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Effect of Different Levels of Nitrogen on SPAD Readings and Yield in Rice (*Oryza sativa* L.) Varieties

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ABSTRACT

An investigation was carried out during *kharif-2019* and *kharif-2020* to study the response of rice varieties on growth and yield parameters under four nitrogen levels (0, 120, 240 and 360 kg N ha^{-1}) as main treatments and three varieties *viz*. BPT5204, NDLR-7and NLR 34449 as sub treatments. The present investigation the SPAD reading increased with the increase in the N application rates. Higher SPAD readings were recorded at tillering stage, panicle initiation and flowering stage. Among the varieties NDLR-7 (V_2) recorded significantly higher SPAD readings (30.40) compared to BPT 5204 (29.4) (V_1). However, SPAD reading of BPT 5204 and NLR 34449 is on par. This variety also recorded higher number of productive tillers (9.50) maximum grain yield 5681.03 kg ha^{-1}. The interaction effect is significant and higher yield was recorded in the combination of 120 kg N ha^{-1} in NDLR-7(7496.77 kg ha^{-1}) and lowest grain yield was recorded in the combination of 360 kg N ha^{-1}in BPT 5204(3141.66 kg ha^{-1}).With increasing N application dose the varieties response is varied significantly but with the higher dose of N all the varieties recoded lower yields. Hence application of the intermediate level of nitrogen was economical and environment-friendly.

Keywords: *Rice varieties, SPADreadings and Yield.*

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 of the human diet. (Tayefe *et al.,* 2014).During past few decades, rice production increased mostly due to adoption of high yielding varieties, increase in irrigated area and use of chemical fertilizers. However, the rate of increase in rice yield is static and if the rate is not possible to increase, severe food shortage is likely to occur in near future. To push up the yield ceiling, sustainable technologies are essential, which are economically viable and environmentally safe. Cost minimization by saving resources and development of low cost technologies must be considered in rice production. Among the crop management practices, judicious application of nitrogenous fertilizer is paramount important for yield enhancement of rice.

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 (Djaman *et al.,* 2018). N influences rice yield by playing major role in the photosynthesis, biomass accumulation, effective tillering, and spikelet's formation (Yoshida *et al.,* 2006). Therefore, N fertilization is imperative for modern rice varieties in order to exploit their full yield potential (Chamely *et al.*, 2015). 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 (Rahman *et al.,* 2007). 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).

Therefore, it is essential to achieve efficient use of nitrogen in chemical fertilizers, through cultivation techniques and fertilizer management with high nitrogen use efficiency and reducing nitrogen inputs from farming to the environment. Evaluating the reaction of rice to diverse doses of nitrogen will aid in the development of high nitrogen use efficiency varieties, and the screening of appropriate genotypes for all cultivated condition. Numerous studies have investigated varietal variation in yield and Nitrogen use efficiency. However, measuring genotypic differences in dry matter production and nitrogen use efficiency at the vegetative growth stage eliminates those additional variables affecting yield. Understanding the mechanisms that regulating the processes of nitrogen uptake, assimilation, utilization efficiency and remobilization are crucial for the improvement of nitrogen use efficiency in crop plants. One important approach is to develop and understanding of the plant response to different nitrogen regimes and studying plants that show better growth under nitrogen limiting conditions. Studies on impacts of elevated nitrogen on growth dynamics, biomass partitioning, chaffy grain and nitrogen use efficiency are limited at present situation.

Hence, the objective of this study is to investigate varietal differences in response to elevated doses of nitrogen fertilizer among 3 rice varieties to provide essential information for the breeding of varieties that are suitable for cultivation with less application and reduced dose of N fertilizer for eco-friendly sustainable agriculture.

MATERIAL AND METHODS

A field experiment was conducted during the *kharif*-2019 and *kharif*-2020 at college farm, Agricultural College, Mahanandi, ANGRAU. The experiment was laid out in a split plot design with four nitrogen levels *i.e.* 0 (Control), 120 kg N ha^{-1}, 240kg N ha^{-1} 360kg N ha^{-1} and three varieties viz BPT 5204 (V_1), NDLR-7 (V_2) and NLR34449 (V_3) as sub treatments and the experiment was replicated thrice. The rice varieties were sown separately in raises bed nursery thirty-day old seedlings were transplanted in to 12 m^2 (4m x 3m) plot by adopting a spacing 20cm x 15 cm between row to row and plant to plants respectively. Nitrogen was applied as per the treatments 120 kg N ha^{-1}, 240kg N ha^{-1} 360kg N ha^{-1} in three equal splits in the form of urea. Depending on the nitrogen treatment one third dose 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 and potassium 40kg K_2O ha^{-1} in the form of muriate of potash applied as basal dose at the time of transplanting. Irrigation and weed management was done in time to time. The border rows were harvested first and then the net plot area was harvested and the produce was threshed by beating on threshing bench cleaned and sun dried to 14 percent moisture level. Plants in one m^2 area were tagged separately.

SPAD Chlorophyll meter readings

The SPAD 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. Mean of five values from five hills was recorded at tillering, panicle initiation and flowering stages.

The data was analyzed statistically following the method given by Panse and Sukhatme (1987) and wherever the results were significant the critical difference (CD) was calculated at 5 per cent level of significance (P=0.05)

RESULTS AND DISCUSSION

SPAD chlorophyll meter readings of rice varieties influenced by varied nitrogen levels was recorded at tillering stage, panicle initiation stage and flowering stage in *kharif2019* and *kharif2020* are presented in Table 2.

Chlorophyll meter equipment's such as Soil-Plant Analyses Development (SPAD, Minolta Camera Co., Osaka, Japan) are designed to determine chlorophyll concentration of leaves, and have become a popular method for estimating leaf N in rice (Turner and Jund, 1991, 1994), since, there is a strong linear relationship between SPAD values and leaf nitrogen concentration. It is possible to monitor leaf N status using SPAD thresholds and guide fertilizer-N timing on irrigated rice (Peng *et al.,* 1996, Huang *et al.,* 2008, Balasubramanian *et al.,*2000)

The data revealed that SPAD values increased up to panicle initiation stage and decline thereafter irrespective of treatments. Significant variability in SPAD readings was observed among nitrogen levels, three rice varieties and their interaction in all growth stages variability in SPAD readings was observed among nitrogen levels, three rice varieties and their interaction in all growth stages *i.e.,* tillering stage, panicle initiation stage and flowering stage. Pooled data on nitrogen levels revealed that nitrogen application at the rate of 120 kg N ha^{-1} (N_2), 240 kg N ha^{-1} (N_3), 360 kg N ha^{-1} (N_4) recorded significantly higher SPAD values compared to control (N_1) in all three growth stages. However, differences among N levels are only numerical.

Devika *et. al.* (2018) reported that SPAD values increased to a maximum and then gradually decreased in N application levels (lower to higher) during the growing season. Yang *et. al.*(2003) reported that the maximum SPAD readings were recorded at 50% flowering stage when treated with 150% of recommended nitrogen. Similar results are reported by Swetha Singh *et. al.* (2020) in a field experiment with six rice genotypes to relate Chlorophyll meter reading sat six N levels reported that SPAD value increased with increased N level and growth stage up to flowering.

Such increase in SPAD in time with N application can be described as plants fed with sufficient N showed a significant enhancement in Nitrate reductase activity, protein and chlorophyll contents were directly associated with SPAD values at different levels of nitrogen used. Linear and positive relationship of SPAD values with leaf nitrogen % indicated the dependence of SPAD values with nitrogen content of leaf at flowering.

Among the three varieties NDLR-7 (V_2) recorded numerically higher SPAD readings (30.40) compared to NLR 34449 (29.0) (V_3) and BPT 5204 (29.4) (V_1) similar to plant nitrogen content. Similar response of varied SPAD readings among rice varieties reported in rice (Sweta Singh *et al.,* 2020). Devika *et. al.* (2018) reported that among the genotypes maximum SPAD value (44.2 and 42.7) was attained at flowering stage in short duration genotypes (CB-08-513 and CO 51) and medium duration genotype (CO 50–41.5) at 150% of recommended nitrogen. observations were noted by other researchers, where the SPAD value increased with the N top-dressing (Balasubramanian *et al.*, 2000, Peng *et al.,* 1996).

Pooled data on interaction effects at harvest revealed that higher SPAD readings was recorded in

Table 1. Effect of different levels of Nitrogenon No. of productive tillers and grain yield (kg ha^{-1}) of rice (*Oryza sativa* L.) varieties at Harvest stage during *Kharif-2019* and *Kharif-2020*

Treatments	No. of Productive tillers plant^{-1}			Grain yield kg ha^{-1}		
	2019	2020	Pooled	2019	2020	Pooled
N application rate (N)						
N_1 (Control)	7.16	7.31	7.23	4257.50	4277.02	4267.26
N_2 (120 Kg N ha^{-1})	9.56	9.44	9.50	5867.83	5735.78	5801.80
N_3 (240 Kg N ha^{-1})	9.29	8.83	9.06	4963.49	5203.18	5083.34
N_4 (360 Kg N ha^{-1})	9.33	9.46	9.39	4494.44	4639.44	4566.94
S.E(m)±	0.39	0.12	0.20	152.45	377.51	216.66
C.D (P=0.05)	1.34	0.42	0.68	527.58	1306.40	749.76
Varieties(V)	8.80	8.59	8.70			
V_1 (BPT 5204)	9.22	9.21	9.21	4338.19	4072.32	4205.25
V_2 (NDLR-7)	8.48	8.48	8.48	5602.28	5759.79	5681.03
V_3 (NLR34449)	0.30	0.25	0.23	4746.97	5059.46	4903.22
S.E(m)±	0.90	0.74	0.69	187.33	290.93	187.35
C.D (P=0.05)	7.16	7.31	7.23	561.63	872.25	561.70

Interaction	No. of Productive tillers			Panicle initiation stage		
	2019	2020	Pooled	2019	2020	Pooled
M_1S_1	7.2	7.7	7.5	4113.89	4228.89	4171.39
M_1S_2	7.47	7.3	7.4	4461.11	4494.87	4477.99
M_1S_3	6.8	6.92	6.9	4197.5	4107.3	4152.4
M_2S_1	9.47	8.63	9.1	5025	4574.17	4799.58
M_2S_2	10.53	10.33	10.4	7530.93	7462.61	7496.77
M_2S_3	8.67	9.37	9	5047.56	5170.56	5109.06
M_3S_1	9.87	9.1	9.5	5113.88	4344.55	4729.22
M_3S_2	8.93	9.37	9.2	4725.42	5496.67	5111.04
M_3S_3	9.07	8.03	8.6	5051.17	5768.33	5409.75
M4S1	8.67	8.93	8.8	3099.99	3141.66	3120.83
M4S2	9.93	9.83	9.9	5691.67	5585	5638.33
M4S3	9.4	9.6	9.5	4691.67	5191.67	4941.67
Mean	13.16	13.72	13.5	4895.82	4963.86	4929.84
N x V						
S.E(m)	0.6	0.49	0.46	374.65	581.87	374.7
C.D (p=0.05)	1.8	1.47	1.38	1123.26	1744.51	1123.4

Table 2. Influence of different nitrogen levels on SPAD Readings of rice (*Oryza sativa* L.) varieties at Tillering stage, stage, Reproductive stage and Harvest stage during *Kharif*-2019 and *Kharif*-2020

Treatments	Tillering stage			Reproductive stage			Harvest stage		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
N application rate (N)									
N_1 (Control)	24.68	30.17	27.42	33.00	30.99	31.99	26.15	25.45	25.80
N_2 (120 Kg Nha^{-1})	36.38	35.47	35.92	32.42	32.94	32.68	31.28	31.46	31.37
N_3 (240 Kg N ha^{-1})	35.19	34.04	34.62	34.22	34.12	34.17	31.56	31.24	31.40
N_4 (360 Kg N ha^{-1})	38.78	37.52	38.15	36.61	34.53	35.57	31.31	30.90	31.10
S.E(m)±	1.25	1.24	0.85	1.59	1.25	1.36	0.87	0.37	0.60
C.D (P=0.05)	4.34	4.29	2.96	5.51	4.33	4.72	3.00	1.27	2.06
Varieties(V)									
V_1 (BPT 5204)	33.35	33.77	33.56	34.41	33.28	33.84	29.66	29.10	29.40
V_2 (NDLR-7)	33.85	34.22	34.04	33.69	32.94	33.32	29.86	30.02	29.90
V_3 (NLR34449)	34.07	34.92	34.49	34.09	33.22	33.65	30.70	30.17	30.40
S.E(m)±	0.84	0.79	0.64	0.99	0.61	0.75	0.41	0.48	0.40
C.D (P=0.05)	2.52	2.36	1.91	2.96	1.82	2.24	1.23	1.44	1.20

Interaction	Tillering stage			Reproductive Stage			Harvest stage		
N x V	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
N_1V_1	25.50	29.71	27.61	34.40	32.29	33.30	25.60	23.79	24.70
N_1V_2	24.00	29.97	27.61	31.93	29.41	30.70	26.05	26.10	26.10
N_1V_3	24.53	30.83	27.61	32.67	31.26	32.00	26.80	26.45	26.60
N_2V_1	35.57	34.37	27.61	31.27	31.69	31.50	31.40	31.43	31.40
N_2V_2	37.80	36.87	27.61	34.57	35.25	34.90	30.93	32.12	31.50
N_2V_3	35.77	35.17	27.61	31.43	31.87	31.70	31.52	30.83	31.20
N_3V_1	34.70	33.00	27.61	34.33	34.58	34.50	30.40	30.39	30.40
N_3V_2	34.70	32.97	27.61	33.40	33.37	33.40	32.05	31.46	31.80
N_3V_3	36.17	36.17	27.61	34.93	34.42	34.70	32.22	31.86	32.00
N_4V_1	37.63	38.00	27.61	37.63	34.53	36.10	31.24	30.77	31.00
N_4V_2	38.92	37.07	27.61	34.87	33.75	34.30	30.42	30.40	30.40
N_4V_3	39.80	37.50	27.61	37.33	35.32	36.30	32.27	31.53	31.90
Mean	33.76	34.30	27.61	34.06	33.14	33.60	30.07	29.76	29.92
N x V									
S.E(m)±	1.68	1.57	1.27	1.97	1.22	1.49	0.82	0.96	0.77
C.D (P=0.05)	5.04	4.72	3.82	5.92	3.65	4.47	2.45	2.88	2.31

NLDR-7 and NLR 34449 in response to 120 kg N per ha^{-1} application followed by 360 kg N ha^{-1} and NLR 34449 at the rate of 360 kg N ha^{-1}. The data indicates that NLR 34449 showed higher response to enhanced nitrogen application followed by NDLR-7.

No. of productive tillers per plant

Pooled data on nitrogen levels revealed that nitrogen application at the rate of 120 kg N ha^{-1} (N2), 240 kg N ha^{-1}(N_3), 360 kg N ha^{-1} (N_4) recorded significantly higher no. of productive tillers per plant compared to control (N_1) (Table1).Pooled data on nitrogen levels revealed that nitrogen application at the rate of 120 kg N ha^{-1} (N_2) recorded significantly higher no. of productive tillers per plant (9.50) and lowest no of productive tillers are recorded are in control (7.23) (N_1). Similar response of higher no of productive tillers at higher nitrogen levels was reported in rice (Afsana Jahan *et al.,* 2020, Biswajit Saha *et al.,* 2017).

Pooled data on interaction effects revealed that higher no of productive tillers per plant are recorded in NLDR-7 (10.4) in response to 120 kg N per ha^{-1}followed by same variety at 360 kg N ha^{-1}.

Grain yield

Pooled data on nitrogen levels revealed that nitrogen application at the rate of 120 kg N ha^{-1} (N2), recorded significantly higher grain yield per ha^{-1} (5801.18 kg ha^{-1}) followed by 240 kg N ha-1 and lowest was recorded in control (N_1). Similar response of enhanced grain yield at higher nitrogen levels was reported in rice (Biswajit Saha *et al.,* 2017). Among the three varieties NDLR-7 (V_2) recorded significantly higher grain yield (5681.03 kg ha^{-1}) followed by NLR 34449 (4903.22) and lowest grain yield was recorded in BPT 5204 (V_1) (4205.23) and similar response of varied grain yield among rice varieties reported in rice (Biswajit Saha *et al.,* 2017).

Pooled data on interaction effects revealed that higher grain yield was recorded in NLDR-7 response to 120 kg N per ha^{-1}followed by same variety at 360 kg N ha^{-1}. Lowest yield was recorded in BPT 5204 in response to 360 kg ha^{-1}

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