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Study on morpho-physiological, yield attributes and quality parameters of rice varieties under different nitrogen levels and zinc application

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Abstract
A field experiment was conducted during kharif, 2018 at College of Agriculture, Rajendranagar, Hyderabad to study the effect of different nitrogen levels and zinc application on growth and development in paddy. The experiment was laid out in split plot design with three varieties as main plots, six nutrient levels as sub plots and replicated thrice. Among the varieties Tella Hamsa had taken less number of days to panicle initiation (63), flowering (82) and maturity (117), recorded highest sterility % (22.7), minimum LAI (4.19, 4.50 and 2.56 at vegetative, flowering and grain filling stage respectively) and lower photosynthetic rate (17.5, 20.9 and 13 µmol CO_2 m^{-2} s^{-1} at vegetative, flowering and grain filling stage respectively). Telangana Sona had taken more number of days to panicle initiation (66), flowering (86) and maturity (121), higher filled grain %, maximum LAI, maximum photosynthetic rate, more panicles m^{-2}, grains panicle^{-1}, filled grain % and low sterility %, higher grain yield and high harvest index (46). Application of 25 % higher than RDN + 0.5 % $ZnSO_4$ foliar spray resulted in maximum LAI, maximum photosynthetic rate, panicles m^{-2}, grains panicle^{-1}, filled grain % Panicle length, grain yield, more test weight and harvest index. Quality parameters were significantly influenced by the different varieties and nitrogen levels. Between varieties, Telangana Sona recorded significantly higher hulling (84.3), milling (73.7) and head rice recovery percentage (65.1).

Keywords: Photosynthetic rate, leaf area index, harvest index, test weight

Introduction
Rice is a staple and an important food crop around the whole world serving the food requirements of more than half of the world population. In India, rice is grown in an area of 44.5 M ha with a production 115.60 Mt and a productivity of 2800 kg ha^{-1}.Telangana State contributes 2.09 m ha area annually with a production of 6.62 mt, with an average productivity of 3295 kg ha^{-1} during 2018-2019 (CMIE, 2019) [2]. Nitrogen is one of the most important nutritional elements contributing for higher productivity of cereal crops and a major factor that limits agricultural yields (Balasubramanian *et al*., 2000) [1]. To obtain a better crop yield, one of the major criteria which need to be taken care of is the plant nutrition. Nitrogen on the basis of its function has been categorized as an essential element, which most recurrently limits the crop yield and growth (Fageria *et al*., 2005) [3]. Nitrogen is the indispensable nutrient for rice production and its uptake is affected by rice varieties, fertilizer levels, nitrate, ammonium transporters, soil and environmental conditions etc. Nitrogen absorbed by rice during the vegetative growth stages contributes in growth during reproduction and grain filling through translocation. The application of nitrogen fertilizer either in excess or less than optimum rate affects both yield and quality of rice to remarkable extent, hence proper management of crop nutrition is of immense importance (Manzoor *et al*., 2006) [13].

Managing nitrogen fertilization is a challenging task for farmers in rice fields because of various losses due to de-nitrification, volatilization, leaching in flooded soils resulting in low uptake and nitrogen use efficiency (Peng *et al*., 2006) [14]. Excess application leads to lodging, pest and disease incidence whereas low application results in low growth and yield production. Fertilizers play an important role in maximizing returns and also reduce environmental loss, thus it is important to develop fertilizer responsive varieties. Excess application of nitrogen results in prolonged vegetative growth period, days to heading, plant height and showed variable trend of increment tillers per plant with the application of higher doses of nitrogen.

The higher dose of nitrogen causes excessive vegetative growth that leads to lodging of the crop and a consequent decline in filled grains per panicle (Zhang *et al*., 2014) [19]. Applied nitrogen has been found to have a synergistic effect with zinc in rice. It has been reported that the uptake and concentration of zinc increases substantially with an increase in the rate of nitrogen application (Jiang *et al*., 2008) [8]. Hence the present study was conducted to evaluate the effect of different levels of nitrogen and zinc application on morphological, yield attributes and quality parameters in paddy.

Material and methods

Field experiment was conducted on sandy clay soil in College farm, College of Agriculture, Rajendranagar, Hyderabad during kharif, 2018. The experiment was laid out in a split plot design with three replications. The seedlings of different rice varieties V_1- Kunaram Sannalu, V_2- Tella Hamsa and V_3-Telangana Sona were selected as main plots. Fertilizers were given as N_1 - RDN (120 Kg N ha^{-1}), N_2– 25 % less than RDN (90 Kg N ha^{-1}), N_3– 25 % higher than RDN (150 Kg N ha^{-1}), N_4– 25 % less than RDN + 0.5 % $ZnSO_4$ Foliar spray, N_5– 25% higher than RDN + 0.5 % $ZnSO_4$ Foliar spray, N_6– Control taken as sub plots.

The varieties were sown separately in raised bed nursery and twenty five day old seedlings were transplanted into 15 m^2 (5 m X 3 m) plots by adopting a spacing of 15 cm between rows and 15 cm with in a row. Nitrogen applied as per treatment in form of urea in 3 splits as basal, maximum tillering and flowering stage. Similarly, 0.5 % $ZnSO_4$ foliar spray was applied 3 times at tillering, panicle initiation and flowering stage. Phosphorus was applied as single super phosphate at the rate of 60 kg ha^{-1} and Potash as muriate of potash at the rate of 40 kg ha^{-1} as a basal dose at the time of transplanting. Irrigation and weed management was done time to time.

The number days taken to panicle initiation, 50 % flowering and maturity from sowing in each variety in each plot were recorded. For analysis of physiological characters, in each plot five plants were tagged and observations were recorded at vegetative, flowering and grain filling stages. Leaf area index at vegetative, flowering and grain filling stages were recorded. Photosynthetic rate measurements were recorded at maximum vegetative, flowering and grain filling stages by using (IRGA- Infra Red Gas Analyser) portable photosynthetic measurement system (PP System,) from leaves. During measurements, Photosynthetically Active Radiation (PAR) was kept at 1200 µmol CO_2 m^{-2} s^{-1}. The CO_2 concentration was kept at 390 ± 6 ppm. These measurements were made between 10.00 am to 12.00 noon at all the sampling dates and expressed as µmol CO_2 m^{-2} s^{-1}.

The crop was harvested manually. Before harvesting, the number of productive tillers i.e., number of panicles in m^2 area in net plot was counted and expressed as panicles per m^2. Five panicles were collected in each net plot and the length of the panicle was measured from the point of scar to tip of the panicle and mean length was expressed in cm. Five panicles were selected randomly in each net plot and the number of spikelets of each panicle was counted likewise for all the five panicles and the average number was arrived. From the five panicles selected, the total number of grains $panicle^{-1}$, filled grain percentage, spikelets $panicle^{-1}$ and sterility percentage was calculated. Five hand full of grain samples were collected at random from the net plot yield of each individual treatment. The grains were counted and weighed to arrive at test weight. A Sample of one hundred grams of well dried paddy from each treatment was dehulled in standard Satake dehuller and milling, hulling and head rice recovery percentage was also calculated. The experimental data recorded on different parameters were analyzed statistically by applying the technique of analysis of variance for split-plot design by using windostat software version 9.2.

Results and discussion

Panicle initiation

Panicle initiation is the time when the panicle primordia initiate the production of a panicle in the uppermost node of the culm. Among the varieties under study, minimum number of days for panicle initiation was recorded in the variety Tella Hamsa (63 days), while the mean maximum number of days to panicle initiation was taken by Telangana Sona (66 days) (Table 1). With increase in dose of applied nitrogen, the number of days to panicle initiation has increased. Maximum number of days to panicle initiation was recorded in 25 % higher than RDN and 25 % higher than RDN + 0.5 % $ZnSO_4$ Foliar spray (67 days), while minimum in treatment supplied with 25 % less than RDN and 25 % less than RDN + 0.5 % $ZnSO_4$ (62 days) which were on par. Interaction effect of varieties and various nitrogen levels for panicle initiation was found to be non significant.

50% Anthesis

Anthesis refers to the events between the opening and closing of the spikelet. Significant difference was recorded in the number of days taken for 50 % anthesis (Table 1). Tella Hamsa recorded least number of days for 50 % anthesis (82 days), while the mean maximum was taken by the variety Telangana Sona (86 days).Timing of anthesis was delayed with higher dose of nitrogen. Among various nitrogen levels, data suggested that treatment 25 % higher than RDN and 25 % higher than RDN + 0.5 % $ZnSO_4$ foliar spray taken maximum number of days to anthesis (86 days), whereas application of RDN, 25 % lesser than RDN and 25 % lesser than RDN + 0.5 % $ZnSO_4$ Foliar spray treatments were flowered early (84 days). Abundant supply of nitrogen (150 kg N ha^{-1}) might have delayed the vegetative growth and shifted the balance between vegetative and reproductive growth, leading to delay in days to 50 % heading (Venugopal, 2005) [17].

Days to maturity

This stage corresponds to the complete grain filling where grain increases in size and weight as the starch and sugars are translocated from the culms and leaf sheaths and the whole grain is hard and ready for harvest. Data pertaining to days taken for maturity has been presented in table 1. Among the varieties there was significant difference in number of days taken for maturity. Telangana Sona has taken maximum number of days taken for maturity (121 days), while minimum being taken by the variety Tella Hamsa (117 days).

Among different levels of applied nitrogen, 25 % higher than RDN and 25 % higher than RDN + 0.5 % $ZnSO_4$ foliar spray taken more number of days (121 days) whereas plants supplied with 25 % lesser than RDN and 25 % lesser than RDN + 0.5 % $ZnSO_4$ foliar spray recorded minimum number of days (118 days) to grain maturity (Table 1). Shahidullah *et al*. (2009) [16] concluded that the wide variation in phenological characters depends on genotypic constituent, micro and macro environments.

Leaf area index (LAI)

The ultimate factors which limit the primary process in crop production i.e. crop photosynthesis is the efficiency of light captured and utilization. Leaf area index (LAI) at different stages of crop has been depicted in table 2. LAI has increased from vegetative to flowering stage and then decreased in grain filling stage. Leaf area index was maximum at flowering stage LAI ranged at maximum vegetative stage from 4.19 to 4.51, at flowering stage from 4.50 to 4.79 and at grain filling stage from 2.56 to 2.77. Telangana Sona has recorded higher LAI followed by Kunaram Sannalu and Tella Hamsa. Data showed higher LAI in Telangana Sona at all the crop growth stages (4.51, 4.79 and 2.77 at vegetative, flowering and grain filling respectively).

The data clearly pinpoints the fact that the leaf area index increased with increasing doses of nitrogen. LAI ranged from at maximum vegetative stage 3.54 to 4.64, at flowering stage from 3.95 to 4.97 and at grain filling stage from 2.27 to 2.88. LAI was found maximum at flowering stage. Highest LAI was recorded in 25 % higher than RDN + 0.5 % $ZnSO_4$ Foliar spray, whereas minimum was recorded in 25 % less than RDN at all the stages of crop. Results from the data showed that application of 25 % higher than RDN + 0.5 % $ZnSO_4$ Foliar spray recorded highest LAI compare to other treatments at various stages (4.64, 4.97 and 2.88 at vegetative, flowering and grain filling respectively). Interaction effect was found to be significant at vegetative and flowering stage whereas at maturity stage it was found not significant. Enhanced LAI in response to high nitrogen application has been reported by Wang *et al*. (2016) [18]. Nitrogen plays a very significant role in cell division which in turn is very essential for the increase in leaf area. Decrease in leaf area may lead to an inadequate grain as well as biological yield as both are closely correlated to LAI (Khalifa *et al*., 2008; Gholizadeh *et al*., 2009) [9] [5].

Photosynthetic rate

Nitrogen nutrition influences the content of photosynthetic pigments, synthesis of the enzymes taking part in the carbon reduction, formation of the membrane system of chloroplasts, and there by increases growth and yield. Significant differences were observed between the varieties in photosynthetic rate at maximum vegetative, flowering and grain filling stage (Table 2). Maximum photosynthetic rate was recorded at flowering stage among the varieties and Telangana Sona has recorded highest photosynthetic rate (19.2 and 22.7 and 13.7 μmol CO_2 m^{-2} s^{-1} at vegetative, flowering and grain filling stage respectively).

Leaf photosynthetic rate increased significantly due to increased application of nitrogen. Among the fertilizer nutrition levels, the photosynthetic rate recorded was maximum at flowering stage and highest rate was recorded in treatment 25 % higher than RDN + 0.5 % $ZnSO_4$ (21.1, 23.9 and 14.3 μmol CO_2 m^{-2} s^{-1} at vegetative, flowering and grain filling respectively). The interaction was found statistically significant between varieties and various nitrogen levels at different growth stages. Hassan *et al*. (2007) [7] suggested low levels of nitrogen can reduce photosynthetic rate as well as leaf chlorophyll content and photosynthetic efficiency. Similar results were also reported by Fallah (2012) [4].

Panicle number m^{-2} and Panicle length

Varieties significantly differed in number of panicles m^{-2} (Table 3). Among them, higher number of panicles m^{-2} was recorded in Telangana Sona (361) over Kunaram sannalu and Tella Hamsa. Significantly lowest number of panicles m^{-2} was recorded in Tella Hamsa (337). This may be due to higher tiller to panicle conversion ratio which might be due to favourable growth conditions and better translocation of assimilates to the sink from the source as reported by Gosh *et al*. (2013) [6].

Panicle length was found statistically significant between the treatments (Table 3). Results suggested nitrogen treatment 25 % higher than RDN + 0.5 % $ZnSO_4$ had recorded significantly more panicle length (24.1 cm) than control (21.6), while lowest panicle length (23.2 cm) was recorded in 25 % lesser than RDN. Panicle length increased with higher levels of nitrogen. Improved growth parameters and translocation of more assimilates to the panicles might be the reason for the higher panicle length. Significant interaction effect was found for panicle length. Pramanik and Bera (2013) [15] observed increase in panicle length with increase in nitrogen levels and they reported longer panicle length and attributed to nitrogen in panicle formation and panicle elongation.

Grains panicle^{-1} and filled grain percentage

Data on grains panicle^{-1} and filled grain percentage was significantly affected by varieties and various nitrogen levels and given in table 3. Telangana Sona (359) has resulted in higher number of grains panicle^{-1} followed by Kunaram Sannalu and Tella Hamsa. Similarly, grains panicle^{-1} increased with respect to increment of nitrogen levels. More number of grains panicle^{-1} (219) were recorded in treatment applied with 25 % higher than RDN + 0.5 % $ZnSO_4$ than control, while lowest number of panicles m^{-2} (217) was recorded at 25% lesser than RDN.

There was significant difference among the varieties at different nitrogen levels. Results on filled grain percentage revealed that Telangana Sona has recorded maximum filled grain percentage (84.6). The variation observed might be due to genetic or inherent characteristics of varieties. Increase in filled grains per panicle with increase in N fertilizers up to 200 kg N ha^{-1} was earlier reported by Krishna *et al*. (2008) [10].

Number of spikelets panicle^{-1} and spikelet sterility percentage

Total number of spikelets panicle^{-1} and spikelet sterility percentage significantly varied among different varieties at different levels of nitrogen (Table 3). Data showed significantly higher total number of spikelets panicle^{-1} in Telangana Sona (218) compared to other varieties. It was observed that increment in application of nitrogen nutrition has significantly affected on number of spikeltes. Treatment supplied with 25% higher than RDN + 0.5 % $ZnSO_4$ recorded highest spikelet number (189) among the treatments studied. The higher number of spikelets might be due to favourable growth, longer panicles and better translocation of assimilates to the sink and also a genetic character.

Different varieties at different levels of nitrogen significantly influenced percentage of spikelet sterility (Table 3).Significantly lower sterility percentage was recorded in variety Telangana Sona (15.1) and maximum sterility was recorded in Tella Hamsa (22.7). Percentage of spikelet sterility decreased with respect to increment of nitrogen levels and zinc application. Application of recommended dose of nitrogen (RDN) has recorded highest sterility (18.2) compared to 25 % higher than RDN + 0.5 % and 25 % lesser than RDN and both were at on par, while lowest was observed in 25 % higher than RDN + 0.5 % $ZnSO_4$ (17.0) and 25 % lesser than RDN + 0.5 % $ZnSO_4$ (17.2), which were on par. Interaction effect was statistically significant for number of spikelets panicle^{-1} and spikelet sterility percentage.

Test weight

Results revealed among the rice varieties studied there was significant difference for 1000 grain weight which ranged from 12.6 to 24.8 g. Data showed maximum test weight in Kunaram Sannalu (24.8 g), while minimum was recorded in Telangana Sona (12.6 g). With increase in nitrogen level there was an increase in the test weight (Table 3). Maximum test weight of 20.5 g was recorded at 25 % higher than RDN + 0.5 % $ZnSO_4$ compared to control, while minimum was recorded at 25 % higher than RDN (20 g). This is due to production of more photosynthates and their translocation from source to sink which in turn resulted in elevated values for yield attributes. Several workers were reported increase in 1000 grain weight with increased application of nitrogen (Mahajan *et al.*, 2011, Malla Reddy *et al.*, 2012). [11] [12]

Grain Yield (kg ha^{-1}) and Harvest index

Grain yield is a complex heritable character influenced by many morphological, physiological and biochemical characteristics of the plant interacting with the environment. A perusal of the data presented in table 4 on grain yield indicates that with increase in nitrogen application there was significant increase in the grain yield (4220 to 5140 kg ha^{-1}). Results showed maximum grain yield has been recorded in Telangana Sona (5140 kg ha^{-1}). Varietal differences observed with respect to the response of grain yield to nitrogen supply might be due to their high leaf area index at the flowering stage.

Significant difference was found among the different treatment, highest grain yield (5129 kg ha^{-1}) supplied with 25 % higher than RDN + 0.5 % $ZnSO_4$ compared to control, whereas lowest grain yield (5023 kg ha^{-1} respectively) was observed at 25 % lesser than RDN. Interaction effect for grain yield was found to be significant.

Harvest index is the measure of how effectively the photosynthates are transferred from source to the sink. It is used to evaluate crop efficiency and also act as a criterion for choosing the cycle of maturity and behavior of the crop against nitrogen stress conditions. Higher the harvest index, higher will be the economic return of the crop. Harvest index was markedly affected by varieties and nitrogen levels (Table 4). Harvest index showed an increasing trend and maximum harvest index was found in the treatment 25 % higher than RDN + 0.5 % $ZnSO_4$ (45.4 %) and lowest in 25 % lesser than RDN (44.6 %).The interaction of varieties and nitrogen levels was found to be significant for harvest index.

Quality parameters

Milling (%), Hulling (%) and Head rice recovery (%)

There was significant difference as well as the interaction effect between rice varieties at different levels of nitrogen on milling, hulling and head rice recovery percentage (Table 4). Telangana Sona recorded significantly higher milling percentage (84.3 %) compared to other varieties. Between the nitrogen treatment 25 % higher than RDN + 0.5 % $ZnSO_4$ has recorded maximum milling percentage (83.7 %).

Hulling percentage also followed similar trend to that of milling (Table 4). Hulling percentage was significantly higher in Telangana Sona (73.7 %) over other varieties and between the treatments. 25 % higher than RDN + 0.5 % $ZnSO_4$ gave maximum hulling percentage (73.3 %). Similar to hulling and milling percent, HRR was more in 25 % higher than RDN + 0.5 % $ZnSO_4$ (64.6 %) followed by 25 % higher than RDN and were on par in Telangana Sona (65.1 %).

Table 1: Panicle initiation, 50% anthesis and days to maturity of rice as influenced by different varieties with nitrogen levels and Zinc application

Treatment	Panicle initiation	50 % anthesis	Days to maturity
Main plots : Varieties			
V1	65	84	120
V2	63	82	117
V3	66	86	121
SEm±	0.11	0.13	0.12
CD (p=0.05)	0.43	0.54	0.49
Subplots : Fertilizer treatments			
N1	65	84	120
N2	64	84	118
N3	67	86	121
N4	64	84	118
N5	67	86	121
N6	62	81	117
SEm±	0.20	0.22	0.14
CD (p=0.05)	0.59	0.64	0.42
Interaction			
Rice varieties at same level of fertilizer treatments			
SEm±	0.35	0.38	0.29
CD (p=0.05)	NS	NS	NS
Interaction			
Fertilizer treatments at same or different rice varieties			
SEm±	0.34	0.38	0.26
CD (p=0.05)	NS	NS	NS

Table 2: Leaf area index and photosynthetic rate of rice as influenced by different varieties with nitrogen levels and Zinc application

Treatment	Leaf area index			Photosynthetic rate (μmol CO_2 m^{-2} s^{-1})		
	Vegetative stage	Flowering stage	Grain filling stage	Vegetative stage	Flowering stage	Grain filling stage
Main plots : Varieties						
V1	4.28	4.63	2.66	18.2	21.7	13.3
V2	4.19	4.50	2.56	17.5	20.9	13.0
V3	4.51	4.79	2.77	19.2	22.7	13.7
SEm±	0.004	0.009	0.004	0.04	0.10	0.08
CD (p=0.05)	0.015	0.038	0.017	0.19	0.41	0.35
Subplots : Fertilizer treatments						
N1	4.46	4.75	2.73	18.9	22.4	13.6
N2	4.33	4.60	2.61	18.0	21.2	12.8
N3	4.55	4.87	2.83	19.7	23.5	13.8
N4	4.41	4.68	2.65	18.5	22.1	13.2
N5	4.64	4.97	2.88	21.1	23.9	14.3
N6	3.54	3.95	2.27	14.6	17.5	12.3
SEm±	0.006	0.006	0.008	0.07	0.08	0.09
CD (p=0.05)	0.019	0.017	0.024	0.22	0.23	0.26
Interaction						
Rice varieties at same level of fertilizer treatments						
SEm±	0.003	0.010	0.014	0.11	0.25	0.21
CD (p=0.05)	0.015	0.031	NS	0.41	0.47	0.50
Interaction						
Fertilizer treatments at same or different rice varieties						
SEm±	0.006	0.013	0.014	0.13	0.16	0.16
CD (p=0.05)	0.019	0.047	NS	0.40	0.45	0.54

Table 3: Yield attributes of rice as influenced by different varieties with nitrogen levels and Zinc application

Treatment	Panicle m^{-2}	Panicle length	Grains $panicle^{-1}$	Filled grains (%)	Spikelet $panicle^{-1}$	Spikelet sterility (%)	Test weight (g)
Main plots : Varieties							
V1	356	22.9	151	82.6	172	17.9	24.8
V2	337	21.8	133	77.7	156	22.7	22.2
V3	361	25.2	359	84.6	218	15.1	12.6
SEm±	0.49	0.05	0.62	0.32	0.52	0.19	0.017
CD (p=0.05)	1.98	0.20	2.45	1.26	2.05	0.75	0.069
Subplots : Fertilizer treatments							
N1	355	23.6	217	82.77	184	18.2	20.3
N2	352	23.2	216	82.06	181	18.0	20.0
N3	359	23.7	218	82.44	186	18.0	20.4
N4	355	23.6	217	83.07	183	17.2	20.1
N5	361	24.1	219	83.20	189	17.0	20.5
N6	325	21.7	198	77.21	169	22.8	18.2
SEm±	0.45	0.07	0.27	0.29	0.41	0.17	0.030
CD (p=0.05)	1.31	0.22	0.79	0.84	1.19	0.49	0.087
Interaction							
Rice varieties at same level of fertilizer treatments							
SEm±	1.20	0.12	0.47	0.50	0.71	0.29	0.051
CD (p=0.05)	2.55	0.42	1.38	1.45	2.07	0.85	0.152
Interaction							
Fertilizer treatments at same or different rice varieties							
SEm±	0.86	0.13	0.76	0.56	0.83	0.33	0.052
CD (p=0.05)	2.83	0.41	2.73	1.81	2.76	1.07	0.153

Table 4: Grain yield, harvest index and quality parameters of rice as influenced by different varieties with nitrogen levels and zinc application

Treatment	Grain yield (Kg ha^{-1})	Harvest index	Milling (%)	Hulling (%)	Head rice recovery (%)
Main plots : Varieties					
V1	5002	44.3	82.6	72.6	64.8
V2	4220	43.5	81.0	70.3	61.9
V3	5140	46.0	84.3	73.7	65.1
SEm±	7.78	0.03	0.12	0.06	0.04
CD (p=0.05)	31.39	0.13	0.50	0.24	0.17
Subplots : Fertilizer treatments					
N1	5060	44.7	82.8	72.5	64.4
N2	5023	44.6	82.6	71.9	63.9
N3	5115	45.1	83.1	73.1	64.5
N4	5039	45.2	82.9	72.3	64.0
N5	5129	45.4	83.7	73.3	64.6

N6	3358	42.3	80.4	69.9	62.2
SEm±	9.83	0.10	0.13	0.07	0.04
CD (p=0.05)	28.52	0.30	0.39	0.22	0.12
Interaction					
Rice varieties at same level of fertilizer treatments					
SEm±	19.07	0.18	0.23	0.13	0.07
CD (p=0.05)	53.27	0.52	0.68	0.38	0.22
Interaction					
Fertilizer treatments at same or different rice varieties					
SEm±	17.38	0.16	0.25	0.13	0.08
CD (p=0.05)	54.39	0.49	0.79	0.42	0.26

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