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Quantitative analysis of upland rice

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ABSTRACT

Analysis of variance of forty upland genotypes indicated that all the genotypes were significantly different, with respect to most of the characters, except number of tillers plant^{-1}, effective tiller plant^{-1} and grain yield panicle^{-1}. Characters like grain yield plant^{-1}, flag leaf area, grain yield panicle^{-1}, plant height, 1000-grain weight and number of grains panicle^{-1} had recorded light to moderate PVC, GCV, heritability and genetic advance as per cent of mean. grain yield plant^{-1} had a significant and positive association with number of tillers plant^{-1}, effective tillers plant^{-1}, plant height, panicle length, number of grains panicle^{-1}, grain yield panicle^{-1}, flag leaf area and 1000-grain weight both at genotypic and phenotypic level. Path analysis revealed that all characters had positive direct effect on grain yield plant^{-1}, except 1000-grain weight. Present study revealed that grain yield panicle^{-1}, number of grains panicle^{-1}, flag leaf area and plant height should be given more weightage during selection for increasing grain yield in upland rice.

Key words: *Upland rice, variability, heritability, character association*

In Jharkhand, upland rice cultivation is most popular where rainfall is scanty. Development of high yielding genotypes under such conditions requires a thorough knowledge of existing genetic variation and extent of association of yield contributing characters. The observed variability is a combined estimate of genetic and environmental causes whereas genetic variability alone is heritable. Moreover, the estimates of genetic variability across the environments within the conditions can, however, result with a favourable environment to exploit complete genetic variability to exercise selection for the development of yield contributing traits. An estimate of heritability alone does not give an idea about the expected gain in the next generation but it has to be considered in conjunction with genetic advance. The knowledge of correlation coefficients and path coefficients had provided a clear picture about the association of yield and yield components. The extent of their direct and indirect effect influences on seed yield in upland rice is scanty. Therefore, the present investigation was made with an objective to identify the yield traits and to determine the magnitude of their contribution for increasing grain yield in upland rice.

MATERIALS AND METHODS

The experimental materials for the study consisted of forty genotypes suitable for upland condition. These genotypes were directly sown in a randomized block design with three replications under upland situation during wet season in a plot size of 8 m X 1 m at a distance of row to row 20 cm and plant to plant 10 cm. Observations were recorded on five randomly selected plants of each entry in every replication for days to first panicle emergence, days to maturity, number of tillers plant^{-1}, effective tillers plant^{-1}, plant height (cm), panicle length (cm), flag leaf area (cm^2), number of grains panicle^{-1}, 1000- grain weight (g), grain yield panicle^{-1} (g), grain yield plant^{-1} (g) and harvest index (%). Mean value was used for calculating the genotypic and phenotypic variance (Johnson *et al*., 1955). The heritability and other variability parameters were estimated following Burton and Devane (1953). Genotypic and phenotypic correlation coefficients were worked out following Mullar *et al*., (1958). The path analysis was done as per the procedure outlined by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance (Table 1) revealed that all the treatments were significantly different with respect to most of the characters except for number of tiller plant^{-1}, effective tiller plant^{-1} and grain yield panicle^{-1}.

The difference between the genotypic and phenotypic variance (Table 2) for plant height, days to maturity, number of grains panicle^{-1} and days to first panicle emergence were moderate which indicates that the environment did not influence these characters much. Values of phenotypic and genotypic variance were very close for grain yield panicle^{-1}, grain yield plant^{-1}, 1000-grain weight, total number of tillers plant^{-1}, flag leaf area and ear bearing tillers plant^{-1} in Dular, Mutant-25, Mutant-24 and Panke. The characters with almost equal value of phenotypic and genotypic variance can be considered stable. Low level of genotypic variance for number of tillers plant^{-1}, effective tillers plant^{-1}, panicle length, grain yield panicle^{-1} and grain yield plant^{-1} is indicative of unstable nature of these characters in Dular, IART-112, Mutant-16 and Chipti. A similar result on genotypic and phenotypic variance have earlier been reported by De and Suriya Rao (1988), Ananda Kumar (1992) and Mokate *et al*. (1998).

The genotypic coefficient of variation provides a measure to compare the genetic variability present in various quantitative characters. The highest genotypic coefficient of variation (24.49) was recorded for grain yield plant^{-1} in Mutant-25, Mutant-24 and 385-B 6164 F-MR-6. The characters like flag leaf area, grain yield panicle^{-1}, 1000-grain weight, number of grain panicle^{-1} and ear bearing tillers gave comparatively higher value for genotypic coefficient of variation (Table 3). The higher values clearly indicated high degree of genotypic variability in these quantitative characters in rice. This finding is in general agreement with those recorded by Chauhan *et al*. (1993), Ganesan *et al*. (1995), Rao *et al*. (1996) and Mokate *et al*.(1998) in rice.

Phenotypic coefficient of variation which measures total relative variation was highest for grain yield plant^{-1} (26.33) and was followed by flag leaf area (23.05), grain yield panicle^{-1} (18.85) and ear bearing tillers plant^{-1} (18.21). Besides, plant height, number of grains panicle^{-1} and 1000-grain weight also had higher phenotypic coefficient of variation in Mutant-25, Dular and 386-B 3632-F-TB-1 1000-grain weight had highest heritability (99.93) followed by days to maturity (96.45), plant height (94.71), flag leaf area (90.95) and grain yield panicle^{-1} (89.90) in Mutant-9, Mutant-24 and 24/89 IART-112, whereas harvest index (58.80) and effective tillers plant^{-1} (47.19) had moderate heritability. The high heritability of the above characters indicated that the influence of the environment of these characters is negligible or low. Hence, plant breeders may use these characters in their upland rice improvement programme.

The estimate of heritability alone is not very

Table 1. Analysis of variance for different characters in upland rice.

Characters	d.f.	Days to first panicle emergence	Days to maturity	Number of tillers plant^{-1}	Effective tillers plant^{-1}	Plant height (cm)	Panicle length (cm)	Flag leaf area	Number of grains (cm^2)	1000 grain wt.(g) panicle^{-1}	Grain yield panicle^{-1} (g)	Grain yield plant^{-1} (g)	Harvest index (%)
Replication	2	36.78**	3.12	0.49	0.86	31.78**	6.59**	2.58	33.26**	0.01	0.02	1.32	63.12**
Genotype	39	150.38**	205.07**	0.80	1.01	439.07**	9.55**	16.35**	167.72**	61.14**	0.13	3.85**	76.52**
Error	78	8.06	2.48	0.08	0.27	8.02	1.04	0.52	7.46	0.01	0.01	0.19	14.48

** Significant at 1% level

Table 2. Estimates of phenotypic (σ^2p), genotypic (σ^2g) and error variance (σ^2e) for different characters in upland rice.

Characters	σ^2p	σ^2g	σ^2e
Days to first emergence	55.50	47.44	8.06
Days to maturity	70.01	67.52	2.48
Number of tillers plant^{-1}	0.32	0.23	0.08
Effective tillers plant^{-1}	0.52	0.24	0.27
Plant height (cm)	151.70	143.68	8.02
Panicle length(cm)	3.87	2.83	1.04
Flag leaf area(cm^2)	5.80	5.27	0.52
Numbers of grains/panicle	60.88	53.41	7.46
1000 Grain weight. (g)	20.39	20.37	0.01
Grain yield/panicle (g)	0.04	0.04	0.00
Grain yield/plant (g)	1.41	1.22	0.19
Harvest index (%)	35.16	20.67	14.48

Table 3. Phenotypic (PVC) and genotypic (GCV) coefficient of variation, heritability (h^2), genetic advance and genetic advance (GA) as percentage of mean for different characters in upland rice.

Characters	PCV	GCV	h^2 (%)	GA	GA as percentage of mean
Days to first panicle emergence	11.17	10.32	85.47	13.11	19.66
Days to maturity	8.44	8.28	96.45	16.62	16.77
Number of tillers plant^{-1}	11.64	9.94	72.89	0.86	17.49
Effective tillers plant^{-1}	18.21	12.51	47.19	0.70	17.71
Plant height (cm)	17.64	17.17	94.71	24.03	34.42
Panicle length (cm)	12.54	10.72	73.09	2.96	18.89
Flag leaf area (cm^2)	23.05	21.98	90.95	4.51	43.19
Number of grains panicle^{-1}	17.33	16.23	87.74	14.10	31.32
1000 Grain weight (g)	17.08	17.08	99.93	9.29	35.17
Grain yield panicle^{-1} (g)	18.85	17.86	89.80	0.40	34.88
Grain yield plant^{-1} (g)	26.23	24.49	86.50	2.11	46.92
Harvest index (%)	12.45	9.55	58.80	7.18	15.08

much useful in predicting resultant effect for selecting the best individuals because, it includes the effect of both additive gene as well as non-additive gene. High genetic advance occurs only due to additive gene action (Panse, 1957). So heritability estimates coupled with the genetic advance would be more useful than heritability alone. On examining the estimates of genetic advance expressed as percentage of mean for different characters (Table 3), it was observed that grain yield plant^{-1} had highest genetic advance as percentage of mean (46.92) and was followed by flag leaf area (43.19), 1000-grain weight (35.17) grain yield panicle^{-1} (34.88), plant height (34.34) and number of grains panicle^{-1} (31.32). Rest of the characters showed appreciable values. When both heritability and genetic advance is considered, it is observed that grain yield plant^{-1}, grain yield panicle^{-1}, 1000-grain weight, number of grains panicle^{-1}, flag leaf area and plant height showed high heritability coupled with high genetic advance. Similar high estimate of heritability and genetic advance has been reported earlier by Rema Bai *et al*. (1992) for plant height, flag leaf area, panicle length and grain yield plant^{-1}.

The result (Table 4) obtained in the present study revealed that the genotypic correlation were slightly higher than their corresponding phenotypic correlations for most of the characters. Grain yield plant^{-1} indicated highly significant and positive association with grain yield panicle^{-1}, number of grains panicle^{-1}, panicle length, plant height, number of tillers plant^{-1} and effective tillers plant^{-1}. 1000 grain weight and flag leaf area showed positive and significant association. Besides these, days to first panicle emergence and days to maturity showed positive but weak association with grain yield plant^{-1} both at genotypic as well as phenotypic level.

Path analysis (Table 5) revealed that the grain yield panicle^{-1} had the highest positive direct effect on grain yield plant^{-1} and its indirect effects through days to first panicle emergence, number of tillers plant^{-1}, panicle length and plant height were also positive though the magnitude was low. Grain yield panicle^{-1} had also high genotypic coefficient of variation, high heritability with high genetic advance in percent of mean. Naturally this character can be used as one of the most important yield component for selection. Number of tillers plant^{-1} had also shown high direct effect on grain yield plant^{-1}. Plant height exhibit positive direct effect on grain yield plant^{-1} and the magnitude was appreciable. Effective tiller plant^{-1} had a good direct effect on grain yield plant^{-1}. Number of grains panicle^{-1} had an appreciable positive direct effect on grain yield plant^{-1}. Flag leaf area, panicle length, days to first panicle emergence, days to maturity and harvest index, though had positive direct effect on grain yield plant^{-1} but low in magnitude. 1000 grain weight had weak direct negative effect on grain yield plant^{-1}.

The residual effect (0.725) suggests that there are possibly more and quite important componental traits affecting grain yield which have not been covered in the present study and it would be worthwhile to include these components for further studies.

Table 4. Phenotypic (P) and genotypic (G) correlation between different pairs of characters in upland rice.

Characters		Days to maturity plant^{-1}	Number of tillers plant^{-1}	Effective tillers (cm)	Plant height (cm)	Panicle length	Flag leaf area(cm^2) panicle^{-1}	Number of grains	1000 Grain Wt. (g) panicle^{-1}(g)	Grain yield	Harvest index (%)	Grain yield plant^{-1}(g)
Days to first panicle emergence	P	0.851**	-0.043	0.060	-0.034	-0.107	-0.234	0.180	0.117	0.248	-0.282	0.221
	G	0.886**	-0.069	0.097	-0.026	-0.159	-0.270	0.189	0.129	0.257	-0.437**	0.230
Days to maturity	P		-0.018	0.076	0.094	-0.099	-0.263	0.162	0.108	0.217	-0.355*	0.229
	G		0.009	0.099	0.096	-0.133	-0.290	0.173	0.111	0.227	-0.481**	0.241
Number of tillers plant^{-1}	P			0.601**	0.740**	0.532**	0.395*	0.340*	-0.132	0.237	-0.147	0.687**
	G			0.852**	0.876**	0.691**	0.479**	0.409**	-0.156	0.272	-0.282	0.708**
Effective tillers plant^{-1}	P				0.442**	0.244	0.190	0.138	-0.025	0.145	-0.129	0.557**
	G				0.690**	0.555**	0.213	0.243	-0.039	0.249	-0.297	0.773**
Plant height (cm)	P					0.638**	0.443**	0.460**	-0.087	0.355*	-0.360*	0.626**
	G					0.713**	0.446**	0.480**	-0.090	0.372*	-0.490**	0.668**
Panicle length(cm)	P						0.362*	0.675**	-0.251	0.421**	-0.075	0.546**
	G						0.387*	0.752**	-0.300	0.436**	-0.231	0.608**
Flag leaf area(cm^2)	P							0.242	0.042	0.291	-0.056	0.357*
	G							0.237	0.044	0.304	-0.083	0.377*
Number of grainspanicle^{-1}	P								-0.373*	0.600**	-0.121	0.522**
	G								-0.400*	0.555**	-0.190	0.516**
1000 Grain Wt. (g)	P									0.496**	-0.133	0.315*
	G									0.529**	-0.172	0.340*
Grain yield panicle^{-1} (g)	P										-0.208	0.789**
	G										-0.316	0.812**
Harvest index (%)	P											-0.217
	G											-0.345*

* Significant at 5% level; ** Significant at 1% level

Table 5. Partitioning of correlation in to direct and indirect effects of different characters on grain yield plant^{-1} in upland rice.

Characters	Days to first panicle emergence	Days to maturity	Number of tillers plant^{-1}	Effective tillers plant^{-1}	Plant height (cm)	Panicle length (cm)	Flag leaf area(cm^2)	Number of grains panicle^{-1}	1000 Grain Wt.(g)	Grain yield panicle^{-1} (g)	Harvest index (%)	Correlation of grain yield plant^{-1} (g)
Days to first panicle emergence	**0.057**	0.039	-0.017	0.012	-0.001	-0.010	0.005	-0.027	-0.002	0.175	-0.011	0.221
Days to maturity	0.048	**0.046**	0.022	0.005	0.003	-0.001	0.001	-0.001	0.000	0.104	-0.005	0.229
Number of tillers plant^{-1}	-0.002	0.003	**0.394**	0.124	0.015	0.050	-0.009	-0.052	0.002	0.174	-0.005	0.687
Effective tillers plant^{-1}	0.003	0.101	0.236	**0.208**	0.000	-0.007	0.001	0.013	-0.001	0.014	-0.001	0.557
Plant height (cm)	-0.002	0.006	0.282	0.000	**0.221**	0.024	-0.004	-0.032	0.000	0.129	-0.009	0.629
Panicle length(cm)	-0.006	-0.000	0.209	-0.014	0.005	**0.095**	0.000	0.156	0.002	0.144	0.004	0.546
Flag leaf area(cm^2)	-0.013	-0.003	0.157	-0.006	0.004	0.001	**0.123**	-0.007	-0.002	0.120	0.000	0.357
Number of grains panicle^{-1}	0.010	0.000	0.136	-0.017	0.005	0.035	-0.001	**0.151**	0.003	0.158	0.001	0.522
1000 Grain weight(g)	0.007	0.000	-0.051	0.009	0.000	-0.016	-0.103	0.036	**-0.014**	0.255	-0.203	0.315
Grain yield plant^{-1} (g)	0.014	0.000	0.097	-0.004	0.004	0.019	-0.004	-0.034	-0.009	**0.707**	0.000	0.789
Harvest index (%)	-0.016	-0.005	-0.154	-0.003	-0.105	0.009	0.000	-0.004	0.001	0.002	**0.040**	-0.217

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