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VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN FINE RICE (*Oryza sativa* L.) AVAILABLE IN BANGLADESH

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ABSTRACT

A field experiment was conducted with 30 fine rice genotypes for morpho-physiogenic traits analysis. A remarkable variation in plant characters and yield performance was noticed among the fine rice. Ranjid gave the highest grain yield (4.32 t/ha) and Dudshor (4.18 t/ha) and Silkumul (4.16 t/ha) gave considerably higher yield. While Lalfota produced the minimum (2.40 t/ha) yield. Phenotypic variance against yield/ha (0.490) was higher than the corresponding genotypic variance (0.301). This indicated the existence of much influence of environment on the expression of the character. This character showed high genotypic (15.85) as well as phenotypic (20.23) co-efficient of variation associated with moderate heritability (62.42%). On the other hand, plant height, spikelets/panicle and sterility (%) were highly heritable. Lodging percentage was highly influenced by environment.

Key words: *Heritability, genetic advance, yield-related traits, fine rice*

INTRODUCTION

Bangladesh agriculture is predominantly rice based. It is fourth rice producing country in the world. In Bangladesh, rice is cultivated in 10.58 million hectares having the average yield of 2.58 metric tons ha^{-1}with the production of 27.32 million for the year 2006-2007 (HAS, 2007) which is very poor as compared to other advanced rice growing countries like South Korea, Spain, Australia, China and Japan where the average production is more than 5 t ha^{-1} (FAO, 1993). Rice occupies about 77% of total cropped areas and it alone constitutes about 92% of the total food grains produced annually in the country.

Rice is second most important grain crops after wheat in the world. Rice is the supreme among all food items. According to the report of International Rice Research Institute, in 2025, the global demand of rice will be 880 million tons which is 70 percent more than the presentproduction. But production is not increasing accordingly. in the years 2007-2008 dramatic world food price was arose, bringing a state of crisis to some of the poorest regions in the world. The global cost of imported rice has jumped at least 20 percent since 2006 to the highest level on record. This is the first time when the price of rice raises more than 500 \$ ton^{-1} in world market.The primitive cultivars which were selected and cultivated by the farmers for many generations are called land races. Land races have more genetic diversity, wider adaptability and high degree of resistance to biotic and abiotic stresses. In Bangladesh, there are thousands of local landraces of rice (Kaul *et al.*, 1983), many of which are either fine grain or aromatic types. However, HYVs cover only one-third of the whole rice cropping area (BBS, 1998) and this coverage is not likely to improve in the near future. Recently hybrid rice varieties may take the place of existing HYVs as because hybrid rice has about a 30 percent yield advantage over conventional pure line varieties (Yuan, 1998). However, the area given to cultivation of local rice varieties is not likely to change for some time, thus it is a vital issue to improve the varieties of local landraces, which cover two-thirds of the cropping area. The yield potential of local rice’s varies from 2.5 to 3.5 t/ha during the aman season (BBS, 1997). Although the nutritional quality, palatability, taste, cooking quality and consumer demand are higher for local rices than for HYV rices, the determining factors of the HYV rices for production are yield per unit area and farmers' profit. Nevertheless, the higher prices and export

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quality of local fine and aromatic rices warrant their higher production, hence the need to increase the yield of local varieties. It is necessary to improve the photosynthesis and assimilate partitioning of local varieties, and adoption of modern breeding techniques to improve their architectures. Varieties having fine seed size and scent or aroma add to the quality of rice, are used for delicious diet like polao, cake etc. Most of them are aman rice but there are some table rices which give pleasant aroma after cooking. Some of the boro rice fall in this group, eg. Pakistani Basmati & Nepali Basmati (Kaul *et al*., 1983).

The genetic improvement of crop plants in relation to various quality attributes is referred to quality breeding. Rice grain quality consists of several components: cooking texture, palatability, flavor, grain appearance, milling efficiency, and nutritional quality. Among these, the cooking, eating, and appearance qualities constitute important economic concerns that influence rice production in many rice-producing areas of the world. Rice grain appearance is mainly specified by grain shape as defined by grain length, width and the length–width ratio (LWR), and chalkiness of the endosperm (Zhang, 2007).

A plant breeding program can be divided into three stages, viz. building up a gene pool of variable germplasms, selection of individuals from the gene pool and utilization of selected individual to evolve a superior varieties (Kempthorne, 1957).The quantitative measurement of individual character provides the basis for an interpretation of analysis of variance. The available variability in a population can be partitioned into heritable and non heritable parts with the aid of genetic parameters such as genetic coefficient of variation, heritabilty and genetic advance (Miler *et al*., 1958). Little attention has been paid so far in Bangladesh to improve the yield status of fine rice varieties. The present work was taken with a view to study the following aspects:

a) To study the physiological and morphological characters of the fine rice genotypes.
b) To study the genetic variation of some important quantitative characters among the fine rice.
c) To find out the genetic parameters in the selected genotypes.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Department of Genetics and Plant Breeding, Hajee Mohammad Danesh Science and Technology University**,** Dinajpur during the period from June to December 2008 to study the morphophysiogenic traits in fine rice. The experimental plot was laid out in Randomized Complete Block Design with three replications. Each replication contained the plants of 30 genotypes having 20×15 cm spacing. Each plot was 2m in length and 1.5m in breadth. The genotypes were randomly distributed to each plot within the blocks. The land was prepared properly and agronomic practices were done when necessary
The following fertilizer and manure doses were applied in the field

Table 1. Fertilizer application information

Types of Fertilizer	Recommended dose ha^{-1}
Urea	150 kg
TSP	100 kg
MP	70 kg
Gypsum	60 kg

All of the fertilizers except urea were applied as basal dose at the time of final land preparation. Urea (150kg ha^{-1}) was applied in equal three splits. The first dose of urea was applied at 21 days after transplanting (DAT). The second dose of urea was added as top dressing at 45 days (active vegetative stage) after transplanting and third dose was applied at 60 days (panicle initiation stage) after transplanting recommended by BRRI.

Data on different yield and yield contributing characters were recorded on plot and plant basis at different dates as per experimental requirements. Data were recorded on the following crop characters-Leaf angle just below the flagleaf (degree), Plant height(cm), Panicle length(cm), Spikelets/panicle, Tillers/hill(at vegetative stage), Tillers/hill(at maturity stage), Effective tillers/hill, Days to first flowering, Days to maturity, 1000-grain weight(g), Yield/hill(g), Yield/ha(t), Sterility (%), Phenotypic acceptability and Lodging percentage.

Table 2. List of the fine rice used in the experiment with their respective Bengali name, English name and place of collection

Accession no.	English name	Place of collection
FR 1	Zirashail	Sadar, Dinajpur
FR 2	Najirshail	Sadar, Kurigram
FR 3	Lal Paijam	Birol, Dinajpur
FR 4	Kalosuru	Sadar, Dinajpur
FR 5	Sanla	Naogaon
FR 6	Ranjid	Fulbari, Dinajpur
FR 7	Chiconsarna	Naogaon
FR 8	Paijam	Fulbari, Dinajpur
FR 9	Shilkamal	Fulbari, Dinajpur
FR 10	Binnipakri	Chirirbondar, Dinajpur
FR 11	Shadakatari	Chirirbondar, Dinajpur
FR 12	Shitabhong	Barisal
FR 13	Zira	Birol, Dinajpur
FR 14	Boldar	Thakurgoan
FR 15	Lalfota	Khulna
FR 16	Darkashail	Natore
FR 17	Badshabhog	Chirirbandar, Dinajpur
FR 18	BRRI 34	BRRI, Joydebpur
FR 19	Dudshar	Rajshahi
FR 20	Begunbichi	Patuakhali
FR 21	Sumonsarna	Naogaon
FR 22	Moulata	Panchagarh
FR 23	Zetha katari	Birol, Dinajpur
FR 24	Lalchicon	Jossore
FR 25	Malshira	Fulbari, Dinajpur
FR 26	Chinigura	Kurigram
FR 27	Rajshahisharna	Thakurgoan
FR 28	Uknimodhu	Kurigram
FR 29	Motamota	Narail
FR 30	Katari	Sadar, Dinajpur

FR= Fine rice

The collected data were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done following Randomized Complete Block Design (RCBD) with the help of a computer package (MSTAT) and the mean differences among the varieties were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Estimation of genetic parameters -

Estimation of Genotypic and Phenotypic Variances

Genotypic and phenotypic variances are to be estimated according to the formulae given by Johnson *et al*. (1955).

Estimation of Genotypic and Phenotypic Coefficient of Variations

Genotypic and phenotypic co-efficient of variations are to be calculated according to the formulae given by Burton (1952) and Singh and Chaudhury (1985).

Estimation of heritability

Heritability in broad sense (h^2_b) is to be estimated following the formula of Johnson *et al.* (1955).

Estimation of genetic advance

Estimation of genetic advance is to be done following formula given by Johnson *et al.* (1955).

Estimation of genetic advance in percentage of mean, GA (%)

Genetic advance in percent of mean was calculated by the formula of Comstock and Robinson (1952) as follows:

Estimation of genotypic and phenotypic co-variances

Genotypic and phenotypic co-variances are to be calculated by using the formulae of Singh and Chaudhary (1985).

Estimation of genotypic and phenotypic correlation coefficients

The genotypic and phenotypic correlation coefficients between yield and its different contributing characters were estimated by the following formula (Johnson *et al.*, 1955).

Results and discussions

The performance of the genotypes for yield and different yield contributing characters were evaluated. It was observed that there were significant variations among the genotypes for all the characters studied. Different genotypes showed better performance for different characters (Table 3).

The highest leaf angle just below the flag leaf (degree) was observed in the genotype Uknimadhu (33.70) and the genotype Zira showed the lowest (14.70) followed by Chiconsarna (17.83), and Silkumul (17.83). Almost all the genotypes were tall, among them the tallest genotypes was Lalfota (151 cm) and Rajshahi saran (115 cm) was short statured (Table 4a).

The variation in panicle length was not very high. The genotype BR-34 had the highest panicle length (32.90 cm) and lowest was in Zira (20.20 cm). Incase of number of spikelets/panicle, the range was high (121.0-186.0). The genotype Ranjid (186) showed higher number of spikelets/panicle and the lowest was in Lalfota (121). The genotypes Binnipakri (79 d), Begunbichi (81.67 d) were the earliest in flowering whereas Bolder (105 d), Badshabhog (103.3 d) were late flowering types. Early maturing genotype was Binnipakri (112.7 d) whereas Boldar (140 d) appeared as late maturing genotype. Motasota (30.72 g) exhibited the maximum 1000 grain weight whereas Chinigura showed the minimum (10.03 g) (Table 4b).

Table 3. Mean squares (MS) derived from RCBD 1 Factor model on morphophysiogenic characters in fine rice

Character	Source of variation with mean sum square			
	Replication (2 d.f.)	genotypes (29 d.f.)	Error (58 d.f.)	Co-efficient of variation (%)
Leaf angle just below the flag leaf (degree)	1.918	79.008**	3.746	7.99
Plant height (cm)	0.755	436.237**	0.365	0.46
Panicle length (cm)	0.097	33.101**	0.264	1.95
Spikelets/panicle	0744	779.551**	1.147	0.72
Tillers/hill(at vegetative stage)	0.336	11.583**	0.193	2.39
Tillers/hill(at maturity stage)	0.369	20.611**	0.347	4.29
Days to first flowering (d)	o.144	152.389**	0.570	0.83
Days to maturity (d)	1.944	169.059**	2.324	1.21
1000-grain weight (g)	0.027	76.468**	0.020	0.81
Yield/hill(g)	0.87	6.204**	0.93	10.08
Yield/ha(t)	0.189	1.429**	0.398	10.11
Effective tillers/hill	0.081	20.852**	0.291	5.06
Sterility (%)	0.008	61.229**	0.062	1.84
Phenotypic acceptability	0.000	10.497**	0.000	0.00
Lodging percentage	555.278	878.352**	163.611	65.78

** indicates significant at 1% level of probability

The highest yield/ha was observed in the genotype Ranjid (4.32 t/ha) followed by Dudshor (4.18 t/ha) and Silkumul (4.16 t/ha) (Table 4b). The highest number of effective tillers/hill was produced by Ranjid (15.97) and Lalfota (5.9) showed the lowest (Table 4c). Highest Lodging percentage was observed in Lalfota (63.33) and no lodging in Ranjid and Silkumul. Sterility percentage (%) was maximum in Lalchicon (23.29%). Dairkashail, Silkumul, Ranjid, BR-34 showed excellent phenotypic acceptability and Zatha katari, Begunbichi showed the poor appearance (Table 4c).

Table 4a: Mean performance of morphophysiogenic characters in fine rice

Accession No.	Variety	Leaf angle just below the flag leaf (degree)	Plant height (cm)	Panicle length (cm)	Spikelets / panicle (no.)	Tillers/ hill (at vegetative stage)	Tillers/ hill (at maturity stage)
FR1	Zirashail	28.50 bd	117.3 m	25.07 kl	141.0 l	19.53 de	14.80 c-f
FR2	Najirshail	19.03 gh	141.0 f	22.80 o	145.7 k	20.43 bc	15.40 cd
FR3	Lal payjam	21.37 fh	148.3 b	31.83 b	151.0 i	18.33 fg	13.03 h
FR4	Kalosuru	18.90 gh	134.9 gh	26.17 j	134.0 n	17.20 i-l	10.60 j-l
FR5	Sanla	31.20 ab	132.2 i	28.50 ef	153.7 h	19.70 c-e	13.50 gh
FR6	Ranjid	27.00 cd	115.1 n	24.33 lm	186.0 a	19.30 de	15.60 cd
FR7	Chiconsarna	17.83 hi	122.2 k	26.33 ij	161.0 f	17.37 h-k	10.73 i-l
FR8	Payjam	26.77 cd	142.7 e	28.57 ef	138.0 m	16.43 l	11.73 i
FR9	Silkumul	17.83 hi	131.5 i	23.97 n	181.0 b	18.17 gh	15.77 cd
FR10	Binnipakri	31.37 ab	149.0 b	30.70 c	151.3 i	15.30 m	13.20 gh
FR11	Sadakatari	23.03 ef	115.7 n	29.37 de	142.7 l	20.70 b	11.60 i-k
FR12	Shitabhog	28.53 bd	121.6 k	23.20 no	147.0 jk	19.03 ef	15.30 c-e
FR13	Zira	14.70 i	131.9 i	20.20 r	167.0 d	17.43 h-j	13.50 gh
FR14	Boldar	27.93 bd	141.7 ef	32.30 ab	138.0 m	14.00 n	8.700 m
FR15	Lalfota	22.87 ef	151.0 a	24.73 lm	121.0 r	17.77 g-i	15.80 c
FR16	Dairkashail	29.60 bc	148.9 b	27.20 gi	131.7 0	16.80 j-l	11.83 i
FR17	Badshabhog	25.80 de	134.9 gh	24.33 lm	129.0 p	19.33 de	14.67 d-f
FR18	BR-34	19.67 fh	125.4 j	32.90 a	142.0 l	19.70 c-e	11.60 i-k
FR19	Dudshor	20.90 fh	118.2 m	22.57 op	156.0 g	21.00 b	18.87 a
FR20	Begunbichi	19.90 fh	149.1 b	26.17 j	141.0 l	16.60 kl	10.53 kl
FR21	Sumonsarna	31.20 ab	115.3 n	21.83 pq	163.0 e	19.93 cd	14.77 c-f
FR22	Maulata	19.47 fh	124.7 j	27.30 gh	148.7 j	19.47 de	17.97 ab
FR23	Zatha katari	18.77 gh	146.1 c	24.10 m	150.7 i	17.07 i-l	11.67 ij
FR24	Lalchicon	22.33 fg	119.9 l	21.47 q	146.7 k	18.13 gh	15.20 c-e
FR25	Malshira	28.50 bd	135.8 g	26.57 hj	163.0 e	19.23 de	14.23e-g
FR26	Chinigura	28.00 bd	144.6 d	29.90 cd	125.0 q	21.13 b	17.37 b
FR27	Raj sarna	18.20 h	115.0 n	25.17 kl	157.0 g	19.37 de	13.83 f-h
FR28	Uknimadhu	33.70 a	124.7 j	28.00 fg	126.0 q	22.27 a	18.53 a
FR29	Motasota	26.53 cd	135.8 g	25.67 jk	173.0 c	14.33 n	10.00 l
FR30	Katari	27.33 cd	134.3 h	29.97 cd	165.3 d	17.63 g-i	11.30 i-k
	LSD	3.163	0.9874	0.8398	1.750	0.7180	0.9628
	Mean	24.23	132.33	26.37	149.211	18.42	13.721
	Range	14.70-33.70	115-151	20.20-32.90	121.0-186.0	14-22.27	8.7-18.87

Table 4b. Mean performance of morphophysiogenic characters in fine rice

Acce-ssion No.	Variety	Days to 1st Flowering (d)	Days to maturity(d)	1000-grain weight (g)	Yield/ hill (g)	Yield/ ha(t)
FR1	Zirashail	90.67 hi	129.0 d-f	19.67 e	8.46 a-d	3.80 a-d
FR2	Najirshail	84.67 mn	120.0 l-n	21.45 d	5.39 g	2.40 f
FR3	Lal payjam	87.00 kl	117.3 no	16.32 j	8.76 a-d	3.86 a-d
FR4	Kalosuru	90.00 ij	125.0 h-j	13.26 o	5.66 fg	2.50 f
FR5	Sanla	84.67 mn	121.0 k-m	10.80 q	7.66 b-e	3.38 b-e
FR6	Ranjid	87.67 k	126.0 g-i	18.17 gh	9.83 a	4.32 a
FR7	Chiconsarna	89.00 j	125.0 h-j	18.28 g	6.90 d-g	3.03 d-f
FR8	Payjam	85.33 m	119.0 mn	16.01 k	9.36 ab	4.12 ab
FR9	Silkumul	90.33 h-j	121.3 k-m	21.42 d	9.46 ab	4.16 ab
FR10	Binnipakri	79.00 p	112.7 q	18.13 gh	8.76 a-d	3.86 a-d
FR11	Sadakatari	92.33 g	126.7 f-h	13.91 n	8.66 a-d	3.81 a-d
FR12	Shitabhog	91.00 hi	123.0 jk	19.67 e	9.40 ab	4.14 ab
FR13	Zira	100.3 d	130.3 d	11.74 p	7.76 b-e	3.42 b-e
FR14	Boldar	105.0 a	140.0 a	10.52 r	7.30 c-f	3.20 c-f
FR15	Lalfota	83.33 n	114.0 pq	21.62 d	5.39 g	2.40 f
FR16	Dairkashail	90.00 ij	121.0 k-m	25.32 b	7.03 d-g	3.12 d-f
FR17	Badshabhog	103.3 b	139.7 a	17.15 i	7.76 b-e	3.42 b-e
FR18	BR-34	83.67 n	121.7 k-m	11.91 p	9.30 ab	4.09 ab
FR19	Dudshor	97.67 e	128.3 d-g	18.17 gh	9.50 ab	4.18 ab
FR20	Begunbichi	81.67 o	115.7 op	10.32 r	7.76 b-e	3.42 b-e
FR21	Sumonsarna	87.67 k	122.0 kl	18.03 h	6.40 e-g	2.83 ef
FR22	Maulata	102.3 bc	133.7 c	25.51 b	9.16 a-c	4.03 a-c
FR23	Zatha katari	86.00 lm	123.3 i-k	14.24 m	6.03 e-g	2.66 ef
FR24	Lalchicon	100.0 d	136.3 b	24.39 c	7.00 d-g	3.10 d-f
FR25	Malshira	100.7 d	136.0 bc	19.15 f	9.43 ab	4.15 ab
FR26	Chinigura	91.67 gh	123.7 i-k	10.03 s	6.16 e-g	2.72 ef
FR27	Raj sarna	102.0 c	139.7 a	19.28 f	7.76 b-e	3.42 b-e
FR28	Uknimadhu	85.33 m	120.0 l-n	15.34l	7.66 b-e	3.38 b-e
FR29	Motasota	94.33 f	127.3 e-h	30.72 a	9.26 ab	4.07 ab
FR30	Katari	90.67 hi	129.7 de	14.15 m	6.26 e-g	2.74 ef
	LSD	1.234	2.492	0.231	1.590	0.7105
	Mean	91.244	125.61	17.49	7.84	3.46
	Range	79.00-105.0	112.7-140	10.03-30.72	5.39-9.83	2.40-4.32

Analysis of variance showed significant variation among the genotypes in respect of all the characters under study. This indicated that there were significant differences among the genotypes for all these characters studied.

Analysis of variance for the character leaf angle just below the flagleaf, the phenotypic variance (28.83) appeared to be slightly higher than genotypic variance (25.08) (Table 5). The phenotypic and genotypic variances for plant height were high, 145.65 cm and 145.20 cm respectively. The phenotypic variance appeared to be higher than genotypic variance, suggested considerable influence of environment on the expression of the genes controlling this trait. Here environmental variance was 0.365. For the character panicle length, the phenotypic variance (11.20) appeared to be slightly higher than genotypic variance (10.94). Spikelets per panicle showed very high phenotypic (259.46) and genotypic (260.615) variance. The considerable difference between genotypic and phenotypic variance indicating effect of environment for the expression of the trait. At vegetative and maturity stage, the phenotypic variance was higher than genotypic variance as

Table 4c. Mean performance of morphophysiogenic characters in fine rice

Accession No.	Variety	Effective tillers/hill	Lodging percentage	Sterility (%)	Phenotypic acceptability
FR1	Zirashail	10.37 h-k	3.333 ef	20.38 b	5.000 b
FR2	Najirshail	10.43 g-j	16.67 c-f	14.76 g	3.000 c
FR3	Lal payjam	10.73 f-i	36.67 bc	15.91 f	5.000 b
FR4	Kalosuru	8.800 l-o	30.00 cd	10.49 l	3.000 c
FR5	Sanla	11.80 de	20.00 c-f	13.40 i	3.000 c
FR6	Ranjid	15.97 a	0.0000 f	9.812 m	1.000 d
FR7	Chiconsarna	8.667 m-o	10.00 d-f	9.703 m	3.000 c
FR8	Payjam	9.067 l-n	23.33 c-f	7.127 p	5.000 b
FR9	Silkumul	15.70 ab	0.0000 f	6.343 q	1.000 d
FR10	Binnipakri	7.333 pq	56.67 ab	14.38 gh	7.000 a
FR11	Sadakatari	7.900 op	40.00 bc	8.977 n	5.000 b
FR12	Shitabhog	13.63 c	3.333 ef	16.56 e	3.000 c
FR13	Zira	9.767 i-l	28.33 c-e	12.66 j	5.000 b
FR14	Boldar	11.87 de	23.33 c-f	16.63 e	3.000 c
FR15	Lalfota	5.900 r	63.33 a	17.92 d	7.000 a
FR16	Dairkashail	9.700 j-l	10.00 d-f	15.74 f	1.000 d
FR17	Badshabhog	11.40 e-g	16.67 c-f	14.33 h	5.000 b
FR18	BR-34	15.23 ab	1.667 f	10.00 m	1.000 d
FR19	Dudshor	14.93 b	3.333 ef	6.713 q	3.000 c
FR20	Begunbichi	6.833 q	56.67 ab	12.05 k	7.000 a
FR21	Sumonsarna	12.57 d	15.00 c-f	19.38 c	3.000 c
FR22	Maulata	11.00 e-h	18.33 c-f	10.87 l	5.000 b
FR23	Zatha katari	8.433 no	20.00 c-f	17.94 d	7.000 a
FR24	Lalchicon	11.60 ef	6.667 d-f	23.29 a	1.000 d
FR25	Malshira	10.70 f-i	23.33 c-f	15.86 f	3.000 c
FR26	Chinigura	9.433 k-m	6.667 d-f	19.04 c	5.000 b
FR27	Raj sarna	11.20 e-h	23.33 c-f	17.98 d	5.000 b
FR28	Uknimadhu	12.67 d	16.67 c-f	7.672 o	3.000 c
FR29	Motasota	8.067 op	3.333 ef	7.675 o	5.000 b
FR30	Katari	8.067 op	6.667 d-f	12.86 j	3.000 c
	LSD	0.8817	20.91	0.4070	0.01634
	Mean	10.658	19.44	13.55	3.867
	Range	5.9-15.97	0-63.33	6.343-23.29	1.000-7.000

presented in. This feature indicated higher influence of environment on the expression of the trait and genetic factors had low expressivity on the number of tillers/hill. For the character days to first flowering, the phenotypic variance (51.18) was much higher than genotypic variance (50.60) and for days to maturity, the genotypic variance and phenotypic variance were 55.58 to 57.90, respectively. The values were high and the phenotypic variance was far to its corresponding genotypic variance. The genotypic variance (25.48) and phenotypic variance (25.50) were almost same indicating least environmental effect for the expression of the character 1000-grain weight.
The components of variance for grain yield/ha showed considerable phenotypic variance (0.490) in comparison to genotypic variance (0.301) indicating the influence of environment to a great extent for this trait. The components of variation for spikelet sterility (%) showed considerable phenotypic variation (20.45) in comparison to genotypic variation (20.38) indicating the influence of environment to a great extent for this trait. Phenotypic acceptability showed the phenotypic variance (3.499) was similar to genotypic variance (3.499).

Variability and Genetic parameters

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are also presented in Table 5. Phenotypic coefficient of variation (PCV) for all the characters was higher

Table 5. Variabilities in 15 characters of fine rice

Characters	Genotypic variance (σ^2g)	Phenotypic variance (σ^2p)	Environmental variance (σ^2e)	GCV%	PCV%
Leaf angle just below the flag leaf (degree)	25.08	28.83	3.746	20.67	22.15
Plant height (cm)	145.20	145.65	0.365	9.106	9.120
Panicle length (cm)	10.94	11.20	0.264	12.54	12.68
Spikelets/panicle	259.46	260.615	1.147	10.78	10.819
Tillers/hill(at vegetative stage)	3.796	3.989	0.193	10.57	10.84
Tillers/hill(at maturity stage)	6.754	7.10	0.347	18.94	19.42
Days to 1st flowering (d)	50.60	51.18	0.570	0.077	0.078
Days to maturity (d)	55.578	57.90	2.324	5.935	6.05
1000-grain weight (g)	25.48	25.50	0.020	28.86	28.87
Yield/hill(g)	1.593	2.540	0.947	16.07	20.31
Yield/ha (t)	0.301	0.490	0.189	15.85	20.23
Effective tillers/hill	6.853	7.144	0.291	24.5	25.078
Sterility (%)	20.38	20.45	0.062	33.32	33.37
Phenotypic acceptability	3.499	3.499	0.000	0.48	0.48
Lodging percentage	238.25	401.86	163.611	79.399	103.12

than genotypic coefficient of variation (GCV).The minimum difference between PCV (22.15) and GCV (20.67) revealed less influence of environment on the expression of the character. High genotypic and phenotypic coefficients of variation were observed for number of effective tillers/hill, 1000-grain weight, yield/hill, yield/ha(t), sterility (%) and lodging percentage. Days to 1st flowering, days to maturity, plant height, panicle length, spiketets/panicle, phenotypic acceptability showed poor genotypic and phenotypic coefficient of variation. For grain yield/ha, the PCV (20.23) and GCV (15.85) were high and PCV was higher than GCV. Reddy and Kumar (1996) reported higher PCV than GCV for grain yield/plant, whereas Choudhury and Das (1997) reported higher values of PCV and GCV.

Heritability and Genetic advance

Heritability study showed that most of the characters had high heritability. In comparison to others, phenotypic acceptability (100%), 1000-grain weight (99.92%), plant height (99.69%), spiketets/panicle (99.55%), showed high heritability (Table 6). Estimates of genetic advance as percent of mean was high for the character phenotypic acceptability (99.65), 1000-grain weight (59.43) and effective tillers/hill (49.55) (Table 6).

Incase of heritability estimation of the character yield/ha showed moderate heritability (61.42%) with genetic advance as percent of mean (25.43) and low genetic advance (0.88). These findings showed agreement with that of Kumar *et al*. (1998) and Shanthakumar *et al.* (1998). Phenotypic acceptability had highest heritability (100) and genetic advance as percent of mean whereas lodging percentage had lowest heritability (59.28) but highest genetic advance as percent of mean. Spikelets/panicle showed high heritability (99.55) with genetic advance (33.10) and genetic advance as percent of mean (22.18) were reported for number of spikelets/panicle that confirmed the findings of Choudhury and Das (1998) and Iftekharuddaula *et al*., (2001).

Table 6. Variabilities in 15 characters of fine rice (Heritability and genetic advance)

Characters	Heritability (%)	Genetic advance (at 5% selection intensity)	Genetic advance (as % of mean)
Leaf angle just below the flag leaf (degree)	87.00	9.623	39.72
Plant height (cm)	99.69	24.78	18.73
Panicle length (cm)	97.67	6.733	25.53
Spikelets/panicle	99.55	33.10	22.18
Tillers/hill(at vegetative stage)	95.16	3.92	21.25
Tillers/hill(at maturity stage)	95.13	5.22	38.05
Days to 1st flowering (d)	98.86	14.57	15.97
Days to maturity (d)	95.98	15.05	11.98
1000-grain weight(g)	99.92	10.39	59.43
Yield/hill(g)	62.71	2.05	26.24
Yield/ha(t)	62.42	0.88	25.43
Effective tillers/hill	95.93	5.28	49.55
Sterility (%)	99.69	9.28	68.54
Phenotypic acceptability	100	3.85	99.65
Lodging percentage	59.28	24.48	125.93

CONCLUSION

A total of fifteen characters were considered to assess the source of variation against thirty genotypes. The genotypes differentially responded and Ranjit was the highest yield potential (4.32 t/ha). Ranjit and Silkamal showed zero lodging. In general, heritability was not analogous to genetic variance due to the effect of environment over the expression of the characters. Better response to selection could be achieved for the characters except yield/hill, yield/ha and lodging percentage. Through the heritability of lodging percentage was not appreciable yet it could not create maximum load while measured as genetic advance as % of mean (125.93). The thirty genotypes exerted a comprehensive phenotypic acceptability from vegetative phase to reproductive phase. The yield potential of the genotypes were influenced by the most of the selected characters.

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