SHORT COMMUNICAITON Oryza Vol. 53 No.2, 2016 (201-206)

Assessment of genetic variability in spring sown upland rice of Uttarakhand hills

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Received : 22 September 2015 Accepted : 3 June 2016 Published : 20 July 2016

ABSTRACT

Genetic variability, genotypic and phenotypic coefficient of variation, heritability, genetic advance, correlation coefficients among yield and yield components, direct and indirect effect of yield components on yield for fifteen characters in twenty rice genotype under rainfed upland ecosystem were carried out. The analysis of variance revealed that there were highly significant differences for all the characters among the genotypes. Higher GCV and PCV were observed in yield per plot and flag leaf width. High heritability with high genetic advance was observed in grains per panicle and fertile grains per panicle which indicated the governance by additive gene. But high heritability with low genetic advance was observed in L/B ratio, flag leaf width, kernel length, kernel width and yield per plot suggesting that these traits had greater influence of the non-additive gene action. Plant height had positive significant correlation with days to 50% flowering, days to maturity, grains per panicle, fertile grains per panicle and kernel width. Days to 50% flowering was significantly and positively correlated with days to maturity, flag leaf length, flag leaf width, grains per panicle and fertile grains per panicle. The path coefficient analysis at phenotypic level revealed that fertile grains per plant had the maximum positive direct effect on grain yield followed by plant height, kernel length and tillers per plant.

Key words: *Spring sown upland rice, variability, correlation, path analysis, yield components*

Rice (*Oryza sativa* L) is a major food for the people of hill regions of Uttarakhand. Spring rice is traditionally grown by the hill farmers of Uttarakhand in rainfed direct seeded upland ecosystem. It is sown when pre-monsoon rainfalls receive in the month of March and April. Although, it has very long growing duration but it is practiced by the hill farmers over the past many decades may be due to the crop varietal adaptability in the existing agro-ecological conditions. Most of the cultivars grown in these regions should have tolerance to water stress, major diseases and insect pests.

Rice grown in upland ecosystem has much less grain yield as compared to irrigated ecosystems because of erratic rainfall pattern, poor soil fertility, weed competition and high temperature. Attempt for improving grain yield under rainfed upland condition has also been very limited. In order to increase the productivity, development of good varieties with specific traits should be taken into consideration. In any rice breeding programme, attempts are always being made to break the yield barrier. Grain yield is a very complex character and it is the result of expression of several interrelated polygenic characters. It is, therefore, imperative to obtain information from different genetic parameters influencing grain yield. Development of high yielding varieties requires a thorough knowledge of existing genetic variation and also the extent of genetic association among the yield contributing characters. Knowledge of correlation between grain yield and other characters is helpful in selection of suitable plant type. When more characters are included in correlation study, the association become complex, in such situations, selection on the basis of direct and indirect effects is much more useful than selection for yield *per se*. Therefore, the present investigation was undertaken to study the genetic variability and character association for yield and its component characters along with the nature and extent of direct and indirect effects of yield components on grain yield in a set of indigenous rice genotypes adapted to rainfed upland ecosystem.

The material for the present investigation consisted of twenty upland rice genotypes (Table1). The experiment was laid out in a completely randomized block design with three replications during wet season at Experimental Farm of ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora. Each plot consisted of seven rows plot of 4m length with spacing of 20 cm between rows. Observations on quantitative traits *viz.*, plant height, tillers per plant, flag leaf length, flag leaf width, panicles per plant, panicle length, grains per panicle, fertile grain per panicle, thousand grain weight, kernel length, kernel width, L/B ratio were recorded on ten randomly selected plant from middle row of each plot while days to 50 per cent flowering, days to maturity and grain yield were recorded on whole plot basis.

The mean value was used as the replicated data and was subjected to statistical analysis using INDOSTAT software package. Analysis of variance were estimated following Panse and Sukhatme (1985). The phenotypic and genotypic coefficient of variability, heritability in broad sense, genetic advance at 5% selection intensity were computed as suggested by Johanson *et al.* (1955). The phenotypic correlations coefficients among all the traits under study were calculated following Al-Jobouri *et al.* (1958) and the path analysis was carried out as per method of Dewey and Lu (1959).

Table 1. List of genotypes and their pedigreefor trait correlation study of spring sown upland rice

Genotypes	Pedigree
VL 11027	Majhera 7 x BL-245
VL 10988	VLD 206 x VLD 221
VL 11028	Majhera 7 x BL-245
VL 10964	VLD 206 x VL 88-971
VL 11049	Majhera 7 x VL 88-971
VL 11054	Majhera 7 x VL 88-971
VL 11032	Majhera 7 x BL-245
VL 31396	SRSN 38 x VL-6394
VL 31409	Basmati 370 x VR 539-2
VL 31341	China 4 x BL-122
VL 31377	China 4 x VL 6394
VL 31448	VHC 1253 x Thapachini
VL 31429	Pant Dhan 6 x VL 3288
VL 8066	VL 9588 x VR 539-2
VL 8040	VL 9632 x VL 6394
VL 11048	Majhera 7 x VL 88-971
VL 11046	Majhera 7 x VL 88-971
VLD 206	Bamni local
VLD 207	VLD 2016 x Annada
VLD 209	(Himdhan x K-39) x VLD 221

Analysis of variance revealed that the difference among the genotypes were highly significant for all the characters studied, indicating the existence of considerable genetic variation in the experimental material (Table 2). The range, mean, standard error of mean, genotypic coefficient of variation, phenotypic coefficient of variation, heritability, genetic advance at 5% selection intensity for different characters are given in Table 3. A wide range of variability was observed for all the characters under study indicating that there is ample scope for selection of grain yield as well as its component traits. The range for plant height (117-149 cm), days to 50% flowering (138-156 days), days to maturity (169-187 days), tillers per plant (5-10), flag leaf length (24.5-45.23 cm), flag leaf width (1.00-2.26 cm), panicles per plant (5-9), panicle length (21.17-27.60 cm), grains per panicle (81-182), fertile grain per panicle (66-155), thousand grain weight (17.51-30.16g), yield per plot (0.50-1.70 kg), kernel length (5.04-8.16 cm), kernel width (2.08-2.83cm) and L/B ratio (1.85-3.63) was observed. The magnitude of standard error was lower than 10% of the population means indicating less role of uncontrollable environment in experiment which showed that results can be accepted to be highly reliable. Higher magnitude of GCV of more than 20 per cent was recorded for yield per plot and flag leaf width. Sinha *et al.* (2004), Padmaja *et al.* (2008) and Ubarhande *et al.* (2009) also recorded similar observation for single plant yield. These traits offer grater scope for genetic improvement through selection. Flag leaf length, grains per panicle fertile grains per panicle, thousand grain weight, kernel length and L/B ratio recorded moderate level of GCV indicating considerable amount of variability expressed for these characters. Similar results were reported by Sharma and Sharma (2007) for these characters. Low GCV estimates were noticed for plant height, days to 50% flowering, days to maturity, tillers per plant, panicles per plant, panicle length and kernel width. These results are in conformity with Sinha *et al.* (2004) for days to 50% flowering, Patil *et al.* (2003) and Padmaja *et al.* (2008) for panicle length. In general, all the traits

Table 2. Analysis of variance for various yield contributing characters

Source of variance	d.f	Plant height	Days to 50% flowering	Days to maturity	Tillers plant^{-1}	Flag leaf length	Flag leaf width	Panicles plant^{-1}	Panicle length	Grains panicle^{-1}	Fertile grains panicle^{-1}	1000 Grain weight	Grain yield plot^{-1}	Kernel length	Kernel width	L/B ratio
Replication	2	9.22	1.55	3.72	0.65	4.59	0.01	0.80	1.04	1.35	2.87	3.11	0.00	0.11	0.01	0.01
Treatments	19	163.81**	76.11**	67.50**	1.45**	84.27**	0.32**	1.19**	5.20**	1340.22**	905.23**	22.73**	0.20**	1.53**	0.11**	0.62**
Error	38	4.48	1.36	1.31	0.44	1.69	0.01	0.38	1.29	15.52	10.28	1.59	0.01	0.05	0.01	0.01

** Significant at 1% level of probability.

exhibited higher magnitude of PCV than GCV indicating the effect of environment on the manifestation of these traits. However, the differences between PCV and GCV were very small for most of the characters indicating the lesser contribution of environmental variation towards the expression of these traits. Similar observations were also recorded by Karad and Pol (2008) and Ubarhande *et al.* (2009) in rice genotypes.

The heritability values expressed high in fertile grains per panicle (96.73), grains per panicle (96.60), days to 50% flowering (94.84), days to maturity (94.38), flag leaf length (94.23), L/B ratio (94.08) and lowest in panicle per plant (41.62) and tillers per plant (43.52). Sharma and Sharma (2007) reported high heritability for fertile grains per panicle, grains per panicle, days to 50% flowering and L/B ratio. The estimate of heritability alone is not very much useful because it includes the effect of both additive and non additive gene. The genetic advance is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. The genetic advance recorded highest in grains per panicle (42.54) followed by fertile grains per panicle (34.99) and lowest in kernel width (0.35), flag leaf width (0.62), panicle per plant (0.69) and tillers per plant (0.79). Sharma and Sharma (2007) also reported similar results for grains per panicle and fertile grains per panicle. High genetic advance is only due to additive gene action and direct selection may be effective for grains per panicle and fertile grains per panicle. Heritability estimates along with genetic advance are more helpful in predicting gain under selection than heritability estimate alone (Sinha *et al.* 2004; Johnson *et al.* 1955). High heritability with high genetic advance was observed in grains per panicle and fertile grains per panicle. This is most likely due to additive gene effect and direct selection may be very effective. High heritability with low genetic advance was observed in L/B ratio, flag leaf width, kernel length, kernel width and yield per plot. These characters are governed by non additive gene action (epistatis/ dominance) and G x E interaction. The high heritability being exhibited in this case is due to favourable influence of the environment rather than genotypic. In these cases, simple selection might not be effective. As such progeny of family testing should be practiced for improvement of these traits. The characters showing high heritability along with moderate or low genetic advance can be improved by intermating superior

Table 3. Range, mean and genetic parameters of yield attributing characters in spring sown rainfed upland rice

Characters	Range	GM	SEm	GCV (%)	PCV (%)	h^2 (%)	GA at 5%	GA as % mean
Plant height (cm)	117-149	133.98	1.73	5.44	5.66	92.22	14.42	10.76
Days to 50% flowering (days)	138-156	149.45	0.95	3.34	3.43	94.84	10.01	6.70
Days to maturity (days)	169-187	179.63	0.94	2.61	2.69	94.38	9.40	5.23
Tillers per plant (number)	5-10	7.15	0.54	8.14	12.34	43.52	0.79	11.06
Flag leaf length (cm)	24.50 - 45.23	32.09	1.06	16.35	16.84	94.23	10.49	32.69
Flag leaf width (cm)	1.00-2.26	1.55	0.09	20.57	21.67	90.10	0.62	40.21
Panicles plant^{-1} (number)	5-9	6.70	0.50	7.76	12.02	41.62	0.69	10.31
Panicle length (cm)	21.17-27.60	23.81	0.92	4.80	6.76	54.40	1.67	7.02
Grains panicle^{-1} (number)	81-182	124.55	3.21	16.87	17.16	96.60	42.54	34.15
Fertile grains panicle^{-1} (number)	66-155	97.88	2.59	17.65	17.94	96.73	34.99	35.75
1000grain weight (g)	17.52-30.16	22.93	1.03	11.58	12.82	81.63	4.94	21.55
Grain yield plot^{-1} (Kg)	0.50-1.70	1.08	0.08	23.47	25.27	86.28	0.49	44.90
Kernel length (cm)	5.04-8.16	6.11	0.19	11.49	12.10	90.15	1.37	22.48
Kernel width (cm)	2.08-2.83	2.48	0.06	7.53	8.16	85.15	0.35	14.31
L/B ratio	1.85-3.63	2.49	0.09	18.01	18.57	94.08	0.89	35.98

genotypes of segregating population developed from combination breeding (Samadia 2005).

The correlation coefficient among yield contributing traits and grain yield in the present investigation is presented in Table 4. The studies of correlation of characters indicate the intensity and direction of character association which helps in improving yield through selection. The information on the inter correlation among the yield components showed the nature and extent of relationship with each other. This will help in the simultaneous improvement of different characters along with grain yield in the breeding programme. In the component traits plant height showed positive significant correlation with days to 50% flowering, days to maturity, grains per panicle, fertile grains per panicle and kernel width, whereas, negative significant correlation with thousand grain weight, kernel length and L/B ratio. Sharma and Sharma (2009) and Subudhi and Dikshit (2009) reported significant positive correlation between plant height and grains per panicle and panicle length. Days to 50% flowering was significantly and positively correlated with days to maturity, flag leaf length, flag leaf width, grains per panicle and fertile grains per panicle. This indicates that days to maturity will increase with increase of days to 50% flowering. Sharma and Sharma (2009) reported significant positive correlation of days to 50% flowering with days to maturity. The positive significant association was observed between days to maturity with flag leaf length, flag leaf width, grains per panicle and fertile grains per panicle. Grains per panicle exhibited positive association with fertile grains per panicle. L/B ratio was significantly and positively correlated with flag leaf width, panicle length, thousand grain weight and kernel length.

Inter-se-association amongst the above traits indicated that although most of the component traits did not exhibit positive significant association with grain yield, their role in contributing towards grain yield could not be overlooked as these component traits exhibited positively significant association with important yield attributes. It is assumed that these traits may be indirectly contributed via other traits in governing grain yield. Therefore, it is important to partition out the observed phenotypic association into direct and indirect effects of the component traits towards grain yield.

Characters contributing to grain yield may contribute directly or indirectly. Here lies the essence of conducting the path analysis. The estimates of direct and indirect effect are presented in Table 5. In present study, fertile grains per plant had the highest positive direct effect on grain yield followed by plant height, kernel length and tillers per plant. Days to maturity, flag leaf width, panicle per plant, grains per panicle, kernel width and L/B ratio exhibited negative direct effect on grain yield. Highest positive but indirect effect was observed for L/B ratio via kernel width. Days to 50% flowering, flag leaf length and panicle length were neither contributing directly or indirectly to a detectable extent. Plant height, days to 50% flowering, days to

Table 4. Phenotypic correlation coefficients among grain yield and component traits in spring sown rainfed upland rice

Characters	Plant height	Days to 50% flowering	Days to maturity	Tillers plant^{-1}	Flag leaf length	Flag leaf width	Panicles plant^{-1}	Panicle length	Grains panicle^{-1}	Fertile grains panicle^{-1}	1000 grain weight	Grain yield plot^{-1}	Kernel length	Kernel width	L/B ratio
Plant height	**1.000**	0.462 **	0.446 **	-0.023	0.170	0.215	-0.085	-0.099	0.340 **	0.333 **	-0.376 **	0.249	-0.324 *	0.379 **	-0.389 **
Days to 50% flowering		**1.000**	0.969**	0.116	0.525**	0.578**	0.069	0.017	0.625**	0.584**	-0.345 **	-0.187	-0.015	-0.153	0.069
Days to maturity			**1.000**	0.122	0.481**	0.585**	0.041	0.077	0.584**	0.529**	-0.269 *	-0.198	0.068	-0.200	0.143
Tillers per plant				**1.000**	0.344 **	0.204	0.748**	0.087	0.228	0.208	0.176	0.059	0.174	-0.037	0.137
Flag leaf length					**1.000**	0.579**	0.375**	-0.127	0.618**	0.579**	-0.166	-0.276 *	-0.043	0.022	-0.045
Flag leaf width						**1.000**	0.181	0.069	0.339**	0.389**	0.072	-0.235	0.355**	-0.346 **	0.381**
Panicles per plant							**1.000**	0.190	0.141	0.064	0.153	-0.077	0.187	-0.080	0.165
Panicle length								**1.000**	-0.040	-0.093	0.461 **	-0.061	0.545**	-0.271*	0.477**
Grains panicle^{-1}									**1.000**	0.923**	-0.188	-0.262 *	-0.198	0.210	-0.233
Fertile grains panicle^{-1}										**1.000**	-0.192	-0.081	-0.174	0.134	-0.183
1000grain weight											**1.000**	-0.124	0.752**	-0.156	0.548**
Grain yield plot^{-1}												**1.000**	-0.166	0.000	-0.108
Kernel length													**1.000**	-0.595**	0.924**
Kernel width														**1.000**	-0.854**
L/B ratio															**1.000**

Table 5. Phenotypic path coefficient analysis among the quantitative characters in spring sown rainfed upland rice

Characters	Plant height	Days to 50% flowering	Days to maturity	Tillers plant^{-1}	Flag leaf length	Flag leaf width	Panicles plant^{-1}	Panicle length	Grains panicle^{-1}	Fertile grains panicle^{-1}	1000 Grain weight	Kernel length	Kernel width	L/B ratio	Grain yield plot^{-1}
Plant height	**0.550**	0.254	0.245	-0.013	0.094	0.118	-0.047	-0.055	0.187	0.183	-0.207	-0.178	0.208	-0.214	0.249
Days to 50% flowering	0.045	**0.097**	0.094	0.011	0.051	0.056	0.007	0.002	0.061	0.057	-0.034	-0.001	-0.015	0.007	-0.187
Days to maturity	-0.074	-0.162	**-0.167**	-0.020	-0.080	-0.098	-0.007	-0.013	-0.098	-0.089	0.045	-0.011	0.033	-0.024	-0.198
Tillers plant^{-1}	-0.007	0.036	0.037	**0.308**	0.106	0.063	0.230	0.027	0.070	0.064	0.054	0.054	-0.011	0.042	0.059
Flag leaf length	0.001	0.004	0.004	0.003	**0.008**	0.005	0.003	-0.001	0.005	0.005	-0.001	0.000	0.000	0.000	-0.276
Flag leaf width	-0.083	-0.223	-0.226	-0.079	-0.223	**-0.386**	-0.070	-0.027	-0.131	-0.150	-0.028	-0.137	0.133	-0.147	-0.235
Panicles plant^{-1}	0.007	-0.006	-0.003	-0.059	-0.030	-0.014	**-0.079**	-0.015	-0.011	-0.005	-0.012	-0.015	0.006	-0.013	-0.077
Panicle length	-0.007	0.001	0.005	0.006	-0.008	0.005	0.013	**0.067**	-0.003	-0.006	0.031	0.036	-0.018	0.032	-0.061
Grains panicle^{-1}	-0.436	-0.801	-0.748	-0.291	-0.791	-0.435	-0.180	0.051	**-1.281**	-1.183	0.241	0.254	-0.269	0.298	-0.262
Fertile grains panicle^{-1}	0.352	0.618	0.560	0.220	0.612	0.412	0.068	-0.098	0.976	**1.058**	-0.203	-0.184	0.141	-0.194	-0.081
1000grain weight	-0.067	-0.062	-0.048	0.031	-0.030	0.013	0.028	0.083	-0.034	-0.034	**0.179**	0.135	-0.028	0.098	-0.124
Kernel length	-0.170	-0.008	0.036	0.091	-0.023	0.186	0.098	0.286	-0.104	-0.091	0.395	**0.525**	-0.312	0.485	-0.166
Kernel width	-0.390	0.157	0.206	0.038	-0.022	0.356	0.083	0.279	-0.216	-0.137	0.160	0.612	**-1.029**	0.878	0.000
L/B ratio	0.528	-0.093	-0.194	-0.186	0.061	-0.517	-0.223	-0.647	0.316	0.249	-0.743	-1.254	1.159	**-1.357**	-0.108

*Residual effect= 0.673

maturity, tillers per plant, flag leaf length, flag leaf width and grains per panicle were observed to contribute positively to an appreciable extent via fertile grains per panicle. The earlier work of Shivani and Reddy (2000); Kavitha and Reddi (2001); Biao *et al.* (2002); Shanthala *et al.* (2004) and Shashidhar *et al.* (2005) have also been reported the direct and indirect effect of yield component traits on grain yield.

ACKNOWLEDGEMENT

We thank the Director, ICAR-VPKAS, Almora and Head, Crop Improvement Division for providing the necessary facilities to carry out the experiment. The authors also duly acknowledge the support of Sri Devendra Lal and Sri Jagdish Kumar Arya.

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