GENETIC VARIABILITY AND ASSOCIATION OF YIELD ATTRIBUTING TRAITS WITH GRAIN YIELD IN UPLAND RICE

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Jambhulkar N. N. and L. K. Bose (2014*): G*enetic variability and association of yield attributing traits with grain yield in upland rice*-* Genetika, Vol 46, No. 3, 831-838
A study was undertaken to find out the genetic variability and correlation between yield and other yield attributing characters of rice genotypes in upland ecology. The experiment was conducted with twenty two upland genotypes grown during Wet season under direct seeded condition in a randomized block design. Analysis of variance shows significance in all the traits indicating the presence of considerable amount of genetic variation among the genotypes. The traits like plant height, ear bearing tiller and yield has high genotypic coefficient of variance, phenotypic coefficient of variance and genetic advance. Plant height, ear bearing tiller, panicle length, panicle weight and length were positively and significantly correlated with yield. Plant height and grain per panicle, 50% flowering, thousand grain weight and ear bearing tiller has high direct effect on yield. Therefore, selection based on plant height, 50% flowering, thousand grain weight and ear bearing tiller could be more effective in upland rice.

Key words: correlation, direct effect, genetic advance, heritability, path analysis, rice

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for a large proportion of the world's population (ZHANG, 2007). In India, rain fed upland rice accounts for 6.00 million hectares, which is 13.5% of the total rice area in the country where farmers mostly used traditional early rice varieties and contributing low productivity i.e. 0.6 to 1.5 t ha^{-1}. Development of high yielding genotypes under such conditions requires a thorough knowledge of existing genetic variation and extent of association of yield contributing characters. Yield revolution witnessed in irrigated areas following the introduction of plant type based high yielding varieties in mid sixties bypassed the eastern region, as the varietal technology hardly suited its highly diverse rainfed environment. The success of any breeding program depends on understanding the genetic nature of the character of interest, creation and prediction of genetic variability in subsequent generations and their inter relation ship

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with other characters. Yield is a complex character and is influenced by various other characters therefore it is essential to understand the association of other characters with yield in addition to the information on genetic variability. Yield contributing traits are interrelated and highly influenced by the environments (CHANDRA *et al*., 2007; NAYAK *et al.,* 2008; PRASAD *et al.,* 2001; ESWARA REDDY *et al.,* 2013) and partitioned into direct and indirect effect for yield (MOHSIN *et al.,* 2009). Efficiency of indirect selection depends on the magnitude of correlations between yield and target yield components (TOKER and CAGIRGAN, 2004; BOSE *et al*., 2007; IDRIS *et al*., 2012; DHANWANI *et al*., 2013; PRATAP *et al*., 2014). The path analysis has been used by plant breeders to support in identifying traits that are promising as selection criteria to improve crop yield and to detect the amount of direct and indirect effect of the causal components on the effect component (BOSE *et al*., 2005; INDU RANI *et al.,* 2008; TOGAY *et al.,* 2008; ALI *et al.,* 2009; CHANDRA *et al*., 2009; AKHATAR *et al*., 2011; CYPRIAN and KUMAR, 2011). Breeding for upland rice is a challenging task because all these information is meagre under stress situations. However, there are several reports on genetic variability and correlation studies on different characters in rice under normal conditions. Keeping in view this urgent need, this investigation was undertaken to understand the genetic variability and correlation between yield and other yield attributing characters under this ecology

MATERIALS AND METHODS

The material for the present investigation consists of 22 upland genotypes. These were grown in a randomized complete block design with three replications during wet season 2011 at Central Rice Research Institute research farm, Cuttack, India. The entries were direct seeded with six rows per entry having 30 hills per row with 20×15 cm spacing and care was taken to maintain 1-2 seedlings per hill. Observations on quantitative traits like days to 50% flowering (DFF), plant height, total tiller (TT), ear bearing tiller (EBT), panicle length (PL), panicle weight (PW), grain per panicle (GPP), test grain weight, yield, spikelet length and spikelet breadth. EBT/ m^2 and seed test weight were recorded on five randomly selected plants excluding the border rows from each entry while days to 50% flowering and plot yield were recorded on plot basis. The genotypic and phenotypic co-efficient of variations were computed through Burton's method (BURTON, 1952). Heritability and genetic advance were worked out as per the method of HANSON *et al.* (1955). Phenotypic correlation co-efficient was calculated according to the procedure suggested by ALJIBOUNI *et al.* (1958) and path analysis was worked out following DEWEY and LU (1959). The statistical analysis was done using SAS 9.2 software.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) shows that among the genotypes all traits were significant indicates the presence of considerable amount of genetic variation among the genotypes (Table 1). The magnitude of variations between genotypes was revealed by high values of mean and range for traits of the genotypes (Table 2). High genetic variability for different traits in rice was earlier reported (KHAN *et al.,* 2009; UMADEVI *et al.,* 2009; AKINWALE *et al.,* 2011; ULLAH *et al.,* 2011). The Estimates of mean, range, coefficient of variance (CV), genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), heritability and genetic advance of studied traits are presented in Table 2. It is observed that phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) indicating environmental effect on the expression of

the characters. Maximum coefficient of variation was observed in TT, EBT and yield (Table 1.) This indicates that there is scope for further improvement of these characters through selection. High GCV values were observed in plant height followed by EBT and yield. This indicates that these characters can be manipulated for breeding high yielding varieties through hybridization and selection in subsequent generations in rice improvement programme under rainfed upland situation. High PCV values were observed in EBT followed by TT, plant height and yield (Table 2). The heritability of all the traits is greater than 89% except TT, EBT and yield (Table 2). The genetic advance values ranges from 19.56% (breadth) to 45.59% (plant height). Moderate to high degree of heritability estimates indicate the presence of additive genetic effects hence selection based on phenotypic performance of these character will be effective.

Table 1: Analysis of Variance for different traits

Source	df	MS										
		DFF	PLHT	TT	EBT	PL	PW	GRAINPP	TGWT	SLENGTH	SBREADTH	YIELD
Replication	2	0.136	15.107	9.365	3.767	0.856	0.139	345.905	0.071	0.035	0.019	0.781*
Genotype	21	469.986*	1244.271*	30.592*	25.949*	29.289*	1.001*	2084.942*	23.217*	2.246*	0.199*	0.814*
Error	42	1.105	6.742	6.430	3.291	0.940	0.039	64.304	0.100	0.019	0.005	0.081
CV		1.582	2.852	15.353	13.451	4.137	6.503	4.455	1.309	1.630	2.616	11.225

*- significant at 1%

DFF: days to 50% flowering; PLHT: plant height; TT: total tiller; EBT: ear bearing tiller; PL: panicle length; PW: panicle weight; GRAINPP: grains per panicle; TGWT: test grain weight; SLENGTH: spikelet length; SBREADTH: spikelet breadth

Table 2: Estimates of different parameters of variability of different traits

Trait	Mean	Range	Phenotypic variance	Genotypic variance	Variability		Heritability (%)	Genetic advance (% of Mean)
					GCV	PCV		
DFF	66.455	42-92	157.398	156.294	18.812	18.879	0.993	38.617
PLHT	91.028	53-140	419.252	412.510	22.312	22.494	0.984	45.592
TT	16.516	8-25.4	14.484	8.430	17.183	23.043	0.556	26.396
EBT	13.487	7.6-23	10.844	7.552	20.377	24.416	0.696	35.032
PL	23.441	15.2-29	10.390	9.450	13.114	13.751	0.910	25.763
PW	3.034	1.9-4.2	0.360	0.321	18.661	19.762	0.892	36.301
GRAINPP	179.988	118-235	737.850	673.546	14.419	15.092	0.913	28.380
TGWT	24.168	18-30	7.806	7.706	11.486	11.560	0.987	23.508
YIELD	2.541	1.5-3.8	0.325	0.244	19.444	22.452	0.750	34.690
SLENGTH	8.467	6.8-10.06	0.761	0.742	10.176	10.306	0.975	20.699
SBREADTH	2.588	2-3.1	0.069	0.065	9.827	10.169	0.934	19.563

DFF: days to 50% flowering; PLHT: plant height; TT: total tiller; EBT: ear bearing tiller; PL: panicle length; PW: panicle weight; GRAINPP: grains per panicle; TGWT: test grain weight; SLENGTH: spikelet length; SBREADTH: spikelet breadth

Table 3: Simple correlation of traits

	PLHT	TT	EBT	PL	PW	GRAINPP	TGWT	SLENGTH	SBREADTH	YIELD
DFF	0.034	0.093	0.110	-0.077	-0.008	0.134	0.087	-0.211	-0.258**	0.116
PLHT		-0.104	0.164	0.596*	0.119	0.090	0.483*	0.459*	-0.028	0.417*
TT			0.852*	-0.300**	-0.091	-0.022	-0.077	-0.206	0.064	0.070
EBT				-0.135	-0.061	0.003	0.172	-0.026	0.022	0.292**
PL					0.591*	0.510*	0.333*	0.566*	-0.102	0.506*
PW						0.755*	-0.028	0.583*	-0.317*	0.323*
GRAINPP							-0.194	0.421*	-0.408*	0.267**
TGWT								0.236	0.239	0.217
SLENGTH									-0.429*	0.294**
SBREADTH										-0.141

*- significant at 1%, ** - significant at 5%

DFF: days to 50% flowering; PLHT: plant height; TT: total tiller; EBT: ear bearing tiller; PL: panicle length; PW: panicle weight; GRAINPP: grains per panicle; TGWT: test grain weight; SLENGTH: spikelet length; SBREADTH: spikelet breadth

Table 4: Genotypic and phenotypic correlation of traits

		PLHT	TT	EBT	PL	PW	GRAINPP	TGWT	SLENGTH	SBREADTH	YIELD
DFF	G	0.034	0.132	0.130	-0.073	-0.004	0.145	0.089	-0.215	-0.269 **	0.134
	P	0.034	0.095	0.111	-0.077	-0.008	0.134	0.087	-0.211	-0.259 **	0.119
PLHT	G		-0.152	0.208	0.624	0.128	0.092	0.494 *	0.474 *	-0.030	0.482 *
	P		-0.103	0.167	0.596 *	0.116	0.087	0.484 *	0.460 *	-0.025	0.425 *
TT	G			0.895 *	-0.404 *	-0.182	-0.002	-0.107	-0.263	0.099	0.171
	P			0.850 *	-0.303 **	-0.083	-0.009	-0.076	-0.207	0.062	0.102
EBT	G				-0.109	-0.091	0.044	0.197	-0.028	0.030	0.459 *
	P				-0.135	-0.055	0.013	0.175	-0.026	0.021	0.325 *
PL	G					0.662 *	0.541 *	0.351 *	0.611 *	-0.112	0.641 *
	P					0.590 *	0.510 *	0.333 *	0.570 *	-0.098	0.514 *
PW	G						0.798 *	-0.036	0.631	-0.337 *	0.391 *
	P						0.752 *	-0.029	0.590 *	-0.311 **	0.307 **
GRAINPP	G							-0.200	0.449 *	-0.450 *	0.303 **
	P							-0.197	0.427 *	-0.404 *	0.246 **
TGWT	G								0.239	0.256	0.256
	P								0.236	0.240	0.223
SLENGTH	G									-0.461 *	0.375 *
	P									-0.435 *	0.312 **
SBREADTH	G										-0.082
	P										-0.126

*- significant at 1%, ** - significant at 5%

DFF: days to 50% flowering; PLHT: plant height; TT: total tiller; EBT: ear bearing tiller; PL: panicle length; PW: panicle weight; GRAINPP: grains per panicle; TGWT: test grain weight; SLENGTH: spikelet length; SBREADTH: spikelet breadth

Table 3 gives the simple linear correlation coefficient between all the pairs of studied traits. It shows that yield is positively and significantly correlated with the traits plant height, EBT, PL, PW, grain per panicle and length. The genotypic and phenotypic correlation coefficient among all the studied traits is given in Table 4, which revealed that the genotypic and phenotypic correlation of yield is positive and significant with plant height, EBT, PL, PW, grain per panicle and length; whereas other traits were not significantly correlated. The genotypic correlation coefficients were partitioned using path analysis to find out the direct and indirect effects of yield contributing traits towards grain yield and number in parenthesis are the direct on yield (Table 5 and Figure 1) which reveals that plant height (0.239) has highest direct effect on yield followed by grain per panicle (0.112), DFF, thousand grain weight and EBT. This suggests that these traits can be manoeuvred successfully for breeding high yielding varieties for this dynamic ecology.

Table 5: Path coefficient showing direct and indirect effects of trait on grain yield

Trait	DFF	PLHT	TT	EBT	PL	PW	GRAINPP	TGWT	SLENGTH	SBREADTH	Total correlation with yield
DFF	(0.062)	0.0013	-0.0041	0.0041	-0.0182	-0.0098	-0.0105	-0.0113	0.0015	0.0013	0.0163
PLHT	0.005	(0.2396)	0.0261	-0.0182	0.0339	-0.0211	-0.0052	-0.0464	-0.047	0.0244	0.1911
TT	0.0056	-0.0092	-(0.0843)	-0.0674	0.0065	-0.0174	0.0032	-0.004	0.0111	0.0044	-0.1515
EBT	0.0015	-0.0018	0.0185	(0.0232)	-0.0068	0.0021	-0.0032	0.0045	-0.0007	-0.0006	0.0367
PL	0.0337	-0.0163	0.0089	0.0335	(-0.1149)	0.0069	-0.0219	-0.001	0.0134	-0.0089	-0.0666
PW	0.0152	0.0084	-0.0198	-0.0088	0.0058	-(0.0959)	-0.0318	-0.0119	-0.0033	0.0033	-0.1388
GRAINPP	-0.019	-0.0024	-0.0043	-0.0153	0.0214	0.0373	(0.1125)	-0.0226	0.0067	0.0161	0.1304
TGWT	-0.0083	-0.0089	0.0022	0.0089	0.0004	0.0057	-0.0092	(0.0459)	0.0048	-0.0096	0.0319
SLENGTH	-0.001	0.0086	0.0058	0.0014	0.0051	-0.0015	-0.0026	-0.0046	(-0.0439)	-0.0051	-0.0378
SBREADTH	-0.0099	-0.0474	0.0244	0.0126	-0.0359	0.0162	-0.0668	0.0976	-0.0537	(-0.4658)	-0.5287

*- significant at 1%, ** - significant at 5%

DFF: days to 50% flowering; PLHT: plant height; TT: total tiller; EBT: ear bearing tiller; PL: panicle length; PW: panicle weight; GRAINPP: grains per panicle; TGWT: test grain weight; SLENGTH: spikelet length; SBREADTH: spikelet breadth
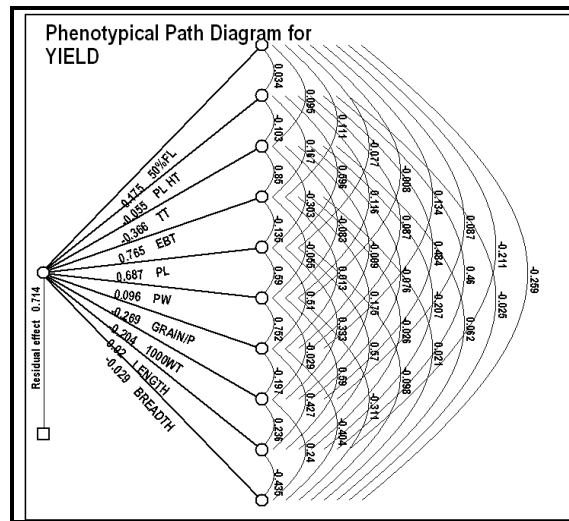
Figure1. Phenotypical path diagram for yield

CONCLUSION

The results of the present study show that there is adequate genetic variability in the studied material. TT, EBT and yield has high coefficient of variation. The traits plant height, EBT and yield has high GCV, PCV and genetic advance. The traits plant height, EBT, PL, PW and length were positively and significantly genetically and phenotypically correlated with yield. Plant height and grain per panicle, 50% flowering, thousand grain weight and EBT has high direct effect on yield. Therefore, for increasing rice grain yield, a genotype with traits like high plant height, EBT, grain per panicle, thousand grain weight and 50% flowering should be considered for upland ecology.

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GENETIČKA VARIJABILNOST PRINOSA I OSOBINA POVEZANIH SA PRINOSOM KOD   BRDSKOG PIRINČA

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Izvod

U ovom radu je proučavana genetička varijabilnost i korelacije prinosa i drugih osobina povezanih sa prinosom kod genotipova pirinča u brdskom području. Eksperiment je izveden sa 22 genotipa brdskog pirinča, gajenih tokom vlažne sezone direktnom setvom u randomiziranom blok dizajnu. Analiza varijanse je pokazala značajnost za sva ispitivana svojstva, ukazujući na prisustvo značajne genetičke varijabilnosti između genotipova. Svojstva kao što su visina biljke, stable sa klasom i prinos imala su visok koeficijent genotipske i fenotipske varijanse i genetičko poboljšanje. Visina biljke zrno po klasu, 50% cvetalih biljaka, masa 1000 zrna I broj stabala sa klasom imaju visok direktan uticaj na prinos. Zbog toga bi selekcija zasnovana na ovim svojstvima trebalo da bude mnogo efikasnija kod brdskog pirinča.