Biological Forum – An International Journal **14(4a): 701-704(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Character Association and Path Analysis for Yield, Iron Content and Component Traits in Indigenous Rice Germplasm

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(Received 10 September 2022, Accepted 19 November, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Rice is one of the major staple foods which contribute the energy source of nutrition. As variation in micronutrients is a major problem affecting the health of people, so selection for indigenous rice germplasm with higher micronutrient for iron and zinc is need of the hour. For selection of characters, character association and direct and indirect contribution of characters play an important role. The present investigation was conducted taking 94 germplasms using augmented design. Observations were recorded on 12 quantitative and 3 quality characters from five randomly selected plants in each genotype. The characters like days to 50 % flowering, days to maturity, plant height (cm), number of tiller per plant, panicle length (cm), number of grains per panicle, 1000-grain weight (g) yield per plant (g), harvest index (%), grain length (mm) grain width (mm), grain L/B ratio, amylose content, gelatinization temperature and iron content in brown rice (ppm) were taken and analyzed for character association and path analysis studies. The characters like 1000-grain weight, harvest index, grain length and grain breadth shown significant association with yield while there was negative association of harvest index with iron content of brown rice. Direct and indirect contributions also supported the character association in same manner. So, selection of 1000-grain weight, grain length and grain breadth are important characters to select plants for improvement of iron content in brown rice as well as yield.

Keywords: Character association, Path analysis, Grain iron content, Yield and Rice.

INTRODUCTION

Rice is one of the major food crops, which is considered as the symbol of life in rice produced and consumed countries in the world. In India, rice occupies an area of nearly 43.8 million hectares, with a total production of 177.6 million tons and productivity of 4,057 kg/ha (FAOSTAT, 2021). It is grown in almost all the states; however, the major rice producing states of the country during 2018-19 are West Bengal, Uttar Pradesh, Andhra Pradesh, Telangana, Punjab, Odisha, Chhattisgarh, Tamil Nadu and Bihar (FAOSTAT, 2020). From the nutritional point of view higher iron content is desirable to eradicate the anemia problem. In West Bengal, the prevalence of anemia is around 63.2 % between the age group of 15 to 43 years (Singh, 2010) and it is in upward trend according to NFHS 5 (outlookindia.com).

Germplasm with high iron content will increase the nutritional status coupled with high yield while used in the breeding programme. So, identification of indigenous iron contributing germplasm with high yield from the existing indigenous rice germplasm with broad genetic base is required. Character association and path analysis are the tools to identify the germplasm selection for crop improvement through different characteristics of the plant. Considering the above facts, in the present investigation the augmented design was adopted to for screening of large number of germplasm for selecting a promising line with high iron and yield. The present investigation was carried out taking ninety-four germplasm which includes 86 indigenous rice, 5 high yielding rice and 3 checks, to determine the associations between different characters for selection of iron rich germplasm.

MATERIAL AND METHODS

Ninety-four germplasms collected from RRS, Chakadah, BCKV, West Bengal were evaluated for character association and path analysis. The experiment was conducted in augmented design (Federer, 1956) in 7

blocks with thirteen germplasm and three check varieties taken in each block at Agricultural Instrumental Farm, BCKV, Jaguli, West Bengal. Observations were recorded on 12 quantitative and 3 quality traits on five randomly selected plants *i.e.*, days to 50 % flowering, days to maturity, plant height (cm), number of grains per panicle, 1000-grain weight (g), yield per plant (g), harvest index (%), grain length (mm), grain width (mm), grain L/B ratio, amylase content (%), gelatinization temperature and iron content in brown rice (ppm). The grain length and breadth was measured using Annadarpana averaged over 10 grains. The quality characters like amylose content of brown rice (Juliano, 1971), gelatinization temperature (Little *et al*., 1958), iron content in brown rice (Bhargava and Raghupathi 2009) were evaluated with standard procedures. The data were analyzed for character association and path analysis following (Wright, 1921; Dewey and Lu 1959).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) indicated highly significant differences for all the characters for checks and significant difference for panicle length in the blocks. This indicates the difference of germplasm under study for panicle length and all other traits with checks. The character association and path analysis were done at phenotypic level (Table 2 and 3). From analysis of association of characters, it was found that all the traits showed positive association with yield except panicle length. One thousand grain weight, harvest index, grain length and grain breadth were the important characters giving significant contribution towards yield.

Table 1: Analysis of variance for 12 quantitative and 3 quality traits in 94 rice genotypes.

Sr. No.	Characters	Mean sum of squares		
		Blocks (6)	Checks (2)	Error (12)
1.	Days to 50% flowering	0.381	706.477**	0.809
2.	Days to maturity	1.205	989.71**	0.993
3.	Plant height (cm)	10.243	7347.286**	5.675
4.	Number of tillers/plant	0.166	7.583**	0.082
5.	Panicle length (cm)	0.426 *	13.58**	0.125
6.	Number of grains/panicle	23.969	1716.335**	14.444
7.	1000 – grain weight (g)	0.107	0.831**	0.083
8.	Harvest index (%)	0.589	5.187**	0.503
9.	Grain length (mm)	0.003	1.278**	0.006
10.	Grain breadth (mm)	0.004	0.675**	0.001
11.	L/B ratio	0.014	0.399**	0.02
12.	Amylose (%)	0.261	19.101**	0.322
13.	Gelatinization temperature	0.006	3.781**	0.008
14.	Iron content in brown rice (ppm)	0.688	583.797**	0.524
15.	Yield/ plant (g)	0.826	16.443**	1.175

Figures inside parentheses indicate degrees of freedom (df) for corresponding source of variation
* Significant at 5 % level of probability, ** Significant at 1 % level of probability

Table 2: Correlation coefficients of 12 quantitative and 3 quality traits in rice at phenotypic level.

Sr. No.	Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of tillers per plant	Panicle length (cm)	No. of grains per panicle	1000-grain weight (g)	Harvest index (%)	Grain length (mm)	Grain breadth (mm)	L / B ratio	Amylose (%)	Gelatinization temperature	Iron content in brown rice (ppm)	Yield per plant (g)
1.	Days to 50 % flowering		0.940 **	0.420**	-0.031	-0.124	0.088	0.089	-0.078	-0.036	0.048	-0.104	-0.109	0.226*	0.08	0.202
2.	Days to maturity			0.475**	0.007	-0.150	0.058	0.076	-0.139	-0.051	0.044	-0.122	-0.154	0.249*	0.174	0.158
3.	Plant height (cm)				-0.007	0.111	-0.168	0.183	-0.168	0.065	0.335**	-0.244*	-0.214*	0.041	0.131	0.096
4.	No. of tillers per plant					-0.073	-0.042	-0.282**	-0.016	-0.229**	-0.124	-0.083	-0.237*	-0.152	0.107	0.134
5.	Panicle length(cm)						0.091	-0.158	0.149	0.055	-0.072	0.127	0.063	0.073	-0.002	-0.126
6.	No. of grains per panicle							-0.393**	0.267**	-0.37	-0.329**	-0.002	0.069	0.002	0.046	0.130
7.	1000 -grain weight (g)								0.191	0.624**	0.549**	0.063	0.043	0.095	0.107	0.591**
8.	Harvest index (%)									0.185	-0.028	0.241*	0.021	0.038	-0.283**	0.442**
9.	Grain length (mm)										0.353**	0.577**	0.088	0.141	0.013	0.287**
10.	Grain breadth (mm)											-0.485**	-0.86	0.084	0.086	0.243**
11.	L/B ratio												0.15	-0.028	-0.092	0.037
12.	Amylose (%)													0.015	-0.001	0.028
13.	Gelatinization temperature														0.007	0.067
14.	Iron content in brown rice (ppm)															0.062

*Significant at 5 % level of probability, ** Significant at 1 % level of probability

Table 3: Direct and indirect effects of component traits on seed yield in rice at phenotypic level.

Sr. No.	Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of tillers per plant	Panicle Length (cm)	No. of grains per panicle	1000-grain weight (g)	Harvest index (%)	Grain length (mm)	Grain breadth (mm)	L/B ratio	Amylose (%)	Gelatinization temperature	Iron content in brown rice (ppm)	Yield per plant (g)
1.	Days to 50% flowering	**0.237**	-0.142	0.022	-0.013	0.005	0.036	0.074	-0.015	-0.005	-0.008	0.018	-0.008	0.004	-0.004	0.202
2.	Days to maturity	0.223	**-0.151**	0.025	0.003	0.006	0.024	0.063	-0.026	-0.007	-0.007	0.022	-0.011	0.004	-0.008	0.158
3.	Plant height (cm)	0.100	-0.072	**0.052**	-0.003	-0.005	-0.07	0.151	-0.032	0.009	-0.057	0.043	-0.016	0.001	-0.006	0.096
4.	No. of tillers per plant	-0.007	-0.001	0.001	**0.415**	0.003	-0.017	-0.233	-0.003	-0.032	0.021	0.015	-0.018	-0.003	-0.005	0.134
5.	Panicle length(cm)	-0.029	0.023	0.006	-0.03	**-0.043**	0.038	-0.131	0.028	0.008	0.012	-0.023	0.005	0.001	0.01	-0.126
6.	No. of grains per panicle	0.021	-0.009	-0.009	-0.017	-0.004	**0.414**	-0.325	0.051	-0.051	0.056	0.001	0.005	0.001	-0.002	0.13
7.	1000-grain weight (g)	0.021	-0.012	0.009	-0.117	0.007	-0.163	**0.827**	0.036	0.086	0.093	-0.011	0.003	0.002	-0.005	0.591**
8.	Harvest index (%)	-0.019	0.021	-0.009	-0.007	-0.006	0.111	0.158	**0.189**	0.026	0.005	-0.043	0.002	0.001	0.014	0.442**
9.	Grain length (mm)	-0.009	0.008	0.003	-0.095	-0.002	-0.153	0.516	0.035	**0.138**	-0.06	-0.103	0.007	0.002	-0.001	0.287**
10.	Grain breadth (mm)	0.011	-0.007	0.017	-0.051	0.003	-0.136	0.454	-0.005	0.049	**-0.169**	0.086	-0.006	0.001	-0.004	0.243*
11.	L/B ratio	-0.025	0.018	-0.013	-0.034	-0.005	-0.001	0.052	0.046	0.08	0.082	**-0.178**	0.011	0.001	0.004	0.037
12.	Amylose (%)	-0.026	0.023	-0.011	-0.098	-0.003	0.029	0.036	0.004	0.012	0.015	-0.027	**0.074**	0.001	0.001	0.028
13.	Gelatinization temperature	0.054	-0.038	0.002	-0.063	-0.003	0.001	0.079	0.007	0.019	-0.014	0.005	0.001	**0.017**	0.001	0.067
14.	Iron content in brown rice(ppm)	0.019	-0.026	0.007	0.044	0.009	0.019	0.088	-0.054	0.002	-0.015	0.016	0.001	0.001	**-0.048**	0.062

Residual effect (PR) = 0.540, Coefficient of determination (R^2) = 70.85, Figures in the diagonal (bold) denote direct effect

One thousand grain weight exhibited positive association with yield (Madhavilatha *et al*., 2005; Mustafa and Elsheikh 2007; Chandra *et al.*, 2009; Osman *et al*., 2012; Jambhulkar and Bose 2014; Bhutta *et al.,* 2019). Harvest index exhibited positive association with yield (Idris *et al*., 2012; Pandey *et al*., 2012; Karim, 2014). Positive association of grain length and breadth with yield (Krishna *et al.*, 2010) and negative association of panicle length with yield were also observed in the study of (Rashid *et al*., 2014). Highest magnitude of association was found between 1000-grain weight and yield per plant (0.591). So, selection of plants for yield through characters like 1000-grain weight, harvest index, grain length and grain breadth were important in the present investigation (Madhavilatha *et al.,* 2005; Gazafrodi *et al*., 2006; Mustaafa, 2007; Karim *et al*., 2014; Rashid *et al*., 2014). But as there is a significant negative association of iron content in brown rice with harvest index (-0.83), so the harvest index may not be considered when selecting plants with high iron content in brown rice.

Path analysis study revealed the direct and indirect effect of the different characters contributing towards yield and other desired characters. Path analysis confirmed the positive direct contribution of days to 50 % flowering, plant height, number of grains per panicle, 1000-grain weight, harvest index and grain length towards yield. All the characters contributed indirectly towards yield where as significant contribution towards yield indirectly through 1000-grain weight, harvest index and grain length and grain breadth (Kishore *et al*., 2007; Chandra *et al*., 2009; Allam *et al*., 2015). Direct effect of harvest index on yield was supported by Sarangi *et al*. (2009); Kayande and Dubaje (2011). Negative effects were observed via panicle length (Rasid *et al*., 2014) and iron content in brown rice on yield (Nagesh *et al*., 2013).

CONCLUSIONS

From the present study it was observed that 1000-grain weight, harvest index (%), grain length and grain breadth were the contributing characters for selection of plants with higher yield while harvest index may not be considered for selecting for contribution iron content of brown rice.

FUTURE SCOPE

The present investigation gives scope for the selection of plants with higher yields and iron content in brown rice. The selected plants can be used further to study the genetic potential of the selected germplasm and identify better parents for developing iron-rich rice varieties.

Acknowledgement. I sincerely extend my thanks to the staff of the Department of Plant Breeding, BCKV, and my advisory committee members for giving me proper guidance throughout the course of study. I also sincerely thank the Director of ICAR-CIWA for providing financial support to carry out the research.

Conflict of Interest. None.

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How to cite this article: Debendra Nath Sarangi, Bijoy Kumar Senapati and Banshidhar Pradhan, Rajesh Kumar Kar, Mihir Ranjan Mohanty and Subhashree Das (2022). Character Association and Path Analysis for Yield, Iron Content and Component Traits in Indigenous Rice Germplasm. *Biological Forum – An International Journal, 14*(4a): 701-704.