International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 11 No. 2 Nov. 2014, pp. 494-502

http://www.ijisr.issr-journals.org/

Evaluation of Habitual Rice (*Oryza sativa* L.) Landraces of Bangladesh through Different Genetic Parameters

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ABSTRACT: The study was carried out with an objective to evaluate the agronomic performance of 76 rice genotypes and to learn the variability, heritability and genetic advance of yield and its components. The genotypes differed significantly for all the characters *viz.,* days to 50% flowering, days of maturity, number of tillers plant^{-1}, number of effective tillers plant^{-1}, plant height, panicle length, number of filled grain panicle^{-1}, number of unfilled grain panicle^{-1}, 1000-seed weight and yield plant^{-1}. The phenotypic co-efficient of variation (PCV) were higher than genotypic co-efficient of variation (GCV) for all the characters studied indicating that they all interacted with the environment to some extent. All the characters studied in the present investigation expressed high heritability estimates ranging from 78.38 to 99.14 percent. High heritability values indicate that the characters under study are less influenced by environment in their expression. High heritability along with high genetic advance was noticed for the traits, number of filled grains panicle^{-1} and number of unfilled grains panicle^{-1}. Other characters showed high heritability along with moderate or low genetic advance which can be improved by intermating superior genotypes of segregating population developed from combination breeding.

KEYWORDS: Genetic variability, Heterogeneous, Gene pool, Stress-tolerance, Cultivars, Additive gene.

1 INTRODUCTION

Rice, the staple food of about 160 million people in Bangladesh, belongs to the family of Gramineae and the genus *Oryza*. *Oryza* contains about 20 different species, of which only two are cultivated: *Oryza sativa* L. ('Asian rice') and *Oryza glaberrima* Steud ('African rice'). The species *O. sativa*, of Asian origin, comprises of two main types: indica and japonica. The indica type is from tropical and japonica is from temperate and subtropical Asia. *Oryza glaberrima* originates from inland delta of the Niger River. Nowadays, the Asian species (*O. sativa*) is cultivated far more than the African species (*O. glaberrima*), mainly for its higher yield potential [1].

Landraces are widespread and popular among farmers, and are an important part of agriculture because their diverse array in a crop creates genetic diversity in agriculture [2]. The genetic variability is a key component of breeding programs aimed at broadening the gene pool of rice and other crops. Landraces are known to be heterogeneous mixtures of genotypes carrying a range of stress-tolerance genes [3]. Landraces also possess traits that are most preferred by farmers and can be used to produce new cultivars or to incorporate desirable traits into varieties.

In rice, as in many other crops, landraces have not been bred as varieties, but have become adapted to the local conditions of environment and inputs where they are cultivated. Landraces have been the mainstay of agricultural systems in many developing countries. Recently, however, the diversity of gene pool has become depleted, mainly on account of extension of modern high-yielding varieties. Over many years, farmers and breeders have selected rice varieties for improved grain yield, quality, disease and pest resistance, and other traits that favor productivity for farmers. The process of domestication narrowed the range of genetic variation that was available in wild populations, causing a genetic bottle neck as a result of the selection pressure imposed by humans. Natural habitats of wild rice are also threatened by various development projects of the farmland. The number of landraces began to decline in 1970's when high-yielding varieties were introduced. Most of the old landraces are now available in certain gene banks only.

Bangladesh constitutes a large part of the South Asian centre of genetic diversity, sharing with India and Myanmar. It has rich genetic diversity of landraces and wild rice. In recent years, these traditional varieties have been replaced by modern improved varieties associated with new cultural practices. Several workers have found and reported genetic variability of landraces for higher yield, for tolerance to various stresses and for improved grain quality. Gomez *et al.* [4] evaluated rice landraces in India and found variability for quality traits such as milled rice percentage and kernel length. Irie *et al.* [5] reported great diversity for photoperiod sensitivity, based on number of days to heading, among 1240 rice landraces of Myanmar. Significant variation for physiological and economic traits was recorded among 11 landraces grown in the Tamil Nadu region of India by Gomez and Kalami [6]. Despite the research already done, the role of landraces in contributing germplasm to breeding programs has not been fully appreciated. This has been due to inadequate testing or lack of genetic information about the landraces. Information from genetic studies could be useful in designing breeding programs that will best exploit economically important grain quality and yield related traits when developing new varieties. To meet the continuously expanding needs of varietal improvement, the assemblage, evaluation and preservation of the entire existing landraces are essential to more rewarding breeding efforts. The specific objectives of the study were as follows:

- to evaluate the agronomic performance of collected landraces
- to study the variability, heritability and genetic advance of yield and its components

2 Materials And Methods

The experiment was conducted at the experimental farm of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during July 2011 to January 2012. Geographically the experimental area is located at $24^0$75 N latitude and $90^0$5 E longitudes at the elevation of 18 m above the sea level. Fifty four rice landraces (i.e. Dudh kalam, Hati bajore, Malagoti, Kuchra, Enghi, Kajol shail, Hogla, Jamai naru, Hari, Dakh shail, Moina moti, Marish shail, Patnai, Bhute shallot, Kute patnai, Mohini shallot, Moghai balam, Sada gotal, Khak shail, Mohime, Holde gotal, Jota balam, Tilek kuchi, Rani Shalot, Kathi goccha, Bashful balam, Bazra muri, Durga bhog, Kumra ghor, Khainol, Ghunshi, Chinikani, Dhar shail, Khejur chori, Shaheb kachi, Raja shail, Hamai, Mura bajal, Lal gotal, Kalmilata, Volanath, Rupessor, Sylhet balam, Karengal, Kalo mota, Mota aman, Ghochi, Chap shail, Mondeshor, Nona kochi, Ghocca, Tal mugur, Ghigoj and Tor balam) were collected from the farmer’s field of southern Bangladesh. Rest of the rice genotypes (21 landraces i.e. Fulkainja, Piarjat, Koicha binni, Lal biroi, Lalanamia, Golapi, Asam binni, Kakua binni, Nona bokhra, Jongli boro, Kashrail, Ledra binni, Nunnia, Rotisail, Genggeng binni, Chinisail, Jolkumri, Ponkhiraj, Mowbinni, Bogi, Kali boro and Binadhan-8) was collected from Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experimental field was divided into three blocks each representing one replication. Each block was then sub-divided in to seventy six plots. The seventy six rice genotypes were placed in each plot. The size of the unit plot was one square meter in size. Row to row and plant to plant distances were 20 cm and 20 cm, respectively in each plot. Analysis of variance was performed using the plant breeding statistical program (PLBSTAT, Version 2N, Utz 2007). The replicates were considered as random variable. Multiple mean comparisons were made with Fisher's least significant difference (LSD) procedure using Stat Graphics Plus for Windows 3.0 (Statistical Graphics Crop. Rockville, USA). Genotypic and phenotypic variances were estimated according to the formula given by Johnson *et al.* [7]. Heritability in broad sense (h^2_b) was estimated according to the formula suggested by Johnson *et al.* [7] and Hanson *et al.* [8]. Genotypic and phenotypic co-efficient of variations were estimated according to Burton [9] and Singh and Chaudhary [10]. Estimation of genetic advance was done following formula given by Johnson *et al.* [7] and Allard [11]. Genetic advance in percent of mean was calculated by the formula of Comstock and Robinson [12].

3 Results And Discussion

3.1 Evaluation of performance of rice landraces

The analyses of variance of different genotypes for quantitative characters are shown in Table 1. It was observed that genotypic effects were highly significant for all characters *viz.,* days to 50% flowering, days to maturity, tillers plant^{-1}, effective tillers plant^{-1}, plant height, panicle length, filled grain panicle^{-1}, unfilled grain panicle^{-1}, 1000-grain weight and yield plant^{-1}. This indicates that there is a genotypic variation among the genotypes for the characters. Yaqoob *et al.* [13] observed significant variation among genotypes for days to maturity, tillers plant^{-1}, effective tillers plant^{-1}, plant height, panicle length, 100-grain weight and yield plant^{-1}. Tiwari *et al.* [14] also observed significant variation among genotypes for days to 50% flowering, effective tillers plant^{-1}, panicle length, number of spikelets panicle^{-1}, number of fertile spikelets and grain yield plant^{-1}.

The mean performances of the 76 rice genotypes for their characters are shown in Table 2. From the tabular results it was observed that Ghunshi was the highest in plant height (173.8 cm) followed by Malagoti and Bazra muri (172.8 and 172.6 cm, respectively) and Binadhan-8 was the lowest (84.40cm) for plant height. Bhute shalot had the highest (30.50 cm) panicle length followed by Genggeng binni (30.30 cm) and Ghigoj had the lowest (20.62 cm) panicle length. Binadhan-8 took the lowest days to 50% of flowering (88 days) and Jamainaru took the highest (140 days) days to 50% of flowering which was not significantly different from Kuchra (139 days). Binadhan-8 was early maturing (130 days) and Kuchra was late maturing (175 days) which was not significantly different from Hati bajore and Mondeshor (174 and 173 days, respectively). Moina moti and Nunnia had the highest and same number of tillers plant^{-1} (22.60) and Genggeng binni had the lowest number of tillers plant^{-1} (9.20). Nunnia had the highest number of effective tillers plant^{-1} (22.40) which was not significantly different from Moina moti (21.80) and Genggeng binni had the lowest number of effective tillers plant^{-1} (9.03). Kakua binni had the highest number of filled grain panicle $^{-1}$ (236.8) and Kumra ghor and Karengal had the lowest (59.60) number of filled grain panicle $^{-1}$. Koicha binni had the highest (85.40) number of unfilled grain panicle^{-1} and Mota aman had the lowest (8.40) number of unfilled grain panicle^{-1}. Highest 1000-grain weight (31.93g) was present in Mota aman followed by Hati bajore (31.23 g) and the lowest in Chinishail (11.28 g) followed by Kakua binni (11.75 g). Among 76 rice genotypes for yield plant^{-1} Bogi yielded the highest (67.80 g) while Ghunshi yielded the lowest yield plant^{-1} (10.20 g).

Table 1. Analysis of variance for plant characters of 76 rice genotypes

Items	d.f	Plant height (cm)	Panicle length (cm)	Days to 50% flowering	Days to maturity	Number of tillers plant^{-1}	Number of effective tillers plant^{-1}	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	1000 seed weight (g)	Grain yield plant^{-1} (g)
Replication	2	130.92	0.372	67.561	204.34	2.453	3.195	125.65	6.92	0.639	5.995
Genotypes	75	651.70**	12.894**	546.827**	515.62**	23.969**	23.168**	4448.18**	563.04**	66.183**	427.840**
Error	150	30.67	1.086	17.235	33.99	0.652	0.691	18.13	1.62	0.968	1.760

*** indicates significant at 0.01 probability*

Table 2. Mean performance of 76 rice genotypes based on different morphological traits related to yield

Genotypes	Plant height (cm)	Panicle length (cm)	Days to 50% flowering	Days to maturity	Number of tillers plant^{-1}
Dudh kalam	148.40	27.32	102.00	140.00	13.40
Hati bajore	154.00	27.80	138.00	174.00	13.80
Malagoti	172.80	25.52	99.00	139.00	13.20
Kuchra	153.40	24.60	139.00	175.00	16.20
Enghi	152.40	28.50	118.00	156.00	12.80
Kajol shail	127.80	25.70	114.00	155.00	12.80
Hogla	154.20	27.70	125.00	170.00	12.80
Jamai naru	144.20	28.20	140.00	171.00	18.00
Hari	116.00	27.13	119.00	155.00	15.00
Dakh shail	145.40	28.52	117.00	155.00	15.40
Moina moti	133.40	25.20	103.00	138.00	22.60
Marish shail	146.20	25.90	129.00	172.00	17.00
Patnai	164.00	24.10	115.00	155.00	12.60
Bhute shalot	141.00	30.50	133.00	171.00	15.40
Kute patnai	152.40	24.74	121.00	155.00	10.80
Mohini shalot	139.40	23.58	129.00	166.00	15.20
Moghai balam	123.60	26.24	120.00	156.00	13.60
Sada gotal	143.00	25.48	125.00	167.00	12.60
Khak shail	142.80	27.20	95.00	137.00	14.80
Mohime	152.40	24.50	120.00	167.00	13.80
Holde gotal	139.20	23.34	121.00	166.00	13.00
Jota balam	138.60	26.40	118.00	155.00	20.80
Tilek kuchi	133.20	26.74	120.00	166.00	11.60
Rani shalot	148.80	25.65	135.00	172.00	14.60
Kathi goccha	148.60	22.84	110.00	147.00	10.60
Bashful balam	148.20	26.60	125.00	155.00	12.40
Bazra muri	172.60	25.86	131.00	169.00	11.20
Durga bhog	143.80	23.40	95.00	138.00	15.40
Kumra ghor	147.40	21.14	132.00	172.00	11.80
Khainol	152.80	28.10	97.00	137.00	16.40
Ghunshi	173.80	21.64	130.00	171.00	10.00
Chinikani	143.00	23.48	116.00	156.00	14.80
Dhar shail	141.00	24.41	110.00	150.00	11.60
Khejur chori	147.40	25.62	133.00	172.00	15.40
Shaheb kachi	138.00	25.78	134.00	171.00	11.80
Raja shail	143.20	24.00	110.00	152.00	12.00
Hamai	153.00	25.12	109.00	151.00	12.60
Mura bajal	149.40	23.62	129.00	171.00	11.60
Lal gotal	142.40	24.50	133.00	172.00	12.40
Kalmilata	147.40	24.62	118.00	155.00	11.80
Volanath	129.00	25.32	128.00	169.00	12.40
Rupessor	116.00	23.16	111.00	147.00	15.40
Sylhet balam	116.20	26.90	100.00	140.00	13.00
Karengal	131.40	23.51	130.00	171.00	11.20
Kalo mota	142.40	24.02	132.00	172.00	10.60
Mota aman	120.60	22.74	126.00	166.00	15.20
Ghochi	155.60	22.60	97.00	137.00	16.00
Chap shail	148.80	25.80	118.00	158.00	11.80
Mondeshor	138.40	26.70	133.00	173.00	10.20
Nona kochi	148.20	26.64	132.00	172.00	11.60
Ghocca	143.60	26.90	105.00	145.00	12.60
Tal mugur	161.80	27.22	100.00	138.00	11.60
Ghigoj	141.60	20.62	110.00	150.00	13.80
Tor balam	156.26	26.26	107.00	147.00	13.40
Fulkainja	118.40	29.54	101.00	137.00	16.40
Piarjat	134.20	29.48	104.00	146.00	14.20
Koicha binni	138.80	28.94	102.00	142.00	13.40
Lal Biroi	143.60	24.88	103.00	143.00	17.20
Lalanamia	123.20	25.62	109.00	145.00	11.00

Genotypes	Plant height (cm)	Panicle length (cm)	Days to 50% flowering	Days to maturity	Number of tillers plant^{-1}
Golapi	143.40	23.30	107.00	146.00	18.20
Asam binni	148.40	26.74	107.00	143.00	14.00
Kakua binni	138.80	27.96	110.00	145.00	18.40
Nona bokhra	141.40	24.20	95.00	139.00	11.60
Jongli boro	136.60	25.00	93.00	137.00	13.00
Kashrail	126.80	27.05	96.00	138.00	10.40
Ledra binni	128.00	27.16	106.00	146.00	20.80
Nunnia	113.00	27.26	103.00	147.00	22.60
Rotisail	109.00	27.28	103.00	147.00	12.60
Genggeng binni	137.80	30.30	105.00	147.00	9.20
Chinisail	124.20	25.06	110.00	146.00	14.40
Jolkumri	138.80	25.72	100.00	136.00	11.60
Ponkhiraj	139.60	24.22	103.00	139.00	11.00
Mowbinni	133.20	22.44	113.00	148.00	10.40
Bogi	144.20	23.60	110.00	147.00	16.20
Kali boro	153.00	24.34	93.00	137.00	11.13
Binadhan-8	84.40	25.40	88.00	130.00	16.20
CV%	3.93	4.07	3.63	3.79	5.86
Minimum	84.40	20.62	88.00	130.00	9.20
Maximum	173.80	30.50	140.00	175.00	22.60
Mean	140.89	25.59	114.43	153.79	13.77
LSD (0.05)	8.94	1.68	6.69	9.40	1.30

Table 2. Continued

Genotypes	Number of effective tillers plant^{-1}	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	1000 seed weight (g)	Grain yield plant^{-1} (g)
Dudh kalam	12.00	115.80	55.80	28.15	28.94
Hati bajore	13.00	100.60	15.00	31.23	32.68
Malagoti	12.86	167.26	45.20	20.93	36.70
Kuchra	15.60	100.60	15.20	28.67	36.48
Enghi	12.60	144.80	20.80	20.59	38.32
Kajol shail	12.40	91.60	21.20	29.27	29.34
Hogla	12.60	80.60	24.20	27.84	18.55
Jamai naru	16.80	112.20	19.26	25.52	35.93
Hari	14.60	153.80	39.60	21.64	42.25
Dakh shail	15.00	181.26	30.60	19.40	44.75
Moina moti	21.80	141.80	22.40	21.60	51.60
Marish shail	15.80	128.40	25.60	24.79	33.76
Patnai	12.20	143.20	19.20	27.11	47.72
Bhute shalot	14.40	95.00	33.60	28.14	36.83
Kute patnai	10.00	164.80	21.60	27.40	40.26
Mohini shalot	14.86	78.26	22.00	29.06	23.41
Moghai balam	12.60	148.20	20.20	26.32	36.99
Sada gotal	11.00	98.80	26.20	30.06	30.27
Khak shail	13.60	133.80	34.60	28.61	42.57
Mohime	13.00	109.20	25.60	28.44	29.95
Holde gotal	12.40	80.80	27.80	26.80	21.27
Jota balam	19.60	113.40	13.40	31.04	49.95
Tilek kuchi	11.00	128.25	25.25	24.58	28.63
Rani shalot	14.20	88.60	10.80	28.91	25.31
Kathi goccha	10.00	141.80	23.00	25.09	25.71
Bashful balam	12.00	117.20	55.20	23.76	28.80
Bazra muri	10.00	106.20	16.40	21.31	19.52
Durga bhog	14.20	118.40	36.00	21.12	24.20
Kumra ghor	11.40	59.60	13.60	25.05	17.03
Khainol	15.80	113.00	38.40	28.31	39.47
Ghunshi	9.40	63.50	13.25	17.84	10.20
Chinikani	13.80	151.00	16.80	12.35	15.67
Dhar shail	10.80	117.60	45.00	14.13	18.11
Khejur chori	15.00	93.00	19.60	27.49	29.16
Shaheb kachi	10.80	82.20	17.40	26.27	17.40
Raja shail	11.60	93.80	28.40	28.27	28.06
Hamai	12.20	99.20	43.60	27.92	30.27
Mura bajal	10.20	112.20	54.40	23.94	28.29
Lal gotal	11.60	91.40	20.00	27.80	23.73
Kalmilata	11.20	111.80	13.80	26.14	25.97
Volanath	10.40	111.36	53.00	24.76	27.85
Rupessor	15.00	90.60	12.80	25.44	29.20
Sylhet balam	12.40	160.60	37.60	21.17	31.47
Karengal	10.80	59.60	21.20	24.02	15.22
Kalo mota	10.00	84.80	24.40	24.80	12.75
Mota aman	14.60	89.86	8.40	31.93	34.65
Ghochi	14.40	179.60	16.40	21.22	21.90
Chap shail	10.80	97.40	22.00	28.72	27.98
Mondeshor	10.00	113.40	22.00	29.50	27.02
Nona kochi	11.40	89.80	14.00	28.50	28.14
Ghocca	11.60	60.60	20.80	24.64	17.18
Tal mugur	10.60	120.60	39.60	27.84	27.30
Ghigoj	13.60	116.20	18.80	27.17	32.41
Tor balam	13.00	81.80	38.20	27.65	26.11
Fulkainja	15.00	115.80	57.60	17.14	24.49
Piarjat	14.00	163.33	23.20	18.08	31.26
Koicha binni	13.00	144.80	85.40	16.95	23.39
Lal biroi	16.80	188.00	34.60	16.01	33.37

Genotypes	Number of effective tillers plant^{-1}	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	1000 seed weight (g)	Grain yield plant^{-1} (g)
Lalanamia	10.80	215.60	29.80	24.53	59.47
Golapi	17.60	201.20	25.40	19.81	58.74
Asam binni	13.60	171.00	14.80	24.51	48.50
Kakua binni	18.20	236.80	24.33	11.75	45.21
Nona bokhra	11.20	138.20	18.20	28.22	53.73
Jongli boro	12.60	96.80	14.80	18.36	16.38
Kashrail	10.00	101.60	37.40	27.36	25.39
Ledra binni	19.20	139.00	12.40	21.66	55.90
Nunnia	22.40	113.00	25.60	16.11	24.69
Rotisail	12.40	190.80	26.60	23.40	52.19
Genggeng binni	9.03	182.00	23.00	22.33	38.96
Chinisail	13.80	125.40	27.00	11.28	18.27
Jolkumri	11.40	158.00	12.20	22.71	35.10
Ponkhiraj	10.40	102.13	9.20	22.57	22.58
Mowbinni	10.20	162.66	36.20	25.18	42.92
Bogi	16.00	206.20	20.20	25.34	67.80
Kali boro	9.60	117.20	9.80	22.55	19.31
Binadhan-8	11.80	119.40	34.26	25.51	29.80
CV%	6.37	3.44	4.79	4.06	4.18
Minimum	9.03	59.60	8.40	11.28	10.20
Maximum	22.40	236.80	85.40	31.93	67.80
Mean	13.05	123.92	26.59	24.23	31.72
LSD (0.05)	1.34	6.87	2.06	1.58	2.14

3.2 ESTIMATION OF GENETIC PARAMETERS OF RICE LANDRACES

Genotypic variances, phenotypic variances, heritability, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), genetic advance and genetic advance in percentage of mean, GA (%) for all the quantitative characters are presented in Table 3.

3.2.1 VARIABILITY PARAMETERS

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Thus, the primary objective of germplasm conservation is to collect and preserve the genetic variability in indigenous collection of crop species to make it available to present and future generations. The results of analysis of genotypic and phenotypic variance are presented in Table 3. The phenotypic co-efficient of variation (PCV) were higher than genotypic co-efficient of variation (GCV) for all the characters studied indicating that they all interacted with the environment to some extent. Bhadru *et al.* [15] also mentioned the same result. The characters studied in the present investigation exhibited low, moderate and high PCV and GCV values. Among the characters, highest PCV and GCV values were recorded for number of unfilled grains panicle^{-1}, followed by grain yield plant^{-1} (g) and the lowest PCV and GCV values were recorded for days to maturity. Tiwari *et al.* [14] also observed the higher magnitude of PCV and GCV for grain yield plant^{-1}, number of fertile spikelets, effective tillers plant^{-1}, panicle length, and number of spikelets panicle^{-1}.

3.2.2 HERITABILITY

The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character. Heritability is classified as low (below 50%), medium (50-70%) and high (above 70%). All the characters studied in the present investigation expressed high heritability estimates ranging from 78.38% to 99.14%. Among the characters, highest heritability was recorded for number of unfilled grains panicle^{-1} followed by number of filled grains panicle^{-1} and panicle length (cm) recorded lowest heritability value (Table 3). High heritability values indicate that the characters under study are less influenced by environment in their expression. The plant breeder, therefore, may make his selection safely on the basis of phenotypic expression of these characters in the individual plant by adopting simple selection methods. High heritability indicates the scope of genetic improvement of these characters through selection. Patel *et al.* [16] observed highest heritability for days to 50% flowering, plant height, total tillers, panicle length, total number of spikelets panicle^{-1}, number of filled spikelets panicle^{-1}, number of unfilled spikelets panicle^{-1} and grain yield m^{-2}.

3.2.3 Genetic advance

The genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value. Genetic advance was highest for number of filled grains panicle^{-1} and lowest for panicle length (cm). The genetic advance as per cent of mean was highest in case of number of unfilled grains panicle^{-1}, while lowest recorded by panicle length (cm). The information on genetic variation, heritability and genetic advance helps to predict the genetic gain that could be obtained in later generations, if selection is made for improving the particular trait under study. In general, the characters that show high heritability with high genetic advance are controlled by additive gene action and can be improved through simple or progeny selection methods. Selection for the traits having high heritability coupled with high genetic advance is likely to accumulate more additive genes leading to further improvement of their performance. In the present study, high heritability along with high genetic advance was noticed for the traits, number of filled grains panicle^{-1} and number of unfilled grains panicle^{-1}. Other characters showed high heritability along with moderate or low genetic advance which can be improved by intermating superior genotypes of segregating population developed from combination breeding. Babu *et al.* [17] estimated highest genetic advance for number of filled grains panicle^{-1}.

Table 3. Estimation of genetic parameters of 76 rice genotypes based on different morphological traits related to yield

Characters	Phenotypic variance	Genotypic variance	PCV (%)	GCV (%)	Heritability (%)	GA	GA (%)
Plant height (cm)	237.69	207.01	10.94	10.21	87.09	27.66	19.63
Panicle length (cm)	5.02	3.94	8.76	7.75	78.38	3.62	14.14
Days to 50% Flowering	193.77	176.53	12.16	11.61	91.11	26.12	22.83
Days to maturity	194.54	160.54	9.07	8.24	82.53	23.71	15.42
Number of tillers plant^{-1}	8.42	7.77	21.08	20.25	92.26	5.52	40.07
Number of effective tillers plant^{-1}	8.18	7.49	21.93	20.98	91.56	5.40	41.35
Number of filled grains panicle^{-1}	1494.82	1476.68	31.20	31.01	98.79	78.68	63.49
Number of unfilled grains panicle^{-1}	188.76	187.14	51.66	51.44	99.14	28.06	105.51
1000 seed weight (g)	22.71	21.74	19.66	19.24	95.74	9.40	38.78
Grain yield plant^{-1} (g)	143.79	142.03	37.80	37.57	98.78	24.40	76.92

4 Conclusion

The results clearly showing that that there were significant variations for all the characters studied among the genotypes. Binadhan-8 was early maturing and Kuchra was late maturing. Among 76 rice genotypes for yield plant^{-1} Bogi yielded the highest while Ghunshi yielded the lowest yield plant^{-1}. The characters studied in the present investigation exhibited low, moderate and high PCV and GCV values. High heritability values indicate that the characters under study are less influenced by environment in their expression. The characters that show high heritability with high genetic advance are controlled by additive gene action and can be improved through simple or progeny selection methods and other characters can be improved by intermating superior genotypes of segregating population developed from combination breeding.

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