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Genetic Variability Analysis of Rice Genotypes Contrasting in Iron Content under Aerobic Condition

Nisarga, K. N.* **and Aftab Hussain, I. S.**

Department of Crop Physiology, UAS, GKVK, Bengaluru-560 065

*Corresponding Author E-mail: nishukgowda@gmail.com

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ABSTRACT

Growing rice in non-puddled, well-drained and non-saturated soils, saves water and is the best cultivation practice under conditions of low water availability. But this method of rice cultivation has inherent problem of micronutrient deficiency, especially iron. Under non-saturated soil conditions, the availability of iron decreases, leading to reduced plant growth and yield. The present study aims to identify the traits which would help in enhancing the iron utilization and increase the yield under such conditions. Field trial was conducted in Kharif 2014 with twenty-four rice genotypes contrasting in leaf and grain iron content under aerobic condition. Iron content in leaf, root, shoot and in the grains was measured. Root biomass and grain yield were also recorded along with iron use efficiency and partitioning efficiency. Genetic variability analysis was done to estimate the genotypic, phenotypic and environmental variability of the measured traits. A path analysis was carried out to estimate the direct and indirect effect of the measured traits on the yield. These analyses revealed the existence of high genotypic variability in the measured traits. Iron use efficiency and partition efficiency had high and positive direct effect on grain yield. We conclude that, grain iron and root iron contents can be used as target traits to select rice genotypes with enhanced iron use efficiency and high yield under aerobic condition.

Key words: *Aerobic rice, Genetic variability and Iron content.*

INTRODUCTION

Rice has been a predominant staple food for more than 1.6 billion people around the world, especially in Asia. Since, rice consumes more water than any other field crop, the increasing scarcity of water has been drastically reducing rice yields over years. Several water-saving strategies are followed, of which aerobic rice production (upland) has gained importance as it saves about 60% water compared to conventional flooded rice (lowland)[3]. This shift from lowland to upland rice cultivation leads to alteration in soil properties, particularly aeration, which ultimately affects the nutrient dynamics of soil and would decrease the bioavailability of micronutrients. For instance, iron (Fe) deficiency is a severe problem in rice grown under aerobic condition, reducing rice productivity[5].

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Hence developing rice genotype with enhanced iron use efficiency suitable for aerobic soil conditions ensures higher yield. Before planning any breeding programme, the assessment of genetic variability and the relationship between traits is necessary. Genetic traits such as genotypic coefficient of variation, heritability and genetic advance, provide precise estimates of genetic variation of quantitative traits. Thus, the present investigation was undertaken to study the genetic variability in iron content in aerobic rice, its relationship between various traits and their contribution to yield.

MATERIAL AND METHODS

The experiment was carried out in the Department of Crop physiology, UAS, GKVK, Bengaluru. Twenty-four rice genotypes contrasting for their leaf and grain Fe content were selected from the 200 rice germplasm accessions which were previously grown under aerobic condition[12]. Field trail was conducted during *Kharif* 2014 in Randomized complete block design with three replications and all the entries were allotted randomly using random number table. Error due to soil heterogeneity was reduced by maintaining uniform blocks and equal spacing between blocks (30 cm) throughout the experiment. Genotypes were raised by direct seeding in the field at a spacing of 25 x 15 cm. The soil at the experimental site had 109.4 ppm of iron.

At physiological maturity, plants were harvested, separated in to root, shoot & leaves, oven dried and dry weight was recorded. The biomass was expressed in grams per plant. The total weight of all filled grains of a plant was recorded and expressed as grain yield in grams per plant. To estimate the iron content from root, shoot, leaves and grains, oven dried samples were digested using di-acid, prepared by using concentrated nitric acid and perchloric acid in 9:4 ratio[8]. Iron content was estimated using Inductively Coupled Plasma Optical Emission Spectrophotometer (ICP-OES) iCAP 6000 series in the Department of Crop Physiology, UAS, Bengaluru. The iron content was calculated as per Laboratory protocols[6] and expressed in ppm. Iron use efficiency and Partition efficiency was calculated as per the procedure given by Shet[12] and expressed in per cent.

Statistical analysis

Correlation and direct & indirect effects were estimated for all the measured traits. The simple correlations (r) between different characters at phenotypic (p) and genotypic (g) levels were worked out as suggested by Searle[11]. Path coefficient analysis was carried out according to Dewey and Lu[4].

RESULTS AND DISCUSSION

High iron content was observed in the wild accessions of rice[1], which provides an understanding about the genetic variability in nutrient uptake and translocation. The evaluation of germplasm gives an immense understanding about the variable growth adaption, nutrient acquisition and transport system which can be exploited for breeding strategies. Mean, range and genetic variability of quantitative traits under investigation are given in table 1. High to medium broad sense heritability coupled with high genotypic coefficient of variation and high genetic advance as percentage of means were exhibited for all the traits under investigation except for the leaf iron content. High broad sense heritability is reported in rice genotypes evaluated for iron content[10,9]. The broad sense heritability captures the proportion of phenotypic variation due to genetic values that may include effects due to dominance and epistasis. Broad-sense heritability estimates of genotypic value give a clear idea to a plant breeder to plan a breeding program and allocate resources efficiently. Broad-sense heritability integrates information on genetic variation and environmental noise into one statistic that is very useful in planning breeding programs. The magnitude of phenotypic coefficient of variation (PCV) estimates in the present investigation was found to be slightly higher than their respective genotypic coefficient of variations (GCV) for all the traits under study, which might be due to influence of environment on the development of these traits. Similar reports have been published in rice earlier[7,13]. However, the narrow magnitude of difference between phenotypic and genotypic coefficients of variations indicates the limited influence of environment in the expression of these traits. The result is in agreement with Babu *et al.*[2] and Purusothoman & Geetha[9], stating small differences between phenotypic and genotypic coefficients of variations of iron content in rice. Thus, selection based on phenotypic performance of these traits would be effective to bring about considerable genetic improvement. High genetic advances as percent of means were recorded by all the traits except for the leaf iron content. In general, a high coefficient of variability indicates that there is a scope of selection and improvement of these traits.

The estimates of simple correlation coefficients (phenotypic and genotypic) computed between measured traits were presented in Table 2. Invariably the traits which showed negative correlation at genotypic level also showed negative correlation at phenotypic level. Overall, only two traits showed significant correlations. Iron use efficiency showed significant positive correlation (phenotypic and genotypic) with grain yield per plant where as the grain iron content had significant positive phenotypic and genotypic correlation with partition efficiency. Except for these two correlations all other correlations between traits were non-significant both at genotypic and phenotypic levels.

Path analysis furnishes information of influence of each contributing independent trait to dependent trait (grain yield) directly as well as indirectly and also enables the breeders to rank the genetic attributes according to their contribution. The direct and indirect effects of different traits components as partitioned by path analysis are given in table 3. The study revealed that Iron use efficiency (1.0543) and partition efficiency (0.2419) had high and positive direct effect on grain yield. Whereas grain iron (0.1154) and root iron (0.0186) had low and negative direct effect on grain yield. Grain iron content expressed high and indirect effects on grain yield through partition efficiency. Similarly root iron and root dry weight expressed high and indirect effects on grain yield through iron use efficiency. Except for these indirect effects all other indirect effects are meager on grain yield. Since the measured traits contributed more to the variability in grain yield of rice the residual effect is very low (0.0314). From the foregoing discussion of association studies in the present set of breeding materials pointed out that, there is much scope for selecting high yielding genotypes under aerobic condition in rice, if selection pressure is exerted on grain iron and root iron content.

Table 1. Estimates of genetic variation of quantitative traits under investigation

	Mean	Range	GCV (%)	PCV (%)	h^2 (%) (Broad sense)	GA (%) of Mean
Root Fe (ppm)	188.20	111.06-265.07	23.96	27.04	78.53	43.74
Shoot Fe (ppm)	119.75	100.81-140.46	8.58	10.80	63.07	14.03
Leaf Fe (ppm)	98.87	64.88-106.64	7.06	10.67	43.75	9.62
Grain Fe (ppm)	30.71	16.46-42.58	27.14	27.16	99.82	55.85
Root DW (g/plant)	8.92	4.62-14.76	35.72	40.54	77.63	64.83
Shoot DW (g/plant)	7.84	3.05-13.23	29.16	33.48	75.83	52.31
Leaf DW (g/plant)	5.78	3.01-9.28	33.26	35.68	86.91	63.88
Fe Use E (%)	4.69	2.60-7.86	26.87	29.37	83.66	50.62
Partition E (%)	14.05	7.83-20.05	26.11	26.70	95.64	52.61
Grain Yld (g/plant)	11.61	6.48-18.56	25.39	27.42	85.73	48.42

GCV - Genotypic Coefficient of variation, PCV - Phenotypic Coefficient of variation
h^2 - Heritability, GA (%) - Genetic Advance

Table 2. Phenotypic (P) and Genotypic (G) correlation coefficients for traits under investigation

		Root Fe (ppm)	Shoot Fe (ppm)	Leaf Fe (ppm)	Grain Fe (ppm)	Root DW (g plant^{-1})	Shoot DW (g plant^{-1})	Leaf DW (g plant^{-1})	Fe Use Efficiency (%)	Partition Efficiency (%)	Grain Yield (g plant^{-1})
Root Fe (ppm)	G	1	0.186	0.042	0.330	0.007	-0.299	0.082	0.150	0.308	0.217
	P	1	0.061	0.032	0.293	0.026	-0.166	0.091	0.149	0.281	0.193
Shoot Fe (ppm)	G		1	-0.17	0.413	0.261	0.002	0.111	-0.194	0.286	-0.030
	P		1	-0.168	0.324	0.230	0.026	0.045	-0.174	0.149	-0.002
Leaf Fe (ppm)	G			1	-0.028	0.088	-0.377	0.010	-0.336	-0.129	-0.265
	P			1	-0.025	0.103	-0.231	0.069	-0.341	-0.187	-0.226
Grain Fe (ppm)	G				1	0.125	-0.141	0.345	-0.141	0.982**	0.040
	P				1	0.109	-0.120	0.321	-0.127	0.963**	0.037
Root DW (g plant^{-1})	G					1	0.052	0.306	0.205	0.079	0.303
	P					1	0.086	0.26	0.133	0.045	0.232
Shoot DW (g plant^{-1})	G						1	0.110	0.060	-0.086	0.004
	P						1	0.122	0.080	-0.076	0.045
Leaf DW (g plant^{-1})	G							1	-0.168	0.345	-0.107
	P							1	-0.162	0.310	-0.110
Fe Use Efficiency (%)	G								1	-0.076	0.972**
	P								1	-0.026	0.964**
Partition Efficiency (%)	G									1	0.077
	P									1	0.082
Grain Yield (g plant^{-1})	G										1
	P										1

Table 3. Direct and indirect effects of different traits under investigation on grain as partitioned by path analysis

Traits	Root Fe (ppm)	Shoot Fe (ppm)	Leaf Fe (ppm)	Grain Fe (ppm)	Root DW (g plant^{-1})	Shoot DW (g plant^{-1})	Leaf DW (g plant^{-1})	Fe Use E (%)	Partition E (%)
Root Fe (ppm)	**-0.0186**	0.0324	0.0060	-0.0380	0.0001	0.0024	0.0003	0.1580	0.0745
Shoot Fe (ppm)	-0.0034	**0.1748**	-0.0243	-0.0477	0.0063	-0.0001	0.0004	-0.2050	0.0691
Leaf Fe (ppm)	-0.0007	-0.0297	**0.1429**	0.0032	0.0021	0.0030	0.0001	-0.3542	-0.0312
Grain Fe (ppm)	-0.0061	0.0723	-0.0040	**-0.1154**	0.0030	0.0011	0.0001	-0.1489	0.2375
Root DW (g plant^{-1})	-0.0001	0.0457	0.0126	-0.0144	**0.0241**	-0.0004	0.0001	0.2159	0.0190
Shoot DW (g plant^{-1})	0.0055	0.0003	-0.0538	0.0162	0.0012	**-0.0081**	0.0004	0.0631	-0.0207
Leaf DW (g plant^{-1})	-0.0015	0.0194	0.0014	-0.0398	0.0074	-0.0009	**0.0003**	-0.1766	0.0835
Fe Use E (%)	-0.0027	-0.0340	-0.0480	0.0163	0.0049	-0.0004	-0.0006	**1.0543**	-0.0183
Partition E (%)	-0.0057	0.0499	-0.0184	-0.1133	0.0019	0.0007	0.0001	-0.0798	**0.2419**

Residual effect = 0.0314; Diagonals (bold) indicates the direct effects

CONCLUSION

The current study identified the presence of adequate genetic variability among twenty four tested rice genotypes. The information generated from this study can be exploited by rice breeder to develop high yielding rice genotypes suitable for aerobic cultivation with enhanced iron use efficiency.

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REFERENCES

1. Anuradha, K., Agarwal, S., Batchu, A.K., Babu, A.P., Mallikarjuna, B.P.S., Longvah, T. and Sarla, N., Evaluating rice germplasm for iron and zinc concentration in brown rice and seed dimensions._*J. Phytology*, **4(1):** 19-2 (2012).
2. Babu,V.R., Shreya, K., Dangi, K.S., Usharani, G. and Nagesh, P.. Genetic variability studies for qualitative and quantitative traits in popular rice (Oryza sativa L.) hybrids of India. *Int. J. Sci. Res. Pub.* **2(6):** 1-5 (2012).

3. Bouman, B., Wang, H., Yang, X., Zhao, J. F. and Wang, C. G., Aerobic rice (Han Dao): a new way of growing rice in water-short areas. *In:* Proceedings of the 12 International Soil Conservation Organization Conference, 26-31 May 2002, Beijing, China. 175-181.
4. Dewey, D.R. and Lu, K.H., Correlation and path coefficient analysis of crested wheat grass seed production, *Agron. J.* **51(9):** 515-518 (1959).
5. Kreye, C., Bouman, B., Castaneda, R., Lampayan, R. M., Faronilo, J., Lactaoen, A. and Fernandez, L., Possible causes of yield failure in tropical aerobic rice. *Field Crops Res.* **111:** 197–206 (2009).
6. Maize nutrition quality and plant tissue analysis laboratory: laboratory protocols Galicia, L., Nurit, E., Rosales, A. and Palacios-Rojas, N. CIMMYT, Mexico, 2009, 42p. (2008).
7. Ogunbayo, S.A., Ojo, D.K., Sanni, K.A., Akinwale, M.G. and Toulou, B., Genetic variation and heritability of yield and related traits in promising rice genotypes (Oryza sativa L.). *J. Plant Breed. Crop Sci*. **6:** 153-159 (2014).
8. Pavithra, G.J., Salimath, M., Rameshraddy, Geetha, K.N. and Shankar, A.G., Genetic variability studies in tomato germplasm for zinc and iron content and its relationship with growth and yield parameters, *Ecology, Environment and Conservation*, **21:** 355-360 (2015).
9. Purusothoman, R. and Geetha, S., Assessment of genetic diversity based on morphological, grain Fe and Zn content in rice, *Electron. J. Plant Breed.* **5(2):** 144-151 (2014).
10. Sala, M., Kumar, C.R., Geetha, S., Gnanamalar, R.P. and Hemalatha, G., Variability studies for iron and zinc content on segregating population of rice. *Electron. J. Plant Breed.* **4(3):** 1201-1204 (2013).
11. Searle, S.R., Phenotypic, genotypic and environmental correlations. *Biometrics*, **17:** 474-480 (1961).
12. Shet, R., Assigning genomic regions controlling iron and phosphorus use efficiencies and economic traits under aerobic condition through association mapping in rice. Ph.D Thesis. University of Agricultural Sciences, Bangalore (2011).
13. Shrivastava, A., Mishra, D.K., and Koutu, G.K., Estimation of genetic parameters of variability for yield and its attributing traits in parental lines of hybrid rice. *Plant Archives*, **15:** 571-574 (2015).
14. Tiwari, D.K., Pandey, P., Tripathi, S., Giri, S.P., and Dwivedi, J.L., Studies on genetic variability for yield components in rice (Oryza sativa L.). *Adv. Agric. Botanics*, **3:** 76-81 (2011).