academicJournals

Vol. 14(3), pp. 187-201, 21 January, 2015
DOI: 10.5897/AJB2014.13961
Article Number: 0828B6A49713
ISSN 1684-5315

http://www.academicjournals.org/AJB

African Journal of Biotechnology

Full Length Research Paper

Genetic assessment of some phenotypic variants of rice (*Oryza* spp.) for some quantative characters under the Gangatic plains of West Bengal

B. K. Senapati and Awaneet Kumar*

Department of Genetics and Plant Breeding, Faulty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal 741 252, India.

Received 3 June, 2014; Accepted 15 January, 2015

Twenty two (22) recombinant inbreed lines (RIL's) derived from interspecific cross derivative of *Oryza sativa* and *Oryza rufipogon* along with two local check varieties MTU 7029 and Ranjit were evaluated in randomized block design (RBD) with two replications at two different environments (1st at Regional Research Station, New Alluvial Zone (NAZ), Bidhan Chandra Krishi Viswavidyalaya, Sub-Centre, Chakdah, Nadia, West Bengal during Kharif season 2009 and 2nd at Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, during Kharif season 2010), to study the polygenic variations in yield for yield and its attributing characters and their cause and effect relationship. The analysis of variances revealed the significant differences among the 24 genotypes against all the characters except panicle weight, grain length, grain breadth and grain L/B ratio. The magnitude of phenotypic coefficients of variation (PCV) was higher than genotypic coefficients of variation (GCV) for all the characters suggesting the influences of the environmental forces on the expression of these characters. High PCV and GCV values were observed in grain yield per plant, 1000 grain weight, L/B ratio, grain breadth and panicle weight. High heritability coupled with moderate to high genetic advance as percent of mean for plant height, panicle weight, grain length, grain L/B ratio, 1000 grain weight and yield per plant while low heritability estimates along with low genetic advance were observed for fertility percentage and florets number per panicle. In general, genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients. Path coefficient analysis revealed that number of characters chosen was very much appropriate as evident from low value of residual effect. Maximum positive direct effect was imparted by number of gains per panicle followed by grain L/B ratio, days to 50% flowering and panicle length respectively. Florets number per panicle imparted the maximum negative direct effect followed by grain breadth, fertility percentage and panicle number per plant. Per se performance revealed that two lines viz; KS-7 and KS-13 were promising in respect of grain yield and some other yield related traits. Number of grains per panicle and floret number per panicle give significant positive correlation with yield.

Key words: Correlation, genotypic coefficients of variation, genetic advance, heritability, phenotypic coefficients of variation, rice, recombinant inbreed lines.

INTRODUCTION

Worldwide, rice (*Oryza sativa* L.) is the second most important cereal crop, just after wheat. It provides 20% of the world's dietary energy supply (FAO, 2004)). Since grain yield is a complex trait, indirect selection through correlated, less complex and easier measurable traits would be an advisable strategy to increase the grain yield. Efficiency of indirect selection depends on the magnitude of correlations between yield and target yield

components (Singh and Chaudhary, 1977; Fakorede and Opeke, 1985; Toker and Cagirgan, 2004; Bhatti et al.2005).

Breeding strategy in rice mainly depends upon the degree of associated characters as well as its magnitude and nature of variation (Zahid et al., 2006; Prasad et al., 2001). Path coefficient analysis furnishes information of influence of each contributing traits to yield directly as well as indirectly and also enables breeders to rank the genetic attributes according to their contribution (Cyprien and Kumar, 2011). In rice, selection of high yielding cultivars via specific traits requires knowledge of not only final yield but also the many compensation mechanisms among yield components resulting from changing genotypic, environmental and management factors. Grain yield of rice is a quantitative trait which is controlled by many genetic as well as environmental factors (Singh and Singh, 2004; Ceyhan and Avci, 2005; Ranjan et al., 2006). For selection in rice, information on correlation coefficient always has been helpful as a basis for selection in a breeding program (Akhtar et al., 2011). Path coefficient analysis partitions this relationship into direct and indirect matrix presenting correlation in a more meaningful way (Mohsin et al., 2009). The path analysis has been used by plant breeders (Indu Rani et al., 2008; Togay et al., 2008; Ali et al., 2009) to support in identifying traits that are promising as selection criteria to improve crop yield and to detect the amount of direct and indirect influence of the causal components on the effect component (Bhatti et al., 2005).

Path coefficient analyses are particularly useful for the study of cause-and-effect relationships because they simultaneously consider several variables in the data set to obtain the coefficients. Determination of correlation and path coefficients between yield and yield criteria is important for the selection of promising rice genotypes to be used in any meaningful breeding program. In this context, the present studies has been made to assess the variability and cause effect relationship with grain yield per plant in two different environment and pooled analysis has been done over the two environments to study the polygenic variations in yield for yield and its attributing characters and their cause and effect relationship.

MATERIALS AND METHODS

The experimental material consisted of 22 stable recombinant inbred lines (RIL's) developed from an interspecific cross *O. sativa* (var, B-32 Selection 4) /*Oryza rufipogon* (var, B-127). Finally, after 11 genes rating of selection, 22 stable RIL's were established. They were designated as Kakdwip selection-1 to Kakdwip selection-22. These were studied during Kharif 2010 along with two local check varieties MTU 7029 and Ranjit at two different environment; one at Regional Research Station, New Alluvial Zone, Sub-Centre Chakadaha (Latitude 23° 30′ N, longitude 89°E and altitude 9.75 m above mean sea level) and another at Instructional farm (Latitude 22° 93′ N, longitude 88.59° E and altitude 9.75 m above mean sea level), Jaguli of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India, under rainfed shallow lowland condition. The soil of the 1st experimental site was sandy loam in texture, normal in pH (7.00), good water holding capacity and high fertility status while the 2nd experimental site was sandy loam in texture, normal in pH, good water holding capacity and medium fertility status. The experiments were laid out in Randomized Block Design (RBD) with two replications having a plot size of 5 × 2 m against each entry. Single seedling per hill was transplanted manually for each entry maintaining a spacing of plant of 20 cm × 15 cm between lines and between plants within lines respectively. Normal agronomic practices were followed to obtain a good harvest. Observations were recorded on five plants selected randomly from each entry against 14 quantitative characters such as plant height (cm), days to 50% flowering, days to maturity, number of panicle per plant, panicle weight (g), panicle length (cm), florets number per panicle, number of grains per panicle, percentage fertility, grain length (mm), grain breadth (mm), grain L/B ratio, 1000 grain weight (g), grain yield per plant (g). Mean data pooled over two environments were statistically analyzed using appropriate computerized statistical programme for the estimation of variability, heritability, genetic advance and correlation coefficient and path coefficient analysis (Deway and Lu, 1959) among the tested characters.

RESULTS AND DISCUSSION

The mean performance for 14 quantitative characters of 22 RIL's and checks varieties in environment 1, environment 11 and pooled data over the two environments are presented in Table 1, 2 and 3, respectively. All the lines exhibited considerable variability for all the characters studied. Line KS-22 recorded highest plant height (135.70 cm) followed by lines KS-13 and KS-20 while check variety MTU-7029 (101.65 cm) showed lowest plant height followed by lines KS-8, KS-2 and KS-6 respectively in environment 1. In environment 2, line KS-17 recorded maximum plant height (145.90 cm) followed by lines KS-20, KS-19 and KS-22 while check variety Ranjit showed the shortest plant height (112.70 cm) followed by lines KS-8, KS-5 and KS-4 respectively. Pooled performance over two environments showed that line KS-22 was the tallest (139.77cm) followed by lines KS-20 and KS-13 while check variety Ranjit showed minimum plant height (108.10 cm) followed by variety MTU-7029 and line KS-8, respectively.

In environment 1, KS-12 was last in days to 50% flowering (123.00 DAS) followed by lines KS-21, KS-10 and KS-11 respectively while line KS-4 was first in days to 50% flowering (111.00 DAS) followed by KS-7, KS-17

*Corresponding author. Email address: awaneet.nikhil@gmail.com.

Table 1. Mean performance of 22 RIL's of rice along with check varieties for 14 characters during Kharif 2009 (Environment-1).

Genotype	Characters													
	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Florets No./ panicle	No. of grains/ panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grain weight(g)	Grain yield/ plant (g)
KS-1	111.50	112.50	143.50	11.00	3.87	22.23	181.15	138.10	75.91	8.27	3.09	2.68	21.55	25.50
KS-2	104.25	118.00	147.00	13.00	2.27	21.27	142.85	107.15	75.03	8.39	3.03	2.76	17.97	24.53
KS-3	113.25	115.00	149.50	11.00	2.38	25.08	183.05	122.75	67.11	8.71	3.06	2.89	19.50	20.04
KS-4	108.80	111.00	145.00	11.50	2.08	21.21	172.90	110.70	64.55	8.15	2.80	2.90	14.40	18.97
KS-5	114.00	116.00	145.00	10.50	2.72	21.77	135.80	100.10	73.59	8.59	3.10	2.76	24.99	17.72
KS-6	104.75	112.50	148.00	10.50	2.70	20.03	139.65	103.10	73.95	8.05	2.32	3.47	14.85	16.70
KS-7	113.00	111.50	148.50	12.00	2.69	23.75	157.00	101.00	64.22	8.23	3.21	2.56	23.81	30.28
KS-8	104.05	116.50	149.00	13.00	3.33	22.51	163.80	116.30	70.92	8.54	3.11	2.74	21.16	17.55
KS-9	110.50	114.00	144.00	12.00	3.27	22.43	164.90	139.55	85.95	8.03	2.88	2.68	22.52	21.81
KS-10	113.05	122.00	152.00	11.00	2.10	22.01	134.05	100.65	74.68	9.59	2.37	4.04	22.87	19.29
KS-11	117.45	121.50	150.00	11.50	2.82	21.57	114.45	87.85	76.58	9.82	2.24	4.38	26.87	19.01
KS-12	109.65	123.00	151.50	11.00	4.23	21.70	179.75	109.35	61.10	8.33	2.39	3.34	25.58	19.70
KS-13	129.45	120.50	150.50	14.00	2.35	19.36	142.35	108.75	76.49	7.78	2.21	3.51	18.21	28.21
KS-14	108.80	117.50	147.00	11.00	3.27	21.44	160.65	114.55	71.07	8.03	2.39	3.35	22.75	24.04
KS-15	108.20	116.00	149.50	15.00	2.91	22.69	145.70	112.80	77.56	8.20	2.83	2.89	20.88	20.69
KS-16	112.95	113.50	143.00	12.50	2.60	23.24	162.05	115.25	72.45	7.90	2.66	2.86	21.40	24.94
KS-17	110.45	112.00	144.50	11.50	2.41	22.51	155.10	112.65	72.62	8.19	2.21	3.70	19.21	18.48
KS-18	111.70	114.00	143.50	14.50	2.94	22.37	151.20	106.75	71.53	8.19	2.66	3.07	18.25	15.13
KS-19	108.75	115.00	142.00	12.00	2.54	23.43	166.45	115.45	69.50	8.45	2.37	3.57	19.23	20.08
KS-20	127.90	119.00	151.00	11.50	2.73	20.24	127.55	93.20	73.59	10.03	2.46	4.09	31.45	19.29
KS-21	123.30	122.00	151.00	13.00	2.63	23.02	177.35	126.05	71.50	8.30	2.53	3.28	19.15	28.09
KS-22	135.70	119.00	152.00	11.50	3.25	22.10	138.45	88.90	65.23	10.06	2.58	3.89	22.83	15.86
Ranjit*	103.50	115.50	144.50	12.00	2.80	21.96	175.30	109.65	62.57	7.97	2.16	3.67	14.79	19.22
MTU 7029*	101.65	115.00	149.50	14.00	2.35	21.43	151.20	105.45	70.11	7.86	2.61	3.00	18.54	19.94
Mean	112.76	116.35	147.56	12.10	2.81	22.05	155.11	110.25	71.56	8.45	2.63	3.25	20.95	21.04
CD (0.05)	2.35	2.69	2.28	2.79	-	1.39	41.57	24.16	11.66	-	-	-	1.21	3.37

*Check variety.

and KS-1. In case of environment 2, KS-12 ranked last in days to 50% flowering (130.00 DAS) followed by lines KS-10 and KS-11 while line KS-1 was the earliest in days to 50 % flowering (117.00 DAS) followed by lines KS-4 and KS-7 respectively. Nearly similar result was obtained for the pooled data in this regards. In environment 1, KS-19 matured earliest (142.00 DAS) followed by KS-18, KS-1 and KS-9 while KS-1, KS-22(152.00 DAS), KS-21 and KS-20 were in the late maturing group. In case of environment 2, line KS-1 matured earliest (147.50 DAS) followed by lines KS-19 and Ranjit while lines KS-11, KS-13 (155.00 DAS), KS- 22 and KS-6 were very late in maturity. According to pooled data, lines KS-19 (147.25 DAS), KS-1, KS-16 and variety Ranjit were earlier than the rest of the genotypes. KS-15 recorded maximum panicle numbers per plant (15.00) followed by lines KS-18 and KS-13 while KS-5 and KS-6 had lowest panicles per plant (10.50) followed by lines KS-3

Table 2. Mean performance of 22 RIL's of rice along with check varieties for 14 characters during Kharif 2010 (Environment-2).

Genotype	Characters													
	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Florets No. / panicle	No. of grains/ panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grain weight(g)	Grain yield/ plant (g)
KS-1	132.10	117.00	147.50	11.00	5.06	25.38	257.15	191.25	74.66	8.00	2.95	2.70	21.90	29.45
KS-2	135.00	120.50	149.50	15.50	3.05	24.54	191.70	117.60	53.64	7.97	2.79	2.87	20.00	32.04
KS-3	138.25	119.00	151.00	15.50	3.72	28.20	212.85	161.35	64.25	8.27	2.61	3.16	20.07	35.89
KS-4	124.65	118.00	150.50	16.50	4.69	26.87	223.00	170.25	74.12	8.10	2.78	2.91	19.12	36.24
KS-5	123.85	123.00	151.50	11.50	3.22	23.95	182.00	107.70	59.21	7.91	2.94	2.69	24.29	28.03
KS-6	125.00	119.00	153.00	20.50	3.65	23.94	233.65	132.10	59.78	7.86	2.68	2.95	19.90	32.43
KS-7	125.80	118.00	150.00	20.00	5.23	26.55	227.50	145.80	63.76	8.03	3.07	2.59	25.25	35.91
KS-8	123.15	124.50	151.00	13.00	4.07	24.43	220.80	151.00	68.34	7.79	2.99	2.60	21.68	32.05
KS-9	126.30	121.00	150.00	14.00	4.20	24.86	196.30	130.50	66.27	8.04	3.00	2.68	23.67	31.53
KS-10	135.65	129.50	152.50	15.50	3.31	25.86	164.60	110.70	62.76	9.70	2.86	3.39	26.30	35.51
KS-11	143.05	129.50	155.00	13.00	5.19	27.13	203.55	128.60	63.13	9.75	2.84	3.43	29.90	32.22
KS-12	137.15	130.00	150.00	11.00	3.14	26.36	255.40	147.90	58.43	9.16	3.01	3.04	29.01	27.87
KS-13	141.85	126.50	155.00	12.50	4.48	22.88	237.65	179.15	74.47	8.14	2.96	2.74	22.02	33.61
KS-14	131.60	122.50	150.50	15.00	2.79	25.59	206.90	145.95	70.25	8.09	2.99	2.68	22.12	26.87
KS-15	140.70	119.00	153..50	13.50	3.39	23.45	199.50	128.00	63.89	7.98	2.99	2.66	23.46	34.70
KS-16	142.15	120.00	150.00	14.00	2.45	26.19	203.20	156.60	77.05	7.97	2.94	2.71	22.39	29.06
KS-17	145.90	119.00	150.50	13.50	2.58	25.54	173.40	120.85	71.27	7.94	2.48	3.19	20.31	26.68
KS-18	141.60	120.00	150.50	17.50	3.88	26.55	234.20	159.10	67.80	7.99	2.81	2.84	20.00	35.72
KS-19	144.60	119.00	148.50	14.00	3.24	25.64	197.50	133.75	69.61	8.12	2.77	2.94	21.72	37.11
KS-20	145.00	125.00	153.00	20.00	3.04	24.37	149.85	73.80	40.04	9.79	2.91	3.36	28.82	24.46
KS-21	127.25	124.00	151.50	12.50	2.35	24.06	131.70	102.80	72.71	8.20	2.43	3.39	21.61	22.29
KS-22	143.85	126.00	154.50	23.00	3.18	24.70	190.55	117.50	52.36	10.13	2.86	3.53	29.66	34.45
Ranji*t	112.70	119.00	149.50	13.00	3.16	24.55	296.40	162.75	47.56	8.07	2.65	3.04	18.97	34.20
MTU 7029*	123.10	119.50	152.00	14.50	2.80	25.06	203.20	141.60	62.21	7.72	2.68	2.89	19.75	29.75
Mean	133.76	122.04	151.31	15.00	3.58	25.27	208.02	138.19	64.06	8.36	2.83	2.95	22.99	33.63
CD (0.05)	1.83	2.53	2.62	2.55	-	0.82	50.10	31.97	18.67	-	-	-	2.63	4.28

*Check variety.

and KS-1 in environment 1.

In environment 2, line KS- 22 recorded maximum panicle number per plant (23.00) followed by lines KS-6, KS-20 and KS-7 respectively while line KS-1 and KS 12 showed minimum number of panicles per plant (11.00) followed by lines KS-5 and KS-13 respectively. It was observed from pooled data that line KS-22 (17.25) had the highest number of panicles per plant followed by KS-18, KS-7 and KS-20 while KS-1, KS-5 and KS-12 possessed lowest panicles number per plant (11.00) followed by KS-10 and KS-11 respectively. In environment 1, maximum panicle weight was observed in KS-12 (4.23 g) followed by KS-1, KS-8 and KS-9 while minimum panicle weight was observed in KS-4 (2.08 g) followed by KS-10 and KS-2 respectively. In environment 2, panicle weight was found to be maximum (5.23 g) in KS-7 followed by KS-11 KS-1 and KS-4 respectively while KS-21 (2.35) recorded minimum panicle weight followed

Table 3. Mean performance of 22 RIL's of rice along with check varieties for 14 characters (pooled over two environments).

Genotype	Characters													
	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Florets No./ panicle	No. of grains/ panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grain weight(g)	Grain yield/ plant (g)
KS-1	121.80	114.75	145.50	11.00	4.24	23.80	219.15	164.67	75.29	8.13	3.02	2.69	21.72	27.47
KS-2	119.62	119.25	148.25	14.25	2.88	22.90	167.27	112.37	64.34	8.13	2.91	2.81	18.98	28.28
KS-3	125.75	117.00	150.25	13.25	3.05	26.64	197.95	142.05	65.68	8.49	2.83	3.02	19.78	27.96
KS-4	116.72	114.00	147.75	14.00	3.38	24.04	197.95	140.47	69.33	8.12	2.79	2.91	16.76	27.61
KS-5	118.92	119.50	148.25	11.00	2.97	22.86	158.90	103.90	66.40	8.25	3.02	2.72	24.62	22.87
KS-6	114.87	115.75	150.50	15.50	3.12	21.99	186.65	117.60	66.87	7.95	2.50	3.21	17.37	24.08
KS-7	119.40	114.75	149.25	16.00	3.96	25.15	192.25	123.40	63.99	8.04	3.14	2.57	24.53	33.09
KS-8	113.60	120.50	150.00	13.00	3.70	23.47	192.30	133.65	69.63	8.13	3.05	2.67	21.42	24.80
KS-9	118.22	117.50	147.00	13.00	3.74	23.64	180.60	135.02	75.93	8.03	2.94	2.68	23.09	26.67
KS-10	124.35	125.75	152.25	12.00	2.70	23.93	149.32	105.67	68.72	9.64	2.61	3.71	24.59	27.40
KS-11	130.25	125.50	152.75	12.25	4.00	24.35	159.00	108.22	69.85	9.78	2.54	3.90	28.38	25.61
KS-12	123.40	126.50	151.25	11.00	3.69	24.03	217.57	128.62	59.76	8.74	2.20	3.19	27.29	26.78
KS-13	135.65	123.25	152.75	13.25	3.42	21.12	190.00	143.95	75.48	7.96	2.58	3.13	20.11	32.41
KS-14	120.20	120.00	148.75	13.00	3.03	23.51	183.77	130.25	70.66	8.06	2.69	3.02	22.44	25.45
KS-15	124.45	117.50	151.15	14.25	3.15	23.06	172.60	120.40	70.72	8.09	2.91	2.78	22.17	27.69
KS-16	127.55	116.75	146.50	13.25	2.52	24.71	182.62	135.92	74.75	7.93	2.80	2.28	21.89	27.00
KS-17	128.17	115.15	147.50	12.50	2.49	24.02	164.25	116.75	71.94	8.06	2.34	3.44	19.75	22.58
KS-18	126.65	117.00	147.00	16.00	3.41	24.46	192.70	132.92	69.66	8.09	2.73	2.95	19.12	24.42
KS-19	126.67	117.00	145.25	13.00	2.89	24.53	181.97	124.60	69.55	8.28	2.57	3.25	20.47	28.59
KS-20	136.45	119.00	152.00	15.75	2.88	22.31	138.70	83.50	56.81	9.91	2.68	3.72	30.13	21.87
KS-21	125.27	123.25	151.25	12.75	2.49	23.54	154.52	114.42	72.11	8.25	2.48	3.33	20.38	25.19
KS-22	139.77	122.50	153.25	17.25	3.21	23.40	164.50	103.20	58.79	10.09	2.72	3.71	26.24	25.15
Ranjit*	108.10	117.25	147.00	12.50	2.98	23.26	235.85	136.20	55.06	8.02	2.40	3.35	16.88	26.71
MTU 7029*	112.37	117.25	150.75	14.25	2.57	23.24	177.20	123.52	66.16	7.79	2.64	2.94	19.14	24.84
Mean	123.26	119.19	149.43	13.55	3.19	23.66	181.56	124.22	67.81	8.42	2.73	3.10	21.97	27.33
CD (0.05)	2.09	2.61	2.45	2.67	-	1.11	45.84	28.06	15.17	-	-	0.30	1.92	3.33

*Check variety.

by KS-16, KS-17 and MTU-7029 respectively. Pooled data revealed that KS-1 (4.42 g) had maximum panicle weight followed by KS-11 and KS-7 while KS-17 and KS-21 recorded (2.49 g) minimum panicle weight followed by KS-16 and variety MTU-7029 respectively.

In environment 1, maximum panicle length was observed in line KS-3 (25.08 cm) followed by KS-7, KS-19 and KS-16 respectively while KS-13 (19.36cm) recorded minimum panicle length followed by KS-6 and KS-20. In case of environment 2, maximum panicle length was observed in line KS-3 (25.20 cm) followed by KS-11, KS-4 and KS-7 while minimum panicle length was recorded in line KS-13 (22.88 cm) followed by KS-15, KS-6 and KS-5, respectively. From the Pooled data, it was observed that KS-3 (26.64) had maximum panicle length followed by KS-7 and KS-16 while minimum panicle length was recorded in line KS-13 (21.12 cm) followed by KS-6 and KS-20 respectively. Florets number per

panicle was found to be highest in KS-3 (185.05) followed by KS-1 and KS-12 while minimum number of florets per panicle was observed in KS-11 (114.45) followed by KS-20 and KS-10 respectively in environment 1.

In case of environment 2, check variety Ranjit recorded highest number of florets per panicle (296.40) followed by KS-1, KS-12 and KS-13 respectively while minimum florets number per panicle was observed in KS-21 (131.70) followed by KS-20, KS-10 and KS-17 respectively. Variety Ranjit performed best against florets numbers per panicle (235.85), as revealed from pooled data over environments followed by KS-1 and KS-12 while KS-20 recorded minimum florets number per panicle (138.70) followed by lines KS-10 and KS-21, respectively. In environment 1, maximum number of grains per panicle was recorded by KS-9 (139.55) followed by KS-1 and KS-21 while minimum number of grains per panicle was observed in KS-11 (87.85) followed by KS-21 and KS-19.

Similarly, in environment 2, highest numbers of grains per panicle was found in KS-1 (191.25) followed by KS-13, KS-4 and check variety Ranjit, respectively while poor number of grains per panicle was observed in KS-20 (73.80), KS-21 and KS-5. According to pooled data over the two environments maximum number of grains per panicle was observed in KS-1 (164.67) followed by KS-13 and KS-3 while minimum number of grains per panicle was observed in KS-20 (83.50) followed by Ks-22 and KS-5 respectively. Maximum fertility percentage was registered by KS-9 (85.95) followed by KS-15 and KS-1 while minimum fertility percentage was observed in KS-12 (61.10) followed by check variety Ranjit and KS-4 in environment 1. Similarly, in environment 2, maximum fertility percentage was found to be in KS-16 (77.05) followed by KS-1, KS-13 and KS-4 respectively while minimum fertility percentage was occurred in KS-20 (40.04) followed by check variety Ranjit and KS-22. Considering pooled data over two environments it was observed thatKS-9 (75.93) had the highest fertility percentage followed by KS-13 and KS-1 while lowest fertility percentage was observed in check variety Ranjit (55.06) followed by KS-20 and KS-22 respectively.

In environment 1, maximum grain length was observed in KS-22 (10.06 mm) followed by KS-20 and KS-11 while minimum grain length was observed in KS-13 (7.78 mm) followed by variety MTU-7029 and line KS-16 respectively. Similarly, in environment 2, highest grain length was recorded in KS-22 (10.13 mm) followed by KS-20, KS-11 and KS-10 while lowest grain length was registered by variety MTU-7029 (7.72mm) followed by lines KS-8 and KS-6 respectively. Pooled data showed that KS-22 (10.09 mm) had maximum grain length followed by lines KS-20 and KS-11 while minimum grain length was recorded by variety MTU-7029 (7.79 mm)followed by KS-16 and KS-6 respectively. Line KS-7 (3.21 mm) recorded maximum grain breadth in environment 1 followed by KS-8 and KS-5 while variety Ranjit (2.16 mm) showed minimum grain breadth followed by KS-17, KS-13 and KS-11 respectively.

Similarly, in environment 2, KS-7 (3.07 mm) had highest grain breadth followed by lines KS-11, KS-8 and KS-15 while KS-21 (2.43 mm), KS-17 and KS-3 was in the low ranking group in this regards. In pooled data over two environments it was observed that KS-7 had maximum grain breadth (3.14 mm) followed by KS-8 and KS 1 as per pooled data, minimum grain breadth was recorded in KS-l2 (2.20 mm) followed by KS-17 and Ranjit, respectively. In environment 1, line KS-11 (4.38) registered highest grain L/B ratio followed by KS-20 and KS-10 while KS-9 (2.68) had lowest grain L/B ratio followed by KS-8 and KS-2. Similarly in environment 2, KS-22 (3.53) recorded highest grain L/B ratio followed by KS-11, KS-21 and KS-20 respectively while KS-7 (2.59) recorded lowest grain L/B ratio followed by KS-8, KS-5 and KS-1 respectively. In case of pooled data, KS-11 (3.90) recorded highest grain L/B ratio followed by KS-20 and KS-22 while KS-16 (2.28) recorded lowest grain L/B ratio followed by KS-7 and KS-8.1000 grain weight was highest in line KS-20 (31.45 g) followed by KS-11 and KS-5 while lowest 1000 grain weight was found in KS-3 (14.40 g) followed by check variety Ranjit andKS-6 in environment 1.

Similarly, in environment 2, maximum 1000 grain weight was observed in KS-11 (29.90 g) followed by KS-22, KS-12 and KS-20 while minimum 1000 grain weight was observed in Ranjit (18.97 g) followed by lines KS-4, KS-6 and MTU-7029 respectively. In this regards pooled data revealed that thaKS-20 recorded highest 1000 grain weight (30.13 g) followed by KS-11 and KS-22 while lowest 1000 grain weight was observed in KS-4 (16.76 g) followed by check variety Ranjit and KS-6.In environment 1, grain yield per plant was found to be highest in KS-7 (30.28g) followed by KS-13 and KS-21 while lowest grain yield per plant was observed in KS-18 (15.13 g) followed by KS-22 and KS-6, respectively. Similarly, in environment 2, highest grain yield per plant was recorded in KS-19 (37.11g) followed by KS-4, KS-7 and KS-3 respectively while lowest grain yield per plant was observed in line KS-21 (22.29 g) followed by KS-20 and KS-14, respectively. In pooled data, maximum grain yield per plant was observed in KS-7 (33.09) followed by KS-13 and KS-19 while minimum grain yield per plant was observed in KS-20 (21.87) followed by KS-17, KS-5 and KS-6 respectively.

The range, mean values, mean square values, standard error of difference of the treatment means, critical difference, phenotypic, genotypic and environmental variances, coefficient of variation (CV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability(BS), genetic advance (GA) and genetic advance as percentage of mean of 22 RIL's along with two local checks of rice grown during kharif-2009 (environment 1) and kharif-2010 (environment 2) along with pooled data are presented in Tables 4, 5 and

Table 4. Variability and genetic parameters for different quantitative characters in rice duringKharif 2009 [Environment-1].

Characters	Mean	Range	Mean square	S.E. (diff.)	Variance			CV (%)	GCV (%)	PCV (%)	h^2 (BS)	G.A.	G.A. as % of mean
					Phenotypic	Genotypic	Environmental						
Plant height (cm)	112.76	101.65-135.70	146.38**	1.13	73.84	72.54	1.29	1.00	7.55	7.62	0.982	17.38	15.42
Days to 50 % flowering	116.35	111.00-123.00	25.76**	1.30	13.72	12.03	1.69	1.11	2.98	3.18	0.876	6.69	5.75
Days to maturity	147.56	142.00-152.00	20.88**	1.10	11.05	9.83	1.21	0.74	2.12	2.25	0.889	6.09	4.12
No. of panicle/plant	12.10	10.50-14.50	3.21**	1.35	2.52	0.69	1.82	11.16	6.89	13.11	0.276	0.90	7.45
Panicle weight (g)	2.81	2.08-4.23	0.51	0.24	0.28	0.22	0.05	8.52	16.90	18.93	0.797	0.87	31.09
Panicle length (cm)	22.05	19.36-25.08	2.99**	0.67	1.72	1.27	0.45	3.06	5.10	5.95	0.735	1.99	9.02
Floret No./panicle	155.11	114.45-183.05	682.15**	20.09	543.03	139.12	403.90	12.95	7.60	15.02	0.256	12.29	7.92
No. of grains/panicle	110.25	87.85-139.55	329.38**	11.68	232.92	96.46	136.45	10.59	8.90	13.84	0.414	13.01	11.80
Fertility %	71.56	61.10-85.95	60.77**	5.64	46.29	14.48	31.81	7.88	5.31	9.50	0.312	4.38	6.12
Grain length (mm)	8.48	7.78-10.06	0.92	0.10	0.46	0.43	0.01	1.21	7.95	8.04	0.977	1.37	16.19
Grain breadth (mm)	2.63	2.16-3.21	0.22	0.08	0.11	0.10	0.01	3.05	12.52	12.89	0.944	0.66	25.07
Grain L/B ratio	3.25	2.56-4.38	0.53	0.10	0.27	0.26	0.01	3.28	15.67	16.01	0.957	1.02	31.60
1000 grains weight (g)	20.95	14.40-31.45	31.62**	0.58	15.98	15.64	0.34	2.79	18.87	19.08	0.978	8.05	38.46
Grain yield/plant (g)	21.04	15.13-30.28	32.76**	1.63	17.71	15.04	2.66	7.76	18.43	19.99	0.849	7.36	34.9

*Significant at 5 % level; ** Significant at 1 % level. CV, Coefficient of variation; GCV, genotypic coefficient of variation; PCV, phenotypic coefficient of variation; GA, genetic advance.

6, respectively. A wide spectrum of variability was noticed for all the characters that offer a good scope of selection for evolving promising lines. The analysis of variance revealed the significant differences among the 24 genotypes against all the characters except panicle weight, grain length, grain breadth and grain L/B ratio.

The wide range of variation that was observed for 10 characters viz. plant height, days to 50 percent flowering, days to maturity, panicles number per plant, panicle length, florets number per panicle, number of grains per panicle, fertility percentage, 1000 grain weight, grain yield per plant, may give good scope for selection on the basis of phenotypic value of component characters. The estimate of phenotypic and genotypic variances were high for florets number per panicle, number of grains per panicles, plant height, and fertility percentage while grain breadth, grain L/B ratio, grain length, panicle length, panicle weight and panicle number per plant showed very low genotypic and phenotypic variances.

In this regard high genotypic and phenotypic variance was reported for number of grains per panicle by Roy et al. (2001). Character like florets number per panicle, number of grains per panicles, plant height and fertility percentage showed high environmental variances simultaneously with high genotypic variances. So, selection for this character would be effective for improvement of these characters in rice.

The magnitude of PCV was higher than GCV for all the characters suggesting the influences of the environmental forces on the expression of these characters. This observation was similar with earlier findings of Chand et al. (2004) and Chaudhary and Singh (1994). High PCV and GCV values were observed in grain yield per plant, 1000 grain weight, grain L/B ratio, grain breadth and panicle weight while number of grains per panicles, grain length, florets number per panicle and plant height exhibited moderate GCV and PCV values therefore there was a large scope for improvements of this characters. In this regard high GCV and PCV for grain yield per plant; 1000 grain weight was earlier reported by Chaubey and Richharia (1993), Nayak and Reddy (2005) and Sarkar et al. (2005). The heritability values varied from 25.6% for florets number per panicle to 98.2% for plant height and genetic advance varied from 4.12% for days to 50% flowering to 38.46 for 1000 grain weight. The heritability estimates were high for plant height, days to maturity, grain length, grain breadth, L/B ratio, 1000 grain weight, panicle weight, panicle length and yield per plant while other characters like fertility percentage and

Table 5. Variability and genetic parameters for different quantitative characters in rice during Kharif 2010 [Environment-2].

Characters	Mean	Range	Mean square	S.E. (diff.)	Variance			C V (%)	G C V (%)	P C V (%)	h^2 (BS)	G.A.	G.A. as % of mean
					Phenotypic	Genotypic	Environmental						
Plant height (cm)	133.76	112.70-145.00	170.27**	0.88	85.52	84.74	0.78	0.66	6.88	6.91	0.990	18.87	14.11
Days to 50 % flowering	122.04	117.00-130.00	31.64**	1.22	16.57	15.07	1.50	1.01	3.18	3.33	0.909	7.62	6.24
Days to maturity	151.31	147.50-155.00	7.55**	1.27	4.58	2.97	1.61	0.83	1.13	1.41	0.648	2.85	1.88
No. of panicle/plant	15.00	11.00-23.00	20.00**	1.23	10.76	9.23	1.52	8.22	20.26	21.86	0.858	5.80	38.67
Panicle weight (g)	3.85	2.35-5.23	1.45	0.12	0.73	0.72	0.01	3.55	23.72	23.98	0.978	1.73	48.32
Panicle length (cm)	25.27	22.88-28.28	3.27**	0.39	1.71	1.55	0.15	1.57	4.93	5.18	0.907	2.44	9.69
Floret No./panicle	208.02	131.70-257.15	2557.35**	24.22	1572.00	985.35	586.64	11.64	15.08	19.05	0.626	51.19	24.61
No. of grains/panicle	138.19	73.80-191.25	1423.74**	15.45	831.30	592.44	238.86	11.18	17.61	20.86	0.712	42.32	30.63
Fertility %	64.06	40.04-77.05	165.03**	9.03	123.28	41.74	81.53	14.09	10.08	17.33	0.338	7.74	12.08
Grain length (mm)	8.36	7.72-10.13	1.06	0.16	0.54	0.51	0.02	2.00	8.59	8.82	0.948	1.44	17.24
Grain breadth (mm)	2.83	2.43-3.07	0.05	0.16	0.04	0.01	0.02	5.76	4.47	7.29	0.375	0.15	5.64
Grain L/B ratio	2.95	2.60-3.53	0.17	0.18	0.10	0.06	0.03	6.28	8.85	10.86	0.665	0.44	14.88
1000 grains weight (g)	22.99	18.97-29.90	23.83**	1.27	12.73	11.10	1.62	5.54	14.48	15.51	0.872	6.41	27.87
Grain yield/plant (g)	33.63	22.29-52.24	95.97**	2.07	50.13	45.83	4.30	6.16	20.13	21.05	0.914	13.33	39.65

*Significant at 5% level; **Significant at 1% level. CV, Coefficient of variation; GCV, genotypic coefficient of variation; PCV, phenotypic coefficient of variation; GA, genetic advance.

Table 6. Variability and genetic parameters for different quantitative characters in rice [pooled over two environments].

Characters	Mean	Range	Mean square	S.E.(diff.)	Variance			CV(%)	GCV(%)	PCV(%)	h^2(BS)	G.A.	G.A. as % of mean
					Phenotypic	Genotypic	Environmental						
Plant height (cm)	123.26	108.10-139.77	158.32**	1.01	79.68	78.64	1.03	0.83	7.21	7.26	0.986	18.13	14.76
Days to 50 % flowering	119.19	114.00-126.50	28.70**	1.26	15.15	13.55	1.60	1.06	3.08	3.26	0.892	7.15	5.99
Days to maturity	149.43	145.25-153.50	14.21**	1.18	7.81	6.40	1.415	0.79	1.63	1.83	0.769	4.47	3.00
No. of panicle/plant	13.55	11.00-17.25	11.60**	1.29	6.64	4.96	1.673	9.69	13.57	17.49	0.567	3.35	23.06
Panicle weight (g)	3.19	2.49-4.42	0.98	0.18	0.51	0.47	0.03	6.04	20.31	21.46	0.887	1.30	39.71
Panicle length (cm)	23.66	21.12-26.64	3.13**	0.53	1.72	1.41	0.30	2.32	5.02	5.57	0.823	2.21	9.35
Floret No./panicle	181.56	138.70-235.85	1619.78**	22.15	1057.51	562.24	459.27	12.30	11.34	15.05	0.441	31.74	16.26
No. of grains/panicle	124.22	83.50-164.67	876.56**	13.56	532.11	344.45	187.65	10.88	13.26	15.72	0.563	27.67	21.22
Fertility %	67.81	55.06-75.93	112.90**	7.35	84.79	28.11	56.67	10.98	7.70	9.79	0.325	6.06	9.10
Grain length (mm)	8.42	7.79-10.09	0.99	0.13	0.50	0.48	0.01	161	8.27	8.43	0.962	1.40	16.71
Grain breadth (mm)	2.73	2.20-3.14	0.14	0.12	0.07	0.06	0.01	4.40	8.49	10.09	0.659	0.41	15.35
Grain L/B ratio	3.10	2.57-3.90	0.35	0.14	0.18	0.16	0.02	4.78	12.26	13.43	0.811	0.73	23.24
1000 grains weight (g)	21.97	16.76-30.13	27.73**	0.93	14.35	13.37	0.98	4.17	16.68	17.29	0.925	7.23	33.17
Grain yield/plant (g)	27.33	21.87-33.09	64.36**	1.85	33.92	30.21	3.48	6.96	19.28	20.52	0.881	10.34	37.32

*Significant at 5% level; **Significant at 1% level. CV, Coefficient of variation; GCV, genotypic coefficient of variation; PCV, phenotypic coefficient of variation; GA, genetic advance.

number of grain per panicle showed moderate heritability and characters like panicle number per plant and florets number per panicle, possessed low heritability. This finding corroborated the earlier findings of Sawant and Patil (1995) and Ashvani et al. (1997). High heritability coupled with moderate to high genetic advance for plant height, panicle weight, grain length, grain breadth, grain L/B ratio, 1000 grain weight and grain yield per plant indicated predominance of additive gene action controlling for this characters and therefore, selection based on phenotypic performance would be effective against this characters.

The character like days to 50% flowering, days to maturity, panicle length, fertility percentage and number of grains per panicle showed moderate to high heritability values associated with moderate to low genetic, advance, suggesting that the inheritance of such traits might be under control of both additive and non-additive gene effects. Low heritability estimates along with low genetic advance observed for panicle number per plant and florets number per panicle suggested that dominances and epistatic gene effects might be operating in the inheritance of these traits. Similarly, in environment 2, the heritability values varied from 38.80% for fertility percentage to 99% for plant height and genetic advance as percentage of mean varied from 1.88% for days to maturity to 39.65% for grain yield per plant.

High heritability coupled with moderate to high genetic advance as percentage of mean for plant height, panicle numbers per plant, panicle weight, grain length, 1000 grain weight and grain yield per plant indicated predominance of additive gene action controlling for this characters and therefore direct selection based on phenotypic performance would be effective against this characters. Low heritability along with low genetic advance observed for grain breadth and fertility percentage suggested that dominance and epistatic gene action were responsible for controlling this traits. In pooled analysis, the heritability values ranged from 32.50% in fertility percentage to 98.60 for plant height and genetic advance as percentage of mean 3% in days to maturity to 37.32% for grain yield per plant. High heritability coupled with moderate to high genetic advance as percent of mean for plant height, panicle weight, grain length, grain L/B ratio, 1000 grain weight and yield per plant indicated predominance of additive gene action for controlling these characters while low heritability estimates along with low genetic advance observed for fertility percentage and florets number per panicle suggested that dominance and epistatic genes were involved in the controlling of this traits.

The genotypic and phenotypic correlation coefficients among the biometrical traits estimated over environment 1 and environment 2 and pooled data are presented in Tables 7, 8 and 9, respectively. In general genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients. This finding was supported earlier by Chaudhary and Singh (1994). Grain yield per plant was significantly positively correlated with number of grains per panicle at genotypic level only in environments 1. In environments 2, it had significant positive correlation against panicle weight and number of grains per panicle at genotypic and phenotypic level whereas against floret number per panicle at genotypic level only. In pooled data analysis it had positive significant correlation against floret number per panicle and number of grains per panicle at genotypic level only.

The genotypic associations of yield and its attributing characters in environment 1, environment 2 and pooled data are presented in Table 10, 11 and 12, respectively. Path coefficient analysis was based on correlation coefficient using grain yield as the dependent factor (effect) and fix other quantitative characters viz., plant height, days to 50% flowering, days to maturity, panicle number per plant, panicle weight, panicle length, floret number per panicle, number of grains per panicle, fertility percentage, grain length, grain breadth, grain L/B ratio and 1000 grain weight as independent factor (Causes). Correlation coefficient of each independent quantitative character was partitioned into direct and indirect effects towards grain yield. Half of the characters viz. plant height, days to 50% flowering, days to maturity, panicle weight, panicle length and number of panicles per plant possessed positive direct effect and other half of the characters, that is, panicles number per plant, florets per panicle, fertility percentage, grain length, grain breadth, grain L/B ratio and 1000 grain weight incurred negative direct effect toward grain yield per plant in environment 1. Number of grains per panicle imparted the maximum positive direct effect on grain yield per plant followed by plant height, days to 50% flowering, panicle length, panicle weight and days to maturity respectively. The present findings are supported by Reuben and Kisanga (1989), Padmavathi et al. (1996) and Sarkar et al. (2005).

Similarly, florets number per panicle imparted maximum negative direct effect on grain yield followed by fertility percentage, grain length, grain L/B ratio, panicle number per plant, grain breadth and 1000 grain weight respectively. Number of grains per panicle had high positive direct effect and also had highly positive significant correlation coefficient with grain yield. Therefore, direct selection for number of grains per panicle would be effective for yield improvement in rice. Majority of characters viz. days to 50% flowering, days to maturity, panicle number per plant, panicle weight, panicle length, number of florets per panicle, grain breadth, grain L/B ratio incurred positive direct effect toward grain yield and rest of the characters recorded negative direct effects in this regards in environment 2. A maximum positive direct effect was imparted by grain L/B ratio followed by number of grains per panicle, grain breadth and panicles number per plant. Panicle weight and number of grains per panicle were positively

Table 7. Genotypic (G) and phenotypic (P) correlation coefficients for grain yield and its attributing characters during Kharif 2009 [Environment-1].

Characters		Days to 50% flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Floret No./ panicle	No. of grains/ Panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grains weight (g)	Grain yield/ plant (g)
Plant height (cm)	G	0.468*	0.464*	-0.037	-0.035	-0.168	-0.492*	-0.397*	0.050	0.576**	-0.190	0.448*	0.442*	0.143
	P	0.433*	0.438*	-0.059	-0.032	-0.158	-0.274	-0.274	0.039	0.557**	-0.189	0.434*	0.429*	0.139
Days to 50 % flowering	G		0.731**	0.069	0.203	-0.324	-0.585**	-0.479*	0.081	0.503*	-0.397*	0.568**	0.459*	0.045
	P		0.695**	0.001	0.170	-0.206	-0.181	-0.220	-0.007	0.466*	-0.383	0.519**	0.416*	0.048
Days to maturity	G			0.026	-0.008	-0.249	-0.609**	-0.652**	-0.185	0.529**	-0.170	0.425*	0.377	0.016
	P			0.026	0.045	-0.201	-0.252	-0.350	-0.098	0.506**	-0.150	0.379	0.360	0.039
No. of panicle/plant	G				-0.164	0.151	0.528**	0.454*	0.083	-0.556**	0.086	-0.387	-0.454*	0.264
	P				-0.140	-0.074	-0.203	-0.052	0.233	-0.248	0.055	-0.186	-0.189	0.136
Panicle weight (g)	G					-0.008	0.359	0.280	-0.049	-0.001	0.159	-0.150	0.374	-0.053
	P					0.016	0.245	0.234	-0.063	0.009	0.146	-0.166	0.346	-0.019
Panicle length (cm)	G						0.530**	0.465*	-0.001	-0.048	0.485*	-0.400*	0.008	0.071
	P						0.513**	0.333	-0.329	-0.040	0.407*	-0.334	-0.009	0.131
Floret No./panicle	G							0.763**	-0.161	-0.838**	0.324	-0.752**	-0.615**	0.389
	P							0.766**	-0.465*	-0.459*	0.217	-0.432*	-0.317	0.216
No. of grains/Panicle	G								0.517**	-0.731**	0.375	-0.711**	-0.384	0.506*
	P								0.208	-0.504*	0.291	-0.514**	-0.253	0.285
Fertility %	G									-0.016	0.099	-0.072	0.241	0.264
	P									-0.000	0.048	-0.037	0.129	0.041
Grain length (mm)	G										-0.101	0.634**	0.641**	-0.384
	P										-0.105	0.631**	0.631**	-0.352
Grain breadth (mm)	G											-01.829	0.077	0.213
	P											-0.824	0.079	0.178
Grain L/B ratio	G												0.275	-0.353
	P												0.264	-0.317
1000 grains weight (g)	G													0.026
	P													0.019

*Significant at 5% level; **Significant at 1% level; G, genotypic correlation coefficient; P, phenotypic correlation coefficient.

associated with grain yield and also recorded high and very high positive direct effects towards grain yield respectively. Therefore, direct selection for these two characters would be effective in yield improvement of rice.

Florets number per panicle was positively associated with grain yield but it had high negative direct effects toward grain yield. Therefore, high amount of indirect effects of number of grains per panicle, grain length and grain breadth were responsible for positive significant correlation. Therefore, during selection these characters should be considered for selection along with florets number per plant. Pooled analysis showed that majority of the characters viz. plant height, days to 50% flowering, days to maturity, panicle weight, panicle length, number of grains per panicle, grain breadth and grain L/B ratio had positive direct effects toward grain yield. Number of grains per panicle incurred a high positive direct effect simultaneously with significant positive

Table 8. Genotypic (G) and phenotypic (P) correlation coefficients for grain yield and its attributing charactersduringKharif 2010 [Environment-2].

Characters		Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Floret No./ panicle	No. of grains/ Panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grains weight (g)	Grain yield/ plant (g)
Plant height (cm)	G	0.279	0.333	0.138	-0.116	0.186	-0.408*	-0.220	0.110	0.462*	0.076	0.399	0.431*	-0.185
	P	0.267	0.270	0.137	-0.105	0.169	-0.314	-0.188	0.066	0.448*	0.054	0.317	0.389	-0.171
Days to 50 % flowering	G		0.603**	-0.105	-0.066	-0.072	-0.323	-0.422*	-0.343	0.764**	0.347	0.549**	0.777**	-0.271
	P		0.611**	-0.101	-0.053	-0.073	-0.214	-0.310	-0.168	0.702**	0.148	0.465*	0.686**	-0.239
Days to maturity	G			0.316	0.029	-0.333	-0.373	-0.493*	-0.464*	0.613**	-0.003	0.590**	0.555**	0.071
	P			0.247	0.044	-0.253	-0.200	-0.235	-0.152	0.477*	0.065	0.331	0.446*	0.077
No. of panicle/plant	G				0.030	0.091	-0.189	-0.308	-0.578**	0.368	-0.105	0.393	0.206	0.352
	P				0.044	0.057	-0.135	-0.288	-0.344	0.323	0.063	0.199	0.169	0.324
Panicle weight (g)	G					0.027	0.474*	0.519**	0.257	0.021	0.548**	-0.268	0.139	0.504*
	P					0.246	0.407*	0.450*	0.175	0.015	0.354	-0.237	0.110	0.499*
Panicle length (cm)	G						0.159	0.357	0.382	0.172	-0.131	0.225	0.070	0.165
	P						0.122	0.223	0.100	0.163	-0.030	0.136	0.060	0.127
Floret No./panicle	G							0.947**	0.149	-0.314	0.261	-0.455*	-0.252	0.474*
	P							0.708**	-0.030	-0.267	0.235	-0.399*	-0.275	0.392
No. of grains/Panicle	G								0.533**	-0.508**	0.274	-0.641**	-0.511	0.452*
	P								0.558**	-0.402*	0.118	-0.414*	-0.408*	0.437*
Fertility %	G									-0.702*	0.093	-0.706**	-0.577**	0.148
	P									-0.386	-0.052	-0.252	-0.303	0.190
Grain length (mm)	G										0.155	0.865**	0.893**	-0.179
	P										0.123	0.704**	0.809**	-0.181
Grain breadth (mm)	G											-0.365	0.630**	0.053
	P											-0.614**	0.391	0.054
Grain L/B ratio	G												0.522**	-0.213
	P												0.374	-0.193
1000 grains weight (g)	G													-0.356
	P													-0.325

*Significant at 5% level; **Significant at 1 % level, G, Genotypic correlation coefficient . P, Phenotypic correlation coefficient.

correlation with grain yield per plant. Florets number per panicle imparted the maximum negative direct effect followed by grain breadth, fertility percentage and panicle numbers per plant. Significant positive correlation simultaneously with highest amount of negative direct effect of florets number per plant suggested that high positive indirect effects of number of grains per panicle, grain length, panicle length etc. were responsible for incurring positive significant yield correlation. Therefore the above mentioned three characters should be considered during selection simultaneous with florets number per plant in rice.

Conclusion

The performance of 22 RIL's revealed that two

Table 9. Genotypic (G) and phenotypic (P) correlation coefficients for grain yield and its attributing characters [pooled over two environments].

Characters		Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Floret no./ panicle	No. of grains/ Panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grains weight (g)	Grain yield/ plant (g)
Plant height (cm)	G	0.373	0.398*	0.050	-0.075	0.177	-0.450*	-0.308	0.080	0.519**	-0.057	0.423*	0.436*	-0.021
	P	0.350	0.354	0.039	-0.068	0.163	-0.294	-0.231	0.052	0.502**	-0.067	0.375	0.233	-0.016
Days to 50 % flowering	G		0.667**	-0.018	0.068	-0.198	-0.454*	-0.450*	-0.131	0.633**	-0.025	0.558**	0.618**	-0.113
	P		0.653**	-0.050	0.058	-0.139	-0.197	-0.265	-0.087	0.584**	-0.117	0.492*	0.551**	-0.095
Days to maturity	G			0.171	0.010	-0.291	-0.491*	-0.572**	-0.324	0.571**	-0.086	0.507**	0.466*	0.043
	P			0.136	0.044	-0.227	-0.226	-0.292	-0.125	0.491*	-0.042	0.360	0.403*	0.058
No. of panicle/plant	G				-0.067	0.121	0.169	0.073	-0.247	-0.094	-0.095	-0.390	-0.124	0.308
	P				-0.048	-0.065	-0.169	-0.170	-0.055	0.037	0.059	0.192	-0.010	0.230
Panicle weight (g)	G					0.131	0.416*	0.399*	0.104	0.010	0..353	-0.209	0.256	0.225
	P					0.131	0.326	0.342	0.057	0.012	0.250	-0.201	0.228	0.240
Panicle length (cm)	G						0.344	0.411**	0.190	0.062	0.177	-0.087	0.039	0.118
	P						0.317	0.278	-0.114	0.061	0.188	-0.099	0.025	0.129
Floret No./panicle	G							0.855**	-0.155	-0.576**	0.292	-0.603**	-0.433*	0.431*
	P							0.737**	-0.247	-0.363	0.226	-0.415*	-0.296	0.304
No. of grains/Panicle	G								0.525**	-0.613**	0..324	-0.676**	-0.447*	0.479*
	P								0.383	-0.453*	0.204	-0.464*	-0.330	0.361
Fertility %	G									-0.359	0.096	-0.389	-0.168	0.206
	P									-0.193	-0.050	-0.144	-0.087	0.115
Grain length (mm)	G										0.027	0.749**	0.676**	-0.281
	P										0.114	0.667**	0.720**	-0.266
Grain breadth (mm)	G											-0.597**	0.353	0.133
	P											-0.719**	0.235	0.116
Grain L/B ratio	G												0.398*	-0.283
	P												0.319	-0.255
1000 grains weight (g)	G													-0.165
	P													-0.153

*Significant at 5% level, **Significant at 1 % level, G: Genotypic correlation coefficient; P: phenotypic correlation.

lines viz; KS-7 and KS-13 were promising in respect of grain yield and some other yield related traits. GCV, PCV, heritability and genetic advance highlighted the importance of plant height, panicle weight, grain length, grain L/B ratio and 1000 grain weight for yield improvement in rice through selection and hybridization. Correlation and path analysis showed that number of grains per panicle and floret number per panicle were the most important yield controlling characters in rice. Therefore, number of grains per panicle and florets number per panicle should be considered during hybridization and selection for yield improvement in rice.

Conflict of Interests

The author(s) have not declared any conflict of

Table 10. Matrix of direct (diagonal) and indirect effect of yield attributing characters on yield of rice during kharif 2009 [Environment-1].

Characters	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Floret no./ panicle	No. of grains/ Panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grains weight (g)	Genotypic yield correlation
Plant height (cm)	0.757	0.309	0.010	0.016	-0.001	-0.111	1.546	-1.059	-0.084	-0.887	0.055	-0.360	-0.049	0.143
Days to 50 % flowering	0.354	0.660	0.017	-0.031	0.007	-0.213	1.837	-1.279	-0.138	-0.775	0.115	-0.456	-0.051	0.045
Days to maturity	0.351	0.048	0.023	-0.012	-0.002	-0.146	1.913	-1.740	0.313	-0.815	0.049	-0.341	-0.042	0.016
No. of panicle/plant	-0.027	0.045	0.006	-0.456	-0.005	0.099	-1.658	1.212	-0.140	0.857	-0.024	0.310	0.051	0.264
Panicle weight (g)	-0.026	0.133	-0.001	0.075	0.035	-0.005	-1.129	0.747	0.083	0.002	-0.046	0.120	-0.042	-0.053
Panicle length (cm)	-0.012	-0.213	-0.005	-0.069	-0.003	0.659	-1.166	1.241	0.000	0.073	-0.141	0.321	-0.008	0.071
Floret No./panicle	-0.372	-0.385	-0.014	-0.240	0.012	0.349	-3.142	2.038	0.273	1.291	-0.094	0.604	0.069	0.389
No. of grains/Panicle	-0.300	-0.316	-0.015	-0.207	0.009	0.306	-2.398	2.671	-0.876	1.127	-0.109	0.571	0.043	0.506**
Fertility %	0.037	0.053	-0.004	-0.037	-0.001	-0.003	0.506	1.380	-1.696	0.023	-0.028	0.058	-0.027	0.264
Grain length (mm)	0.436	0.332	0.012	0.253	-0.005	-0.031	2.633	-1.953	0.026	-1.541	0.029	-0.509	-0.072	-0.384
Grain breadth (mm)	-0.144	-0.261	-0.004	-0.039	0.005	0.319	-1.018	1.002	-0.168	0.155	-0.291	0.665	-0.008	0.213
Grain L/B ratio	0.339	0.375	0.010	0.176	-0.005	-0.264	2.362	-1.899	-0.122	-0.977	0.241	-0.803	-0.030	-0.353
1000 grains weight (g)	0.334	0.302	0.008	0.207	0.013	0.004	1.933	-1.025	-0.409	-0.988	-0.022	-0.221	-0.112	0.026

*Significant at 5% level, **Significant at 1% level, residual effect = 0.4653.

Table 11. Matrix of direct (diagonal) and indirect effect of yield attributing characters on yield of rice during kharif 2010 [Environment-2].

Characters	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Floret No./ panicle	No. of grains/ Panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grains weight (g)	Genotypic yield correlation
Plant height (cm)	-0.194	0.051	0.129	0.062	-0.027	0.014	0.398	-0.344	-0.048	-0.815	0.077	0.710	-0.199	-0.185
Days to 50 % flowering	-0.054	0.158	0.235	-0.047	-0.015	-0.005	0.314	-0.658	0.152	-1.346	0.351	0.977	-0.359	-0.271
Days to maturity	-0.064	0.112	0.389	0.142	0.006	-0.025	0.363	-0.769	0.205	-1.081	-0.002	1.050	-0.266	0.071
No. of panicle/plant	-0.026	-0.019	0.123	0.451	0.007	0.006	0.184	-0.480	0.256	-0.649	-0.106	0.700	-0.095	0.352
Panicle weight (g)	0.022	-0.012	0.011	0.013	0.237	0.020	-0.462	0.810	-0.114	-0.036	0.555	-0.477	-0.064	0.504*
Panicle length (cm)	-0.036	-0.013	-0.129	0.041	0.064	0.075	-0.155	0.557	-0.169	-0.304	-0.132	0.400	-0.032	0.165
Floret No./panicle	0.076	-0.059	-0.145	-0.085	0.112	0.012	-0.975	1.478	-0.006	0.544	0.264	-0.811	0.116	0.474*
No. of grains/Panicle	0.042	-0.078	-0.192	-0.138	0.0123	0.026	-0.924	1.560	-0.236	0.896	0.277	-1.142	0.236	0.452*
Fertility %	-0.021	-0.063	-0.180	-0.260	0.061	0.028	-0.145	0.832	-0.444	1.237	0.094	-1.257	0.266	0.148
Grain length (mm)	-0.089	0.141	0.239	0.166	0.004	0.013	0.306	-0.793	0.311	-1.763	0.156	1.540	-0.412	-0.179
Grain breadth (mm)	-0.014	0.064	-0.001	-0.047	0.130	-0.009	-0.254	0.427	-0.041	-0.272	0.012	-0.649	-0.291	0.053
Grain L/B ratio	-0.077	0.101	0.229	0.177	-0.063	0.016	0.443	-1.000	0.313	-1.525	-0.369	1.781	-0.241	-0.213
1000 grains weight (g)	-0.083	0.144	0.216	0.092	0.032	0.005	0.245	-0.797	0.256	-1.574	0.638	0.930	-0.462	-0.356

*Significant at 5% level, ** Significant at 1 % level, residual effect = 0.4047.

Table 12. Matrix of direct (diagonal) and indirect effect of yield attributing characters on yield of rice [pooled over two environments].

Characters	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of panicle/plant	Panicle weight (g)	Panicle length (cm)	Floret No./ panicle	No. of grains/ Panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	1000 grains weight (g)	Genotypic yield correlation
Plant height (cm)	0.281	0.180	0.070	0.039	-0.014	-0.048	0.972	-0.701	-0.066	-0.849	0.066	0.175	-0.214	-0.021
Days to 50 % flowering	0.150	0.422	0.126	-0.039	-0.011	-0.109	1.076	-0.969	0.141	-1.069	0.233	0.260	-0.205	-0.113
Days to maturity	0.143	0.297	0.206	0.065	0.003	-0.094	1.138	-1.255	0.259	-0.948	0.023	0.354	-0.149	0.043
No. of panicle/plant	-0.027	0.013	0.061	-0.453	0.006	0.053	-0.736	0.365	0.058	0.103	-0.065	0.505	-0.022	0.308
Panicle weight (g)	-0.024	0.060	0.056	0.044	0.136	0.012	-0.796	0.778	-0.015	-0.041	0.254	-0.178	0.053	0.225
Panicle length (cm)	-0.081	-0.113	0.067	-0.014	0.031	0.367	-0.19	0.899	-0.084	-0.222	-0.137	0.360	-0.016	0.118
Floret No./ panicle	-0.146	-0.222	-0.079	-0.163	0.062	0.180	-2.095	1.758	0.103	0.229	0.084	-0.103	0.092	0.431*
No. of grains/ Panicle	-0.128	-0.197	-0.103	-0.173	0.066	0.166	-1.661	2.116	-0.556	0.393	0.084	-0.285	0.139	0.479*
Fertility %	-0.029	-0.058	-0.092	-0.149	0.029	0.014	0.180	1.106	-1.070	0.630	0.032	-0.599	0.119	0.206
Grain length (mm)	0.173	0.236	0.125	0.210	0002	-0.022	1.470	-1.373	0.168	-1.652	0.093	0.515	-0.242	-0.281
Grain breadth (mm)	-0.079	-0.098	-0.002	-0.043	0.068	0.155	-0.636	0.715	-0.104	-0.058	0.360	.657	-0.149	0.133
Grain L/B ratio	0.131	0.238	0.119	0.176	-0.034	-0.123	1.430	-1.450	0.218	-1.231	-0.063	0.488	-0.136	-0.283
1000 grains weight (g)	0.125	0.223	0.112	0.150	0.023	0.005	1.089	-0.911	-0.076	-1.281	0.307	0.354	-0.287	-0.165

*Significant at 5% level; **Significant at 1% level; residual effect = 0.4350.

interests.

REFERENCES

Akhtar N, Nazir MF, Rabnawaz A, Mahmood T, Safdar ME, Asif M, Rehman A (2011).Estimation of heritability, correlation and path coefficient analysis in fine grain rice (*Oryza sativa* L.). J. Anim. Plant Sci. 21(4):660-664.

Ali MA, Nawad NN, Abbas A, Zulkiffal M, Sajjad M (2009). Evaluation of selection criteria in *Cicerarietinum* L. using correlation coefficients and path analysis. Aust. J. Crop Sci. 3(2):65-70.

Ashvani P, Dhaka RPS, Sharma R K, Arya KPS, Panwar A (1997). Genetic variability and inter-relationship in rice. Adv. Plant Sci. 10(1):29-32.

Bhatti MK, Ijaz M, Akhter M, Rafig M, Mushtag Ch (2005). Correlation coefficient analysis of yield and yield components in fine rice lines/varieties. International Seminar on Rice Crop at Rice Research Institute.

Ceyhan E, Avci MA (2005). Combining ability and heterosis for grain yield and some yield components in pea (*Pisum sativum* L.). Pak. J. Biol. Sci. 8(10):1447-1452.

Chand SP, Roy SK, Mondal GS, Mahato PD, Panda S, Sarkar G, Senapati BK (2004). Genetic variability and character association in rainfed lowland Aman paddy (*oryza sativa* L.) Environ. Ecol. 22 (2):430-434.

Chaubey PK, Richharia AK (1993). Genetic variability, correlation and path coefficients in Indian rice. Indian J. Genet. Plant Breed. 53(4):356-360.

Chaudhary PK, Singh RP (1994). Genetic variability, correlation and path analysis of yield components of rice. Madras Agric. J. 81(9):458-470.

Cyprien M, Kumar V (2011). Correlation and path coefficient analysis of rice cultivars data. J. Reliab. Stat. Stud. 4(2):119-131.

FAO (Food and Agriculture Organization) (2004). Rice is life. Italy: FAO International Year of Rice 2004. Rice and Human Nutrition; 2004. Hereditas 140:226-228.

Indu Rani C, Veeraragathantham D, Sanjutha S (2008). Studies on correlation and path Kalyani Publishers. New Delhi.

Mohsin T, Khan N, Naqvi FN (2009). Heritability, phenotypic correlation and path coefficient studies for some agronomic characters in synthetic elite lines of Wheat. J. Food Agric. Environ. 7:278-282.

Nayak AR, Reddy JN (2005). Seasonal influence on quality characters in scented rice (*oryza sativa* L.) Indian Journal of Genetics and Plant Breeding. 65(2):127-128.

Padmavathi N, Mahadevappa M, Reddy OVK (1996). Association of various yield components in rice (oryza sativa L.). Crop Res. Hasar 12(3):352-357.

Prasad B, Patwary AK, Biswas PS (2001). Genetic variability and selection criteria in fine rice (*Oryza sativa* L.). Pak. J.

Biol. Sci. 4:1188-1190.
Ranjan S, Kumar M, Pandey SS (2006). Genetic variability in peas (*Pisum sativum* L.). Legume Res. 29(4):311-312.
Reuben SWM, Kisanga JRL (1989). Cause and effect relationship of yield and its components in advanced breeding lines of upland rice. Oryza 26 (4):338-342.
Roy B, Hossain M, Hossain F (2001). Genetic variability in yield components of rice (*oryza sativa*). Environ. Ecol. 19(1):186-189.
Sarkar KK, Bhutia KS, Senapati BK, Roy SK, Panda S, Mondal AB (2005). Genetic variability and relationship between grain yield and its component traits in rice (*Oryza sativa* L.). Environ. Ecol. 23(4):702-706.
Sawant DS, Patil S L (1995). Genetic variability and heritability in rice. Annals of agricultural Research. 16(1):59-61.
Singh JD, Singh IP (2004) Selection parameters for seed yield in field pea (*Pisum sativum* L.). Nat. J. Plant Improv. 6(1):51-52.
Singh RK, Chaudhary BD (1977). Biometrical methods in quantitative genetics analysis.
Togay N, Togay Y, Yildirin B, Dogan Y (2008). Relationships between yield and some yield components in pea (*Pisum sativum* ssp. arvense L.) genotypes by using correlation and path analysis. Afr. J. Biotechnol. 7(23):4285-4287.
Toker C, Cagirgan MI (2004). The use of phenotypic correlations and factor analysis in coefficient analysis on yield attributes in Root Knot Nematode Resistant F1 hybrids of tomato. J. Appl. Sci. Res. 4(3):287-295.
Zahid M, Akhter M, Sabar M, Zaheen M, Tahir A (2006). Correlation and path analysis studies of yield and economic traits in basmati rice (*Oryza sativa* L). Asian J. Plant Sci. 5 (4):643-645.