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Interventions in Nutrient Management for Enhancement of Grain Yield and Quality of Popular Rice Varieties

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ABSTRACT

A field experiment was conducted at Agricultural College Farm, Bapatla on a sandy clay loam soil during *kharif* season of 2010-11 to study the effect of different treatments in improving the rice grain quality. The experiment consisted of two varieties *viz*., BPT 5204, NLR 33892 and seven zinc treatments in combination with urea. The findings of the experiment revealed that the higher grain yield and harvest index were recorded with rice variety Pardhiva (NLR 33892). Quality characteristics of Samba Mahsuri (BPT 5204) manifested supremacy over Pardhiva. Significant improvement in productivity and quality characteristics of rice was noticed with soil application of 50 kg $ZnSO_4$ ha^{-1} or combined application of 2% urea and 0.5% $ZnSO_4$ spray at flowering stage.

Key words : Quality parameters, Rice varieties, Soil application, Urea, Yield, $ZnSO_4$.

Nutritive security is as important as food security for the developing countries of tropical Asia in general and India in particular. Among the plant nutrients, nitrogen occupies prime position in realizing the yield potential of high yielding rice varieties and, it is needed in high quantity particularly up to panicle initiation stage. Zinc is a major component and activator of several enzymes involved in metabolic activities (Chaudary *et al*., 2007).

Ferti-forification, which involves fertilizing crops with micronutrients (such as Fe, Zn, Mn, Cu, B, Mo) gives immediate results and in, general, goes well along with an increase in yield. Ferti-forification can largely help in alleviating micronutrient malnutrition in human beings and it is considered more sustainable and cost effective approach used to enhance zinc concentration in rice (Prasad, 2009). Recently, a few high yielding varieties suitable for cultivation have been developed but improving the quality of grain of these varieties has to be studied to come up with suitable agronomic recommendations. Keeping this in view, an investigation was carried out to improve quality of rice grain through the application of nitrogen and zinc.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* season of 2010-11at Agricultural college farm, Bapatla. The soil was sandy clay loam (sand 60.2%, silt 12.6 %, clay 27.2 %) with pH 8.1, organic carbon 0.4% and 226, 17, 305 kg ha^{-1} and 0.56 ppm available N, P_2O_5, K_2O and Zn, respectively. Thirty days old seedlings were transplanted on 10-09-2010 with a spacing of 20 cm ×15 cm. The experiment consisted of two rice cultivars (V_1: BPT 5204-Samba Mahsuri, V_2: NLR 33892-Pardhiva) and seven treatments *viz*., Recommended NPK only (T_1), T_1 + 5 t ha^{-1} FYM (T_2), T_1 + 50 kg $ZnSO_4$ ha^{-1} as soil application (T_3), T_1 + 2 % urea spray at flowering stage (T_4), T_1 + 0.5 % $ZnSO_4$ spray at flowering stage (T_5), T_1 + 2 % urea + 0.5 % $ZnSO_4$ spray at flowering stage (T_6), T_1 + 2 % $ZnSO_4$ enrichment of third split application of nitrogen (T_7). The experiment was laid out in randomized block design with factorial concept and replicated thrice. A recommended dose of 160 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied through urea, single superphosphate and muriate of potash respectively. Entire quantity of phosphorus and potassium and half of the N was applied just before transplanting. The remaining nitrogen was applied in two equal splits at active tillering and panicle initiation stages. Zinc sulphate @ 50 kg ha^{-1} was applied to soil after N, P and K application as per the treatments. For foliar application of N and Zn, sprays of urea (2%) and $ZnSO_4$ (0.5%) were given (500 L ha^{-1}) with hand sprayer during morning hours between 7 A.M. and 10 A.M. No measurable foliar burning or precipitation was recorded within 24 hours of foliar treatments. Recommended

Table 1. Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and Harvest index (%) as influenced by varieties and treatments

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index (%)		
	Varieties			Varieties			Varieties		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 :Recommended NPK only	3918	3995	3956	5598	5190	5394	41.2	43.4	42.3
T_2 :T_1 + 5 t ha^{-1} FYM	4399	4635	4517	5949	5328	5638	42.4	46.5	44.5
T_3 :T_1 + 50 kg ha^{-1} $ZnSO_4$ as soil application	5726	5993	5859	6742	6071	6406	45.9	49.7	47.8
T_4 :T_1 + 2 % urea spray at flowering stage	4511	4814	4662	6257	5507	5882	41.9	46.7	44.3
T_5 :T_1 + 0.5 % $ZnSO_4$ spray at flowering stage	4714	4968	4841	6322	5638	5980	42.7	46.9	44.8
T_6 :T_1 + 2 % urea + 0.5 % $ZnSO_4$ spray at flowering stage	5442	5788	5615	6529	5888	6208	45.4	49.6	47.5
T_7 :T_1 + 2 % $ZnSO_4$ enrichment of third split application of nitrogen	4907	5171	5039	6430	5739	6085	43.3	47.4	45.3
Mean	4802	5052		6261	5623		43.3	47.1	
	SEm±	CD (0.05)	CV (%)	SEm±	CD (0.05)	CV (%)	SEm±	CD (0.05)	CV (%)
Varieties (V)	83	243	8	60	176	5	0.4	1.3	4.5
Treatments (T)	156	454		113	329		0.8	2.4	
Interaction(VT)	221	NS		160	NS		1.2	NS	

NS: Non-Significant V1: BPT 5204 V2: NLR 33892

agronomic practices and plant protection measures were followed for well being of the crop. The crop was harvested on 31-1-2011.

Plant samples were collected at harvesting stage and Nitrogen was determined by the Microkjeldhal method (Jackson, 1973) and Zinc by Atomic Absorption Spectrophotometer method (Lindsay and Norvell, 1978). The grain samples which were properly dried and processed, were taken for the assessment of quality of rice. The physical and chemical quality parameters like hulling per cent, milling per cent (Chauhan *et al*., 1994), head rice recovery (Bandyopadhyay and Roy,1992), amylose (Sadasivam and Manickam, 1992) and protein content (Jackson, 1973) were analysed. Cooking character like volume expansion ratio was determined as described by Murthy (1965).

RESULTS AND DISCUSSION

Grain and straw yields of rice were significantly influenced both by rice varieties and treatments. However, the interaction between varieties and treatments was non significant (Table 1). Between the two varieties, higher grain yield and harvest index were observed with NLR 33892 (5052 kg ha^{-1}). The higher grain yield could be attributed to more number of filled grains panicle^{-1} and higher test weight in NLR 33892. The lower grain yield (4802 kg ha^{-1}) with BPT 5204 might be due to its lower number of yield attributes.

The higher straw yield (6261 kg ha^{-1}) was recorded with BPT 5204 but it was on a par with that of NLR 33892 (5623 kg ha^{-1}). Significant effect on straw yield of varieties might be due to their significant influence on plant height and tiller number

Table 2. Hulling (%), milling (%) and head rice recovery (%) of rice as influenced by varieties and treatments

Treatments	Hulling %			Milling %			Harvest index (%)		
	Varieties			Varieties			Varieties		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 :Recommended NPK only	76.5	74.8	75.7	74.4	73.6	74.0	62.8	61.6	62.2
T_2 :T_1 + 5 t ha^{-1} FYM	77.6	75.8	76.7	75.5	74.0	74.8	63.1	62.3	62.7
T_3 :T_1 + 50 kg ha^{-1} $ZnSO_4$ as soil application	81.8	81.2	81.5	79.4	78.6	79.0	64.9	64.7	64.8
T_4 :T_1 + 2 % urea spray at flowering stage	78.2	76.2	77.2	75.8	74.8	75.3	63.7	62.6	63.2
T_5 :T_1 + 0.5 % $ZnSO_4$ spray at flowering stage	78.5	76.6	77.6	76.3	75.4	75.9	63.8	63.1	63.4
T_6 :T_1 + 2 % urea + 0.5 % $ZnSO_4$ spray at flowering stage	82.2	81.5	81.9	80.5	79.6	80.1	65.4	65.2	65.3
T_7 :T_1 + 2 % $ZnSO_4$ enrichment of third split application of nitrogen	80.0	78.7	79.4	78.0	76.5	77.3	64.2	63.8	64.0
Mean	79.3	77.8		77.1	76.1		64.0	63.3	
	SEm±	CD (0.05)	CV (%)	SEm±	CD (0.05)	CV (%)	SEm±	CD (0.05)	CV (%)
Varieties (V)	0.4	1.2	2.5	0.2	0.7	1.5	0.17	0.5	1.2
Treatments (T)	0.8	2.3		0.5	1.4		0.31	0.9	
Interaction(VT)	1.1	NS		0.7	NS		0.44	NS	

NS: Non-Significant V1: BPT 5204 V2: NLR 33892

as the straw is the product of these two parameters. The higher harvest index was recorded with NLR 33892 (47.1). This might be due to efficiency of this variety in converting drymatter into grain.

Grain quality characters *viz*., hulling per cent, milling per cent, head rice recovery, amylose and protein contents and volume expansion ratio were significantly influenced by rice varieties and treatments. However, the interaction between these two parameters exhibited non - significant values. Hulling per cent, milling per cent, head rice recovery, amylose and protein contents and volume expansion ratio (Table 2 and Table 3) were significantly superior with the variety BPT 5204. The genetic make up of the varieties might be responsible for variations in quality characteristics of rice.

The higher grain (5859 kg ha^{-1}), straw yields (6406 kg ha^{-1}) and harvest index (47.8) was recorded with soil application of $ZnSO_4$ @ 50 kg ha^{-1} (T_3) which was on a par with T_1 + 2 % urea + 0.5 % $ZnSO_4$ spray at flowering stage (T_6), followed by T_1 + 2 % $ZnSO_4$ enrichment of third split application of nitrogen (T_7) but significantly superior to rest of the treatments (Table 1). The higher grain yield could be attributed to higher number of productive tillers m^{-2}, number of filled grains $panicle^{-1}$ and 1000-grain weight. The increased grain yield was attributed to significant improvement in yield components as was reported by Jana *et al*. (2009). The significant increase in straw yield in rest of the treatments over Recommended NPK only (T_1) was as a result of higher N uptake and growth characters like plant height and number of tillers m^{-2} and drymatter production which in turn influenced by higher Zn uptake and might have contributed for increased straw yield .

Significant improvement in the quality characters *viz*., hulling per cent, milling per cent, head rice recovery, amylose and protein contents and volume expansion ratio (Table 2 and Table 3) was due to the combined application of 2% urea and 0.5% $ZnSO_4$ spray at flowering stage (T_6), which

Table 3. Protein content (%), amylose content (%) and volume expansion ratio of rice as influenced by varieties and treatments

Treatments	Protein content %			Amylose content %			Volume expansion ratio		
	Varieties			Varieties			Varieties		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 :Recommended NPK only	76.5	74.8	75.7	74.4	73.6	74.0	62.8	61.6	62.2
T_2 :T_1 + 5 t ha^{-1} FYM	77.6	75.8	76.7	75.5	74.0	74.8	63.1	62.3	62.7
T_3 :T_1 + 50 kg ha^{-1} $ZnSO_4$ as soil application	81.8	81.2	81.5	79.4	78.6	79.0	64.9	64.7	64.8
T_4 :T_1 + 2 % urea spray at flowering stage	78.2	76.2	77.2	75.8	74.8	75.3	63.7	62.6	63.2
T_5 :T_1 + 0.5 % $ZnSO_4$ spray at flowering stage	78.5	76.6	77.6	76.3	75.4	75.9	63.8	63.1	63.4
T_6 :T_1 + 2 % urea + 0.5 % $ZnSO_4$ spray at flowering stage	82.2	81.5	81.9	80.5	79.6	80.1	65.4	65.2	65.3
T_7 :T_1 + 2 % $ZnSO_4$ enrichment of third split application of nitrogen	80.0	78.7	79.4	78.0	76.5	77.3	64.2	63.8	64.0
Mean	79.3	77.8		77.1	76.1		64.0	63.3	
	SEm±	CD (0.05)	CV (%)	SEm±	CD (0.05)	CV (%)	SEm±	CD (0.05)	CV (%)
Varieties (V)	0.4	1.2	2.5	0.2	0.7	1.5	0.17	0.5	1.2
Treatments (T)	0.8	2.3		0.5	1.4		0.31	0.9	
Interaction(VT)	1.1	NS		0.7	NS		0.44	NS	

NS: Non-Significant V1: BPT 5204 V2: NLR 33892

was at par with soil application of 50 kg $ZnSO_4$ ha^{-1}(T_3), but significantly superior to recommended NPK alone (T_1). Increase in hulling and milling percentages of rice may be attributed to increase in boldness of rice grain due to balanced fertilization of N and Zn to rice crop. Higher head rice recovery was due to an increase in the protein content of brown rice and decrease in chaffy grains. The protein bodies functioned as a binder, occupying the space between unpacked starch granules, which results in an increased resistance of rice grain to breakage during milling thus resulting in increased hulling, milling percentages of rice (Sakdajong Kaewwarattana *et al*., 1993). The increase in protein and amylose contents might be due to higher absorption of N and Zn through crop foliage. Zinc has a synergistic effect on N uptake there by increases the N content of grain and in turn increases the amylose and protein contents of the rice grain.

From the present investigation, it can be concluded that under sandy clay loam soils of Bapatla, NLR 33892 performed better in giving higher yield, however, the quality characteristics of BPT 5204 manifested supremacy over NLR 33892. Soil application of 50 kg $ZnSO_4$ ha^{-1} or combined application of 2% urea and 0.5% $ZnSO_4$ spray at flowering stage was found to be better which resulted in higher productivity and improved quality characteristics of rice.

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