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Yield, Quality and Nutrient Uptake of Different Rice Varieties as Affected By FYM and Fertilizer Treatments

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ABSTRACT

An investigation carried out on clay loam soil of Agricultural College Farm, Bapatla during *kharif* season of 2012 to study the effect of different treatments on increasing yield and improving grain quality of rice grain .. The findings of the experiment revealed that the higher grain yield, straw yield, harvest index and nutrients uptake was recorded with the variety, Akshaya (BPT 2231). Quality characteristics of Indra (MTU 1061) manifested supremacy over Swarnamukhi (NLR 145). Significant improvement in productivity and quality characteristics of rice was noticed with soil application of 10 t ha^{-1} of FYM along with zinc through foliar spraying twice at panicle initiation and heading stages.

Key words : Foliar application, Nutrient Uptake, Rice varieties, Soil application, Quality, Yield.

Nutritive security is as important as food security for the developing nations of tropical Asia, in general and India, in particular. Rice is the staple food crop for more than half of the world's population which supplies adequate energy in the form of calories and is a good source of thiamine, riboflavin, and niacin (Stalin *et al*., 2011). But, it is a poor source of many essential mineral nutrients, especially Zn and Fe, which are specially required for human nutrition. Undoubtedly, with the introduction of high yielding varieties of cereals and their continued cultivation causes the deficiency of secondary and micronutrients in time and space, which resulted in yield stagnation (Gill and Singh, 2009). In this context, zinc (Zn) deficiency is a well-documented problem in food crops, causing decreased crop yields and nutritional quality.

The major reason for zinc deficiency in human beings is the reliance on cereal-based diets that may induce Zn deficiency-related health problems in human beings. For better zinc nutrition of human beings, cereal grains should contain around 40-60 mg Zn kg^{-1}, but in the present situation, the polished rice grain contains an average of 12 mg Zn kg^{-1} only. Zn plays an important role in the production of proteins in the body and thus, helps in wound healing, blood formation and growth and maintenance of all tissues. Zn also supports immune function and storage release and function of insulin and it is important in host defence mechanism against cancer (Rajendra Prasad, 2010). Zn deficiency is responsible for many severe health complications, including impairments of physical growth, immune system and learning ability, combined with increased risk of infections, DNA damage and cancer.

As such, the quality indices in rice play a major role in nutritional budgeting of millions of Indians as well as Indian economy. Fertilizer application is an important point of nutrient management in agronomic approaches to enhance crop quality and produce.

Ferti-fortification, 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. 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, present investigation was carried out to improve quality of rice grain through FYM and zinc treatments.

MATERIAL AND METHODS

A field experiment was conducted during *kharif*, 2012 at the Agricultural College Farm, Bapatla. The soil was clay loam (sand 28 %, silt 24 %, clay 48 %) with pH 8.0, organic carbon 0.4% and 210, 20, 362 kg ha^{-1} and 0.6 ppm available N,

P_2O_5, K_2O and Zn, respectively. The soil was deficient in available zinc. Twenty eight day old seedlings were transplanted on 14-08-2012 with a spacing of 20 cm ×15 cm. The experiment was laid out in a Randomized Block Design with factorial Concept and replicated thrice. The experiment consisted of three varieties (BPT 2231, MTU 1061, NLR 145) and six treatments viz., Recommended NPK only (T_1), T_1 + 10 t ha^{-1} FYM (T_2), T_1 + 50 kg $ZnSO_4$ ha^{-1} as soil application (T_3), T_1 +10 t ha^{-1} FYM+ 50 kg $ZnSO_4$ ha^{-1} as soil application (T_4), T_1 + 10 t ha^{-1} FYM + 0.5 % $ZnSO_4$ foliar spray at panicle initiation (PI) and heading stages (T_5), T_1 + 0.5% $ZnSO_4$ foliar spray at PI and heading stages (T_6). A well decomposed farmyard manure as per the treatments was used as organic source for NPK in the present study and was applied at the time of final land preparation just 3 days prior to zinc application. A common 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 half of potassium and one third of the N was applied at the time of final land preparation just before transplanting. The remaining nitrogen was applied in two equal splits at active tillering (30 DAT) and panicle initiation (60 DAT) stages. The remaining half of K was applied at PI stage. Zinc sulphate @ 50 kg ha^{-1} was applied to soil 3 days after N, P and K application as per the treatments. For foliar application of Zn, sprays of $ZnSO_4$ (0.5 %) were given (500 L ha^{-1}) with hand sprayer during morning hours between 8 A.M. and 9 A.M. However, no measurable foliar burning or precipitation was recorded within 24 hours following foliar application.

Plant samples at harvesting stage from different treatments were utilized for chemical analysis after grinding into fine powder. Total N was determined by the Microkjeldhal method (Jackson, 1973), total P was estimated by Vanado Molybdo Phosphoric Acid method(Jackson, 1973), total K was estimated by Flame photometer method, (Jackson, 1973) and Zn by Atomic absorption Spectrophotometer method (Lindsay and Norvell, 1978). The grain samples which were properly dried and processed were used for the assessment of quality of rice. The physical and chemical quality parameters like hulling per cent (Chauhan *et al*., 1994), milling percent (Chauhan *et al*., 1994), head rice recovery (Bandyopadhyay and Roy,1992) and amylose (Sadasivam and Manickam, 1992) , protein content(Jackson, 1973) were analysed. Cooking character like volume expansion ratio was determined by Murthy (1965).

RESULTS AND DISCUSSION

Yield

Among the three varieties, BPT 2231 (Table 1) recorded higher grain and straw yields (5765 and 6966 kg ha^{-1}respectively) followed by NLR 145 (5220 and 6466 kg ha^{-1}) and MTU 1061 (5021 and 6646 kg ha^{-1}) respectively. The highest grain and straw yields of 5632 and 6967 kg ha^{-1} was recorded with T_5 (10 t of FYM + Zn 0.5% foliar spray twice at PI and heading stages) which was significantly superior to T_6 (Zn 0.5% foliar spray twice at PI and heading stages) which, in turn remained on a par with T_4 (10 t of FYM along with soil application @ 50 kg $ZnSO_4$ ha^{-1}) and found significantly superior to rest of the treatments. The increased yield with Zn foliar spray might be attributed to enhanced yield components viz., number of productive tillers, number of filled grains $panicle^{-1}$, and faster grain filling and also due to biochemical utilization of zinc in the shoot. The present results corroborate with the findings of Chaudhary and Sinha, 2007 and Malla Reddy *et al*., 2011. Further, Stalin *et al.* (2011) also observed that the supply of zinc through foliar spray resulted in better absorption of this nutrient, thereby helping in photosynthetic activity and effective translocation to storage organs and thus, contributed to the increased yield. Harvest index (45.7) was higher with BPT 2231, which might have more efficiency in converting drymatter into grain. The highest harvest index (46.8) was recorded with T_5 (10 t of FYM + Zn 0.5% foliar spray twice at PI and heading stages) which was significantly superior to T_6 (Zn 0.5% foliar spray twice at PI and heading stages) and rest of the treatments which might be due to increased efficiency in converting drymatter into grain due to the application of zinc.

Nutrient Uptake

Total uptake of N, P and K (Table 1) was higher (141 kg ha^{-1}, 16.7 kg ha^{-1} and 66.9 kg ha^{-1}, respectively) and with BPT 2231, which was superior to NLR 145 and MTU 1061 and higher

Table 1. Yield and Nutrient Uptake of rice crop as influenced by varieties , FYM and fertilizer treatments.

Particulars	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	Nitrogen Uptake kg N ha^{-1}	Phosphorus Uptake kg P_2O_5 ha^{-1}	Potassium Uptake kg K_2O ha^{-1}	Zinc Uptake(kg ha^{-1})	
							Grain	**Straw**
Varieties (V)								
V_1: BPT-2231 (Akshaya)	5765	6966	45.8	140.6	16.8	67.0	0.209	0.822
V_2: MTU-1061 (Indra)	5021	6646	44.3	108.5	10.3	46.0	0.156	0.690
V_3 : NLR-145 (Swarnamukhi)	5220	6466	44.5	113.4	12.5	54.3	0.176	0.722
SEm±	40.5	29.9	0.17	0.40	0.06	0.26	0.0008	0.0004
CD (p=0.05)	147	91	0.5	1.3	0.2	0.8	0.003	0.012
Treatments (T)								
T_1: Recommended NPK	5063	6285	43.4	107.8	11.0	48.7	0.118	0.494
T_2: T_1 + 10 t ha^{-1} of FYM	5212	6517	44.0	113.6	11.9	51.5	0.128	0.539
T_3: T_1 + soil application of ZnSO4 @ 50 kg/ha.	5283	6744	44.4	120.5	12.8	54.6	0.178	0.717
T_4: T_1 + 10 t ha^{-1} of FYM + soil application of ZnSO4 @ 50 kg/ha.	5359	6763	44.9	123.5	14.3	57.9	0.197	0.845
T_5: T_1 + 10 t ha^{-1} of FYM+ Zn 0.5% foliar spray twice at PI and heading stages	5632	6967	46.8	132.7	14.7	62.2	0.237	0.956
T6: T_1 + Zn 0.5% foliar spray twice at PI and heading stages	5464	6880	45.6	126.8	14.5	59.6	0.225	0.916
SEm±	40.2	29.9	0.02	0.42	0.07	0.27	0.0001	0.0038
CD (p=0.05)	123	109	0.6	1.5	0.3	0.9	0.004	0.014
Interaction(V X T)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.8	10.1	6.2	7.1	6.7	7.4	6.1	7.6

Table 2. Quality parameters of rice as influenced by varieties, FYM and fertilizer treatments.

Particulars	Hulling (%)	Milling (%)	Head rice recovery (%)	Protein content (%)	Amylose content (%)	Volume expansion ratio
Varieties (V)						
V_1: BPT-2231 (Akshaya)	80.43	73.4	66.4	9.4	23.2	3.7
V_2: MTU-1061 (Indra)	80.82	73.8	66.8	7.5	21.4	4.3
V_3 : NLR-145 (Swarnamukhi)	79.91	72.9	65.9	8.1	22.4	4.0
SEm±	0.003	0.12	0.02	0.03	0.13	0.04
CD (p=0.05)	0.01	0.4	0.1	0.1	0.4	0.1
Treatments (T)						
T_1: Recommended NPK	78.6	71.6	64.6	8.0	19.6	3.8
T_2: T_1 + 10 t ha-^{1} of FYM	78.7	71.7	64.7	8.1	21.1	3.9
T_3: T_1 + soil application of ZnSO4 @ 50 kg/ha.	79.8	72.8	65.8	8.2	22.6	4.0
T_4: T_1 + 10 t ha^{-1} of FYM + soil application of ZnSO4 @ 50 kg/ha.	80.3	73.3	66.3	8.3	23	4.1
T_5: T_1 + 10 t ha^{-1} of FYM+ Zn 0.5% foliar spray twice at PI and heading stages	81.7	74.7	67.7	8.9	24.1	4.1
T6: T_1 + Zn 0.5% foliar spray twice at PI and heading stages	80.8	73.8	66.8	8.4	23.5	4.0
SEm±	0.03	0.13	0.03	0.03	0.13	0.03
CD (p=0.05)	0.1	0.4	0.1	0.1	0.4	0.1
Interaction(V X T)	NS	NS	NS	NS	NS	NS
CV (%)	5.9	4.0	5.0	4.9	4.0	5.0

zinc uptake (grain and straw i.e. 0.209 kg ha^{-1} and 0.822 kg ha^{-1} respectively) with BPT 2231over NLR 145(grain and straw i.e. 0.176 kg ha^{-1}and 0.722 kg ha^{-1}) respectively and MTU 1061 (grain and straw i.e.0.156 kg ha^{-1} and 0.690 kg ha^{-1}).Similar observations were reported by Priyadarsini (2001).

The maximum total uptakes of N, P and K (132.7 kg ha^{-1}, 14.7 kg ha^{-1} and 62.3 kg ha^{-1}) were recorded with T_5 (NPK along with 10 t of FYM + Zn 0.5% foliar spray twice at PI and heading stages) which was closely followed by T_6 (NPK along with Zn 0.5% foliar spray twice at PI and heading stages) and these two treatments were found significantly superior to rest of the treatments.

The maximum zinc uptake (grain and straw i.e 0.237 kg ha^{-1} and 0.956 kg ha^{-1} respectively) was recorded with T_5 (10 t of FYM + Zn 0.5% foliar spray twice at PI and heading stages), which was closely followed by T_6 (Zn 0.5% foliar spray twice at PI and heading stages) and significantly superior to rest of the treatments. The uptake being the product of content and drymatter production, the increase in Zn uptake by the crop might be due to easy availability of Zn at higher concentrations and rapid rate of absorption caused by greater mobility of zinc when applied as foliar spray. The present findings are in conformity with the findings of Das *et al.*(2004) and Yadav *et al.*(2011).

Quality

Grain quality (Table 2) characters viz., hulling per cent, milling percent, head rice recovery and amylose, 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 (80.8), milling per cent (73.8), head rice recovery (66.8), protein content

(9.4%), volume expansion ratio (4.3) were significantly superior with the variety MTU 1061 while amylose content (22.4%) was superior with the variety BPT 2231. The genetic make up of the varieties was responsible for variations in quality characteristics of rice. The present findings are in accordance with those of Priyadarsini (2001).

Among the different treatments tested, the highest hulling per cent (81.7), milling per cent (74.7), head rice recovery (67.7), protein content (8.9%) and amylose content (24.1%) were recorded with T_5 (10 t of FYM + Zn 0.5% foliar spray twice at PI and heading stages) which was significantly superior to rest of the treatments. Whereas, highest volume expansion ratio (4.1) was observed with T_5 (10 t of FYM + Zn 0.5% foliar spray twice at PI and heading stages) which remained on a par with T_6 (Zn 0.5% foliar spray twice at PI and heading stages) and T_4 (10 t of FYM + soil application of ZnSO4 @ 50 kg/ha) and found significantly superior to other remaining treatments.

It can be concluded that application of FYM@10 t ha^{-1} along with zinc through foliar spray twice at PI and flowering stages was found to be effective in increasing yield, nutrient uptake and also found to be better as it resulted in higher quality. The variety, BPT 2231 seems to be the most promising variety in realization of higher grain yield whereas, MTU 1061 seems to be best in recording higher grain quality.

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