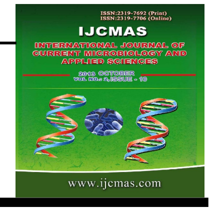

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 2 Number 11 (2013) pp. 384-387**
http://www.ijcmas.com

Review Article

Agronomic Biofortification of Rice with Special Reference to Zn and Fe Nutrition

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A B S T R A C T

In cereals rice is the most important and staple food for ¾th of Indian population. Accordingly its productivity, quality and profitability have become an integral part of our National Food System. The micro-nutrient malnutrition in rice is a common phenomenon due to deficiency of iron, zinc, iodine and vitamin A and may cause lower resistance to diseases in children and reduced the probability of child survival at birth.

Keywords

Cereals rice; National Food System; malnutrition.

Introduction

Biofortification of rice with micro-nutrient is the only tool to reduce micro-nutrient malnutrition of staple foods whose edible portions are more dense in bioavailable minerals and vitamins. A Global Challenge Programme (GCP) on biofortification has just been approved by consultative group on International Agricultural Research (CGIAR), aims to support all efforts to improve the nutritional value of rice, especially iron, zinc, vitamin A, calcium, iodine and selenium which are usually low in rice for particularly rice consuming communities (Graham, 2002). Cereals are often most productive but are generally low in micro-nutrients. In developing countries cereals dominate dietary system and thus appears to be the most likely reason of micro-nutrient deficiencies in the society (Welch and Graham, 1999). Therefore it is imperative to increase the micro-nutrient density of the major staple food crops and it can be achieved by fertilization. In addition to traditional fertilizer practices, increased demand of micro-nutrients in present day agriculture has emerged due to cultivation of high yielding varieties of rice under high intensity cropping system.

Large variation in iron and zinc content in grains of rice varieties, have been observed. The aromatic cultivars have consistently higher concentration of iron and zinc in grain than the non-aromatic types (Graham *et al.,* 1997). Zn-efficient varieties with Zn-dense seeds are higher yielding in Zn-deficient soils (Cakmak, 1999).

The density of several micro-nutrients in grain can effectively be enhanced by application of appropriate mineral forms (House and Welch, 1989). The sources of micro nutrients are inorganic, synthetic chelates or natural organic complexes. Foliar fertilization has many advantages over soil application due to lower requirement and immediate crop response, (Mortvedt, 2000). Zn deficiency can be corrected by either foliar or soil applications of $ZnSO_4$ or Zn EDTA. Application of Zn on soil are more effective than foliar applications. Sahu *et al.* (1994) found a significant increase in dry matter yield of rice due to application of Zn @ 2.5 to 5 mg kg^{-1} soil as $ZnSO_4$ or 0.3 mg kg^{-1} soil as Zn EDTA over control. Similarly, Srivastava *et al.* (1999) reported that Zn EDTA treatment, inspite of supplying the lowest amount of zinc, produced the highest yield of rice and the highest “Zn mobilization efficiency” compared to other Zn sources. Patil and Meisheri (2003) reported that application of 25 kg $ZnSO_4$ ha^{-1} or 10 kg chelate ha^{-1} significantly increased zinc content and uptake by rice grain as well as straw. Kulandaivel *et al.* (2004) also reported significant influence on Zn and Fe uptake by hybrid rice due to application of different levels and modes of zinc and ferrous sulphate.

Though iron (Fe) is the second most abundant metal in nature and fourth most abundant element in the earth crust, about 11% Indian soils are in deficient supply of iron (Singh, 1999a). Because of their iron absorption efficiency, cereals provide an important entry point for iron into the food chain, however, the concentration of iron in the grain are quite low compared to meat-iron sources. Among the various inorganic Fe – carriers $FeSO_4.7H_2O$ is the most commonly used fertilizer for correcting Fe-deficiency in rice. Synthetic Fe chelates are generally the most effective Fe sources for soil and foliar applications their cost may be prohibitive but it may be cost-effective if crops are of high value (Fageria *et al.*, 2002). Most of the research on methods of iron application have shown the superiority of foliar application over soil application. Soil application of 20 Kg Fe ha^{-1} as $FeSO_4$ proved inferior to 3 foliar sprays with 2% unneutralized $FeSO_4$, solution in amending Fe deficiency in rice grown on coarse textured soils (Das, 2000). New attempts are being made to develop slow-release fertilizers that will gradually release Fe to the soil. Resin-coated soluble Fe materials such as $FeSO_4$ or Fe EDTA were tested as slow – release fertilizers with little success (Natt, 1992). Ram Sakal (2001) reported that application of 50 kg $FeSO_4$ ha^{-1} alone significantly increased the grain yield of rice by 8.7 q ha^{-1} over control (No Fe). They further reported that the magnitude of yield response as well as Fe uptake by rice due to $FeSO_4$ or pyrite was enhanced in presence of compost.

Organic amendments, especially FYM, increase the concentrations of many nutrients and can be seen to enhance the nutritional value and nutrient balance of plant foods (Graham *et al.,* 2000). Organic acids such as citric, malic, oxalic and phenolic that form Fe complexes are released when organic matter decomposes. These Fe complexes enhance the mobility and bioavailability of Fe (Lindsay, 1991). With the objective of improving nutritional quality of high yielding rice varieties (special reference to zinc and iron) through agronomic management, Sreedevi *et al.* (2005) reported, 100% RFD + Zn as soil/foliar application and 50% RFD + 50% FYM were found to be promising in increasing grain yields as well as in improving zinc content of grain.

In human nutrition terms, bioavailability is commonly defined as the amount of a nutrient in a meal that is absorbable and utilizable by the person eating the meal (Van Campen and Glahn, 1999). The total amount of a micronutrient in a plant food does not represent the actual micronutrient content of the food that is utilizable by the consumer. This quantity (i.e. the bioavailable amount) must be determined independently using methodologies especially developed for such purposes. However, such human experimentation is costly and long-term in nature. Therefore, initial bioavailability screening of promising lines of micro-nutrient enriched staple food crops was performed using a rat model as rats are more efficient at absorbing Fe and Zn than human from plant food sources.

Micronutrient malnutrition is a leading health-care issue in the world today and much more detectable in developing countries. Selection of nutritionally rich (aromatic) varieties of rice can form the basis for a food-based solution to the nutrition needs of the population. Application Zn fertilizers on soil are more effective than foliar. Foliar application (2-3) of Fe containing fertilizers proved more effective as compared to its soil application. Inclusion of organic amendments (FYM) in fertilizer schedule was found promising in improving the Zn and Fe content of rice. Besides, agronomical approach, the bioavailable amount of Zn and Fe in rice should also be determined with cost effective method.

References

Cakmak, I., 1999. Zinc deficiency as a practical problem in plant and human nutrition in Turkey : A NATO-Science for Stability Project. Field Crop Res. 60: 175-188.

Das, D.K., 2000. Micro-nutrient : Their Behaviour in Soils and Plants, Kalyani Publishers, New Delhi.

Fageria, N.K., V.C. Bajigar and Clark, R.B. 2002. Micro-nutrients in crop production. Adv Agro. 77 : 187-266.

Graham, R.D., 2002. Biofortification : A Global Challenge Programme, Coordinator for biofortification, University of Adelaide, Currently Consultant, IRRI, www.org/publications/i..../1/1/2002 page 2 of 7.

Graham, R.D., J.M. Humphrius, and Kitchen, J.L. 2000. More enhanced cereals : a sustainable foundation for diet. Asia Pacific J. Clin. Nutr. **9** (Suppl.) : S9.

Graham, R.D., D. Senadhira and Ortiz-Monasterio, I. 1997. A strategy for breeding staple-food crops with high micro-nutrient density. Soil Sci. Plant Nutr. 43: 1153-1157.

House, W.A., and Welch, R.M. 1989. Bioavailability of and interactions between zinc and selenium in rats fed wheat grain intrinsically labeled with ^{65}Zn and ^{75}Se. J. Nutr. 199: 916-921.

Kulandaival, S., B.N. Mishra, B. Gangiah and Mishra, P.K. 2004. Effect of levels of zinc and iron and their chelation on yield and soil micronutrient status in hybrid rice (*Oryza sativa*) – wheat (*Triticum aestivum*) cropping system. Ind. J. Agron. 49(2) ; 80-83.

Lindsay, W.L., 1991. Inorganic equilibria affecting micro-nutrients in soil. *In* "Micro nutrients in Agriculture", 2nd edition (J.J. Mortvedt, F.R. Cox, L.M. Shuman and R.M. Welch Eds.), Soil Sci. Soc. America, Madison, WI, pp. 89-112.

Mortvedt, J.J., 2000. Bioavailability of micronutrients. *In* "Handbook of Soil Science". (M.E. Sumer, Ed.) pp. D78-

D88. CRC Press, Boca Raton, FL.

Natt, C. 1992. Effect of slow release iron fertilizer on chlorosis in grape. J. Plant. Nutr. 15: 1891-1912.

Patil, K.D., and Meisheri, M.B. 2003. Diruet residual effect of applied zinc along with FYM on rice in soils of Konkan region of Maharashtra. Ann. Agri. Res. New Series. 24(4) : 927-933.

Sahu, S.K., G.N. Mishra and S.C. 1994. Effect of Zn sources of uptake of Zn and other micro nutrient by rice on vertisols. J. Indian Soc. Soil Sci, 42 (3) : 487-189.

Sakal, R., 2001. Efficient Management of micronutrient for sustainable crop production. J. Ind. Soc. Soil Sci., 49 (4): 593-608.

Singh, M.V., 1999a. Micro-nutrient deficiency delineations and soil fertility mapping. In : National Symposium on Zinc Fertilizer Industry-Whiter to? Held at Lucknow on 24 April 1999, U.P. Zinc Sulphate Manufactures Association.

Sree Devi, B., K. Surekha and Ravindra Babu, V. 2005. Agronomic Management or Enhancing Nutritional Quality of Basmati and Non-Basmati Varieties. National Symposium on Basmati Rice Research : Current Trend and Future Prospects, SVBPUA & T, Meerut, India, 6-7 Sept. 2005.

Srivastava, P.C., D. Ghosh And Singh, V.P. 1999. Evaluation of different Zn sources are low land rice production. Biol. Fertility Soils. 30 (1-2) : 168-172.

Van Campen, D.R., and Glahan, R.P. 1999. Micronutrient bioavailability techniques : Accuracy, problems and limitations. Field Crops Res. 60: 93-113.

Welch, R.M., and Graham, R.D. 1999. A new paradigm for world agriculture : Meeting human needs; productive, unsustainable, nutritious. Field Crops Res. 60: 1-10.