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Studies on variability, heritability, genetic advance and path analysis in some indigenous *Aman r*ice (*Oryza sativa* L.)

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ABSTRACT

A wide range of variability was observed for nineteen quantitative characters in 26 indigenous aman rice cultivars. Five genotypes viz., Sabita, Kamini, Kumorogor, Sadakamisoru and Narkelchari were superior in grain yield per plant and grain L/B ratio simultaneously. The magnitude of PCV was higher than the corresponding GCV for all the characters. High heritability was observed days to 50 per cent flowering, plant height, 1000 grain weight, panicle length, florets number per panicle, kernel length and kernel L/B ratio. Number of grains per panicle recorded the highest genetic advance followed by floret number per panicle, plant height and number of secondary branches. High heritability in conjunction with high genetic advance was registered for plant height, days to 50 per cent flowering and number of secondary branches. High heritability with low genetic advance was observed for panicle length, panicle weight, kernel length and kernel L/B ratio. Grain yield per plant was significantly correlated with number of secondary branches per panicle at phenotypic lavel while panicle weight, florets number per panicle, number of grains per panicle and fertility percentage at genotypic and phenotypic level. The florets number per panicle imparted the highest positive direct effect on grain yield per plant.

***Keywords*:** Correlation coefficient, genetic advance, heritability, indigenous and path coefficient.

The variability in the breeding material is extremely important in the selection of superior type plant, where selection is based not only on yield but also on its component traits. Such information on segregating population, where selection is actually practiced, will be more meaningful and of immediate practical utility. Moreover, most of the yield component traits are quantitative in nature and the variability present in them is both heritable and non-heritable.Rice being an important crop throughout the world and to increase its production a study of association of yield and its component characters *viz.* plant height, number of panicle per plant, panicle weight, panicle length, florets number per panicle, fertility %, number of grain per panicle, 1000 grain weight etc. is important and is also essential fundamental task before making any successful breeding programme. The yield component does not act independently. In general, they are interrelated with each other that ultimately bring about the grain yield in rice. Therefore, an analysis of direct and indirect contribution of each component character is necessary to plan any effective breeding programme.

MATERIALS AND METHODS

The experiment was conducted at Balindi Research Farm, Bidhan Chandra Krishi Vishwavidyalaya, Balindi, Nadia, West Bengal, during *Kharif,* 2012. The experiment was laid out in Randomized Block Design with two replications. The materials consisted 26 genotypes of indigenous *aman* rice. Single seedling per hill was transplanted with a spacing of 20 × 15 cm in 4 × 3 m plot. The recommended packages of practices were followed to obtain a good harvest. The observation on 19 characters *viz*., days to 50 per cent flowering, days to maturity, plant height, panicle weight, number of panicle per plant, panicle length, number of primary branches per panicle, number of secondary branches per panicle, number of grains per panicle, number of florets per panicle, fertility per cent, 1000 grain weight, grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant were recorded on five randomly selected plants from each replication. The data were used for statistical analysis following appropriate computer based statistical software (Genres).

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RESULTS AND DISCUSSION

The mean performances of indigenous *aman* rice for 19 characters are presented in table-1. The mean data showed that days to 50 per cent flowering ranged from 96 days in genotype Latisal to 123 days in Khejurchari with a grand mean of 112.5 days. Days to maturity varied from 134 to 154 days. Khejurchari had the longest maturity duration and Harmanona was the earliest in this regard followed by genotype Narkelchari and Nonaketum. Plant height varied from 77 to 163.5cm with a grand mean of 135.14 cm. The tallest genotype was Kanakchur followed by Lalkaminisal and Dadsal while the shortest genotype being Mashuri. Number of panicles per plant ranged from 5.5 to 11. It was observed that genotype Niko (11) registered the highest number of panicles per plant followed by Marshal (10.75) and Geri (10.50) respectively. The lowest number of panicles per plant was observed in Asammota (5.5). The range for panicle weight was varied from 1.32 to 5.32g with a grand mean of 2.48g. The maximum panicle weight was observed in Sabita (5.32g) followed by genotype Kamini (4.30g) while the minimum value for panicle weight was observed in Solerpona (1.32g). Genotype Latisal registered the maximum panicle length (31.16 cm) followed by Kamimi (30.64 cm). The minimum panicle length was observed in Ghiyus (18 cm) followed by Narkelchari (20.89). The genotype Ghiyus (6.20) possessed the minimum number of primary branches and the genotype Sadakamisoru (14.10) possessed the maximum number of primary branches followed by the genotype Kanakchur (11.90) and Sadamota (11.80). The number of secondary branches varied from 15.65 to 59.00 with an overall mean value of 30.92. The maximum number of secondary branches was observed in line Kamimi (59.00) followed by Kanakchur (45.00) while the minimum value was observed in genotype Ghiyus (15.65) followed by Lalgetu(19.10) in this regard. Florets number per panicle ranged from81.50 to 270. The highest florets number per panicle was observed in Kamini (270) followed by Kanakchur (200) while the lowest florets number per panicle was observed in genotype Lalgetu (81.50) followed by Hamai (89). The number of grains per panicle varied from 47.0 to 251.0. Kamini (251) was found to possess the highest number of grains per panicle while the genotype Lalgetu (47) had the lowest number of grains per panicle.

The grain L/B ratio varied from 1.58 to 3.98 with a mean of 2.94. Moniakundu registered maximum grain L/B ratio (3.98) while the minimum grain L/B ratio (1.58) was found in Chinikamini. The range for kernel length was found to be 2.05 to8.07 mm. The maximum kernel length was observed in Sabita (8.07 mm) followed by Asammota (7.64 mm) while the minimum kernel length was observed in Chinikamini (2.05 mm). Kumorogor showed maximum kernel breadth (2.78 mm) followed by Marsal (2.74 cm) and the minimum kernel breadth was observed in Lalkaminisal (1.41mm) followed by Moniakundu. The range for kernel L/B ratio was 1.21 to 3.86. Solerpona (3.86) possessed highest kernel L/B ratio followed by line Geri (3.59). Chinikamini (1.21) recorded the lowest kernel L/B. Grain yield per plant showed highest amount of variability (CV 20.956) with a mean of 16.41 g. Sabita registered the maximum grain yield per plant (28.38g) followed by Kamini (26.22g) while Solerpona recorded the minimum (7.43g) grain yield per plant.

Estimates of different genetic parameters for 19 different characters have been presented in table 2. The analysis of variance revealed highly significant differences for all the characters, indicating the presence of high genetic variability in the tested genotypes. The estimates of genotypic coefficient of variation ranged from 2.83 per cent in days to maturity to 32.72 percent in number of grains panicle^{-1}, whereas for phenotypic coefficient of variation it was 3.96 percent in days to maturity to 35.64 per cent in number of grains panicle^{-1}. The high estimates of GCV and PCV were obtained for number of grains per panicle, panicle weight, florets number per panicle, number of secondary branches, grain yield per plant, kernel L/B ratio and 1000 grain weight. In this regards, Sawant *et al.* (1994) reported high GCV and PCV for grains per panicle, plant height, 1000 grain weight and grain yield per plant; Singh and Choudhary (1996) for number of panicle per plant, number of grains per panicle, grain yield per plant and 1000 grain weight; Nayak *et al.* (2002) for number of panicle per plant, number of spikelet per panicle, number of grains per panicle and grain yield per plant; Sarkar *et al*. (2005) for number of panicle per plant, number of tiller per plant and grain yield per plant; Raut *et al.* (2009) for seed yield per plant, 1000 grain weight, grains per panicle and effective tiller per plant; Karthikeyan *et al.* (2009) for straw yield per plant, grain yield per plant, total biological yield per plant, number of fertile florets per panicle and number of branches per panicle; Anjaneyulu *et al*. (2010) for number of grain per panicle, fertility per cent and grain yield per plant and Kumar and Senapati (2013) for grain yield per plant, panicle weight, number of panicles per plant, number of secondary branches per panicle, number of grains per panicle, 1000 grain weight and florets number per panicle.High heritability was observed for days to 50 percent flowering, plant height, 1000 grain weight, panicle length, florets number per panicle, kernel length, kernel L/B ratio, number of secondary branches per panicle, panicle weight and number of grains per panicle. The similar results were earlier reported by Bihari et*al.* (2004) for days to 50 per cent flowering and test weight; Sankar *et al*. (2006) for days to 50 per cent flowering, plant height, panicle length, grains per panicle and test weight and Karthikeyan *et al.* (2009) for days to 50 per cent flowering, 1000 grain weight. Other characters like grain length, grain L/B ratio, grain breadth, number of primary branches, grain yield per plant, number of panicle per plant, days to maturity and grain breath were observed to possess low heritability. The grain length had the lowest

Table 1: Mean performance of different characters of some indigenous *Aman* rice (*Oryza sativa* L.)

Genotypes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Kanakchur	104.00	143.50	163.50	8.50	2.17	27.35	11.90	45.20	200.00	185.00	92.47	11.86	5.15	2.10	2.45	4.92	1.62	3.10	14.74
Narkelchari	114.00	138.00	144.50	8.00	3.29	20.89	11.20	35.50	152.50	125.50	81.90	21.75	8.72	2.78	3.14	6.77	2.50	2.72	20.99
Kumorogor	112.50	149.50	135.50	10.25	2.68	25.25	9.10	26.90	137.00	116.00	84.50	18.92	6.82	2.96	2.30	5.40	2.78	1.94	22.13
Khejurchari	123.00	154.00	154.25	9.00	2.01	22.99	9.30	23.70	100.00	83.00	82.93	24.56	8.49	2.62	3.27	4.76	1.53	3.11	14.52
Kamini	113.50	145.00	134.25	7.60	4.30	30.64	11.00	59.00	270.00	251.00	92.87	7.94	6.44	2.60	2.48	5.01	2.37	2.10	26.22
Solerpona	122.50	151.50	122.85	7.00	1.32	23.59	10.30	23.30	133.00	109.00	82.13	16.31	9.40	2.38	3.93	6.48	1.67	3.86	7.43
Harmanona	114.00	134.00	137.75	8.25	2.94	27.65	9.80	33.10	127.50	85.00	66.93	21.46	9.49	2.71	3.56	5.96	1.67	3.57	19.49
Lalgetu	113.50	146.00	97.37	9.00	1.40	27.20	8.20	19.10	81.50	47.00	57.23	21.59	7.93	3.02	2.70	6.29	2.17	3.02	9.94
Chinikamini	105.00	142.00	149.25	7.00	2.19	21.67	10.30	29.80	131.00	100.50	77.54	18.44	2.90	1.81	1.58	2.05	1.70	1.21	12.17
Masuri	113.00	145.50	77.00	6.00	2.45	23.92	9.90	25.80	96.00	69.00	71.17	20.33	8.01	2.27	3.51	6.17	2.06	2.98	11.83
Laikaminisal	106.00	143.00	159.00	6.75	2.39	21.62	7..80	28.50	119.00	62.25	52.07	8.21	5.03	2.21	2.27	4.25	1.41	3.02	13.00
Nonaketum	113.50	138.50	117.75	7.50	2.30	21.25	10.10	41.60	106.40	75.50	69.75	14.09	6.10	2.21	2.76	4.99	1.59	3.14	13.81
Latisal	96.00	151.00	98.00	6.50	2.79	31.16	9.90	41.90	200.00	173.00	86.47	21.36	8.12	2.47	3.06	6.87	2.25	3.05	14.64
Moniakundu	116.50	141.50	115.00	7.75	3.07	22.56	11.40	41.40	164.40	132.00	80.51	18.05	6.57	1.63	3.98	3.06	1.50	2.04	19.13
Ghiyus	114.50	146.00	145.50	9.75	1.75	18.00	6.20	15.65	91.50	57.90	63.69	27.20	5.71	1.93	2.95	4.09	1.52	2.64	13.54
Hamai	117.00	148.50	147.50	8.50	1.99	25.83	10.20	28.00	89.00	62.60	70.48	19.60	7.58	2.84	2.64	6.50	2.67	2.43	13.47
Bahurupi	109.50	141.00	128.50	8.00	2.08	24.84	9.20	36.90	141.00	113.00	79.32	19.60	7.18	2.75	2.59	6.00	2.15	2.80	13.41
Anasphal	110.00	142.50	136.50	8.00	2.51	23.06	11.00	33.00	104.50	89.50	85.65	23.08	9.19	2.60	3.52	6.10	1.83	3.33	16.43
Asammota	113.50	140.50	136.50	5.50	2.51	27.15	9.60	20.20	124.00	77.50	63.09	27.36	9.59	2.80	3.42	7.64	2.73	2.81	11.06
sabita	112.00	147.50	128.00	6.70	5.32	24.49	9.60	29.40	130.00	113.50	87.27	27.13	9.98	2.65	2.76	8.07	1.99	2.26	28.38
Sadamota	114.50	149.50	144.75	9.75	2.26	22.26	11.80	27.90	125.50	84.00	68.30	19.63	8.91	2.79	3.18	4.86	1.52	3.20	17.68
Dadsal	110.50	146.50	157.00	10.75	2.39	24.96	10.40	36.00	116.50	91.00	77.89	18.17	7.39	2.72	2.70	5.89	2.24	2.63	20.51
Niko	117.50	153.50	142.00	11.00	1.98	25.98	7.90	20.70	98.00	87.50	89.72	26.28	7.25	2.85	2.53	6.08	2.61	2.33	17.36
Marsal	116.00	146.00	144.50	10.75	1.80	25.44	9.20	20.60	111.50	72.50	64.76	19.44	6.61	2.85	2.31	5.34	2.74	1.94	15.62
Geri	112.50	151.50	153.50	10.50	2.12	26.41	10.60	24.90	110.00	100.00	90.49	23.15	6.18	2.47	2.49	5.48	1.52	3.59	18.05
Sadakamisoru	112.00	142.00	143.50	10.25	2.57	24.18	14.10	36.00	125.00	103.00	82.40	21.87	8.63	2.58	3.33	5.72	1.73	3.30	21.10
Mean	**112.55**	**145.30**	**135.14**	**8.40**	**2.48**	**24.63**	**10.00**	**30.92**	**130.18**	**102.52**	**76.98**	**19.88**	**7.44**	**2.52**	**2.94**	**5.57**	**2.06**	**2.85**	**16.41**
LSD (0.05)	**1.57**	**8.31**	**9.23**	**2.42**	**0.68**	**1.71**	**2.07**	**7.85**	**38.61**	**41.42**	**19.20**	**2.36**	**3.30**	**0.46**	**0.90**	**0.94**	**0.95**	**0.61**	**7.06**

Residual effect = 0 .137

1	Days to 50 percent flowering	6	Panicle length (cm)	11	Fertility percent	16	Kernel length (mm)
2	Days to Maturity	7	No. of primary branches	12	1000 grains weight (g)	17	Kernel breadth (mm)
3	Plant height (cm)	8	No. of secondary branches	13	Grain length (mm)	18	kernel L/B ratio
4	No. of panicle.plant^{-1}	9	Florets No.panicle^{-1}	14	Grain breadth (mm)	19	Grain yield.plant^{-1} (g)
5	Panicle weight (g)	10	No. of grains panicle^{-1}	15	Grain L/B ratio		

Table 2: Variability and genetic parameters for different characters of some indigenous *Aman* rice (*Oryza sativa* L.)

Characters	Mean	Range	Variance			C.V	G.C.V.	P.C.V	*h2(BS)*	G.A.	G.A. as per cent of mean
			Phenotypic	Genotypic	Environmental						
1	112.580	96-123	30.817	30.236	0.581	0.676	4.885	4.932	0.981	11.222	9.968
2	145.300	134-154	33.223	16.942	16.281	2.776	2.833	3.967	0.510	6.054	4.167
3	135.140	77-163.5	432.010	411.896	20.114	3.318	15.018	15.380	0.953	40.822	30.207
4	8.400	5.5-11	3.217	1.833	1.384	14.000	16.108	21.338	0.570	2.104	25.050
5	2.480	1.32-5.32	0.755	0.644	0.112	13.467	32.260	34.945	0.852	1.521	61.349
6	24.630	18-31.16	8.391	9.082	0.691	3.373	11.758	12.233	0.924	5.734	23.281
7	10.000	6.2-14.10	2.894	1.882	1.011	10.050	13.720	17.011	0.651	2.279	22.796
8	30.920	15.65-59	102.032	87.481	14.551	12.335	30.245	32.663	0.857	17.837	57.690
9	130.850	81.50-270	1863.965	1512.391	351.574	14.329	31.246	33.109	0.891	72.531	55.431
10	102.520	47-251	2158.514	1754.048	404.446	19.615	32.722	35.640	0.843	77.531	75.855
11	76.980	52.07-92.87	168.786	81.878	86.908	12.109	13.228	15.385	0.739	12.981	16.864
12	19.880	7.94-27.36	27.077	25.759	1.318	5.774	25.518	26.162	0.951	10.193	51.271
13	7.440	2.9-9.98	3.446	2.191	1.255	15.053	15.585	27.222	0.328	2.430	32.665
14	2.520	1.63-3.02	0.155	0.104	0.051	8.928	12.707	15.538	0.669	0.543	21.559
15	2.940	1.58-3.98	0.440	0.248	0.192	14.897	17.919	21.502	0.695	0.770	26.191
16	5.570	2.05-8.07	1.794	1.582	0.212	8.258	22.586	24.058	0.881	2.431	43.661
17	2.060	1.41-2.78	0.250	0.175	0.075	13.252	18.685	29.329	0.406	0.740	35.941
18	2.850	1.21-3.86	0.525	0.364	0.161	14.070	26.217	28.150	0.867	1.031	36.207
19	16.410	7.43-28.38	29.862	18.034	11.828	20.956	25.809	33.193	0.605	6.796	41.419

C V: Coefficient of variation, GCV: Genotypic coefficient of variation, PCV: Phenotypic coefficient of variation, GA: Genetic advance

1	Days to 50 percent flowering	6	Panicle length (cm)	11	Fertility percent	16	Kernel length (mm)
2	Days to Maturity	7	No. of primary branches	12	1000 grains weight (g)	17	Kernel breadth (mm)
3	Plant height (cm)	8	No. of secondary branches	13	Grain length (mm)	18	kernel L/B ratio
4	No. of panicle.plant^{-1}	9	Florets No.panicle^{-1}	14	Grain breadth (mm)	19	Grain yield.plant^{-1} (g)
5	Panicle weight (g)	10	No. of grains panicle^{-1}	15	Grain L/B ratio		

Table 3: Genotypic (G) and phenotypic (P) correlations among yield and quality traits in some indigenous *Aman* rice (*Oryza sativa* L.)

Characters		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	G	0.246	0.062	0.312	-0.186	-0.305	-0.125	-0.419*	-0.406*	-0.357	-0.125	0.241	0.406*	0.277	0.420*	0.076	0.049	0.099	-0.034
	P	0.191	0.062	0.248	-0.171	-0.281	-0.070	-0.381	-0.370	-0.315	-0.056	0.236	0.314	0.185	0.332	0.046	0.032	0.058	-0.024
(2)	G		-0.015	0.444*	-0.311	0.159	-0.308	-0.361	-0.210	-0.022	0.486*	0.216	-0.046	0.332	-0.282	0.143	0.132	0.117	-0.158
	P		0.045	0.285	-0.159	0.155	-0.164	-0.344	-0.068	0.019	0.230	0.194	0.107	0.133	0.039	0.077	0.095	0.022	-0.006
(3)	G			0.517**	-0.076	-0.215	0.095	-0.020	-0.019	-0.005	0.112	-0.103	-0.357	0.034	-0.512**	-0.283	-0.127	-0.138	0.237
	P			0.412*	-0.068	-0.196	0.077	-0.035	0.014	0.024	0.097	-0.090	-0.230	0.029	-0.322	-0.266	-0.122	-0.110	0.192
(4)	G				-0.432*	-0.101	-0.052	-0.271	-0.419*	-0.316	0.029	0.219	-0.148	0.506**	-0.438*	-0.168	0.272	-0.342	0.107
	P				-0.251	-0.032	0.019	-0.197	-0.166	-0.073	0.191	0.140	-0.109	0.222	-0.247	-0.159	-0.016	-0.069	0.350
(5)	G					0.218	0.267	0.568**	0.525**	0.527**	0.422*	-0.050	0.327	0.025	0.358	0.262	0.104	0.186	0.850**
	P					0.196	0.232	0.466*	0.507**	0.513**	0.341	-0.008	0.176	0.007	0.182	0.234	0.099	0.125	0.804**
(6)	G						0.166	0.365	0.415*	0.527**	0.351	-0.132	0.207	0.478*	-0.121	0.449*	0.505**	0.043	0.191
	P						0.153	0.354	0.493*	0.515**	0.301	-0.122	0.176	0.368	-0.069	0.391*	0.392*	0.047	0.164
(7)	G							0.583**	0.427*	0.465*	0.565**	-0.268	0.243	-0.073	0.335	0.033	-0.200	0.225	0.385
	P							0.548**	0.356	0.397*	0.384	-0.187	0.154	-0.041	0.191	-0.024	-0.120	0.070	0.274
(8)	G								0.901**	0.884**	0.585**	-0.647**	-0.139	-0.261	0.021	-0.124	-0.072	-0.104	0.568**
	P								0.750**	0.752**	0.417*	-0.596**	-0.170	-0.193	-0.072	-.0140	-0.096	-0.063	0.367
(9)	G									0.985**	0.646**	-0.577**	-0.203	-0.195	-0.116	-0.105	0.095	-0.221	0.392*
	P									0.954**	0.441*	-0.490*	-0.097	-0.163	-0.021	-0.066	-0.044	-0.112	0.421*
(10)	G										0.761**	-0.477*	-0.140	-0.157	-0.067	-0.039	0.121	-0.165	0.454*
	P										0.678**	-0.412*	-0.101	-0.134	-0.039	-0.033	0.052	-0.080	0.478*
(11)	G											0.038	-0.172	-0.007	0.187	0.173	0.144	0.058	0.540**
	P											0.008	-0.027	-0.046	-0.004	0.044	0.007	0.051	0.458*
(12)	G												0.549**	0.318	0.416*	0.415*	0.181	0.263	-0.001
	P												0.444*	0.245	0.327	0.386	0.183	0.166	0.029
(13)	G													0.660**	0.756**	0.884**	0.219	0.804**	0.305
	P													0.516**	0.797**	0.712**	0.187	0.514**	0.084
(14)	G														0.025	0.708**	0.691**	0.218	0.298
	P														-0.074	0.663**	0.628**	0.121	0.137
(15)	G															0.515**	-0.266	0.805**	0.193
	P															0.353	-0.187	0.476*	0.008
(16)	G																0.520**	0.638**	0.145
	P																0.504**	0.521**	0.111
(17)	G																	-0.320	0.246
	P																	-0.456*	0.079
(18)	G																		-0.024
	P																		0.070

**, ** Significant at 5 % and 1%level, respectively; G: Genotypic correlation coefficient, P: Phenotypic correlation coefficient*

1	Days to 50 percent flowering	6	Panicle length (cm)	11	Fertility per cent	16	Kernel length (mm)
2	Days to Maturity	7	No. of primary branches	12	1000 grains weight (g)	17	Kernel breadth (mm)
3	Plant height (cm)	8	No. of secondary branches	13	Grain length (mm)	18	kernel L/B ratio
4	No. of panicle.plant^{-1}	9	Florets No.panicle^{-1}	14	Grain breadth (mm)		
5	Panicle weight (g)	10	No. of grains panicle^{-1}	15	Grain L/B ratio		

Table 4: Path coefficient (Genotypic) analysis showing direct (Bold) and indirect effect of component traits in some indigenous Aman rice (*Oryza sativa* L.)

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Correlation
1	**0.095**	0.003	-0.003	0.188	-0.200	0.006	-0.011	-0.058	-0.602	0.646	-0.051	-0.001	-0.165	0.087	0.070	0.059	-0.033	-0.062	-0.034
2	0.023	**0.015**	0.000	0.267	-0.336	-0.003	-0.021	-0.050	-0.311	0.040	0.199	-0.001	0.018	0.104	-0.047	0.112	-0.090	-0.073	-0.158
3	0.005	0.000	**-0.060**	0.312	-0.081	0.004	0.008	-0.002	-0.027	0.009	0.046	0.000	0.145	0.010	-0.085	-0.223	0.086	0.087	0.237
4	0.029	0.006	-0.031	**0.603**	-0.466	0.002	-0.004	-0.037	-0.622	0.572	0.011	-0.001	0.060	0.159	-0.073	-0.132	-0.185	0.216	0.107
5	-0.017	-0.004	0.004	-0.260	**1.079**	-0.004	0.024	0.078	0.778	-0.954	0.173	0.000	-0.133	0.007	0.059	0.206	-0.071	-0.117	0.850**
6	-0.028	0.002	0.012	-0.060	0.235	**-0.021**	0.015	0.050	0.764	-0.953	0.144	0.000	-0.084	0.150	-0.020	0.354	-0.344	-0.027	0.191
7	-0.011	-0.004	-0.005	-0.031	0.288	-0.003	**0.091**	0.081	0.634	-0.841	0.232	0.001	-0.098	-0.022	0.056	0.026	0.136	-0.142	0.385
8	-0.039	-0.005	0.001	-0.163	0.613	-0.007	0.053	**0.139**	1.337	-1.599	0.240	0.004	0.056	-0.082	0.003	-0.097	0.049	0.065	0.568**
9	-0.038	-0.003	0.001	-0.253	0.566	-0.010	0.039	0.125	**1.483**	-1.782	0.265	0.003	0.082	-0.061	-0.019	-0.083	-0.064	0.140	0.392*
10	-0.033	0.000	0.000	-0.190	0.569	-0.011	0.042	0.122	1.461	**-1.809**	0.312	0.003	0.056	-0.049	-0.011	-0.030	-0.082	0.104	0.454*
11	-0.011	0.007	-0.006	0.017	0.455	-0.007	0.051	0.081	0.958	-1.377	**0.411**	0.000	-0.070	-0.002	0.031	0.136	-0.098	-0.036	0.540**
12	0.022	0.003	0.006	0.132	-0.054	0.002	-0.024	-0.089	-0.855	0.863	0.015	**-0.006**	-0.223	0.100	0.069	0.327	-0.123	-0.166	-0.001
13	0.038	0.000	0.021	-0.089	0.353	-0.004	0.022	-0.019	-0.301	0.253	0.070	-0.003	**-0.407**	0.208	0.126	0.697	-0.149	-0.509	0.305
14	0.026	0.005	-0.002	0.305	0.026	-0.010	-0.006	-0.036	-0.289	0.284	-0.002	-0.002	-0.268	**0.315**	0.004	0.558	-0.471	-0.138	0.298
15	0.039	-0.004	0.030	-0.264	0.386	0.002	0.030	0.002	-0.171	0.121	0.076	-0.002	-0.308	0.007	**0.167**	0.405	0.181	-0.510	0.193
16	0.007	0.002	0.017	-0.101	0.282	-0.009	0.003	-0.017	-0.156	0.070	0.071	-0.002	-0.360	0.223	0.086	**0.788**	-0.354	-0.404	0.145
17	0.004	0.002	0.007	0.164	0.112	-0.010	-0.018	-0.010	0.140	-0.218	0.059	-0.001	-0.089	0.218	-0.044	0.409	**-0.682**	0.202	0.246
18	0.009	0.001	0.008	-0.206	0.200	0.000	0.020	-0.014	-0.328	0.299	0.023	-0.001	-0.327	0.068	0.134	0.503	0.218	**-0.633**	-0.024

*, ** *Significant at 5 % and 1%level, respectively; Residual effect = 0.247*

1	Days to 50 percent flowering	6	Panicle length (cm)	11	Fertility percent	16	Kernel length (mm)
2	Days to Maturity	7	No. of primary branches	12	1000 grains weight (g)	17	Kernel breadth (mm)
3	Plant height (cm)	8	No. of secondary branches	13	Grain length (mm)	18	kernel L/B ratio
4	No. of panicle.plant^{-1}	9	Florets No.panicle^{-1}	14	Grain breadth (mm)	19	Grain yield.plant^{-1} (g)
5	Panicle weight (g)	10	No. of grains panicle^{-1}	15	Grain L/B ratio		

heritability. Number of grains per panicle recorded the highest GA followed by floret number per panicle, plant height, number of secondary branches, fertility percent, day's to50 percent flowering, and 1000 grain weight. These findings were in agreement with that of Amirthadevathinam (1990) for grains per panicle; Lokaprakash *et al*. (1992) for1000 seed weight and number of fertile spikelets per panicle and Sarma *et al*. (1996) for number of secondary branches per panicle. Lowest GA was observed in grain breadth. The estimates of genetic advance as percent of mean were highest for number of grain per panicle, followed by panicle weight, number of secondary branches, florets number per panicle,1000 grain weight, kernel length, grain yield per plant, kernel L/B ratio, kernel breath, grain length, plant height, grain L/B ratio, number of panicle per plant and panicle length respectively. These findings were earlier corroborated by different workers for one or more characters e.g. Chaubey and Singh (1994) for grain yield per plant, panicle weight and total number of spikelets; Sarma *et al.* (1996) for effective tillers/m row length and panicle weight; Karthikeyan *et al.* (2009) for number of branches per panicle, straw yield per plant, total biological yield per plant and grain yield per plant; Kumar and Senapati (2013) for grain yield per plant The lowest GA as percentage of mean was observed in days to maturity followed by panicle length, kernel length, days to 50 percent flowering and grain length. High heritability coupled with high genetic advance was obtained for plant height, days to 50 percent flowering, number of secondary branches, florets number per panicle, number of grains per panicle, fertility percent and 1000 grain weight. These findings were corroborated by Singh *et al*. (2005) for plant height; Sanker *et al*. (2006) for days to 50 per cent flowering, plant height, productive tiller per plant, panicle length, grain per panicle, 1000 seed weight and single plant yield; Singh et al. (2007) for days to 50 percent flowering and grain per panicle; Kishore *et al.* (2008) for days to 50 per cent flowering, plant height, water uptake and gel consistency; Sabesan *et al*. (2009) for grain yield per plant, 100 grain weight, productive tillers per plant, grains per panicle, grain length, grain breadth, kernel length, panicle length and plant height; Anjaneyulu *et al.* (2010) for number of grains per panicle, plant height and fertility per cent ;Gyanendra *et al.* (2011) for grain yield/plant spikelets per panicle, panicle bearing tillers per plant, flag leaf area and days to 50 percent flowering. Hence it indicated the predominance of additive gene action for controlling these characters. Therefore, these characters can be improved simply through selection. High heritability with low genetic advance was observed for panicle length, panicle weight, kernel length and kernel L/B ratio. It suggested non-additive gene action for the expressions of these characters. The high heritability was exhibited due to favorable influence of environment rather than genotype and selection for such traits might not be rewarding. Low heritability coupled with high genetic advance was registered for days to maturity and grain yield per plant. It revealed that the character is governed by additive gene effects. The low heritability was being exhibited due to high environmental effects. Therefore, selection for this character might be effective. Low heritability coupled with low genetic advance was observed for number of panicle per plant, number of primary branches, grain length, grain breadth and grain L/B ratio. It indicated that these characters were highly influenced by environmental factors and selection would be ineffective. Correlation studies (Table3.) revealed that Grain yield per plant was positively significantly correlated with panicle weight, number of secondary branches, number of grains per panicle and fertility percent. This finding was in agreement with that of Chaubey and Singh (1994) and Monalisa *et al.* (2006) for panicle weight; Choudhury and Das (1997) for grains per panicle ; Reddy *et al.* (1997) for number of grains per panicle and panicle weight; Raut *et al.* (2009) for secondary branches per panicle. Therefore, above mentioned characters were the principal yield determining trait in rice. Genotypic pathway associations of yield attributing characters are presented in table 4. Correlation is partitioned into direct and indirect effects through genotypic path coefficient analysis. Residual effect of path coefficient analysis was low (0.1372744). It indicated that the number of characters, chosen for the study were appropriate for yield determination in rice. Characters namely plant height, panicle length, number of grains per panicle, 1000 grain weight, grain length, kernel breadth and kernel L/B ratio incurred negative direct effect on grain yield per plant. The florets number per panicle imparted the highest positive direct effect on grain yield per plant followed by panicle weight per plant, kernel length, fertility percent and grain breadth respectively. The value of correlation coefficient between panicle weight and grain yield per plant was nearly equal to its direct effect. Therefore, correlation explained the true relationship and a direct selection through panicle weight would be effective. Similarly the value of correlation coefficient between fertility percent and grain yield per plant was nearly equal to its direct effect. Therefore, correlation explained the true relationship and a direct selection through fertility percent would be very much effective. The number of grains per panicle was positively and significantly correlated with grain yield per plant but its direct effect was negative, indicating that indirect effects would be the cause of correlation. In this situation, the indirect causal factors were to be considered simultaneously for selection. Therefore, it would be better to consider the other characters that showed high indirect effect on grain yield per plant. The number of secondary branches and fertility per cent was significantly correlated with grain yield per plant but they had small direct effect. Therefore, indirect effects of number of secondary branches and fertility per cent through other component characters were mainly responsible for the production of such correlation coefficient. In this circumstance, indirect selection through these characters would be practiced for yield improvement in rice.

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