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Study on difference in morphological, physiological and yield parameters with two different levels of nitrogen in rice genotypes

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Abstract
Rice is the one of the major staple food crop across the world. With growing population the rice productivity has to be increased from present 2.05 t/ha to 3.3 - 4.05t/ha in the next 40 years to keep pace with the increasing demand for rice. This is achieved with increased input levels especially the fertilizers. However, an excessive application of chemical fertilizer often leads to a series of environmental problems. Nitrogen (N) is the key major nutrient element required in large quantities by rice. Only 30–40% of the applied N reaches the plant and the remaining is lost to the environment. N is lost through ammonia volatilization, denitrification, surface runoff and leaching in irrigated lowland rice cultivation. Leaching of nitrogen may lead to water contamination and eutrophication of water bodies. Thus, developing rice varieties that are less dependent on the heavy application of N fertilizers is essential for the sustainable agriculture production.

Keywords: Nitrogen, productivity, fertilizer, environment

Introduction
India is the second largest producer of rice and has the world's largest area. Earlier, rice was mostly cultivated under native soil fertility conditions without much use of fertilizers. During green revolution, the introduction of semi-dwarf high yielding rice varieties made rice productivity heavily reliant on artificial fertilization. Since 1960's, yields of agricultural crops have been continuously increased with the increase in fertilizer inputs, especially N (Cassman 1999) [1]. Fertiliser consumption especially Nitrogen fertilizer has increased. The amount of nitrogen increases as yield increases. A large amount of nitrogenous fertilizer is applied to fields to maximize rice yields due to its impact on plant productivity. In India, around ~220 kg of urea is applied for irrigated rice in general as three split doses viz., basal, vegetative and panicle initiation stages (Raghuveer Rao *et al*., 2014) [5]. Since the uptake of N from soil lasts only for few weeks, the mismatching of nitrogen availability with crop requirements also leads to excess N losses (Robertson and Vitousek 2009) [4]. The excess nitrogen fertilizer use, increases environmental pollution and the cost of the rice cultivation. The role of greenhouse gases viz., methane and nitrous oxide emitting from rice fields has emphasized the use of rationale nitrogen fertilization. Therefore, it is important to aim at efficient use of nitrogen through management techniques and also by developing varieties with high nitrogen use efficiency.

Material and Methods
The field experiment was conducted at Indian Institute of Rice Research, Rajendranagar, Hyderabad during *Kharif* 2016. It comes under Southern Telangana agro-climatic zone of Telangana state. The weather data on rainfall, number of rainy days, mean maximum and minimum temperatures, relative humidity, evaporation and sunshine hours recorded from June to November 2016 at the Meteorological Observatory of Agricultural Research Institute, Rajendranagar, Hyderabad.

A field experiment was conducted with 2 nitrogen levels of T1- 50% Recommended Dose of Nitrogen and T2-100% Dose of Nitrogen and 12 rice genotypes with 3 replications. Recommended P:K (60:40) along with two treatments of nitrogen was applied. Recommended dose of fertilizer was applied in the form of urea, single super phosphate and muriate of potash. Nitrogen was applied in three splits at basal stage, maximum vegetative stage and panicle initiation stage whereas P2O5 and K2O was applied @ 60:40 kg/ha as basal. One month old seedlings were transplanted in the main field. A spacing of 20x10cm was adopted uniformly. A thin layer of 2-3 cm water was maintained constantly till the establishment of seedlings. Thereafter about 5 cm of water was maintained up to dough stage of the crop. Irrigation was withheld at the physiological maturity of the crop. Five plants per plot were sampled at vegetative stage, flowering and harvest stage for recording the observations. The observations were made on different agronomic and physiological characters in each treatment.

Plant height (cm)

The plant height measured from base of the plant to the tip of the terminal leaf or panicle on main stem.

Stem thickness (cm)

Stem thickness was measured at the base of the mother stem using a digital caliper.

Number of green leaves

Number of green leaves on the tagged plants was counted.

Days to 50% flowering

The number days taken for 50% of plants to flower in each variety in both treatments were noted in days to 50% flowering.

Days to maturity

In rice, as physiological maturity approaches the erect flag leaves starts desiccating. The number of days taken from sowing to physiological maturity was recorded and expressed in days.

Shoot biomass and Root biomass

Plants were uprooted from the field and separated into leaves, stem and panicle (at harvest) and oven dried at 80°C for 3 days until constant weight was attained. Shoot and Root biomass expressed as g plant-1 was recorded using electronic balance.

SPAD Chlorophyll meter readings (SCMR)

The SPAD (Soil Plant Analytical Development) chlorophyll meter readings (SPAD 502; Minolta Company Ltd) measures the greenness or relative chlorophyll content of leaves. This meter enables to obtain instant readings without destroying the plant tissue. The third leaf from top was used for measuring SCMR, which was taken midway between the leaf base and tip.

Nitrogen Use Efficiency

NUE (in kilograms of grain per kilogram of N applied) were calculated as following equation = Yield/Ninput (Zhang *et al*., 2018) [7].

Yield and yield components

The parameters like number of productive tillers per plant, number of grains per panicle and spikelet sterility and grain yield per plant were recorded at maturity for assessing the relationship between yield and its components.

Data processing and statistical analysis

The data generated on various parameters during the course of investigation were statistically analysed by applying the technique of analysis of variance (Gomez, 1984) [6].

Results and Discussion

Morphological traits

Morphological parameters showed increased values with increase in nitrogen level. But the increase is below 20%. Among T1 and T2, T2 has 10% increase in mean plant height, 16% increase in stem thickness and number of green leaves, 19% increase in shoot biomass and 11% increase in root biomass than T1. Adequate N always increased the amount of protoplasm and chlorophyll which are key factors for increasing leaf area which inturn might have enhanced dry matter production of rice (Kwo & Chen, 1980).

SPAD readings

Among T1 and T2 SPAD readings were increased with N levels. T2 showed 12% increase than that of T1. Genotypes grown at N2 conditions had significant differences ($P<0.01$) for SPAD reading, while genotypic differences were not appeared at N0 and N1 conditions (Ferhat, *et al*., 2017) [3].

Nitrogen Use Efficiency

The results showed that the NUE was higher for T1 than T2. There was a significant difference in the NUE among the treatments (Table 3). It is due to less utilization when compared to absorption at higher N concentration. Decreasing NUE at higher N rates indicates that rice plants could not absorb or utilize N at higher rates or that N loss exceeded the rate of plant uptake (Devika *et al.,* 2018) [2].

Yield and Yield parameters

The 1000 grain weight was almost similar at T1 and T2, whereas there is a slight increase in grain yield at T2. Thus, a small decrease in the theoretical maximum achievable yield caused by reduction of N application rate will not severely reduce the grain yield in practice (Zhang *et al*., 2018) [7]. As the ultimate requirement is yield, the plot treated with T1 treatment has no much difference when compared to T2. Thus applying half amount of recommended dose of nitrogen will give the yield by reducing effect on the environment.

Table 1: Study on influence of different nitrogen levels on morphological parameters in rice genotypes

Genotypes	Plant height		Stem thickness		No. of leaves		Days to 50% flowering		Days to maturity		Shoot biomass		Root biomass	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Varadhan x BPT 5204/6	109.33	114.67	9.9	11.5	72	119	95	97	125	125	62.2	59.6	4.4	4.68
Varadhan x BPT 5204/10	97.33	107.67	9	10.9	98	102	112	113	141	143	54.5	72.3	6.01	3.83
Sampada x Jaya/2	105.67	122	9.7	11.6	85	115	111	112	139	142	53.8	82.2	5.52	7.37
Sampada x Jaya/3	106	118.67	9.4	10.9	84	65	107	108	135	136	50.1	59.5	5.63	6.61
Varadhan x MTU 1010/2	103	112.67	9.4	11	86	106	96	99	126	127	51.3	63.1	4.14	4.13
Rasi x Jaya/2	100.33	108.67	9.5	10.6	107	84	88	89	116	117	44.1	61.9	2.66	5.4
Varadhan	96.33	103.33	8.4	10.9	77	80	86	87	115	115	42.4	57.3	3.36	5.29
BPT-5204	120	125.33	9.8	12.3	87	102	109	109	137	137	45.1	77.3	7.32	5.89

Sampada	113.33	124.33	9.6	10.8	75	125	111	111	139	140	52.3	74	4.81	6.01
Jaya	106.33	120.67	9.8	11.5	110	75	112	112	141	141	53.6	66.7	5.08	5.74
MTU-1010	127.67	136.33	8.6	11.4	60	104	100	100	128	128	84.3	77.5	5.85	6.76
Rasi	105.33	111.33	9.9	11.2	70	107	111	112	141	142	60.1	66.3	3.51	4.08
Mean	107.6	117.1	9.4	11.2	84	99	103	104	132	133	54.5	68.1	4.86	5.48
Treatments (T)	*		*		*		NS		NS		NS		NS	
Genotypes (G)	*		*		*		NS		NS		*		*	
T xG	NS		NS		*		NS		*		NS		NS	

*significant at 5 % level of significance

Table 2: Study of influence of different N levels on physiological parameters in rice genotypes

Genotypes	SPAD readings		NUE	
	T1	T2	T1	T2
Varadhan x BPT 5204/6	27.6	36.2	15.88	6.3
Varadhan x BPT 5204/10	30.2	37.3	10.4	6.7
Sampada x Jaya/2	33.1	36.3	13.26	8.38
Sampada x Jaya/3	29.6	35.8	9.52	5.32
Varadhan x MTU 1010/2	32.2	33.3	14.44	7.59
Rasi x Jaya/2	29.7	35.4	15.78	8.15
Varadhan	37.4	38.4	15.94	8.51
BPT-5204	32.4	34.6	11.84	6.15
Sampada	35.3	34.4	12.88	7.91
Jaya	30.2	37.2	13.86	8.7
MTU-1010	32.3	40.2	16.38	4.06
Rasi	31.3	32.7	15.22	7.49
Mean	31.8	36	13.78	7.11
Treatments (T)	NS		*	
Genotypes (G)	NS		*	
T xG	NS		*	

Table 3: Study on influence of different N levels on yield parameters in rice genotypes

Genotypes	1000 grain weight (g)			Grain yield (g m-2)		
	T1	T2	Mean	T1	T2	Mean
Varadhan x BPT 5204/6	24.2	23.7	24	794	630	712
Varadhan x BPT 5204/10	14	13.5	13.8	520	670	595
Sampada x Jaya/2	16.1	15.6	15.9	663	838	751
Sampada x Jaya/3	26.7	28.5	27.6	476	532	504
Varadhan x MTU 1010/2	24.3	23.9	24.1	722	759	741
Rasi x Jaya/2	22	24.3	23.2	789	815	802
Varadhan	21.9	21.4	21.7	797	851	824
BPT-5204	26.5	26.9	26.7	592	615	604
Sampada	16.6	16.5	16.6	644	791	718
Jaya	16.3	16.2	16.3	693	870	782
MTU-1010	24.5	23.8	24.2	819	406	613
Rasi	14.4	14.4	14.4	761	749	755
Mean	20.6	20.7	20.7	689.2	710.5	699.8
Treatments (T)		NS			NS	
Genotypes (G)		*			*	
TxG		*			NS	

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