Management of Fe rich red and lateritic soils for food and nutritional security

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Introduction

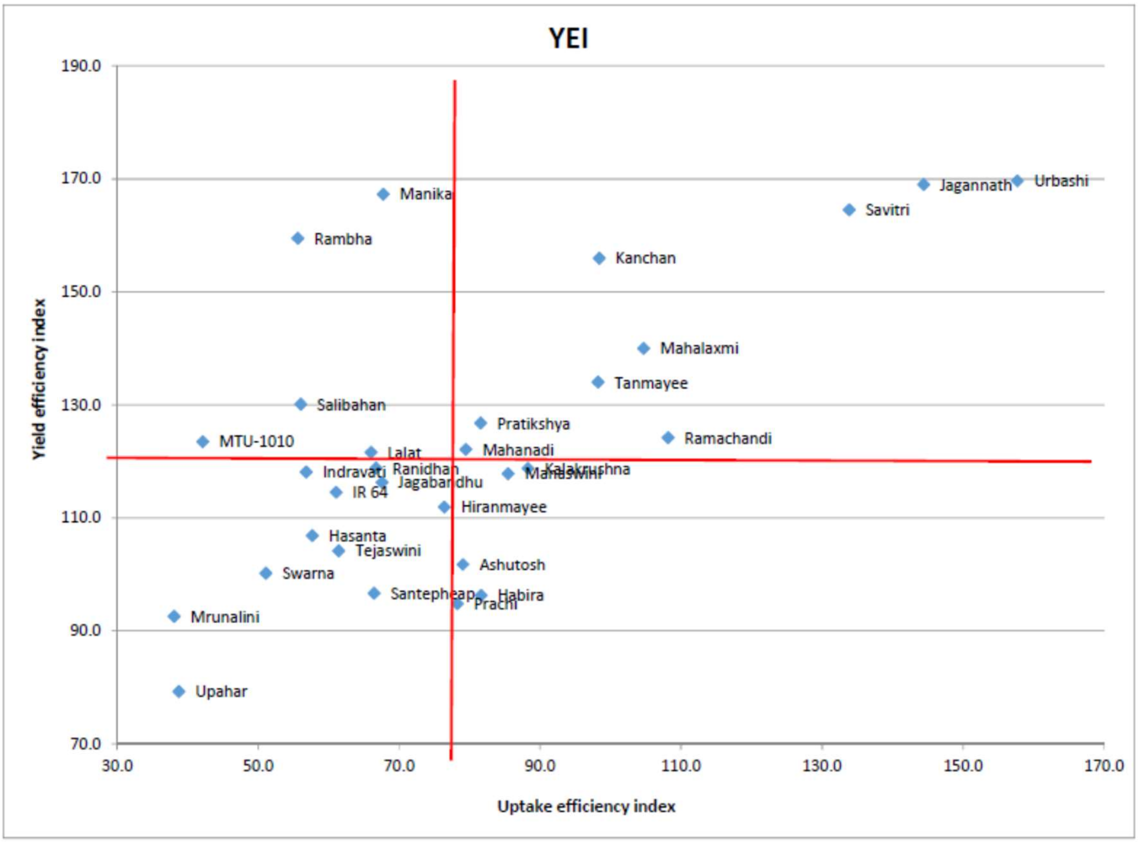
Iron (Fe) is an essential element for most of the living organisms, including all animals and plants. Its distribution is abundance in the Earth's crust. Both deficiency and toxicity of Fe in soil affects crop growth and yield. Iron uptake by plants in excess quantity is having highly deleterious effect, as it catalyses the generation of reactive oxygen species. From GPS and GIS based soil survey work done by AICRP on Micronutrient, Odisha it was found that Fe content of soils of Odisha varied from 0.012 to 530 mg kg^{-1} with mean value 97.96 mg kg^{-1}(Nayak et al,2017). Iron (Fe) is present in sufficient amount in soils of Odisha except in some regions of Kalahandi, Sambalpur and Sundargarh districts. In Odisha, low lying rice growing areas occupy an area of 14.82 lakh ha, out of which 0.75 lakh ha is subjected to Fe toxicity (Jena, 2008). In Odisha, red laterite soils, mixed red and yellow soil contain high amounts of total Fe. Iron toxicity has been reported to reduce rice yields by 12-100 % depending on the intensity of the stress and tolerance of rice cultivars (Audebert and Sahrawat, 2000). The yield reduction of rice cultivars due to Fe toxicity depends on tolerance or susceptibility of cultivars to toxicity. Such high Fe content in Odisha soils might be due to red laterite soil, acidic condition, submergence or water-logged condition. (Poonamperuna ,1972)

Out of eight essential micronutrients iron is present in abundance amounts and is fourth widely distributed element in earth's crust. Excessive amounts of iron in the soil and reducing conditions as generally prevail in lowland soil solutions upset the nutrient balance in plants. The disorder occurs when large amounts of iron are mobilized *in situ* or when an inflow of iron occurs from adjacent upper slopes, especially in the inland valley. Weathering of parent materials release significant amounts of nutrients in the soil solution, including iron. When the Fe^{2+}concentration of reduced or submerged soils is high, its uptake may be in excess than plant demand and may prove toxic to rice plants. Light-textured soils high in extractable acidity are especially prone to iron toxicity. It is also known that a high concentration of iron in solution decreases the absorption of other nutrients, especially phosphorus (P), potassium (K), and zinc (Zn) (Yoshida, 1981).

Though Fe is present in abundant in earth crust but 1.62 billion people suffer from Fe deficiency anaemia (IDA) globally (WHO, 2008) particularly women and children. Daily Fe requirement is 18 mg/day/women and 8 mg/day/man as per National Institute Health. If the excess Fe in soil can be translocated to edible plant parts like grains of rice which is a staple food, the problem of Fe deficiency or anaemia can be mitigated to a great extent.

To screen the rice cultivars or selection of suitable genotypes which can be successfully grown a technique is used by drawing a scatter diagram using yield and uptake efficiency indices on X and Y axis, respectively. The perpendicular and parallel lines to X axis were drawn with average uptake and yield efficiency to divide the scatter diagram to clarify the genotypes into four groups viz. Efficient or tolerant, efficient and non-responsive, Inefficient and responsive and Inefficient or susceptible. Tolerant varieties are genetically efficient genotypes on the soils high in Fe as they produce high yield under elevated Fe condition. With this background a varietal evaluation study was conducted under high Fe content (457 mg kg^{-1} DTPA Fe) red and to identify the varieties accumulating more Iron (Fe) in grains (uptake efficiency).

The varieties falling under quadrant C or group III are the varieties which possesses yield efficiency index lower than the average value of 123.3% and also the uptake efficiency index is lower than the average value of 83.3%. These two indices indicate that they produce relatively more yield in Fe toxic soil than Fe non-toxic soil and also produced more Fe uptake in Fe toxic soils than non-toxic soil and these varieties are regarded as tolerant or efficient varieties. Low score values indicate their



laterite soils of Central farm, OUAT, Bhubaneswar by taking 30 different high yielding rice varieties and grown under both high and low Fe content soils simultaneously. The study was conducted with the following objectives to evaluate the performance of rice varieties under elevated soil Fe concentration

tolerance to Fe toxicity. Out of 30 varieties screened, 13 varieties are falling under this category and regarded as tolerant to Fe toxicity or genetically efficient varieties to perform well in high Fe soils with respect to yield and Fe uptake.

Conclusion

A good variability among varieties tested was observed for Fe toxicity tolerance. The varieties Lalat, Prachi, Jagabandhu, Upahar, Mrunalini, Santepheap, Ranidhan, Swarna, Manaswini, Tejaswini, Indravati and IR 64 with low yield efficiency and uptake efficiency are found resistant/tolerant to iron toxicity as proven by their better performances under Fe toxicity condition. These varieties are genetically efficient to produce more yields in Fe toxic soil can be used in breeding programs to increase rice production in iron toxic areas of the state. Varieties like Manika, Rambha, Salibahan, MTU 1010 though giving less yield in Fe toxic soil but higher uptake efficiency can be used for agronomic biofortification for production of high Fe enrichment in grain These varieties accumulated more Fe in the grains (without husk) which can be used for agronomic biofortification as hyper Fe accumulators for anaemic people. Hence accordingly varieties may be used either as yield performer or grain Fe accumulator.