Evaluation of Some Popular Rice Genotypes with Special Emphasis on Zinc, Iron and Protein Content

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Abstract- The present study provides a vivid idea regarding iron, zinc and protein content of 65 diverse rice germplasm in association with yield and yield attributing traits. Experiment was conducted using RBD design (Randomized Block Design) and ANOVA was done for estimation of variation in the population under study. The estimation of heritability and Genetic advance obtained proves that most of the characters are profitable tools for selection in future breeding programs. Correlation coefficient analysis suggests a positive correlation between zinc and iron content indicating that selection of any of the micronutrient content will provide an approximate idea regarding the probable estimate of the other. Path analysis was performed providing valuable input regarding influence of different traits upon yield per plant.

Index Terms- Zinc content, Iron content, Protein content, Correlation analysis,

I. Introduction

Rice (*Oryza sativa* L.) is a "Global Grain", cultivated widely across the world and is the major staple for billions of people. Global demand for food is rising because of population growth, increasing affluence and changing dietary habits. To meet this demand, the global food production needs to increase by over 40% by 2030 and 70% by 2050 (FAO, 2009). Humans require 49 nutrients for their normal growth, development and for proper metabolic rate. The basic demand of most of the micronutrients is supplied by cereal crops like rice, wheat, maize etc. As rice is deficit in proper micronutrient balance, 2.7 billions of people, taking rice as their staple food, suffering from micronutrient deficiency. More than 30% of the world's population is suffering from anemia (Stevens, 2013). Global studies identify that approximately half of this anemic situation is due to iron-deficiency anemia (IDA) (Brotanek *et.al*, 2005). Rice is deficient in essential micronutrient such as iron (Fe) and zinc (Zn). Milled grains of popular rice varieties have approximately 2 µg/g iron and 16 µg/g zinc concentration (Trijatmiko *et al* 2016) while average protein content is approximately 8% (Ravindra Babu *et.al.*, 2012). Although rice protein ranks high in nutritional quality among cereals , having modest protein content (IRRI).Protein functions as enzymes, hormones, and antibodies, as well as transport and structural components. Beside micronutrients, protein deficiency is also affecting human health (Bouis et al., 2003). The proteins are concentrated in the in the bran fraction but milling procedure losses most of the protein content. In order to enhance the micronutrient concentration in the grain suitable breeding program should be followed. Recently, a complimentary solution to mineral malnutrition termed '**BIOFORTIFICATIION**' has been proposed which may be an effort to alleviate hidden hunger with little recurring costs by enhancement of nutritional value either through conventional breeding method or through genetic manipulation. Although biofortification has gained requisite importance in the present days, no rice variety will attract the attention of the farmers only due to its high micronutrients and/or protein content unless it gives high yield. There is very keen chance that for only enriched nutritional quality farmers will get premium price. Hence, breeding objectives is to be augmented giving equal preference both for high yield and high nutritional quality.

II. Materials & Method

The experiment was conducted at Calcutta University Agricuture Farm, Baruipur,South24 pgs,West Bengal during Boro 2014 . following RBD design. The study was included 65 diversely collected rice germplasm including two check varieties, one high yielding variety Satabdi (IET 4786) and another check was IR-64. Yield and yield attributing data set were recorded before harvesting i.e. panicle no, filled grains per panicle, 1000 grain weight and grain yield per plant (GY) along with grain iron content(Fe), grain zinc content (Zn) , grain protein content after harvesting. Zinc and iron content of rice was estimated using Atomic Absorption Spectrophotometer and the samples were prepared by tri-acid Nitric acid 10: Perchloric acid 4: Sulphuric acid 1 digestion method suggested by Lindsay and Novell (1978). Protein is determined by first carrying out micro Kjeldahl digestion **(1883)** and ammonia distillation and then using titration the digest to determine nitrogen content, which is converted to protein by the factor 5.95. The genotypic (GCV) and phenotypic (PCV) coefficient of variation was calculated along with genetic advance (GA) for all the parameters under study as suggested by Johnson *et al.* (1955).

III. Result & Discussion

In the present study, the micronutrient content (Zn and Fe) and the protein content of diversely collected rice germplasm were estimated. Mean performance, variability analysis and estimation of association among the traits under study was undertaken and direct or indirect influences among the traits were studied. The mean performance of all the 65 genotypes is presented in Table no.I showing a highly significant variability for all the traits under study among the genotypes. The study evinced that zinc content of all the 65 genotypes ranged between 13.81 mg/g to 41.34 mg/g with the mean of 25.95 mg/g.

Maximum Zn content was observed for the check variety satabdi followed by Azucena (40.9 mg/g) and Kalapahar (33.70 mg/g) whereas minimum Zn content was recorded for the genotype Rathuwee. Grain iron content was also recorded for all the 65 genotypes. The range observed for this trait is 9.31 mg/g to 23.71 mg/g. Maximum iron content was found in variety IR-1552 followed by Khittish (21.76 mg/g) and Azucena (21.66 mg/g) and minimum Fe content was recorded for the genotype IR-5882-23-1-3-1. The mean value calculated for iron content was recorded to be 13.46 mg/g. Previous study indicated that Japonica varieties had higher Fe content than the Indica rice variety (Cheng.*et.al*, 2009), similar observations were also observed in the present study.Grain Protein Content analyzed using Kjeldhal Method showed a range between 3.47% to 10.69%. Maximum protein content was observed for the Japonica variety Tondok (10.69%) followed by Peh-Kuh (9.30%) and Carolina Gold Selection (8.66%) and minimum protein content was observed for Poroma Ahu (3.47%).

Analysis of Variance (ANOVA) suggested that a considerable variation was present among the 65 genotypes with respect to 8 traits at 0.01% level of significance. In case of the agromorphic traits a considerable difference was observed between PCV and GCV suggesting that environment has enough impact upon the traits. A higher estimate of heritability along with GA was observed in all the traits except for zinc and protein content along with no. of panicles/plant. Thus for such traits selection can be profitable since the characters are governed by additive gene action. In other cases selection may prove to be quite difficult since non additive gene actions are responsible.

A significantly positive correlation (0.729G, 0.710P) between grain zinc content and iron content was observed which are in accordance with Stangoulis *et al.*, 2007, Jeom Ho et al. 2008. While for protein content both the micronutrient traits are negatively correlated but the correlation is not significant at all which may conclude that zinc and iron content did not affect protein content and that may indicate that enhancement of micronutrient content does not approve the enhancement of protein percent in rice grain. Grain yield has a positively significant correlation with different yield attributing traits i.e. with 1000 grain weight (0.900 G, 0.840 P), filled grains per panicle (0.888 G, 0.845 P), panicle length (0.774 G, 0.711 P) and panicle per plant (0.728 G, 0.700 P).

Zinc content and grain yield per plant has non significantly negative correlation between themselves, where r= -0.129(G), and r= -0.173. Assessment of the relationship between grain yield and zinc concentration using linear regression proved that there was a negative correlation between the traits (Fig.1). Similarly, for iron content and yield per plant a non-significant negative correlation was observed between themselves, where r= -0.123(G), and r= -0.200. Assessment of the relationship between grain yield and iron concentration using linear regression proved that there was a negative correlation between the traits (Fig 2).

The relationship between grain micronutrient content and grain yield with other yield attributing traits also may show a positive or negative association but this analysis reveals the net result of direct effect of the particular trait and indirect effect via other traits and also indicates the cause and effect relationship between yield and their related traits. The experiment evinced high positive direct effect for 1000 grain weight (0.634) and no. of filled grains per panicle (0.674) as well panicle per plant (0.464) and panicle length (0.482); both the traits are yield attributing traits. But considering the zinc concentration the direct effect showed a negative association (-0.136). Similarly, a negative association was also observed for iron content. Iron content is direct negative association towards yield (-0.145). Grain iron content and grain zinc content showed negative to low indirect effects on grain yield via other characters. For iron content also negative to low indirect effects showed on grain yield via other characters. Both the micronutrients have negative indirect effect via protein content towards yield parameters but a moderate direct effect for protein content was observed toward grain yield. Similar report was also established by Nagesh et.al. (2012). This analysis also established that selection for enhancement of the grain yield and micronutrient enrichment could be executed separately but simultaneously. The residual effect determines how best the casual factors responsible for the variability of the dependent factor, i.e. the yield. The experiment reveals residual effect 0.43; explain about 76% of the variability in the yield.

IV. CONCLUSION

The present investigation sheds a light upon the status of a group of rice genotypes of diverse origin in terms of their micronutrient and protein content along with yield attributing traits. A vivid idea regarding the levels of iron zinc and protein content along with yield among the 65 rice genotypes was obtained and it could be concluded that genotypes like Dudheswar, Kalapahar, IR-1552 and Black gora performed better than or at par with check varieties like Satabdi and IR64. For protein content, genotypes Tondok, Peh-kuh and Carolina Gold (Selection) performed better than both the check varieties and also showed a considerably yield per plant. The study also provided valuable information regarding the association between the traits under investigation. It was observed that zinc and iron content has a positive significant correlation between them suggesting that selection of one can automatically suggest a higher estimation of the other. This provides a very subtle idea that the levels of both the micronutrient for a specific genotype may be dependent upon the mechanisms responsible for their uptake. Thus future studies aiming at understanding the above mentioned relation can be undertaken.

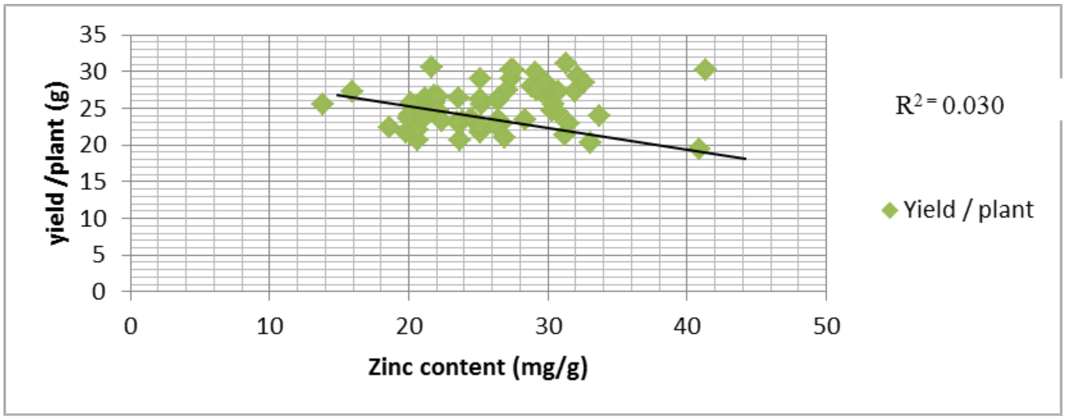

Figure 1: Relationship between grain zinc content and grain yield/plant

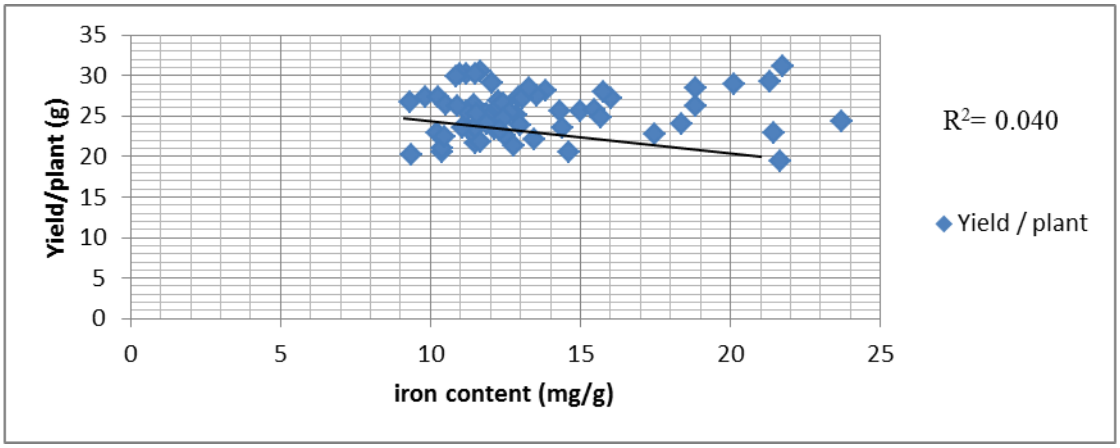

Figure 2: Relationship between grain iron content and grain yield/plant

Table no: I **Mean Performance of 65 genotypes for zinc, iron and protein content along with yield and yield related parameters**

Sl No	**Genotypes**	Zinc content (mg/g)	Iron content(mg/g)	Protein content(%)	No. of panicles/plant	Panicle length (cm)	Filled Grains/panicle	1000grain weight (g)	Yield / plant (g)
1	Surjamukhi	20.63	10.41	7.45	9.33	29.10	182.33	19.07	20.57
2	IR68144-2B-2-2-3-1-127	29.96	12.28	6.72	9.67	28.43	146.00	18.93	26.91
3	IR5882-23-1-3-1	21.82	9.31	6.57	13.33	24.53	134.67	23.80	26.74
4	Daya	23.85	12.12	7.73	12.33	28.23	228.33	16.37	23.34
5	Patharea	19.84	11.50	5.41	10.67	28.00	134.33	18.27	21.62
6	Nipponbare	25.2	15.00	6.91	8.67	23.13	123.00	22.17	25.55
7	IR 64	30.75	9.85	7.26	11.33	27.83	141.00	22.07	27.29
8	CN1646-2	26.43	18.83	6.28	8.67	28.50	171.67	15.63	26.27
9	IR 68144-120	29.48	13.86	6.80	12.33	29.53	165.33	18.43	28.12
10	IR 50	24.47	11.24	5.39	11.67	26.40	144.00	21.23	23.55
11	Ratna	21.05	12.39	6.53	11.67	28.53	185.67	19.57	24.94
12	IR-36	21.21	11.46	7.50	10.67	26.73	143.00	18.67	26.33
13	ARC 10086	21.06	11.90	8.51	10.33	26.20	121.67	26.67	25.34
14	Peh-kuh	26.48	12.47	9.30	11.00	27.73	144.67	22.40	26.08
15	PSRBC-68	33.08	9.37	5.29	16.00	24.00	161.67	15.70	20.25
16	BR-714-35	27.33	11.22	7.86	14.00	21.13	129.33	20.37	30.20
17	CN 915	21.08	12.86	7.38	12.33	23.10	116.33	20.93	25.18
18	PNR 519	26.88	10.39	6.56	11.00	28.33	170.67	15.93	21.05
19	Dular	31.99	10.26	8.54	14.00	29.03	144.67	22.83	27.35
20	Kashalath	31.27	12.76	7.61	10.33	26.00	191.67	16.90	21.30
21	CN 1646-1	30.33	11.94	8.28	13.67	28.70	210.00	21.23	24.58
22	Deokjeokjodo	25.15	11.66	6.24	11.33	25.50	215.00	17.60	21.73
23	Tequing	29.55	16.01	6.25	9.00	21.37	152.00	23.57	27.22
24	JALDI 6	25.15	12.07	8.16	10.67	24.40	113.00	26.50	29.03
25	Rathuwee	13.81	11.19	6.27	14.00	28.77	237.00	21.03	25.60
26	JALDI 13	27.12	12.93	6.80	12.33	23.37	104.33	20.33	27.37
27	Krishna-Hamsha	26.68	10.20	6.11	12.00	25.57	148.33	18.33	22.85
28	IA-1	27.34	20.11	3.75	10.00	29.27	152.67	16.80	28.93
29	Naveen	21.84	15.47	8.44	12.67	26.03	176.67	19.83	25.77
30	Oryzicallonos-5	23.59	10.51	6.25	11.33	27.57	182.33	20.40	26.37
31	`IA-2	32.11	21.33	7.06	7.00	24.77	104.33	14.87	29.30

32	Assamlaya	26.42	12.30	5.14	11.00	23.40	132.00	21.50	26.27
33	Carolina gold sel	21.68	11.67	8.66	19.00	23.07	117.33	22.57	30.50
34	Kalapahar	33.70	18.36	6.25	14.33	24.57	134.33	20.73	23.97
35	Gerdeh	21.24	13.00	6.52	13.67	27.20	142.33	21.07	23.83
36	Doble carolina	22.12	12.46	6.25	9.00	26.93	145.33	23.77	26.57
37	Dudheswar	31.47	21.43	5.54	15.33	23.63	149.67	16.50	22.87
38	Kharbela	25.16	12.50	4.72	13.00	26.21	174.33	20.63	22.60
39	Lemont	28.86	15.78	6.10	13.00	26.17	145.00	23.57	27.90
40	IR-1552	30.64	23.71	8.08	15.67	23.37	133.33	19.50	24.40
41	Trembese	29.17	13.53	7.76	14.67	23.47	125.33	22.53	27.43
42	Badami	21.13	15.68	6.94	14.67	27.47	193.67	20.33	24.77
43	PNR 546	27.58	10.97	7.78	12.33	22.80	155.67	20.23	30.23
44	MTU 1010	23.47	11.38	5.48	8.33	24.00	141.67	21.60	23.13
45	BonAhu	26.47	11.51	7.53	10.00	22.17	103.33	23.00	23.50
46	Khittish	31.32	21.76	6.40	16.00	25.40	140.00	19.83	31.17
47	Black gora	32.65	18.86	4.58	16.00	26.37	130.67	24.27	28.47
48	Satabdi	41.34	11.48	5.28	12.67	24.13	136.33	16.30	30.23
49	Padmini	30.4	12.66	5.44	13.00	29.27	144.00	21.30	25.47
50	Triguna	20.06	11.87	6.14	13.33	22.73	141.33	21.13	24.07
51	CO 39	26.25	17.48	5.11	9.67	25.10	119.00	19.63	22.77
52	I-Zeo-Tze	15.99	13.10	6.48	11.00	23.87	126.00	24.00	27.23
53	Paroma ahu	28.37	14.39	3.47	8.33	29.57	165.67	17.63	23.47
54	IET 20144	25.15	10.89	7.18	10.67	27.33	101.67	18.90	26.23
55	Phudugey	23.66	14.62	6.82	9.00	26.17	122.00	17.50	20.60
56	Kalinga2	29.1	10.87	5.57	12.67	26.40	113.00	19.50	29.83
57	Azucena	40.9	21.66	6.53	9.33	25.83	134.67	21.97	19.37
58	ARC 10372	22.15	12.44	7.11	12.67	26.37	100.67	22.70	24.63
59	Tchibanga	20.66	11.53	6.96	10.00	23.27	177.33	22.17	25.30
60	Tondok	19.99	11.07	10.69	9.67	24.30	114.00	17.93	23.57
61	Asse Y Pung	20.6	13.47	4.72	12.00	29.03	125.33	13.87	22.11
62	Khanika	20.19	14.30	4.42	10.33	27.17	142.33	17.97	25.67
63	Pravat	29.85	13.29	8.46	11.67	25.10	106.33	19.03	28.43
64	Cenit	18.65	10.47	6.80	10.33	28.03	114.33	16.60	22.37
65	Zhenshan-2	22.39	12.32	4.75	8.00	27.97	146.33	19.73	23.23

Mean	**25.93**	**13.46**	**6.62**	**11.80**	**25.96**	**145.69**	**20.09**	**25.37**
Range	**13.81-41.34**	**9.31-23.71**	**3.47-10.69**	**6.33- 19.00**	**21.13 – 29.57**	**100.67-237**	**15.20 - 26.67**	**19.37 – 31.17**
CD(5%)	**4.94**	**2.47**	**1.40**	**3.00**	**2.49**	**5.88**	**3.73**	**2.79**
CD(1%)	**6.49**	**3.25**	**1.85**	**3.43**	**3.10**	**6.27**	**4.17**	**3.84**

Table no: II Analysis of variance (ANOVA) for the yield and yield attributing traits

source	Df	MEAN SUM OF SQUARES							
		Zinc content	Iron content	Protein content	No. of panicles/plant	Panicle length	Filled grain/panicle	1000 seed wt	Yield/plant
Variety	64	395.25**	118.88**	25.12**	16.27	3.37**	2.80**	2.21**	3.39**
Replication	2	3.68	9.34	4.15	3.85	14.76	29.24	70.05	18.88
Error	128	6.34	1.37	5.57	1.50	2.69	3.79	4.48	6.65

Table no. III Estimates of genetic parameters

Traits	GCV	PCV	Heritability(h%)	Genetic Advance
Zinc content	19.67	23.02	73.12	5.36
Iron content	24.55	27.12	81.92	12.46
Protein content	19.82	23.89	68.82	5.52
No. of panicles/plant	16.86	24.70	46.60	1.90
Panicle length	51.11	51.95	96.79	21.03
Filled grains/panicle	20.69	21.55	92.10	15.72
1000 grain weight	52.52	52.71	99.29	17.52
Yield/plant	9.52	13.84	65.17	10.66

Table no: IV. Correlation coefficient for micronutrient content protein content with yield and yield related traits

		Zinc content	Iron content	Protein content	Panicle/plant	Panicle length	Filled grains/panicle	1000 grain weight	yield/plant
Zinc content	G	1	0.729*	-0.030	0.187	-0.074	-0.121	0.087	-0.129
	P	1	0.710*	-0.095	0.166	0.092	0.021	0.046	-0.173
Iron content	G		1	-0.163	0.088	-0.101	-0.107	-0.125	-0.123
	P		1	-0.065	0.104	0.093	0.010	0.017	-0.200
Protein content	G			1	0.208	-0.168	-0.044	0.328	0.179
	P			1	0.119	0.100	0.007	0.325	0.152
Panicle/plant	G				1	0.156	0.323	0.220	0.728*
	P				1	0.095	0.245	0.205	0.700
Panicle length	G					1	0.714*	0.140	0.774*
	P					1	0.667	0.084	0.711*
Filled grains/panicle	G						1	-0.208	0.888**
	P						1	-0.213	0.845**
1000 grain weight	G							1	0.900**
	P							1	0.840**
yield/plant	G								1
	P								1

Table no:V Path coefficient analysis of different traits indicating their direct and indirect effects on grain yield

	Direct and indirect effects via							Genotypic Correlation with grain yield/Plant
	Zinc content	Iron content	Protein content	Panicle/plant	Panicle length	Filled grains/panicle	1000 grain weight	
Zinc content	**-0.136**	0.056	-0.071	0.081	-0.058	-0.064	0.063	**-0.129**
Iron content	0.06	**-0.158**	-0.037	0.017	0.019	0.018	-0.042	**-0.123**
Protein content	-0.006	-0.014	**0.127**	-0.046	-0.011	0.007	0.122	**0.179**
Panicle/plant	0.077	0.063	0.044	**0.464**	-0.012	0.131	-0.039	**0.728**
Panicle length	-0.011	-0.007	-0.024	-0.046	**0.481**	0.118	0.263	**0.774**
Filled grains/panicle	-0.008	-0.006	0.01	0.088	0.049	**0.654**	0.101	**0.888**
1000 grain weight	-0.018	-0.011	0.038	0.068	0.083	0.106	**0.634**	**0.900**

Residual effect : 0.427 (Bold & underlined portion showed the direct effect)

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