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Genetic Variability, Correlation and Path Coefficient Analysis of Some Physiological Traits of Transplanted Aman Rice (*Oryza sativa* L.)

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Abstract: Diversity of ten physiological characters along with yield was assessed in T. Aman season 2008 at Sonagazi Regional Station of BRRI. Analysis of variance revealed significant differences among the genotypes for all the traits. Flag leaf area, LAI at flowering, CGR at flowering, RGR at flowering, NAR at flowering and harvest index exhibited that they were controlled by additive gene action and selection for the improvement of these traits would be rewarding. The phenotypic variance was higher than the corresponding genotypic variance for all the characters. All the characters showed moderate to low phenotypic and genotypic coefficient of variation. The highest genotypic variance was noticed for growth duration and the highest phenotypic variance was found for CGR at flowering. Genotypic coefficient of variation and phenotypic coefficient of variation was the highest for NAR at flowering (41.21 and 45.75, respectively) followed by CGR at flowering and the lowest for panicle exertion rate (3.75 and 4.05, respectively). Growth duration showed the highest heritability (98.97) followed by days to flowering (98.00) and flag leaf area (92.29). The highest genetic advance was found for NAR at flowering and the lowest for panicle exertion rate. Considering the correlation and path analysis, harvest index, CGR at flowering, flag leaf area and panicle exertion rate are important characters to be considered for yield improvement.

Key words: Correlation · Path Analysis · Physiological Divergence · Rice

INTRODUCTION

Rice, *Oryza sativa* (2n=24) belonging to the family Gramineae is the staple food for half of the world's population and occupies almost one-fifth of the total land area covered under cereals. The world's rice production has doubled during last 25 years, largely due to the use of improved technology such as high yielding varieties. Bangladesh is the forth largest producer and consumer of rice in the world, with annual production of 27.318 million metric tons. It occupies 74.77% of total cropped areas and it alone constitutes about 90% of the total food grain produced annually in the country [1] Bangladesh needs 2.7 % increases in rice production per year due to increasing population [2] Among Aus, Aman and Boro seasons, Aman occupied the highest area coverage (34% of gross cropped area) [1] So, we have to give more attention for the improvement of T. Aman rice varieties to increase rice production in order to satisfy our population's need of food. Further scope of crop improvement depends on the conserved use of genetic variability and diversity in plant breeding program assisted by correlation and path coefficient analysis. So, the aim of the study is to assess the genetic parameters, correlation and path coefficient in T. Aman rice.

MATERIALS AND METHODS

The experiment was conducted at the farm of Bangladesh Rice Research Institute (BRRI) regional station Sonagazi, Feni in T. Aman season, 2008

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(from July to November) considering 20 BRRI developed HYVs and one local variety named Rajasail. An individual well puddled and levelled bed of 1.5m ×1.0m dimension, demarcated by 15 cm deep channels, was allotted for seedling growing using germinated seeds of each variety at the rate of 1.00 Kg/bed on 14th July 2008. The experiment was laid out in randomized complete block design with three replications with the dimension of an individual plot of 3.0 m × 5.0 m having plot to plot and block to block distance of 0.5 m and 1.0 m, respectively. A fertilizer rate of 60–25–30–3.5 kg ha^{-1} of N–P–K–S in the form of urea, triple super phosphate (TSP), muriate of potash (MP) and gypsum respectively was applied. Thirty days old seedlings were transplanted on the 13th August, 2008 at the rate of two to three seedlings with the spacing of 20 cm × 20 cm. Data were recorded on seedling vigour (mg/cm), days to flowering (50%), panicle exertion rate (%), flag leaf area (cm^2), days to maturity, LAI at flowering using length-width method [3]. CGR at flowering were measured following the formula proposed by Radford [4]. Relative growth rate (RGR) at flowering was measured as growth rate per unit plant biomass following Tanaka *et al.* [5]. Net assimilation rate (NAR) at flowering was calculated using the formula of Kubota *et al.* [6]. The data were analyzed by MSTAT program for ANOVA. The mean sum of square (MSS) of error (considered as error variance, σ^2_e), phenotypic variances (σ^2_p) and genotypic variances (σ^2_g) were estimated following Johnson *et al.* [7]. Genotypic and phenotypic coefficient of variations was estimated according to Genotypic and phenotypic coefficient of variations was estimated according to the formulae of Burton [8]. Broad sense heritability and genetic advance (GA) were estimated using the formula suggested by Johnson *et al.* [7] and Hanson *et al.* [9]. Genotypic and phenotypic correlation coefficients were carried out using formula suggested by Miller *et al.* [10], Hanson *et al.* [9] and Johnson *et al.* [7]. The correlation coefficient were further partitioned into components of direct and indirect effects by path coefficient analysis developed by Wright [11] and later described by Deway and Lu [12].

RESULTS AND DISCUSSION

All the physiological characters showed highly significant variation among the genotypes (Table 1). The phenotypic variance was higher than the corresponding genotypic variance for all the characters and showed moderate to low phenotypic and genotypic coefficient of variation. Relatively low environmental variance due to low difference between phenotypic variance and genotypic variance were observed for the characters of days to flowering, panicle exertion rate, flag leaf area, growth duration, CGR at flowering, harvest index and for yield which indicate that the expression of the genes controlling these characters are not markedly influenced by the environmental conditions.

The differences between phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) of these traits are also very low. Day to flowering, panicle exertion rate, flag leaf area, growth duration, CGR at flowering, harvest index and yield showed difference between phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) of 0.06, 0.30, 0.97, 0.03, 2.44, 1.73 and 2.02, respectively, which also reveals that the influence of the environment on the expression of these traits is very little. So, the expressions of these traits are mainly due to the genetic constituents of the populations and the effect of environment is not so effective in case of expression of these traits. Relatively high environmental variance and high difference between PCV and GCV for the traits of seedling vigour (7.40), LAI at flowering (4.59), RGR at flowering (5.70) and NAR at flowering (4.54) which indicate that these characters are largely influenced by the environmental conditions rather than the genetic constituents of the population.

Heritability in broad sense was found high for all the characters except seedling vigor (38.99 %). High genetic advance along with high heritability were found for flag leaf area (92.29 and 46.95, respectively), LAI at flowering (63.25 and 29.22, respectively), CGR at flowering (87.33 and 67.05, respectively), RGR at flowering (70.91 and 52.73, respectively), NAR at flowering (81.15 and 76.48, respectively), harvest index (73.70 and 18.56, respectively) and yield (76.18 and 22.37, respectively) indicating presence of additive gene action for controlling these traits and selection for the improvement of these characters might be rewarding. The remaining characters viz. seedling vigor, days to flowering, panicle exsertion rate and growth duration showed that they are controlled by non-additive gene action and in this case heterosis breeding might be used rather than selection for the improvement of these traits.

Correlation and Path Analysis: Yield is a complex product being influenced by several interdependable quantitative characters. Thus developing a breeding protocol for yield improvement may not be effective unless the other yield components influencing it directly or indirectly are taken into consideration. When selection pressure is exercised for improvement of any character highly associated with yield, it simultaneously affects a number of other correlated characters. Hence knowledge

Table 1: Genetic parameters, mean, heritability (h^2_b) and genetic advance (GA) for physiological characters in T. Aman rice cultivars

Characters	MSS	CV%	Mean	$\delta^2 g$	$\delta^2 p$	$\delta^2 e$	GCV	PCV	h^2_b	GA
Seedling vigor (mg/cm)	0.45**	15.39	2.56	0.10	0.26	0.16	12.30	19.70	38.99	15.83
Days to flowering (50%)	129.68**	0.89	105.11	42.93	43.81	0.88	6.23	6.29	98.00	12.71
Panicle exertion rate (%)	42.49**	1.54	97.75	13.41	15.67	2.26	3.75	4.05	85.55	7.14
Flag leaf area cm^2	162.49**	6.86	30.59	52.69	57.10	4.41	23.73	24.70	92.29	46.95
Growth duration	190.73**	0.61	133.25	63.36	64.02	0.66	5.97	6.00	98.97	12.24
LAI at flowering	1.98**	13.60	4.17	0.55	0.87	0.32	17.84	22.43	63.25	29.22
CGR at flowering	187.26**	13.27	22.15	59.54	68.18	8.64	34.83	37.27	87.33	67.05
RGR at flowering	0.001**	19.47	0.044	0.002	0.002	0.0002	30.39	36.09	70.91	52.73
NAR at flowering	19.22**	19.86	5.92	5.95	7.33	1.38	41.21	45.75	81.15	76.48
Harvest Index (HI)	0.01**	6.27	0.43	0.002	0.003	0.001	10.49	12.22	73.70	18.56
Yield (t/ha)	0.77**	6.96	3.89	0.23	0.31	0.08	12.44	14.26	76.18	22.37

** means significant difference at 1% level of significance.

Table 2: Genotypic (upper right) and phenotypic (lower left) correlation coefficient among physiological characters of T. Aman rice

Characters	Seedling vigor (mg/cm) (50%)	Days to Flowering rate (%)	Panicle exsertion	Flag leafarea (cm^2)	Growth duration	LAI at flowering	CGR at flowering	RGR at flowering	NAR at flowering (HI)	Harvest Index	Yield (t/ha)
Seedling vigor (mg/cm)	1.000	-0.144	0.054	-0.327	-0.139	0.072	0.481*	0.306	0.410	-0.0594	-0.099
Days to flowering (50%)	-0.088	1.000	-0.299	0.564**	0.996**	0.753**	0.216	0.045	0.349	-0.243	-0.180
Panicle exertion rate (%)	-0.006	-0.268	1.000	-0.065	-0.247	-0.031	-0.249	-0.069	-0.112	0.054	0.241
Flag leaf area cm^2	-0.254	0.532*	-0.034	1.000	0.586**	0.703**	0.094	-0.056	0.094	0.291	0.278
Growth duration	-0.106	0.986**	-0.223	0.562**	1.000	0.734**	0.209	0.052	0.329	-0.207	-0.151
LAI at flowering	0.088	0.567**	-0.049	0.542*	0.561**	1.000	0.402	0.278	0.294	-0.208	-0.083
CGR at flowering	0.300	0.202	-0.227	0.103	0.184	0.331	1.000	0.822**	0.760**	-0.153	0.251
RGR at flowering	0.167	0.050	-0.110	-0.028	0.024	0.217	0.762**	1.000	0.731**	-0.107	-0.207
NAR at flowering	0.187	0.298	-0.086	0.095	0.300	0.227	0.614**	0.480*	1.000	0.119	-0.299
Harvest Index (HI)	-0.076	-0.224	0.072	0.238	-0.188	-0.146	-0.122	-0.099	0.115	1.000	0.721**
Yield (t/ha)	0.018	-0.171	0.200	0.220	-0.132	-0.046	-0.230	-0.283	-0.190	0.600**	1.000

** means significant difference at 1% level of significance. * means significant difference at 5% level of significance. df=N-2=21-2=19

Table 3: Path analysis showing direct and indirect effects of 10 physiological traits on yield in 21 T. Aman rice cultivars

Characters	Seedling vigor (mg/cm)	Days to flowering (50%)	Panicle exertion (%)	Flag leaf area cm2	Growth duration	LAI at flowering	CGR at flowering	RGR at flowering	NAR at flowering	Harvest Index (HI)	Correlation with yield
Seedling vigor (mg/cm)	**-0.413**	0.530	0.000	0.319	-0.486	0.079	0.256	-0.142	-0.176	-0.067	-0.099
Days to flowering (50%)	0.059	**-3.686**	0.002	-0.551	3.489	0.836	0.115	-0.021	-0.150	-0.273	-0.180
Panicle exertion rate (%)	-0.022	1.102	**-0.008**	0.064	-0.867	-0.035	-0.133	0.032	0.048	0.061	0.241
Flag leaf area cm^2	0.135	-2.079	0.001	**-0.977**	2.055	0.781	0.050	0.026	-0.040	0.328	0.278
Growth duration	0.057	-3.670	0.002	-0.573	**3.504**	0.815	0.111	-0.024	-0.141	-0.233	-0.151
LAI at flowering	-0.030	-2.775	0.000	-0.687	2.573	**1.110**	0.214	-0.129	-0.126	-0.234	-0.083
CGR at flowering	-0.198	-0.794	0.002	-0.091	0.733	0.446	**0.533**	-0.382	-0.326	-0.172	0.251
RGR at flowering	-0.126	-0.166	0.001	0.054	0.182	0.309	0.438	**-0.465**	-0.314	-0.120	-0.207
NAR at flowering	-0.169	-1.288	0.001	-0.092	1.153	0.326	0.405	-0.340	**-0.430**	0.134	-0.299
Harvest Index (HI)	0.024	0.896	0.000	-0.285	-0.726	-0.230	-0.082	0.050	-0.051	**1.125**	0.721**

Residual effect = 0.497; Bold figures indicate the direct effects

regarding association of character with yield and among themselves provides guideline to the plant breeder for making improvement through selection and provides a clear understanding about the contribution in respect of establishing the association by genetic and non genetic factors.

Correlation analysis among yield and its contributing character (Table 2) revealed that the genotypic correlation coefficients in most cases were higher than their phenotypic correlation coefficients indicating the association is largely due to genetic reason. In some cases phenotypic correlation coefficients were higher than genotypic correlation indicating suppressing effect of the environment which modified the expression of the characters at phenotypic level [13].

Significant positive genotypic and phenotypic correlation was found between flag leaf area and days to flowering, days to flowering and growth duration, days to flowering and LAI at flowering, flag leaf area and growth duration, flag leaf area and LAI at flowering, growth duration and LAI at flowering, CGR at flowering and RGR at flowering, CGR at flowering and NAR at flowering, RGR at flowering and NAR at flowering and harvest index and yield. It means increase of one character will cause increase in the correlated character also. Only genotypic correlation was found significant between seedling vigor and CGR at flowering. No significant negative correlation was observed. Yield showed significant positive correlation with harvest index only and showed positive correlation with flag leaf area followed by CGR at high

flowering and panicle exertion rate upon which emphasis may given during selection.

Path coefficient analysis (Table 3) showed that growth duration had the maximum direct effect (3.504) on yield followed by harvest index (1.125), LAI at flowering (1.110) and CGR at flowering (0.533). Days to flowering showed the highest direct negative effect on yield (-3.686) followed by flag leaf area (-0.977), RGR at flowering (-0.465), NAR at flowering (-0.430), seedling vigor (-0.413) and panicle exertion rate (-0.008).

Though growth duration showed highest positive direct effect on yield but its genotypic correlation with yield is negative due to high negative indirect effect through seedling vigor (-0.486), panicle exertion rate (-0.867), RGR at flowering (-0.024), NAR at flowering (-0.141) and harvest index (-0.233). Similarly, LAI at flowering showed positive direct effect on yield but its genotypic correlation with yield is negative due to high negative indirect effect through panicle exertion rate (-0.035), RGR at flowering (-0.129), NAR at flowering (-0.126) and harvest index (-0.234).

Panicle exertion rate showed negative direct effect on yield but has positive genetic correlation due to positive indirect effect through days to flowering, flag leaf area, RGR at flowering, NAR at flowering and harvest index. Similarly, Flag leaf area showed negative direct effect on yield but has positive genetic correlation due to positive indirect effect through seedling vigor, panicle exertion rate, growth duration, LAI at flowering, CGR at flowering, RGR at flowering and harvest index. Seedling vigor, days to flowering, RGR at flowering and NAR at flowering showed negative direct effect on yield along with negative genetic correlation with yield. Harvest index showed significant positive correlation (both genotypic and phenotypic correlation) with yield along with positive direct effect on yield which might be considered in developing breeding strategy for yield improvement. Among other traits, CGR at flowering, flag leaf area and panicle exertion rate could also be considered.

CONCLUSION

Genetic variability parameters reveal that seven characters viz. flag leaf area, LAI at flowering, CGR at flowering, RGR at flowering, NAR at flowering, harvest index and yield can be improved by selection. Considering the path analysis of various component characters with grain yield and themselves, harvest index, CGR at flowering, flag leaf area and panicle exsertion rate are important characters for yield improvement.

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