Oryza Vol. 50 No.1, 2013 (41-44)

Association of grain iron and zinc content with yield in high yielding rice cultivars

Nagesh[1], Ravindra Babu V[*2], Usha Rani G[1], Dayakar Reddy T[1], Surekha K[2] and Vishnu Vardhan Reddy D[3]

[1]Acharya N.G. Ranga Agricultural University, Hyderabad
*[2]*Directorate of Rice Research, Hyderabad*
[3]ADR, Warangal, Andhra Pradesh
Email : vrbabu@drricar.org

ABSTRACT

Iron and zinc deficiencies have been reported to be a food-related primary health problem affecting nearly two billion people worldwide. The brown and red rice genotypes have high grain iron and zinc content and an attempt was made to study the association between these mineral content with grain yield. A field experiment was conducted during wet season 2010 involving fourteen genotypes with different viz., brown rice, red rice and basmati types. These genotypes were tested to estimate phenotypic and genotypic association among grain iron, zinc, yield attributes and grain yield. It was observed that grain yield was positively correlated with number of productive tiller plant^{-1} and number of grains panicle^{-1}. A positive correlation between iron and zinc content was observed while a negative correlation between grain iron content and grain yield was recorded. Grain iron content inversely related with grain yield plant^{-1}. Path analysis revealed the highest direct effect of test weight on grain yield followed by number of productive tillers plant^{-1} and iron content.

Key words: *rice, grain iron, zinc, correlation, path analysis*

Rice is a staple food for millions of people and having great importance in food and nutritional security. Rice is the second most widely consumed food grain in the world next to wheat. From poorest to richest person in this world consume rice in one or other form. In the last two decades, new research findings generated by the nutritionists have brought to light the importance of micronutrients, vitamins and proteins in maintaining good health, adequate growth and even acceptable levels of cognitive ability apart from the problem of protein energy malnutrition. Biofortification (Bouis, 2002) is a genetic approach which aims at biological and genetic enrichment of food stuffs with vital nutrients (vitamins, minerals and proteins). Ideally, once rice is biofortified with vital nutrients, the farmer can grow the variety indefinitely without any additional input to produce nutrient packed rice grains in a sustainable way. This is also the only feasible way of reaching the malnourished population in India.

In this context breeders are now focusing on breeding for nutritional enhancement to overcome the problem of malnutrition. The range of iron and zinc concentration in brown rice is 6.3-24.4 µg g^{-1} and 13.5-28.4 µg g^{-1}, respectively. There is approximately a fourfold difference in iron and zinc concentration, suggesting some genetic potential to increase the concentration of these micronutrients in rice grains (Gregorio, 2002). A scarce scientific literature is available on the association between grain iron and zinc content with grain yield. The present research was taken up to study the association of grain zinc and iron with grain yield.

MATERIALS AND METHODS

The experiment was conducted at Directorate of Rice Research Farm, Hyderabad, India, during wet season 2010. The experimental material comprised of 14 genotypes which were selected based on low iron and

Table 1. List of genotypes used in the study with their parentage and concentration of iron and zinc content in the grains

Genotypes	Parentage	Iron concentration (mg 100g^{-1} of brown rice)	Zinc concentration (mg 100g^{-1} of brown rice)	Yield(t ha^{-1})	Year of release
RP Bio-226 (Improved BPT5204)	BPT 5204*4/SS1113	1.07	2.2	4.63	2007
Swarna	Vasisa /Mahsuri	0.78	2.28	6.50	1979
MTU1010 (Cottondora Sannalu)	Krishnaveni/IR 64	0.73	2.54	6.70	2000
IR 64	IR5657-33-2-1/IR 2061-465-1-5-5	1.05	1.05	5.00	1985
PR116	PR108/PAU 1628//PR 108	0.77	2.38	7.20	2000
Madhya Vijaya	Sona x Mahsuri	0.73	2.49	5.50	1986
Chittimuthyalu	Local landrace	2.51	3.07	-	-
Ranbir Basmati	Selection from Basmati 370	1.33	2.96	2.70	1994
Madhukar	Selection from Gonda	2.85	4.72	-	1969
Jalmagna	Selection from Badhon	1.62	1.94	-	1969
Type-3 (Dehradoon basmati rice)	Selection from Deharadun Basmati	1.41	3.06	3.00	1978
Jalpriya	IET 4060/Jalmagna	2.44	3.37	3.50	1993
Suraksha	Sasyasree x MR-1523	1.06	2.53	5.75	1988
BR 2655	(BR 10 X BR 4) X (BR7 X Palghar 84-3)	1.05	2.37	8.00	2001

zinc and some with high iron and zinc (Table 1). Seedlings at 26 days after sowing were transplanted in the main field. Each entry was planted in two rows each having ten plants with a inter row spacing of 20 cm and intra row spacing of 10 cm. The experiment was laid out in completely randomized block design with two replications. Genotypes were grown as under irrigated condition and standard crop production and crop

Table 2. Phenotypic and genotypic correlation coefficients among yield and yield attributes of various rice genotypes

		DM	PH	PL	PT	TW	GPP	Fe	Zn	GY
DFF	P	0.381	0.342	-0.032	0.201	-0.306	0.453*	0.287*	0.121	0.287
	G	0.487*	0.533*	-0.063	0.273	-0.489*	0.585*	0.154	0.093	0.372
DM	P		-0.006	-0.069	0.525*	-0.061	-0.056	0.290*	0.129	0.272
	G		-0.004	-0.212	0.615**	-0.052	-0.045	0.183	0.149	0.274
PH	P			0.240	-0.331	-0.018	0.036	0.454**	0.376	-0.120
	G			0.345	-0.369	-0.044	0.054	0.868**	0.435	-0.166
PL	P				-0.160	-0.335	-0.063	0.425	-0.136	-0.338
	G				-0.303	-0.465*	-0.061	0.662**	-0.101	-0.425
PT	P					0.048	-0.002	-0.209	-0.024	0.677**
	G					0.058	0.024	-0.535*	-0.103	0.741**
TW	P						-0.433	-0.181	0.064	0.311
	G						-0.445	-0.369	0.068	0.304
GPP	P							-0.195	-0.066	0.433
	G							-0.287	-0.053	0.470*
Fe	P								0.440	-0.326
	G								0.689**	-0.776**
Zn	P									-0.066
	G									-0.091

P @ 0.05 = 0.458, P @ 0.01 =0.612, * and ** indicates significant at 5 %and 1 % level respectively, DFF-days to 50 per cent flowering DM-days to maturity, PH-plant height, PL-panicle length , PT-productive tillers, TW-test-weight, GPP-grains panicle $^{-1}$, Fe-grain iron, Zn-grain zinc, GY-grain yield protection practices were followed. Data on days to 50% flowering (DFF), days to maturity (DM) recorded at respective stage of crop while, plant height (PH), panicle length (PL), productive tillers per plant (PT) were recorded at harvest and number of grains per panicle (GPP), test-weight (TW), grain iron content (Fe), grain zinc content (Zn) and grain yield per plant (GY) were recorded after harvest. Iron and zinc content of grain samples were estimated by Atomic Absorption Spectrophotometer as suggested by Lindsay and Novell (1978). Both phenotypic and genotypic correlation coefficients were worked out by following the method outlined by Al-Jibuori *et al*. (1958). The direct and indirect effects of individual characters on grain yield were estimated using the method suggested Wright (1921) and illustrated by Dewey and Lu (1959).

RESULT AND DISCUSSION

Selection based on the detailed knowledge of magnitude and direction of association between yield and its attributes is very important in identifying the key characters, which can be exploited for crop improvement through suitable breeding programme. The genotypic correlation coefficients were higher than the phenotypic correlation coefficient, indicating the predominant role of genetic background rather than environmental effect for association between different characters (Table 2). These findings are corroborating with the observations of Shashidhar *et al.* (2005), Bhattacharyya *et al.* (2007) and Habib *et al.* (2007). Grain yield plant^{-1} showed significantly positive correlation with number of productive tillers per plant (Shashidhar *et al.,* 2005, Girish *et al.,* 2006, Monalisa *et al*., 2006) and number of grains per panicle (Sharma and Dubey, 1997, Verma and Mani 1997, Yogameenakshi *et al.* 2004, Shashidhar *et al.,* 2005, Monalisa *et al*., 2006, Suman *et al*., 2006). However grain yield per plant had positive and moderate correlation with days to 50% flowering, days to maturity and test weight. Grain iron content had significant negative correlation with grain yield while grain zinc had negative and non-significant correlation with grain yield these results are in contradicting with Kalmeshwer Goud Patil (2008) where iron and zinc was reported positive non-significant correlation with grain yield both genotypic and phenotypic level. Grain iron content had significantly positive correlation with grain zinc content these findings are in accordance with Stangoulis *et al.* (2007) and Jeom Ho *et al.* (2008) Kalmeshwer Goud Patil (2008).

Though the estimates of correlation coefficients mostly indicate the inter-relationship of different characters they do not furnish information on cause and effect. The path coefficient analysis indicated that the highest positive direct effect was contributed by test weight followed by productive tillers plant^{-1}, zinc content and grains panicle^{-1} whereas. iron content had highest negative direct effect on grain yield. There was no contribution through indirect effects except iron content had highest negative indirect effect *via* zinc content. Similar results were found for a number of productive tillers plant^{-1} by Monalisa *et al.* (2006), Panwar *et al.* (2007) and Kole *et al.* (2008); for number of grains panicle^{-1} by Choudhury and Das (1998), Yogameenakshi *et al.* (2004) and Panwar *et al.* (2007) and for test-weight by Suman *et al.* (2006),

Table 3. Path coefficient analysis indicating direct and indirect effects of components

	DFF	DM	PH	PL	PT	TW	GPP	Fe	Zn	‘r’
DFF	-0.060	0.075	0.087	-0.004	0.156	-0.251	0.201	-0.132	-0.083	0.273
	-0.024	0.186	-0.003	-0.009	0.281	-0.035	-0.024	0.023	-0.192	0.275
DM	-0.025	-0.002	0.209	0.029	-0.126	-0.021	0.018	-0.422	0.168	-0.122
	0.003	-0.024	0.059	0.068	-0.131	-0.231	-0.021	0.024	0.002	-0.321
PH	-0.019	0.104	-0.052	-0.018	0.503	0.038	0.014	0.138	-0.153	0.670
	0.023	-0.010	-0.006	-0.026	0.028	0.672	-0.175	-0.071	-0.008	0.310
PL	-0.031	-0.011	0.009	-0.004	0.017	-0.295	0.398	0.201	-0.012	0.444
	-0.010	-0.006	0.123	-0.002	-0.110	0.066	-0.108	-0.658	0.247	-0.329
PT	0.009	-0.090	0.103	0.012	-0.191	-0.016	-0.014	-0.400	0.495	-0.068

Residual effect = 0.001196, DFF-days to 50 per cent flowering, DM-days to maturity, PH-plant height, PL-panicle length, PT-productive tillers, TW-test-weight, GPP-grains panicle^{-1}, Fe-grain iron, Zn-grain zinc, GY-grain yield

Bhattacharyya *et al.* (2007), Habib *et al.* (2007), Kole *et al*. (2008) towards yield. The overall results indicated that selection of higher productive tillers, test weight, number of grains per panicle would particularly encourage the breeders to achieve higher grain yield. There is a negative correlation and negative direct effect of grain iron while zinc non-significant negative correlation through path it reveals it had positive direct effect on grain yield. These negative relation and effects obstacles the selection of high grain iron and zinc.

REFERENCES

Al-Jibouri HA, Miller P A and Robinson H F 1958. Genotypic and environmental variances and co-variances in an upland cotton cross of interspecific origin. Agron J 50: 633-636.

Bhattacharyya R, Roy B, Kabi MC and Basu AK 2007.Character association and path analysis of seed yield and its attributes in rice as affected by bio-inoculums under tropical environment. Trop Agric Res and Exte. 10:23-28.

Bouis HE 2002. Plant breeding: A new tool for fighting micronutrient malnutrition. J Nutr 132: 491-494.

Choudhury PK and Das PK 1998. Genetic variability, correlation and path co-efficient analysis in deep water rice. Ann Agric Res. 19: 120-124.

Dewey DR and Lu KN 1959. Correlation and path coefficient analysis of components of crested wheat grass seed production. Agron J 51:515-518.

Girish T, Gireesha T, Vaishali M, Hanamareddy B and Hittalmani S 2006. Response of a new IR50/ Moroberekan recombinant inbred population of rice (*Oryza sativa* L.) from an indica × japonica cross for growth and yield traits under aerobic conditions. Euphytica 152: 149-161.

Gregorio GB 2002. Symposium: Plant Breeding: A New Tool for Fighting Micronutrient Malnutrition: Progress in Breeding for Trace Minerals in Staple Crops. J Nutr 132:500-502.

Habib SH, Hossain MK, Hoque MA, Khatun MM and Hossain MA 2007. Character association and path analysis in hybrid rice. Journal of Subtropical Agricultural Research and Development 5(3): 305-308.

JeomHo L, KyuSeong L, HungGoo H, ChangIhn Y, SangBok L, YoungHwan C, OYoung J and Virk P 2008. Evaluation of iron and zinc content in rice germplasms. Korean J Breed Sci 40(2): 101-105.

Kalmeshwer Goud Patil 2008. Molecular characterization, inheritance and validation of markers linked to aroma in rice (*Oryza sativa* L.) under aerobic condition. PhD. Thesis. University of Agricultural Sciences, Bangalore.

Kole PC, Chakraborty NR and Bhat JS 2008. Analysis of variability, correlation and path coefficients in induced mutants of aromatic non-basmati rice. Trop Agric Res and Exte 11:60-64.

Lindsay WL and Novell WA 1978. Development of a DTPA soil test for zinc, manganese and copper.Soil Sci Soci Am J 42: 421-428.

Monalisa M, Md Nasim Ali and Sasmal B G 2006. Variability, correlation and path co-efficient analysis in some important traits of low land rice. Crop Res 31: 153-156.

Panwar A, Dhaka RPS and Vinod Kumar 2007. Path analysis of grain yield in rice. Adv Plant Sci 20: 27-28.

Sharma RK and Dubey SB 1997. Variation and association among panicle traits in rice. Oryza 34: 8-12.

Shashidhar HE, Pasha F, Janamatti M, Vinod MS and Kanbar A 2005. Correlation and path co-efficient analysis in traditional cultivars and double haploid lines of rainfed lowland rice. Oryza 42: 156-159.

Stangoulis JCR, Huynh B, Welch MR, Choi E and Graham RD 2007. Quantitative trait loci for phytate in rice grain and their relationship with grain micronutrient content. Euphytica 154: 289-294.

Suman A, Sreedhar N and Subba Rao L V 2006. Correlation and path analysis of yield and its components in rice (*Oryza sativa* L.). Int J Trop Agric 24: 49-53.

Verma SK and Mani S C 1997. Yield component analysis and its implications for early generation selection in rice. Oryza 34(2): 102-106.

Wright S, 1921. Correlation and Causation. J Agric Res 20: 557-585.

Yogameenakshi P, Nadarajan and Anbumalarmathi J 2004. Correlation and path analysis on yield and drought tolerant in rice (*Oryza sativa* L.) under drought stress. Oryza 41: 68-70.