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Research Article

ASSESSMENT OF GENETIC VARIABILITY FOR AGRO-MORPHOLOGICAL IMPORTANT TRAITS IN AMAN RICE (*ORYZA SATIVA* L.)

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Abstract

The present study was conducted in the experimental farm, Sher-e-Bangla Agricultural University (SAU), Dhaka during July 2013-December 2013. The analysis of variance revealed significant deviation for all the characters studied and indicated the existence of variation among the genotypes. The PCV values were slightly higher than the respective GCV values for all the characters except unfilled grains per panicle indicating that the characters were less influenced by the environment. Total tillers per plant, effective tillers per plant, filled grains per panicle, unfilled grains per panicle and yield per plant showed high heritability coupled with high genetic advance percentage of mean which indicated the preponderance of additive gene action and such characters could be improved through selection. High heritability along with low genetic advance as percentage of mean was found for plant height, days to 50% flowering, panicle length, days to maturity and thousand grains weight which indicated the non additive gene action for expression of these characters. Considering the genetic parameters and other agronomic performances, the genotypes Special from AL-29, AL-36, PP-4B(i), AL-17(iii)B, AL-17(iii), AL-17(ii)A, Special from-129, Special from 17(iv), AL-44(i), AL-17, Special from AL-36(D), PP-48, IR-25B, Special from AL-33, IR-25B (Tall), P-5B (ii) might be considered better parents for future hybridization programme.

Key words: Genetic variability; Agro-morphological; Traits; Aman rice

Introduction

Rice is a major food crop, ranking second to wheat among the most cultivated cereals in the world (Anbanandan *et al*., 2009). It is the staple food crop of more than half of the world's population (Anonymous, 2009). Rice provides 21% energy and 15% of per capita protein of global human (Maclean *et al*., 2002). The world dedicated 162.3 million hectares in 2012 for rice cultivation and the total production were about 738.1 million tons (Anonymous, 2012). By 2030, the world must have to produce 60% more rice than it produce in 1995 to meet the demands (Virmani *et al*., 1997).

More than 90% of the world's rice is produced and consumed in Asia. Bangladesh is the fourth largest producer of rice in the world with production of 33.8 million tons in 2012 (Anonymous, 2012). It occupies 74.77% total cropped areas and it alone constitutes 90% of the total food grain produced annually in the country (Anonymous, 2009). Bangladesh needs 2.7% increases in rice production per year due to increasing population (Alam *et al*., 2004).

Rice is grown in Bangladesh under diverse ecosystem of irrigated, rainfed and deep water conditions in three distinct seasons namely Aus, Aman, and Boro (Rashid, 1994). Among Aus, Aman and Boro seasons, Aman occupied the highest area coverage (34% of gross cropped area) (Anonymous, 2009). Moreover, there is lack of well-developed Aman rice variety in our country. So we have to give more attention for the improvement of Aman rice varieties to increase rice production in order to satisfy our population's need of food.

The presence and magnitude of genetic variability in a gene pool is the pre-requisite of a breeding programme. A survey of genetic variability with the help of suitable parameters such as genotypic co-efficient of variation, heritability, and genetic advance are necessary to start an efficient breeding programme (Mishra *et al*., 1988). Heretability plays a vital role in deciding the suitability and strategy for selection of a particular character. Although, the presence of high heritability values indicates the effectiveness of selection on the basis of phenotypic performance, it does not show any indication to the amount of genetic progress for selecting the best individuals which is possible by using the estimates of genetic advance. Moreover, knowledge of heritability is essential for selection based improvement, as it indicates the extent of transmissibility of a character into future generations (Sabesan *et al*., 2009). Genetic advance provides information on expected genetic gain resulting from selection of superior individuals (Satheesh kumar and Saravanan, 2012). High heritability estimates along with

high genetic advance are more helpful in predicting the gain under selection than heritability estimates alone (Thomas and Lal, 2012). The present investigation was undertaken to study the genetic variability and agro-morphological important traits in the 42 Aman rice genotypes.

Materials and Methods

The soil of the experimental site is clay loam in texture and olive gray with common fine to medium distinct dark yellowish brown mottles lies in Agro-ecological region of "Madhupur Tract" (AEZ No. 28). Forty two rice genotypes (G1: AL-17 (iii) B, G2: AL-17 (iii), G3: AL-42, G4: From IR-25B (Yellow), G5: From IR-25B, G6: Special (Early), G7: Richer, G8: AL-35, G9: Special-130, G10: IR-25B (Dwarf), G11: AL-36(C), G12: Special from AL-36(D), G13: P-5B (i), G14: Hira, G15: AL-17(iii) (Tall), G16: Aloron, G17: IR-25B (Tall), G18: AL-36(iii), G19: Special from AL-33, G20: Special from AL-29 (Basmoti type), G21:S-1 (Basmoti type), G22: S-2 (Basmoti type), G23; S-5 (Basmoti type), G24: AL-33(ii) (Basmoti type), G25: AL-36 (Basmoti type), G26: AL-42(ii) (Basmoti-Yellow type), G27: AL-44(i) (Basmoti-Yellow type), G28: AL-17(ii) A, G29: AL-47, G30: PP-48, G31: PP-4B(i), G32: Special from-129, G33: P-5B (ii), G34: AL-36, G35: Special stigma color, G36: IR-25B, G37: Special from-17(iv), G38: Special from S-2, G39: Special from AL-33, G40: AL-44(i), G41: AL-17 and G42: AL-104) were used in this experiment. The experiment was conducted using Randomized Complete Block Design with three replications. Single seedling/hill was transplanted maintaining 20 cm × 25 cm spacing from plant to plant and row to row, respectively. All recommended agronomic practices were properly adopted during the crop season. Data were recorded on individual plant basis from 10 randomly selected plants. Observations were recorded on various plant traits i.e. days to 50% flowering, days to maturity, plant height, total tillers per plant, effective tillers per plant, panicle length, fertile grains per panicle, unfertile grains per 1000 grains weight and yield per plant. The data were analyzed for different components. Analysis of variance was done using the mean value (Singh and Chaudhary, 1985). Mean, range, co-efficient of variation (CV) was estimated using MSTAT computer programme. Phenotypic and genotypic variance was estimated by the formula used by Johnson *et al.* (1955). Genotypic and phenotypic co-efficient of variation were estimated according to Burton (1952) and Singh and Chaudhary (1985). Heritability and genetic advance were measured using the formula by Johnson *et al.* (1955), Hanson *et al.* (1956) and Allard (1960). Genetic advance in percent of mean was calculated by Comstock and Robinson (1952).

Results and Discussion

The analysis of variance indicated the existence of highly significant variability for all the characters studied. The mean sum of square, mean, range, variance components, heritability estimates, genetic advance and genetic advance in percent of mean (GAPM) are presented in Table 1 and Table 3.

Genotypic and phenotypic variability in rice genotypes are shown in Fig. 1. Aman heritability and genetic heritability advance over mean in Aman rice genotypes are shown in Fig. 2.

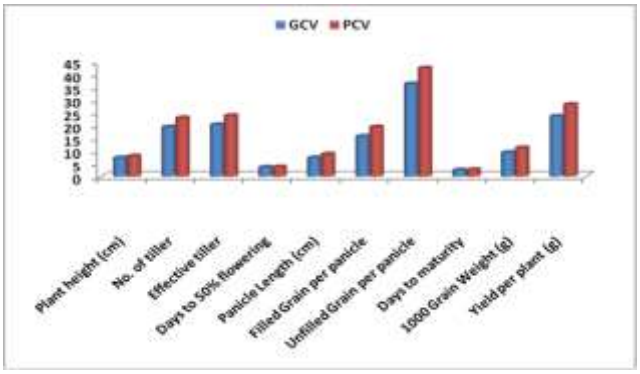

Fig. 1: Genotypic and phenotypic variability in Aman rice genotypes

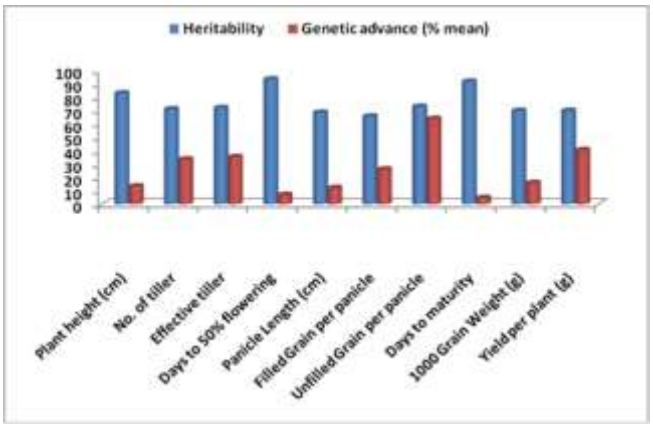

Fig. 2: Heritability and genetic advance over mean in Aman rice genotypes

Plant height (cm)

The grand mean of plant height recorded was 102.40 cm. It was ranged from 88 cm to 116.44 cm (Table 1). The maximum plant height (116.44 cm) was recorded by G1 and the lowest (61.00cm) was recorded by G3 (Table 2). The PCV and GCV were 7.98 and 7.27 percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character showed high heritability (83.17) coupled with low genetic advance in percent of mean (13.66) which indicated non additive gene action for expression of this character.

Total tillers per plant

The grand mean of total tillers per plant recorded was 20.32. It was ranged from 12.78 to 30.56 (Table 2). The maximum total tillers per plant (30.56) was recorded by the G30 and the lowest total tillers per plant (12.78) was recorded by G27 (Table 3). The PCV and GCV were 22.96 and 19.39

percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character The character showed high heritability (71.3) with high genetic advance in percent of mean (33.71) which indicated the governance of additive gene action for expression of this character. Therefore selection could be effective through this character.

Effective tillers per plant

The grand mean of effective tillers per plant recorded was 18.88. It was ranged from 11.11 to 28.00 (Table 1). The maximum effective tillers per plant (28.00) were recorded by the G30 and the lowest (11.11) were recorded by G3 (Table 2). The PCV and GCV were 23.86 and 20.27 percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character also showed high heritability (72.15) with high genetic advance in percent of mean (35.49) which indicated the governance of additive gene action for expression of this character. Therefore selection could be effective through this character. Satheesh kumar *et al*. (2012) also found high heritability with high genetic advance in percent of mean for the character effective tillers per plant.

Days to 50% flowering

The grand mean of days to 50% flowering recorded was 101.48. It was ranged from 92.00 to 108.00 (Table 1). The maximum days to 50% flowering (108.00) was recorded by the G35 and the lowest (92.00) was in G41 (Table 2). The PCV and GCV were 3.72 and 3.61 percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character showed high heritability (93.64) coupled with low genetic advance in percent of mean (7.19) which indicated non additive gene action for expression of the character.

Panicle length

The grand mean of panicle length recorded was 25.90 cm. It was ranged from 22.08 cm to 30.39 cm (Table 1). The maximum panicle length (30.39 cm) was recorded by the G13 and the lowest was recorded by G29 (22.08 cm) (Table 2). The PCV and GCV were 8.75 and 7.25 percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character also showed high heritability (68.68) with low genetic advance in percent of mean (12.4) which indicated non additive gene action for expression of this character. Plate 1 shows some panicle appearance of different rice genotypes.

Filled grains per panicle

The grand mean of filled grains per panicle recorded was 148.28. It was ranged from 87.67 to 208.89 (Table 1). The maximum panicle length (208.89) was recorded by the G31 and the lowest (87.67) was recorded by G14 (Table 2). The PCV and GCV were 19.39 and 15.74 percent respectively (Table 3). There was lower difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character also showed high heritability (65.88) with high genetic advance in percent of mean (26.31) which indicated the governance of additive gene action. Therefore selection could be effective through this character. Prasad *et al*. (2001), Singh *et al*. (2011) and Tuwar *et al*. (2013) also found high heritability coupled with high genetic advance as percent of mean for the trait filled grains per panicle. Plate 2 shows some grain appearance of different rice genotypes.

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Table 1: Estimation of genetic parameters in ten characters of 42 genotypes in Aman rice

Parameters	Range	Mean	MS	CV (%)	σ^2 p	σ^2g	σ^2 e
PH	88.00-116.44	102.40	177.70**	3.27	66.72	55.49	11.23
TTP	12.78-30.56	20.32	52.80**	12.30	21.77	15.52	6.25
ETP	11.11-28.00	18.88	49.56**	12.59	20.29	14.64	5.65
DFF	92.00-108.00	101.48	41.09**	0.94	14.31	13.4	0.91
PL	22.08-30.39	25.90	12.20**	4.90	5.14	3.53	1.61
FG	87.67-208.89	148.28	1915.94**	11.33	826.67	544.64	282.03
UFG	7.89-45.78	19.35	166.42**	22.00	67.57	49.43	18.14
DM	126.00-138.00	133.28	34.36**	0.74	12.11	11.13	0.98
TGW	20.36-30.45	24.32	17.77**	6.10	7.4	5.19	2.21
YPP	13.83-52.61	38.25	279.45**	15.41	116.32	81.57	34.75

PH = Plant height (cm), TTP = Total tillers per plant, ETP = Effective tillers per plant, DFF = Days to 50% flowering, PL = Panicle length (cm), FG = Filled grains per panicle, UFG = Unfilled grains per panicle, DM = Days to maturity, TGW = Thousand grains weight (g), YPP = Yield per plant (g), MS = mean square, CV (%) = Coefficient of variation, σ^2 p = Phenotypic variance, σ^2g = Genotypic variance and σ^2 e = Environmental variance, *, ** = Significant at 1% and 5%respectively

Table 2: Mean performance of various growth parameters and yield components of 42 genotypes in Aman rice

Genotypes	PH	TTP	ETP	DFF	PL	FG	UFG	DM	TGW	YPP
G1	116.44	20.11	18.56	97.00	26.77	174.00	23.44	131.00	25.80	41.74
G2	114.45	20.67	18.89	101.00	26.10	165.45	23.33	130.00	20.79	35.22
G3	88.00	13.00	11.11	98.00	23.16	133.33	19.52	130.33	23.71	17.96
G4	99.22	19.11	17.22	100.67	24.65	164.44	25.89	131.00	24.99	27.63
G5	104.67	19.22	17.55	104.33	27.30	155.00	22.89	130.67	24.78	41.68
G6	90.45	18.33	15.89	94.67	23.50	108.33	11.22	126.00	25.25	33.62
G7	102.11	17.11	16.89	98.00	23.90	151.22	8.89	127.33	22.70	33.31
G8	94.33	23.00	20.44	104.00	23.60	107.33	11.33	136.00	23.46	42.45
G9	98.00	22.56	20.67	102.00	25.17	121.11	9.11	134.67	21.76	41.56
G10	106.78	21.55	18.67	105.00	26.32	130.78	21.22	130.00	21.67	40.03
G11	107.11	22.44	21.00	102.00	26.38	156.89	26.78	134.00	25.18	50.02
G12	90.45	27.56	24.89	103.00	24.38	134.78	12.33	134.00	23.73	47.14
G13	103.33	20.33	18.89	102.00	30.39	151.66	24.89	130.00	25.48	24.99
G14	101.78	23.78	19.33	107.33	22.16	87.67	32.56	134.00	24.53	20.96
G15	110.33	26.55	25.22	101.33	26.41	179.89	9.11	130.00	23.51	45.62
G16	103.78	21.89	19.66	105.00	23.71	119.00	9.00	135.67	23.21	46.10
G17	115.33	19.11	18.56	104.00	29.27	127.45	13.56	136.00	27.03	52.34
G18	115.44	13.11	11.66	104.67	26.02	160.33	14.22	137.00	20.83	40.40
G19	110.22	22.33	20.89	102.00	24.38	112.56	19.78	136.00	26.51	33.46
G20	103.67	24.00	22.78	105.00	27.49	194.78	45.78	134.67	20.51	28.93
G21	103.44	20.78	19.44	102.00	29.10	150.33	15.89	135.00	28.69	33.55
G22	105.55	15.55	14.67	101.67	28.53	152.56	23.78	134.67	30.45	35.08
G23	101.55	14.44	13.55	101.00	24.81	152.11	17.33	135.33	28.88	33.40
G24	96.00	21.89	20.00	103.00	26.44	141.44	28.22	136.00	22.24	13.83
G25	109.22	13.89	13.56	100.00	27.07	187.67	21.11	135.67	27.59	35.02
G26	102.67	13.55	13.00	95.00	27.50	121.78	23.67	126.00	24.03	26.04
G27	105.78	12.78	12.33	94.00	28.63	137.33	13.67	126.00	25.20	26.19
G28	111.44	20.89	19.55	107.00	24.03	163.89	22.45	137.00	26.49	48.84
G29	94.22	22.78	22.22	100.00	22.08	120.00	20.56	137.00	20.36	38.75
G30	93.67	30.56	28.00	102.00	24.91	158.00	20.56	130.67	21.41	52.61
G31	94.22	20.67	19.89	97.00	26.54	208.89	28.22	132.00	22.77	42.80
G32	101.00	16.00	13.00	102.00	28.74	171.89	22.55	135.00	22.74	43.93
G33	88.78	25.89	24.67	101.67	24.01	123.33	15.78	136.00	23.35	52.00
G34	98.22	21.11	20.45	102.00	24.17	145.78	15.11	135.00	27.35	40.47
G35	92.89	22.56	21.89	108.00	24.93	148.89	13.00	136.00	23.51	35.07
G36	102.78	25.11	24.89	105.00	25.59	151.45	7.89	135.67	21.15	49.38
G37	108.44	18.78	17.45	103.00	27.74	174.33	23.11	138.00	22.52	48.50
G38	102.22	17.22	15.11	99.00	26.73	139.89	14.44	135.00	24.80	29.09
G39	92.89	26.89	26.45	107.00	26.98	142.00	19.89	137.00	26.91	47.46
G40	100.44	19.45	18.11	96.67	28.66	175.00	23.11	136.67	26.03	48.01
G41	104.89	18.66	18.11	92.00	25.22	172.11	22.89	130.00	26.32	37.03
G42	114.67	18.33	17.78	102.33	24.27	153.00	14.78	129.67	23.21	44.21

Table 3: Estimation of genetic parameters in ten characters of 42 genotypes in Aman rice

Parameters	PCV	GCV	ECV	Heritability	Genetic advance (5%)	Genetic advance(% mean)
PH	7.98	7.27	3.27	83.17	13.99	13.67
TTP	22.96	19.39	12.3	71.3	6.85	33.72
ETP	23.86	20.27	12.59	72.15	6.7	35.49
DFF	3.73	3.61	0.94	93.64	7.3	7.19
PL	8.75	7.25	4.9	68.68	3.21	12.4
FG	19.39	15.74	11.33	65.88	39.02	26.31
UFG	42.48	36.33	22.01	73.15	12.39	64.03
DM	2.61	2.5	0.74	91.91	6.59	4.94
TGW	11.19	9.37	6.11	70.14	3.93	16.16
YPP	28.2	23.61	15.41	70.13	15.58	40.73

PCV = Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation, ECV = Environmental coefficient of variation

Plate 1: Some panicle appearance of different Aman rice genotypes

Plate 2: Some grain appearance of different Aman rice genotype

Unfilled grains per panicle

The grand mean of unfilled grains per panicle recorded was 19.35. It was ranged from 7.89 to 45.78 (Table 1). The maximum unfilled grains per panicle (45.78) was recorded by the G20 and the lowest (7.89) was recorded by G36 (Table 2). The PCV and GCV were 42.48 and 36.33 percent respectively (Table 3). There was considerable difference between the phenotypic and genotypic co-efficient of variation indicating significant environmental influence in the expression of this character. The character also showed high heritability (73.15) with high genetic advance in percent of mean (64.03) which indicated that additive genes are said to control the traits and also highlights the usefulness of plant selection based on phenotypic performance.

Days to maturity

The grand mean of days to maturity recorded was 133.38. It was ranged from 126.00 to 138.00 (Table 1). The maximum days to maturity (138.00) was recorded by G37 and the lowest (126) was in G6 (Table 2). The PCV and GCV were 2.61 and 2.50 percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character also showed high heritability (91.91) with low genetic advance in percent of mean (4.94) which indicated the non additive gene action for expression of the character.

Thousand grains weight

The grand mean of thousand grains weight recorded was 24.32. It was ranged from 20.36 to 30.45 (Table 1). The maximum thousand grains weight (30.45) was recorded by the G22 and the lowest thousand grains weight (20.36) was recorded by G29 (Table 2). The PCV and GCV were 11.19 and 9.37 percent respectively (Table 3). There was little difference between the phenotypic and genotypic co-efficient of variation indicating little environmental influence in the expression of this character. The character showed high heritability (70.14) with low genetic advance in percent of mean (16.16) which is indicative of non-additive (dominant/epistatic) control for expression of this character.

Yield per plant

The grand mean of yield per plant recorded was 38.25 g. It was ranged from 13.83 g to 52.61 g (Table 1). The maximum yield per plant (52.61 g) was recorded by the G30 and the lowest (13.83 g) was recorded by G24 (Table 2). The PCV and GCV were 28.20 and 23.61 percent respectively (Table 3). There was lower difference between the phenotypic and genotypic co-efficient of variation indicating lower environmental influence in the expression of this character. The character also showed high heritability (70.13) with high genetic advance in percent of mean (40.73) which indicated the governance of additive gene action for expression of this character. Therefore selection could be effective through the character.

Conclusion

All the genotypes varied significantly for all the studied characters indicated the presence of considerably variations among the genotypes. The PCV values were slightly higher than the respective GCV values for all the characters except unfilled grains per panicle indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of the traits. High heritability with high genetic advance as percentage of mean was found for the characters total tillers per plant, effective tillers per plant, filled grains per panicle, unfilled grains per panicle and yield per plant which indicated the governance of additive gene action for the expression of these characters. Therefore selection could be effective for these characters. High heritability coupled with low genetic advance as percentage of mean was found for the characters plant height, days to 50% flowering, panicle length, days to maturity and thousand grains weight. It revealed that there is non additive gene action for expression of these characters. Considering this idea and other agronomic performances, the genotypes Special from AL-29, AL-36, PP-4B(i), AL-17(iii)B, AL-17(iii), AL-17(ii)A, Special from-129, Special from 17(iv), AL-44(i), AL-17, Special from AL-36(D), PP-48, IR-25B, Special from AL-33, IR-25B (Tall), P-5B (ii) might be considered better parents for future efficient hybridization programme.

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