Research Article

# Effect of Biofortification of hybrid rice with Zinc and Iron on yield and yield attributes of hybrid rice (*Oryza sativa* L.)

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**Abstract**

A field experiment was conducted at College of Agriculture, V.C. Farm, Mandya, University of Agricultural sciences, Bengaluru, to study the Effect of Biofortification of hybrid rice with Zinc and Iron on yield and yield attributes of hybrid rice. The effect of twelve combinations of micronutrient application and methods of rice cultivation were studied on the yield attriubutes and yield. Different yield attributing parameter such as number of productive tillers per hill, Panicle length, total number of grains per panicle were maximum in the treatment with SRI method of rice cultivation compare to the other method of rice cultivation and among the biofortification treatments Zn and Fe applied as Seed treatment combined with foliar sprays at panicle initiation and bootleaf stage. Grain yield was recorded high in SRI method of rice cultivation and soil application of $ZnSO_4$ at 20 kg $ha^{-1}$ and $FeSO_4$ at 10 kg $ha^{-1}$.

**Keywords:** Yield attributes, micronutrient application, Rice cultivation, grain yield, Hybrid rice

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## Introduction

Rice is the only cereal crop cooked and consumed mainly as whole grain and the quality considerations are much more important than for any other food crop [1]. It has become a common dietary in the world, particularly in developing countries. it is known as the grain of life and is synonymous with food for Asians as it supplies majority of starch, protein and micronutrient requirements. It provides 23 % of the calories consumed by the world's population and provides 50–80 % of the energy intake of the people in the developing countries which is more than that of wheat or corn. However, rice is a poor source of many essential minerals and organic substances, especially iron (Fe), zinc (Zn) and lysine (Lys) and other essential amino acids for human nutrition. Currently, malnutrition of Fe and Zn afflicts more than 50 % of the world's population [2]. This weakens immune function and impairs growth and development [3] and continuous heavy consumption of rice with low concentration of Fe and Zn has been considered a major contributor [4] and Zn deficiency is currently listed as a major risk factor for human health and causes of death globally. Moreover, Zn deficiency affects, on average, one-third of world's population, ranging from 4 to 73 % in different countries.

Fertilization is the key point of nutrient-integrated management in agronomic approaches to enhance crop quality and yield, so that fertilization could be one of the sustainable and low cost strategies to improve Fe and Zn density in edible portions of staple food crops [5].

Rice is grown under submerged condition. On the other hand, submerging rice fields brings a series of physical, chemical and microbiological changes in the soil, which profoundly affects growth of rice plant as well as availability, loss and absorption of nutrients. For producing 1kg of rice about 3000 -5000 litres of water is required owing to increasing water scarcity, a shifting trend towards less water demanding crops against rice is noticed in most part of India and this warrants alternate methods of rice cultivation that aims at higher water and crop productivity. Cultivation of rice through System of Rice Intensification (SRI) can increase rice yields by two to three fold compared to current yield levels [6]. Aerobic rice cultivation where fields remain unsaturated throughout the season like an upland crop offers an opportunity to produce rice with less water [7]. Therefore, the present investigation was conducted to study the effect of different methods of micronutrient application and methods of rice cultivation on the yield and yield attributes of hybrid rice to find out the suitable method micronutrient application for biofortitication and method of cultivation for maximum yield.

## Materials and Methods

The field experiment was conducted in the kharif, 2014 at the college of Agriculture, V.C. Farm, Mandya, Karnataka on red sandy loam soil. To study the Effect of Biofortification of hybrid rice with Zinc and Iron on yield and yield attributes of hybrid rice. Hybrid rice variety used is KRH-4.The experiment was laid out in split plot design consisting of three replications with three main plots as methods of rice cultivation *viz*., SRI method, Conventional method and Aerobic method and four subplots with micronutrient management practices *viz*., Control without Zn and Fe, Soil application of $ZnSO_4$ at 20kg/ha and $FeSO_4$ at 10kg/ha, Seed treatment with $ZnSO_4$ at 0.2% and $FeSO_4$ at 0.1% and Seed treatment combined with the Foliar spray of $ZnSO_4$ and $FeSO_4$ at 0.5% each at boot leaf stage and panicle initiation stage. Nutrients were applied as par the treatment.

## Results and Discussion

***Effect of biofortification of hybrid rice with Zn and Fe under methods of rice cultivation on yield attributes***

**Table 1** Yield attritubes of hybrid rice influenced by Biofortification of rice with Zinc and Iron

| Treatment | No. Productive tillers per hill | Panicle length(cm) | Total Number of grains per panicle |
|---|---|---|---|
| **Main plot: Methods of cultivation** | | | |
| $M_1$ = SRI method of cultivation | 18.5 | 22.74 | 193.92 |
| $M_2$ = Conventional method of cultivation | 15.50 | 22.16 | 193.08 |
| $M_3$ = Aerobic method of cultivation | 14.88 | 20.60 | 157.08 |
| Sem± | 0.89 | 0.15 | 5.24 |
| CD(P=0.05) | 3.49 | 0.57 | 21.28 |
| **Subplot: Micronutrient management practices** | | | |
| $S_1$ = Control without Zn and Fe, | 14.44 | 20.84 | 161.11 |
| $S_2$ = $ZnSO_4$ at 20 kg/ha + $FeSO_4$ at 10 kg/ha through Soil application | 16.56 | 22.27 | 183 |
| $S_3$ = $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.1 % as Seed treatment | 17.24 | 21.80 | 185.22 |
| $S_4$ = $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.1 % as Seed treatment + Foliar spray of $ZnSO_4$ at 0.5 % and $FeSO_4$ at 0.5 % at panicle initiation and boot leaf stage. | 16.93 | 22.42 | 196.11 |
| Sem± | 0.60 | 0.30 | 9.12 |
| CD(P=0.05) | 1.78 | 0.88 | 27.08 |

The observations *viz*, *of* productive tillers per hill, Panicle length(cm), total number of grains per panicle (**Table 1**), grain yield (kg $ha^{-1}$) of hybrid rice (**Table 2**) indicated that in the present investigation of Zinc and Iron application significantly influenced the yield attributes and grain yield of hybrid rice. SRI method recorded significantly higher total number of grains per panicle (193.92), productive tillers per hill (18.50), Panicle length (22.74cm) and grain yield (6377 kg $ha^{-1}$) and which was on par with the conventional method in total number of grains per panicle (193.08), productive tillers per hill (15.50), Panicle length (22.16cm) and grain yield (6253 kg $ha^{-1}$) compared to aerobic method of rice cultivation. Yield parameter like productive tillers per hill, total number of grain per hill and grain yield were also recorded in SRI due to wider spacing and large root volume which reduced the Intra species competation in the SRI method compared to conventional method and aerobic method of rice cultivation and that might be attritubed to significantly higher Absolute growth rate, Crop growth rate and total dry matter accumulation in the plants were conformity with the findings of Uphoff ( 2002) **[8]** reported that increased in yield of rice under SRI method of rice cultivation. SRI practices reduce transplanting injury and increases tiller number and other yield attitributes reported by Takeshihorie *et al*.,(2003) **[9]** and Makarim *et al*.,(2007) **[10].**

Among biofortification treatments of hybrid rice with Zn and Fe, higher total number of grains per panicle (196.11) and Panicle length (22.27cm) was recorded in Zn and Fe applied as Seed treatment combined with foliar sprays at panicle initiation and bootleaf stage and it was on par with seed treatment alone followed by soil application of Zn and Fe fertilizers than control. Significantly higher grain yield (6293 kg

$ha^{-1}$) was recorded in Soil application of Zinc and Iron increased the plant height and leaf area, which eventually contributed to the increase in dry matter accumulation, better nutrient uptake and yield attritubes. Zinc and Iron are essential for several enzyme systems that regulate various metabolic activities in plants and photosynthesis, resulting in increased plant height and other growth and yield parameters were reported in the findings of Ram *et al*.,(1995) [11] and Ananda and Patil (2005) **[12]** in wheat crop.

**Table 2** Grain yield hybrid rice influenced by Biofortification of rice with Zinc and Iron

| **Treatment** | **Grain yield(kg $ha^{-1}$)** |
|---|---|
| $M_1$ = SRI method of cultivation | 6377 |
| $M_2$ = Conventional method of cultivation | 6253 |
| $M_3$ = Aerobic method of cultivation | 5531 |
| Sem± | 95 |
| CD(P=0.05) | 374 |
| $S_1$ = Control without Zn and Fe, | 5604 |
| $S_2$ = $ZnSO_4$ at 20 kg/ha + $FeSO_4$ at 10 kg/ha through Soil application | 6293 |
| $S_3$ = $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.1 % as Seed treatment | 6159 |
| $S_4$ = $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.1 % as Seed treatment + Foliar spray of $ZnSO_4$ at 0.5 % and $FeSO_4$ at 0.5 % at panicle initiation and boot leaf stage. | 6158 |
| Sem± | 133 |
| CD(P=0.05) | 396 |

## Conclusion

From the findings it may be concluded that, SRI method shows higher yield attritubing characters and application of micronutrient at critical growth stages is better for biofortification of hybrid rice. SRI method of cultivation among the methods of rice cultivation and seed treatment combined with the foliar application of zinc and iron at panicle initiation and boot leaf stage can be recommended for the biofortification of micronutrient in hybrid rice.

## Reference


[1] Ravindrababu, V., Shreya, K., Kuldeep, S. D., Usharani, G. and Nagesh. P, 2013, Evaluation of popular rice hybrid for quantitative, qualitative and nutritional aspects. Int. J.of Sci. Res. Pub., 3, ISSN 2250- 3153.

[2] Welch, R. M., 2005, Biotechnology, biofortification, and global health. Food and Nutri. Bull., 26: 419-421.

[3] Welch, R. M., 2002, The impact of mineral nutrients in food crops on global human health. Pl. Soil, 247: 83-90.

[4] Welch, R. M. and Graham, R. D., (1999), A new paradigm for world agriculture: meeting human needs. Productive, sustainable, nutritious. Field Crops Res.,60: 1-10.

[5] Rengel, Z., Batten, G. D. and Crowley, D.E., 1999, Agronomic approaches for improving the micronutrient density in edible portions of field crops.Field Crops Res., 66: 27-40.

[6] Uphoff, N., 2005, „The development of the system of rice intensification" in J.Gonsalves et al.(eds), Participatory Research and development for sustainable Agriculture and Rural Development, 3:119-125.

[7] Bouman, B. A. M., Wang hua, Q. I., Yang xiao guang., Zhao jun fang and Wang chang gui, 2002, Aerobic rice (Han Dao): a new way of growing rice in water-short areas. In: Proce. of the 12th Inter. Soil Conser. Organ.Conf., 26-31 May 2002, Beijing, China. Tsinghua University Press, pp. 175-181.

[8] Uphoff, N., 2002, System of rice intensification for enhancing productivity of land, labourand water. J. Agric. Resources Manag.,1(1): 43-49.

[9] Takeshihorie, Koki Homma and Hiroe Yoshida, 2003, SRI practices in Japan. Proc. Crop Sci., Japan, 40: 90-94.

[10] Makarim, A. K., Zain, Z., Gani, A. and Syamsiah, I., 2007. Water management practices in philippine. In: Water Wise Rice Production, IRRI, Manila, pp. 129-141.

[11] Ram, N.E., Raja, V. and Reddy, K.R. 1995. Grain yield affected by micronutrients application. Int. J. Tropical Agric., 5(2): 102-109.

[12] Ananda, N. and Patil. B. N. 2005. Effect of micronutrients (Zn and Fe) and Time of Nitrogen application on growth and yield of Durum wheat (Triticum spp). Karnataka J. Agric. Sci., 18(3): 604-608.

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