitrogen concentration in grain. The present results are in consonance with the research findings of Sandhu and Mahal (2014) [9].

Table 2: Number of filled grains panicle^{-1}, Grain yield, Straw yield, Harvest Index and Nitrogen uptake by grain and straw of direct seeded rice as influenced by varieties and nitrogen levels during *kharif* 2017 and 2018

Treatments	2017						2018					
	Number of filled grains panicle^{-1}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	Nitrogen uptake (kg ha^{-1})		Number of filled grains panicle^{-1}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	Nitrogen uptake (kg ha^{-1})	
					Grain	Straw					Grain	Straw
Varieties												
V_1- NLR-145	137	5383	6636	45.0	62.4	26.0	135	5082	6291	45.2	61.0	24.7
V_2- BPT-5204	149	5962	7076	46.0	68.0	29.5	146	5581	6715	46.1	65.8	28.0
V_3- NLR-34449	126	4843	6382	43.2	55.2	23.1	124	4612	6043	44.1	52.6	22.7
S.Em±	2.69	185.21	134.15	0.31	2.05	0.98	1.96	167.43	120.13	0.39	1.23	0.89
CD (p = 0.05)	11	589	527	1.2	7.5	3.9	8	515	472	1.5	4.8	3.5
CV (%)	6.9	6.4	7.0	5.3	11.3	13.0	8.0	7.9	6.6	5.1	7.0	12.3
Nitrogen levels												
N_1- 60 kg ha^{-1}	110	4778	5734	45.5	54.9	22.5	113	4565	5390	46.5	52.5	21.8
N_2- 80 kg ha^{-1}	132	5288	6523	44.8	58.2	25.3	129	4890	6131	44.9	55.7	24.4
N_3- 100 kg ha^{-1}	146	5616	6898	45.7	61.7	27.3	143	5263	6623	45.2	58.9	26.3
N_4- 120 kg ha^{-1}	155	5903	7637	43.6	69.8	29.4	152	5647	7256	44.2	67.8	28.1
S.Em±	2.02	100.03	174.22	0.77	2.67	0.63	2.33	129.13	169.33	0.99	2.93	0.56
CD (p = 0.05)	6	285	518	NS	8.0	1.9	7	381	503	NS	8.8	1.7
CV (%)	8.5	7.4	7.8	5.5	18.9	16.1	8.2	7.7	8.0	6.6	15.9	15.4
Interaction												
VX N	NS	S	NS	NS	NS	NS	NS	S	NS	NS	NS	NS
N X V	NS	S	NS	NS	NS	NS	NS	S	NS	NS	NS	NS

Table 3: Interaction between varieties and levels of nitrogen on grain yield (kg ha^{-1}) of direct seeded rice during 2017 and 2018

Treatments	Levels of Nitrogen applied to rice (2017)				Mean	Levels of Nitrogen applied to rice (2018)				Mean
	N_1 -60 kg ha^{-1}	N_2 -80 kg ha^{-1}	N_3-100 kg ha^{-1}	N_4 -120 kg ha^{-1}		N_1 -60 kg ha^{-1}	N_2-80 kg ha^{-1}	N_3-100 kg ha^{-1}	N_4 -120 kg ha^{-1}	
V_1- NLR-145	4852	5025	5627	6029	5383	4615	4912	5359	5441	5082
V_2- BPT-5204	4976	6122	6200	6548	5962	4752	5127	5720	6727	5581
V_3- NLR-34449	4504	4716	5020	5131	4843	4329	4631	4710	4773	4612
Mean	4778	5288	5616	5903		4565	4890	5263	5647	
	S.Em±	CD (*p*=0.05)	CV (%)			S.Em±	CD (p=0.05)	CV (%)		
Main Plot	185.21	589	6.4			167.43	515	7.9		
Sub Plot	100.03	285	7.4			129.13	381	7.7		
Interaction										
VXN	176.87	538				225.78	681			
NXV	168.07	499				223.66	664			

Conclusion

Direct sown variety BPT-5204 recorded significantly highest plant height, number of tillers m^{-2}, drymatter accumulation, and yield and nitrogen uptake. Among nitrogen levels application of 120 kg N ha^{-1} showed significantly highest plant height, number of tillers m^{-2}, drymatter accumulation, yield and nitrogen uptake over other nitrogen levels *viz.*, 60 kg N ha^{-1}, 80 kg N ha^{-1} and 100 kg N ha^{-1} during two successive years of study. Therefore, variety BPT-5204 responded well to higher doses of fertilizer in attaining higher yields.

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