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Study of high iron and high zinc contents varieties of rice in Jharkhand condition through biofortification

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Abstract
Rice (*Oryza sativa*) is the most important cereal crop in the developing world and is the staple food of over half the world's population. Roughly one-half of the world population, including virtually all of East and Southeast Asia, is wholly dependent upon rice as a staple food. Though rice is the predominant source of energy, protein and micronutrients for more than 50% of the world population, it does not provide enough essential mineral nutrients to match human requirements. Mitigating hidden hunger with the biofortification of rice surely can be a beneficial strategy for people who consumes rice as a staple food. Significant enhancement in iron and zinc levels, as well as with other essential minerals and vitamins is achieved in rice biofortification by various approaches. Zinc and iron deficiency are recognized as major nutrient disorders in humans and its effects are more profound in children. Therefore, Zn and Fe deficiency is a chronic problem among human populations that have rice based diets. Raza Q. *et al*. (2020). Identification of the amount of genetic variability for Fe and Zn concentration in the germplasm is the initial step, then improving rice Fe and Zn concentration. Seventy entries were planted in three replications in Alpha lattice in GXE interaction trial at BAU, Research Farm under biofortified rice through Harvest Plus Challenge Programme under the collaboration of BAU and IRRI for developing high zinc and high iron rice varieties suitable for Eastern India including Jharkhand during *kharif* 2014. Micronutrient estimations were carried out using the XRF technology and cross checked with AAS/ICP in selected entries especially those that are highs for iron/zinc facilitated by Harvest Plus-ICRISAT. The entry no. 22 (SAPONYO), Fe 7.7 ppm and Zinc 20.7 ppm recorded maximum yield (38.14 q/ha) followed by entry no. 20 (PORA MEUNYA) Fe 7.7 ppm and zinc 22.7 ppm which yielded 33.45 q/ha. Consequently, new genetic and management strategies need to be developed to minimize Iron and Zn deficiency for people whose staple diet is rice and emphasis should be being given to nutritional aspects since micronutrient deficiency, especially of Zn and Fe, has become a global issue.

Keywords: Rice, Iron, Zinc, Biofortification, contents

Introduction
Rice is one of the chief grains of India. It is, in fact, the dominant crop of the country. India is one of the leading producers of this crop. Rice is the basic food crop and being a tropical plant, it flourishes comfortably in a hot and humid climate. Rice is mainly grown in rain-fed areas that receive heavy annual rainfall. Rice is most dominant crop of Jharkhand and it is grown in all agro- ecological conditions existing in 24 districts of the State. The total geographical area of state is 79.71 lakh ha which is 46% of undivided Bihar. The cultivation of different crops are restricted to only 25.0 lakh ha and out of which rice alone is cultivated in 18.20 lakh hectare during the wet season. This clearly speaks the importance of rice cultivation in socio-economic condition of Jharkhand. Moreover, it occupies more than 70% of total cultivated area as it is grown from Tanr-I, Tanr-II, Tanr-III, Don-III, Don-II and Don-I. The area of each category may be summarized as.

Area of each category

Sl. No.	Category	Sub Category	Area in lakh/ha.
1	Upland	Tanr-I to Tanr-III	5.0
2	Medium Land	Don-III & Don-II	9.0
3	Lowland	Don-I	4.0

Out of total cultivated area (18.0 lakh ha) under rice, only 2.0 lakh ha are direct seeded or broadcasted and remaining 16.0 lakh hectare are transplanted. The average rainfall of the State is 1380 mm in a year. But more than 83.5% of total rainfall is received in monsoon months starting from 15th June to 30th September but due to global warming and climate change not only the total amount of rainfall has been reduced but its distribution has also gone very erratic and uneven. In the month of July and August when more water is required for transplanting of rice, comparatively less rainfall is received which are effecting transplanting of rice in a very negative manner and when less water is required in the month of September and October, more rainfall is received. It means production of rice and other crops totally depend on rain received during monsoon months. Drought has become regular feature of the State and it is witnessed once in every three years. Area under assured irrigation is 12% and remaining 88% is total rainfed meaning thereby rainfed agriculture is the main feature of Jharkhand State. In such a situation, drought tolerant varieties of rice at least for upland and medium land and resistance to blast having many good agronomic traits are very much required so that farmers can harvest better yield even in drought like situation.

Micronutrient malnutrition, or hidden hunger, afflicts billions of people. It is caused by a lack of micronutrients in the diet. Fruits, vegetables, and animal products are rich in micronutrients, but these foods are often not available to the poor. Their daily diet consists mostly of a few inexpensive staple foods, such as rice, wheat, maize, etc, which have few micronutrients. The consequences, in terms of malnutrition and health, are devastating and can result in blindness, stunting, disease, and even death. Biofortification is an additional tool to current interventions, it complements other strategies such as supplementation, fortification and dietary diversity to reduce micronutrient malnutrition. Biofortification is a plant breeding technique used to increase the levels of micronutrients in staple food crops. In Harvest Plus we use plant breeding to enhance the levels of 3 micronutrients that are most limiting: vitamin A, iron and zinc to measurable impact on nutritional status at the public health level.

Further rice is the main crop which is in a food habit of State of Jharkhand. The varieties/hybrid of rice which are grown by farmers of State lacks in desired quantities of zinc and iron. Most of the varieties which are popular and grown are having zinc availability of 14.0 ppm/gm and 5.0-6.0 ppm/gm in iron. Similar result was given by Kappara S and *et al.* (2018) [2]. This is resulting to poor percentage of hemoglobin especially in ladies and problem of diaroohea in children. It has also been observed that less percentage of zinc available in cultivated varieties of rice is responsible for diaroohea and less availability of iron leads to problem of hemoglobin. Khan JA, *et al*. (2019) [4] and Yoneyama T. *et al*. (2015) [5]. Considering the importance of rice in social economic condition and food habit in natives of State, the International Centre of Tropical Agricultural (CIAT) and International Food Policy Research Institute (IFPRI) had initiated a programme of biofortified rice through Harvest Plus Challenge with BAU and IRRI of following.

Objectives

- Zinc content in adapted cultivars and available breeding lines to be validated and justifies further development of biofortified rice with target enhanced expression of zinc. Positive correlation between iron and zinc content in rice grain allows simultaneous improvement.
- Transfer of high zinc density traits into high yielding adapted cultivars and/or generation of micronutrient density via exploiting transgressive segregation, maternal effects etc.
- Crosses directed to target agro-ecologies combining zinc density with traits relevant for variety adoption with particular environments were conducted and early breeding populations developed.
- Best early and intermediate products are advanced towards final products following intensive selection and testing for attributes relevant for variety adoption in target agro-ecologies and micronutrient density.

Materials and Methods

Harvest Plus Challenge Programme initiated for developing high zinc and high iron rice varieties suitable for Eastern India including Jharkhand. The IRRI had provided 62 lines of biofortified rice. The nursery was raised on 27.08.2013. The phenotypically superior genotypes were selected and identified at the time of flowering and all the required data on agronomical traits were recorded. Phenotypically superior selected/ identified genotypes were earmarked and number of crosses were made with the most popular or adapted variety like IR-64. The large number of crosses were made from a single cross so that sufficient quantities of F_1's seed were produced. The seed of phenotypically superior genotypes, cross seed (F_1s) were sent to Hyderabad for analysis of Zinc and Iron. Seventy entries were planted in three replications with plot size Plot Size: 4 x 0.8 m^2, Fertilizer: 80:60:40 NPK Kg/ha, Spacing: 15 x 20 cm in Alpha lattice. The Date of sowing was 11/7/2014 and date of transplanting: 12/8/2014.

Estimation of zinc and iron contents in rice grains

Zinc (Zn) and Iron (Fe) contents of rice grain samples are determined by using Atomic Absorption Spectrophotometer (AAS). In this process the samples are digested by the application of di-acid mixture which includes nitric acid (HNO3): and perchloric acid (HClO4) in 2:1 ratio. Zinc and iron contents are estimated in the aliquot of seed extract by using Atomic Absorption Spectrophotometer (AAS) at 213.9 nm and 248.33nm respectively.

Results and Discussion

The varietal differences were not significant. The entry no. 22 (SAPONYO), recorded maximum yield (38.14 q/ha). The iron content of the entry was 7.7 ppm and Zinc content was 20.7 ppm followed by entry no. 20 (PORA MEUNYA) where the iron content was 7.7 ppm and zinc content was 22.7 ppm which yielded 33.45 q/ha. Similar findings were suggested by Shilpa M Naik *et al.* (2020) [1] and Wang Y, *et al*. (2020) [6].

Table 1: GxE investigation (Kharif 2014-15)

Entry No.	Entry Name	Yield (q/ha)	DTF	Plant height	Fe (ppm)	Zinc (ppm)
20	PORA MEUNYA	33.45	96	83	7.7	22.7
37	TAKER AM	30.13	93	98	7.8	21.0
23	ROSHO	27.95	96	95	11.2	24.8
52	IR 82475-110-2-2-1-2	26.19	101	70	7.1	20.4
64	RP Bio 5477-NH 686	25.59	100	113	8.9	21.2
65	Swarna	14.57	99	67	5.9	16.4
68	IR 64	14.74	79	76	7.2	20.3
66	Sambha Mahsuri	9.47	105	73	6.2	22.7
67	MTU1010	16.15	96	104	7.0	15.6
70	Local check 2 (Naveen)	16.32	88	92	7.8	21.0
69	Local check 1 (Lalat)	16.52	110	102	5.0	17.6
CD		NS				
CV %		27.96				

Conclusion

The study showed non-significant varietal differences in yield, with entry no. 22 (SAPONYO) exhibiting the highest yield at 38.14 q/ha, accompanied by 7.7 ppm iron and 20.7 ppm zinc. Entry no. 20 (PORA MEUNYA) followed closely with 7.7 ppm iron, 22.7 ppm zinc, and a yield of 33.45 q/ha. These findings are consistent with research by Shilpa M Naik *et al*. (2020) [1] and Wang Y *et al*. (2020) [6]. Overall, the study highlights the potential of certain entries in enhancing yield and nutrient content, contributing valuable insights to agricultural practices.

References

1. Naik SM, Prasad K, Izhar T, Kumar A, *et al*. Genotype × environment interactions for grain iron and zinc content in rice. J Sci Food Agric. 2020;100(11):4150-4164. DOI: 10.1002/jsfa.10454.
2. Kappara S, Neelamraju S, Ramanan R. Down regulation of a heavy metal transporter gene influences several domestication traits and grain Fe-Zn content in rice. Plant Sci. 2018;276:208-219.
3. Raza Q, Riaz A, Saher H, Bibi A, Raza MA, Ali SS, *et al*. Grain Fe and Zn contents linked SSR markers based genetic diversity in rice. PLoS One. 2020 Sep 28;15(9).
4. Khan JA, Narayana KK, Holla S, Shrinivas SM, Dar ZA, Shashidhar. J Sci Food Agric. 2019 Feb;99(3):1311-1321.
5. Yoneyama T, Ishikawa S, Fujimaki. Route and Regulation of Zinc, Cadmium, and Iron Transport in Rice Plants (*Oryza sativa* L.) during Vegetative Growth and Grain Filling: Metal Transporters, Metal Speciation, Grain Cd Reduction and Zn and Fe Biofortification. Int J Mol Sci. 2015;16(8):19111-29.
6. Wang Y, Zhang Y, Rasheed A, Li M, Xia X, He Z, *et al*. Dissection of Molecular Processes and Genetic Architecture Underlying Iron and Zinc Homeostasis for Biofortification: From Model Plants to Common Wheat. Int J Mol Sci. 2020 Dec 5;21(23):9280.