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Research Article

Studies on genetic parameters, correlation and path analysis for yield attributes and Iron content in a backcross population of rice [*Oryza sativa* (L.)]

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Abstract
In any crop breeding program, the effective selection of traits that are associated with yield depends on the information on nature and magnitude of variation in the traits and its response to the environment. A study was conducted to determine the variability, heritability, correlation and path analysis of yield and yield components in BC_1F_2 generation of backcross combination, CO 51 × RPHP 48. The population was developed in order to introgress the high iron content in CO 51 background. The narrow difference between GCV and PCV indicates that there was a meagre influence of environment on the expression of 12 traits studied. Broad sense heritability was high for grain iron content and low for kernel length/breadth ratio. Grain yield was found to be significant and positively correlated with the number of productive tillers per plant, panicle weight, the number of grains per panicle and 100 seed weight indicating yield improvement can be achieved through improvement of these traits. The results of genotypic path analysis revealed that the number of productive tillers per plant and kernel length had a high positive direct effect which could be considered as good selection criteria for yield improvement.

Key words
Rice, BC_1F_2, Yield components, Correlation, Path coefficient

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the crucial staple cereal crops for more than 50% population and also it is called as “Global grain”. In developing countries, people often rely on rice as their sole source of nutrition. About 51 nutrients are essential for human to lead a healthy life (Ross, 2003). Lack of any of the nutrients can cause several physiological disorders and nutritional deficiency syndromes. Among the different micronutrients, Iron has a profound influence on human wellbeing. The average content of Iron in rice grains is 1.2mg/100g (Mallimar *et al*.,2015). Malnutrition due to Iron deficiency is widely prevalent in developing countries where rice is a staple food.

Rice is mainly selected for nutritional improvement because Fe deficiency anemia is a critical problem in rice eating countries. The third agricultural revolution increases the grain production but decreases the availability of micronutrient content (Ross, 2003). In order to enhance the nutritional quality and yield through selection, the knowledge on genetic variability and the magnitude of heritable traits are needed for better selection. The character association and path coefficient analysis helps in the elucidation of traits related to yield improvement and in traits based plant breeding programmes.

MATERIALS AND METHODS

The variety CO 51 is a high yielding short duration variety, popular in Tamil Nadu and RPHP 48 is an iron

rich variety. In order to introgress iron content in CO 51 background, a backcross population was developed. The BC_1F_2 seeds of backcross combination *viz.*, CO 51 X (CO 51x RPHP 48) along with the parents were evaluated at Anbil Dharmalingam Agricultural College and Research institute, Trichy during September, 2019. All the entries were raised in rows of three meter length with a spacing of 20 × 15 cm following all the recommended agronomic package of practices. Observations on 12 quantitative traits *viz.,* days to 50% flowering, plant height, the number of productive tillers per plant, panicle length, panicle weight, the number of grains per panicle, 100 seed weight, kernel length, kernel breadth, kernel length/breadth ratio, single plant yield and grain iron content were recorded in 100 plants selected at random from the population. Iron content of the grain samples were estimated by Atomic Absorption Spectrophotometer at 248.3 nm after digestion using triple acid mixture.

Broad sense heritability (h^2) was calculated as per the procedure suggested by Lush (1940) and genetic advance as per cent of mean (GAM) was estimated based on the formula proposed by Johnson *et al* (1955). Correlation coefficients and path coefficients were estimated as per the methods suggested by Pearson (1897 and Dewey and Lu (1959) respectively using TNAUSTAT software.

RESULT AND DISCUSSION

The data on mean performance along with different variability parameters for all the characters indicated the existence of variability in the population (**Table 1**). The character, the number of grains per panicle showed a higher range of variation (31-128) followed by plant height (64 – 146 cm). High variation for grain iron content (8.6 -62.9µg/g) was also recorded with a mean of 22.78µg/g. The presence of such wide range of variation indicated the existence of large genetic variation among the individuals. Apart from the mean performance for a trait, the extent of variability created in the population measures the potentiality of a cross.

Estimates of nature and magnitude of genotypic and phenotypic variability present in a population plays a key role in formulation of successful breeding programme. The estimates of genotypic and phenotypic coefficient of variation for different quantitative characters for BC_1F_2 population (**Table 1**) showed that the phenotypic coefficient of variation was greater than those of genotypic coefficient of variation for all the traits. Similar result was reported by Sadhegi (2011) which proved the masking effect of environment. However, the highest PCV (53.2) and GCV (35.53) was recorded for the number of productive tillers/ plant followed by grain iron content (PCV: 45.21 and GCV: 45.1) and the number of grains per panicle (PCV: 35.68 and GCV: 33.83). Purusothoaman *et al*. (2014), Kujur *et al.* (2019) and Saha *et al.* (2019) reported similarly for the number of productive tillers / plant in rice and Babu *et al.* (2012) for grain iron content. This showed that these characters are major contributors to the total variability.
The traits plant height, panicle length and 100 seed weight had moderate GCV and PCV indicating selective breeding could be done for these characters. The studies of Kujur *et al.,* (2019) for plant height, Mohanasundaram *et al.* (2019) for 100 seed weight and Purusothoaman and Geetha (2014) and Patil *et al.* (2015) for panicle length supports the present findings. Low PCV and GCV were

Table 1. Variability parameters for various quantitative traits in BC_1F_2 population

Traits	Mean	Range		Phenotypic Coefficient of Variance	Genotypic Coefficient of Variance	Heritability	Genetic advance	Genetic Advance as per cent of mean
		Minimum	Maximum					
Days to 50 % flowering	85.51	82.0	91.0	2.84	2.26	63.38	3.17	3.70
Plant height (cm)	98.33	64.0	146.0	17.57	13.64	60.24	21.40	21.81
Number of productive tillers per plant	3.99	1.0	14.0	53.22	35.53	44.56	1.94	48.86
Panicle length (cm)	20.6	12.0	27.5	16.35	14.78	81.32	5.64	27.39
Panicle weight (g)	1.60	0.67	2.6	27.95	26.51	90.00	0.82	51.82
Number of grains per panicle	59.23	31.0	128.0	35.68	33.83	89.89	39.14	66.08
100 seed weight (g)	2.05	1.3	2.6	17.58	11.94	46.15	0.34	16.72
Kernel length (mm)	7.00	5.8	7.9	6.54	4.73	52.38	0.49	7.06
Kernel breadth (mm)	2.20	1.8	2.5	8.01	6.54	66.66	0.23	11.01
Kernel L/B ratio	3.25	2.4	4.2	9.23	5.32	33.33	0.20	6.33
Grain Iron content (µg/g)	22.78	8.6	62.9	45.21	45.18	99.84	7.98	93.01
Single plant yield (g)	17.16	12.2	32.0	23.41	23.00	96.53	21.18	46.55

observed for days to 50% flowering, kernel length, kernel breadth and kernel length/breadth ratio which showed that the variability for these characters was meagre. These results were in accordance with Prabhu *et al.* (2017) for days to 50% flowering and Mohanasundaram *et al.* (2019) for kernel length and length/breadth ratio.

The amount of heritable variation present in the population assumes greater importance to achieve gain in selection programme. Most of the characters showed high heritability (above 60). It is very high for grain iron content (99.84) followed by single plant yield (96.53). The GAM was higher for iron content (93.01). The least values for h^2 (33.3) and GAM (6) was observed in kernel length/breadth ratio. Mohanasundaram *et al.* (2019), Patil *et al.* (2015) and Sala *et al.* (2012) reported similar results for grain iron content and single plant yield. In this study, the highest values of heritability and genetic advance were obtained for panicle weight, the number of grains per panicle and panicle length indicating that these traits could be governed by additive gene action. This is in accordance with the results of Rajesh *et al.* (2019) and Devi *et al.* (2019) for panicle weight.

The correlated response of certain characters was known to occur while the selection is imposed on another character (Falconer, 1964). The results of simple phenotypic correlation may not be reliable for selection programme as there may be influence of environment on these traits. Genotypic correlation estimates heritable part of the variation and identifies true relationship between various traits under study (Fiyaz *et al.,* 2011). High significant and positive correlations of single plant yield with the number of productive tillers per plant, panicle weight, the number of grains per panicle, 100 seed weight and plant height at genotypic level was observed in the present study (**Table 2**). These observations support the earlier findings of Ajmera *et al.* (2017) and Priya *et al.* (2017) for plant height and the number of productive tillers per plant, Venkatesh *et al.* (2018) and Uppal *et al*. (2019) for panicle weight.

Table 2. Genotypic Correlation Coefficients of different traits in BC_1F_2 population of CO 51 X RPHP 48

	DFF	PH	NPT/P	PL	PW	NG/P	100SW	KL	KB	KLBR	IRON	SPY
DFF	**1**	-0.115	-0.110	-0.049	-0.139	-0.037	-0.065	0.122	0.106	-0.020	0.014	-0.213
PH		1	0.350*	0.247*	0.321*	0.340*	0.296*	-0.257	-0.0331	-0.137	-0.042	0.307*
NPT/P			1	0.226**	0.70*	0.732*	0.246*	-0.170	-0.078	-0.040	-0.050	0.664*
PL				1	0.296*	0.217**	0.205**	-0.169	0.052	-0.160	0.096	0.184**
PW					1	0.845*	0.171	-0.119	-0.069	-0.020	-0.037	0.460*
NG/P						1	0.226**	-0.191	-0.158	0.015	-0.061	0.515*
100SW							1	-0.295	-0.060	-0.156	0.042	0.399*
KL								1	0.221*	0.494*	0.044	-0.018
KB									1	-0.732	0.241*	-0.018
KLBR										1	-0.179	0.005
IRON											1	-0.107
SPY												1

***Significant at 5%, * *Significant at 1%**

DFF- Days to 50 % flowering, PH- Plant height (cm), NPT/P- Number of productive tillers per plant, PL- Panicle length (cm) , PW- Panicle weight (g), NG/P- Number of grains per panicle,100SW-100 seed weight (g),KL- Grain length (mm),KB- Grain breadth (mm),LBR- L/B ratio, IRON- Grain Iron content (µg/g),SPY- Single plant yield (g)

Number of grains per panicle exhibited a highly significant and positive correlation at genotypic level with panicle weight (0.84) followed by the number of productive tillers/ plant (0.73) indicating their contribution towards yield improvement. Days to 50% flowering was negatively correlated with all traits except kernel length, kernel breadth and grain iron content. The correlogram depicted a strong positive correlation between panicle weight and the number of productive tillers per plant whereas kernel length/breadth ratio and kernel breadth showed a significant and negative correlation (**Fig. 1**). The single plant yield had a moderate correlation with panicle weight, the number of grains per panicle and 100 seed weight. The empty squares in the figure represent a non significant correlation between the traits.

Selections based on the results of correlation coefficient analysis may not often produce the desired result and hence the study of path coefficient analysis for the estimates of degree of relationship is necessary. Path coefficient analysis allows the separation of the correlation coefficients into direct as well as indirect effects. Among all the yield traits, the number of productive tillers per plant (0.57) was positive and very high in addition to its significant association with grain yield per plant followed by kernel length (0.47), 100 seed weight (0.28) and the number of grains per panicle (0.22) indicating the selection for these characters is likely to bring about an overall improvement in grain yield directly. Yadav *et al.* (2012) and Bhadru *et al.* (2012) reported similar results for the number of productive tillers per plant.

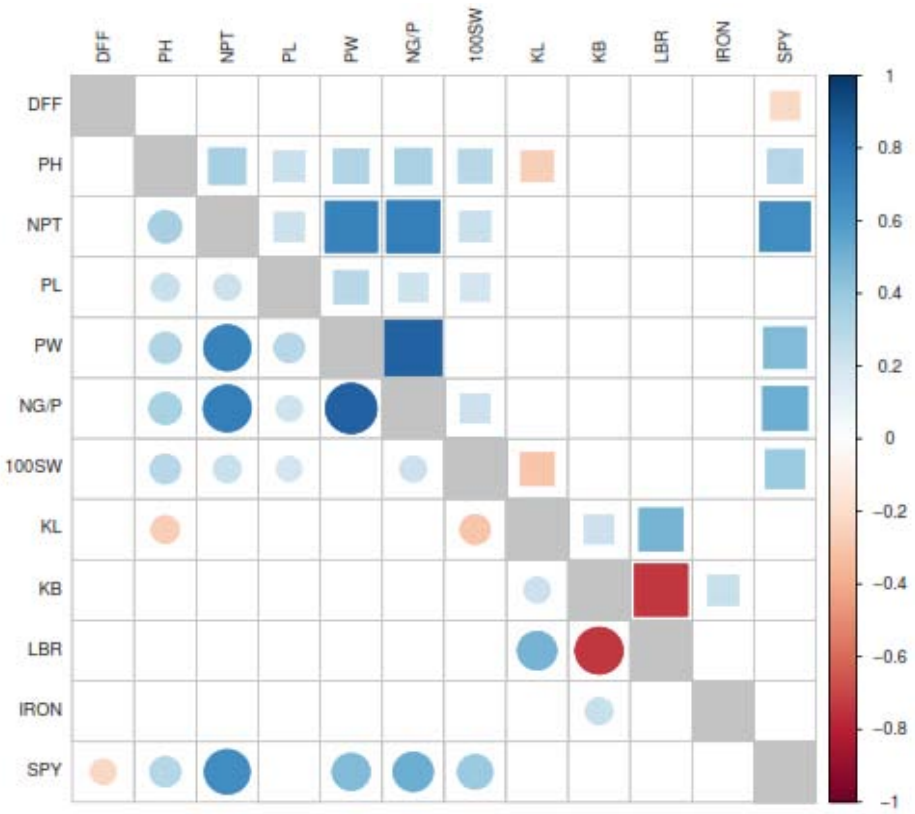

Fig 1.Correlogram visualizing the correlation in yield and its attributing traits in BC_1F_2 population of CO 51 X RPHP 48

Circles and Squares – corresponds to relative correlation (r) values ;Squares- Genotypic correlation ; Circle – Phenotypic correlation; Dark colour- high correlation values; Light colour- low correlation values; Red colour – Negative correlation; Blue colour – Positive correlation

Table 3. Path analysis of various different traits in BC_1F_2 population of CO 51 X RPHP 48

	DFF	PH	NPT/P	PL	PW	NG/P	100SW	KL	KB	KLBR	IRON	SPY
DFF	**-0.1806**	-0.0046	-0.0632	-0.0016	0.028	-0.0082	-0.0184	0.0585	-0.0303	0.008	-0.0016	-0.2139
PH	0.0208	**0.0399**	0.2006	0.0082	-0.0645	0.075	0.0833	-0.1232	0.0094	0.0539	0.0045	0.3079*
NPT/P	0.02	0.014	**0.5723**	0.0075	-0.1418	0.1613	0.0691	-0.0818	0.0224	0.016	0.0053	0.6643*
PL	0.0089	0.0099	0.1298	**0.0332**	-0.0594	0.0479	0.0575	-0.0814	-0.0151	0.063	-0.0102	0.1842**
PW	0.0252	0.0128	0.4046	0.0098	**-0.2005**	0.1861	0.0482	-0.0573	0.0199	0.0082	0.0039	0.4608*
NG/P	0.0067	0.0136	0.4193	0.0072	-0.1695	**0.2202**	0.0636	-0.0916	0.0452	-0.006	0.0065	0.5152*
100SW	0.0118	0.0118	0.1408	0.0068	-0.0344	0.0499	**0.2806**	-0.1417	0.0172	0.0614	-0.0045	0.3998*
KL	-0.022	-0.0103	-0.0977	-0.0056	0.024	-0.0421	-0.083	**0.4793**	-0.063	-0.1937	-0.0047	-0.0187
KB	-0.0192	-0.0013	-0.0451	0.0018	0.014	-0.0349	-0.017	0.1061	**-0.2847**	0.2871	-0.0255	-0.0188
KLBR	0.0037	-0.0055	-0.0234	-0.0053	0.0042	0.0034	-0.044	0.2369	0.2086	**-0.3918**	0.019	0.0058
IRON	-0.0027	-0.0017	-0.0287	0.0032	0.0074	-0.0136	0.0119	0.0211	-0.0687	0.0703	**-0.1059**	-0.1073

RESIDUE= 0.6512

Bold figures indicate direct effects

DFF- Days to 50 % flowering, PH- Plant height (cm), NPT/P- Number of productive tillers per plant, PL- Panicle length (cm) , PW- Panicle weight (g), NG/P- Number of grains per panicle,100SW-100 seed weight (g),KL- Grain length (mm),KB- Grain breadth (mm),LBR- L/B ratio, IRON- Grain Iron content (µg/g),SPY- Single plant yield (g)

Uppal *et al.* (2019) and Parimala *et al.* (2020) for the number of grains per panicle. The high positive indirect effect on single plant yield was from the number of productive tillers per plant *via* the number of grains per panicle followed by the number of productive tillers per plant via panicle weight. Thus indirect selection for these traits would be beneficial in enhancing the yield potential of rice varieties.

The direct effects of days to 50% flowering, panicle weight, kernel breadth, kernel length/breadth ratio and grain iron content were negative. Similar results were reported by Nagesh *et al.* (2012) and Rajamadhan *et al.* (2011) for grain iron content whereas Yadav *et al.* (2010), Pankaj Garg *et al.* (2010), Rajamadhan *et al.* (2011), Babu *et al.* (2012), Yadav and Panday (2012) for days to 50% flowering. The traits panicle weight and kernel length/breadth ratio had an indirect positive influence on single plant yield. In current research, the residual effect is 0.6512 showing that the characters involved in present study contributed almost 35% of variability influencing to the dependent variable *i.e.,* single plant yield. The higher residual value of in the study indicates that apart from the traits considered, there could be several other morphometric traits which could have a significant influence in expression of yield.

Eventhough, higher values of PCV were recorded than GCV, the difference was very narrow for almost all the characters studied indicating the least influence of the environment. However, the characters, the number of productive tillers per plant, grain iron content and the number of grains per panicle showed a wide range of variation. High heritability with high GAM was exhibited by grain iron content and single plant yield in this population. Due to a significant and positive association with yield, the three traits *viz*., the number of productive tillers per plant, panicle weight and the number of grains per panicle have to be considered as major characters while selecting the genotypes for yield improvement. Direct positive association towards grain yield was contributed by the traits the number of productive tillers per plant, kernel length and 100 seed weight in the population and selection for these traits would be effective to enhance the yield potential.

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