ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Assessment of Genetic Variability and Association Studies in Dry Direct Sown Rice (*Oryza sativa* L.)

H.P. Pavan Shankar, B. Krishna Veni, J. Dayal Prasad Babu and V. Srinivasa Rao

Department of Genetics and Plant Breeding, Agricultural College, Bapatla 522101

Received: 20th March, 2016; Accepted : 14th October, 2016

Abstract

Genetic variability and character association for 12 yield and quality traits were studied under dry direct sowing conditions in rice. The results of genetic parameters revealed high GCV and PCV coupled with high heritability and high genetic advance as percent of mean for filled grains per panicle and alkali spreading value suggesting an additive type of gene action. The remaining traits manifested low to moderate estimates for GCV and PCV, moderate to high heritability and low to high estimates for genetic advance as percent of mean indicating the preponderance of both additive and non-additive gene effects in controlling these traits. The results of correlation and path analysis studies indicated that positive direct effects coupled with positive correlation coefficients with plant height, ear bearing tillers, days to 50% flowering, panicle length, test weight, kernel breadth, L/B ratio and alkali spreading value. Hence, selection of the above traits would result in improvement of grain yield in rice.

Key words: Genetic parameters, Correlation, Path analysis, Grain yield

Introduction

Direct seeding is becoming an attractive alternative to transplanting of rice. Farmers are shifting to direct sowing to reduce labour input, drudgery and cost of cultivation. It is replacing the traditional transplanting in areas with good drainage and water control. The increased availability of short duration rice varieties and cost effective selective herbicides has encouraged farmers to try this method. Current high yielding popular rice varieties are suitable for transplanted rice and little is known about the yield potential and plant type requirements for direct seeding. To date no specific variety was released for direct sowing conditions. Hence, an attempt was made to study the variability and character association for yield and quality traits of rice genotypes under dry direct sown conditions.

Material and Methods

The experiment was carried out during *Kharif*, 2014 at Agricultural College Farm, Bapatla, Andhra Pradesh. The experimental material consists of 22 genotypes including popular rice varieties and advanced cultures developed at Rice Research Unit Bapatla. These genotypes were evaluated in randomized block design with three replications under dry direct sowing by manual dibbling. Each replication consisted of 8 rows of 4 meter length with a spacing of 20x15 cm between and within the row respectively. All recommended cultural practices were followed for raising the crop. Observations were recorded on five plants selected at random per genotype per replication on twelve yield and quality traits *viz*., plant height (cm), ear bearing tillers per plant, panicle length (cm), days to 50% flowering, filled grains/panicle, test weight (g), grain yield per plot (kg), kernel length (mm), kernel breadth (mm), L/ B ratio, amylose content and alkali spreading value and their means were used for statistical analysis. However, observations on test weight, days to 50% flowering and grain yield were recorded on plot basis along with quality parameters as per standard procedures delineated by Jennings *et al*. (1979), Sadasivam and Manickam (1996). Phenotypic and genotypic coefficients of variation (PCV and GCV) were computed according to Burton and Devane (1953). Heritability in broad sense was estimated as per Allard (1960) and genetic advance was estimated as per the formula proposed by Johnson *et al.* (1955). Phenotypic and genotypic correlations were worked out by using the formulae suggested by Falconer (1964) and path coefficient analysis by Dewey and Lu (1959) was used to calculate the direct and indirect contribution of various traits to yield.

Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating that the data generated from the above diverse material would yield reliable information. The genetic variability studies revealed that the material used in the present investigation possessed considerable variability which provides sufficient basis for selection by the breeder. In general, the values of phenotypic coefficient of variation were higher when compared to genotypic coefficient of variation, but the difference was low suggesting less environmental influence on these traits. Most of the characters showed high heritability estimates ranging from 80-90% reflecting ample scope for their improvement through appropriate breeding procedures.

The mean, range, genotypic and phenotypic coefficients of variation, heritability and genetic advance as per cent of mean values obtained for 22 genotypes are presented in Table 1. Wide range of variation was observed for plant height (71.46-124.06 cm), days to 50% flowering (79-102.66) and filled grains per panicle (105-220) among the twelve characters studied. Highest phenotypic and genotypic coefficients of variation was observed for alkali spreading value (41.42 and 41.14 respectively) while amylose content manifested the least values (5.01 and 4.43, respectively). The estimates of heritability ranged from 61.8 (grain yield/plant) to 98.6 (alkali spreading value), the maximum value for genetic advance as percent of mean was observed for alkali spreading value (84.18) followed by filled grains per panicle (42.05), test weight (34.24) and ear bearing tillers per plant (33.73).

High GCV and PCV coupled with high heritability and high genetic advance as percent of mean were recorded for filled grains per panicle and alkali spreading value suggesting an additive type of gene action. Hence, good response to selection can be attained for improvement of these traits. These findings are in agreement with the results reported by Gampala *et al.* (2015) and Asish Binodh *et al*. (2007). Remaining all other yield components and quality parameters manifested low to moderate estimates for genotypic and phenotypic coefficient of variation, moderate to high heritability estimates and low to high genetic advance as percent of mean indicating the role of both additive and non-additive gene effects in the expression of these traits. These results are in accordance with Jaiswal *et al.* (2007), Vijaya Lakshmi *et al*. (2008), Pratap *et al.* (2012) and Dhurai *et al.* (2013).Hence, instead of simple selection, other methods like heterosis breeding or recurrent selection could be better alternative methods for improvement of these traits.

The genotypic correlation coefficient values were of higher magnitude when compared with the phenotypic correlation values. This may be due to the relative stability of genotypes as majority of them were subjected to certain amount of selection (Johnson *et al.*, 1955). Grain yield per plot exhibited a significant positive correlation with plant height (0.4676 and 0.5876), panicle length (0.3669 and 0.6064), filled grains per panicle (0.2641 and 0.3309), test weight (0.2739 and 0.3491) and kernel length (0.2405 and 0.3124) both at phenotypic and genotypic levels respectively and with days to 50% flowering (0.2927) and kernel breadth (0.2641) at genotypic level (Table 2) suggesting simultaneous improvement of these traits with grain yield. These results are in agreement with the results reported by Eradasappa *et al*. (2007) for plant height and panicle length, Khare *et al.* (2014) for days to 50% flowering and Patel *et al.* (2014) for plant height. Ear bearing tillers per plant recorded positive non-significant correlation (0.1106 and 0.0810 respectively) at phenotypic and genotypic levels with grain yield which is in accordance with the previous results reported by Janardhanam *et al*. (2001). Amylose content showed negative non significant association with grain yield per plot at both the levels in the present study which is in confirmation with the findings of Siva Parvathi (2010).

When characters having direct bearing on grain yield are selected, their relationship with other characters are to be considered simultaneously as this will indirectly influence the grain yield. Significant positive correlations at both phenotypic and genotypic levels were recorded for plant height with days to 50% flowering (0.4014 and 0.4162), panicle length (0.5088 and 0.6241), test weight (0.2792 and 0.2924), kernel length (0.5162 and 0.5749) and L/B ratio (0.2609 and 0.2581) suggesting that genotypes with more plant height possessed longer duration, more panicle length and test weight also. Similar results were reported previously by Janardhanam *et al*. (2001) and Patel *et al*.(2014).The trait panicle length showed positive and significant association with filled grains per panicle (0.5877 and 0.4961)at both genotypic and phenotypic levels respectively indicating that more panicle length may accommodate more number of filled grains. These findings are in accordance with the previous results of Panwar (2006) and Eradasappa *et al*.(2007). Panicle length also recorded positive relationship with test weight, kernel length and L/B ratio. Among quality traits kernel length is positively and significantly associated with L/B ratio (0.6486 and 0.6023) and alkali spreading value (0.3490 and 0.3152) at genotypic and phenotypic levels respectively. Significant positive association of kernel length with L/B ratio was reported previously by Krishna Veni and Shobha Rani (2006). L/B ratio exhibited significant positive relationship with amylose content and alkali spreading value.

Considering grain yield as effects and other 11 characters as causes, correlations were partitioned by using path coefficient analysis to find out the direct and indirect effects of yield contributing characters towards grain yield. The results (Table 3) revealed kernel breadth (0.6245) followed by plant height (0.5083), L/B ratio (0.4671), ear bearing tillers per plant (0.2898) and test weight (0.1275) exhibited maximum positive direct effect (Janardhanam *et al*., 2001, Jaiswal *et al.*, 2007 and Khare *et al.*, 2014). The other traits which manifested positive direct effects on grain yield includes days to 50% flowering and panicle length among yield components and amylose content (Reena Bhattacharyya *et al.*, 2007) and alkali spreading value among quality parameters studied. Hence, under dry direct sowing conditions, importance should be given to these traits while exercising selection for improvement of grain yield. Filled grains per panicle (-0.0580) and kernel length (-0.0929) exhibited negative direct effects. These results are in accordance with Girija Rani and Sreerama Reddy (2010) and Reena Bhattacharya *et al.* (2007). Although filled grains per panicle exhibited negative direct effect, its association with grain yield is positive suggesting that indirect effects seem to be cause of positive correlation and indirect causal factors are to be considered simultaneously for selection to improve yield.

Table 1: Mean, range and the estimates of genetic parameters for yield components and quality traits in rice genotypes

S. No.	Character	Mean	Range	GCV (%)	PCV (%)	Heritability (h^2)	Genetic advance as % of mean
1	Plant height (cm)	98.31	71.46 - 124.06	16.18	17.20	88.5	31.36
2	Ear bearing tillers per plant	16.49	11.46 - 21.20	17.38	18.44	88.8	33.73
3	Panicle length (cm)	22.77	20.18 - 27.26	8.73	9.92	77.4	15.82
4	Days to 50% flowering	92.59	79 - 102.66	7.73	8.51	82.4	14.45
5	Filled grains/ panicle	151.32	105– 220	20.98	21.57	94.6	42.05
6	Test weight (g)	17.97	13.46 - 24.50	17.29	17.99	92.4	34.24
7	Grain yield per plot (kg)	3.88	2.85 - 4.42	10.52	13.38	61.8	17.03
8	Kernel length (mm)	5.62	5.10 - 6.43	6.51	6.87	89.8	12.70
9	Kernel breadth (mm)	1.92	1.68 - 2.38	7.90	8.71	82.3	14.76
10	L/ B ratio	2.94	2.55 - 3.83	10.50	11.01	91.0	20.64
11	Amylose content (%)	23.89	22.31 - 25.88	4.43	5.01	78.0	8.06
12	Alkali spreading value	2.68	1.13 - 4.90	41.14	41.42	98.6	84.18

GCV= Genotypic coefficient of variation PCV= Phenotypic coefficient of variation

Table 2: Estimates of phenotypic (above diagonal) and genotypic (below diagonal) correlations for yield and quality traits in rice genotypes

Character	Plant height (cm)	EBT/ plant	Days to 50% flowering	Panicle length (cm)	Filled grains/ panicle	Test weight (g)	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Amylose content	Alkali spreading value	Grain yield/ plot (kg)
	1	2	3	4	5	6	7	8	9	10	11	12
Plant height (cm)	**1.0000**	0.1554	0.4014**	0.5088**	0.2400	0.2792*	0.5162**	0.0816	0.2609*	- 0.4011**	0.1858	**0.4676****
EBT/ plant	0.1621	**1.0000**	-0.0087	-0.0013	-0.5066**	0.5473**	0.1264	0.4870**	-0.3121*	-0.4444**	-0.1725	**0.1106**
Days to 50% flowering	0.4162**	-0.0024	**1.0000**	0.1848	0.0979	0.1202	-0.0413	-0.0728	0.0101	-0.1723	0.1486	**0.2181**
Panicle length (cm)	0.6241**	0.0021	0.2103	**1.0000**	0.4961**	0.2333*	0.3053 *	0.1565	0.3280 **	0.0612	0.1323	**0.3669****
Filled grains/ panicle	0.2557*	-0.5543**	0.0963	0.5877**	**1.0000**	-0.2090	-0.1812	-0.2325	0.0564	0.2312	0.2004	**0.2641***
Test weight (g)	0.2924*	0.6209**	0.1199	0.2527*	-0.2280	**1.0000**	0.1523	0.2451*	-0.1014	-0.1031	-0.2456*	**0.2739***
Kernel length (mm)	0.5749**	0.1378	-0.0236	0.3755**	-0.2031	0.1395	**1.0000**	0.0926	0.6023**	-0.2512*	0.3152 *	**0.2405***
Kernel breadth (mm)	0.1344	0.5614**	-0.0472	-0.2300	-0.2617*	0.3065*	0.0329	**1.0000**	-0.7355**	-0.5475**	-0.2182	**0.1627**
L/B ratio	0.2581*	-0.3416**	-0.0058	0.4254**	0.0563	-0.1440	0.6486**	-0.7367**	**1.0000**	0.2854*	0.3832**	**0.0287**
Amylose content	-0.4968**	-0.5362**	-0.1696	0.0476	0.2713*	-0.1037	-0.2697*	-0.6766**	0.3569**	**1.0000**	-0.0482	**-0.1424**
Alkali spreading value	0.2091	-0.1837	0.1688	0.1489	0.2057	-0.2562*	0.3490**	-0.2415	0.4142*	-0.0522	**1.0000**	**0.0891**
Grain yield/ plot (kg)	**0.5876****	**0.0810**	**0.2927***	**0.6064****	**0.3309****	**0.3491****	**0.3124***	**0.2641***	**0.0115**	**-0.1821**	**0.1062**	**1.0000**

*= Significant at 5% level, **= Significant at 1% level

EBT: Ear bearing tillers, L/B ratio: Kernel length/Kernel breadth

Table 3: Direct and indirect effects of yield and quality traits on grain yield in rice genotypes

Character	Plant height (cm)	EBT/ plant	Days to 50% flowering	Panicle length (cm)	Filled grains/ panicle	Test weight (g)	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Amylose content	Alkali spreading value
	1	2	3	4	5	6	7	8	9	10	11
1	**0.5083**	0.0790	0.2040	0.2586	0.1220	0.1419	0.2624	0.0415	0.1326	-0.2039	0.0945
2	0.0450	**0.2898**	-0.002	-0.0004	-0.1468	0.1586	0.0366	0.1411	-0.0905	-0.1288	-0.0500
3	0.0066	-0.0001	**0.0165**	0.0031	0.0016	0.0020	-0.0007	-0.0012	0.0002	-0.0029	0.0025
4	0.0428	-0.0001	0.0156	**0.0842**	0.0418	0.0196	0.0257	-0.0132	0.0276	0.0052	0.0111
5	-0.0139	0.0294	-0.0057	-0.0288	**-0.0580**	0.0121	0.0105	0.0135	-0.0033	-0.0134	-0.0116
6	0.0356	0.0698	0.0153	0.0297	-0.0266	**0.1275**	0.0194	0.0312	-0.0129	-0.0131	-0.0313
7	-0.0480	-0.0117	0.0038	-0.0284	0.0168	-0.0141	**-0.0929**	-0.0086	-0.0559	0.0233	-0.0293
8	0.0510	0.3041	-0.0455	-0.0977	-0.1452	0.1531	0.0579	**0.6245**	-0.4593	-0.3419	-0.1363
9	0.1219	-0.1458	0.0047	0.1532	0.0263	-0.0474	0.2813	-0.3435	**0.4671**	0.1333	0.1790
10	-0.0695	-0.0770	-0.0299	0.0106	0.0401	-0.0179	-0.0435	-0.0949	0.0494	**0.1733**	-0.0083
11	0.0553	-0.0514	0.0442	0.0394	0.0596	-0.0731	0.0938	-0.0650	0.1141	-0.0143	**0.2977**
Grain yield/ plot (kg)	**0.4676**	**0.1106**	**0.2181**	**0.3669**	**0.2641**	**0.2739**	**0.2405**	**0.1627**	**0.0287**	**-0.1424**	**0.0891**

Residual effect = 0.5147, Bold and diagonal values indicate direct effects

References

Allard RW. 1960. *Principles of Plant Breeding*. John Wiley and Sons Inc., New York. 485.

Asish BK, Kalaiyarasi R and Thiyagarajan K. 2007. Genetic parameter studies on quality traits in rice. *Madras Agricultural Journal*. 94(1-6): 109-113.

Burton GW and Devane EW. 1953. Estimating heritability in tall fescue (*Festuca arundiraceae*) from replicated clonal material. *Agronomy Journal*. 45: 478-481.

Dewey DR and Lu KH. 1959. A Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*. 51(9): 515-518.

Dhurai SY, Mohan Reddy D, Bhati PK and Ravi S. 2013. Studies on variability, heritability, and genetic advance for yield and quality traits in rice (*Oryza sativa* L.). *Society for Scientific Development in Agriculture and Technology*. 8: 482-484.

Eradasappa E, Nadarajan N, Ganapathy KN, Shanthala J and Satish RG. 2007. Correlation and path analysis for yield and its attributing traits in rice (*Oryza sativa* L.). *Crop Research*. 34(1,2,3): 156-159.

Falconer DS. 1964. *An Introduction of Quantitative Genetics-Second edition*. Oliver and Boyd, Edinburgh. 312-324.

Gampala S, Singh VJ, Pathak SK, Srivastava N, Kaushik SK and Rangare NR. 2015. Estimation of genetic variability for yield and quality traits in rice (*Oryza sativa* L.) genotypes. *Environment & Ecology*. 33(1): 303-305.

Girija Rani M and Sreerama Reddy N. 2010. Comparision of direct and indirect effects of yield contributing and physiological characters between hybrids and varieties of rice. *The Andhra Agricultural Journal*. 57(1): 56-61.

Jaiswal HK, Srivastava AK and Day A. 2007. Variability and association studies in indigenous aromatic rice (*Oryza sativa* L.). *Oryza*. 44(4): 351-353.

Janardhanam V, Nandarajan N and Jebaraj S. 2001. Correlation and path analysis in rice (*Oryza sativa* L.). *Madras Agricultural Journal*. 88(10-12): 719-720.

Jennings PR, Coffmann WR and Kaufman HE. 1979 *Grain quality in rice improvement.* IRRI, Manila, Philippines.

Johnson HW, Robinson HF and Comstock RE. 1955. Estimates of genetic and environmental variability in soybean. *Agronomy Journal*. 47(7): 314-318.

Khare R, Singh AK, Eram S and Singh PK. 2014. Genetic variability, association and diversity analysis in upland rice (*Oryza sativa* L.). *SAARC Journal of Agriculture*. 12(2): 40-51.

KrishnaVeni B and Shobha Rani N. 2006. Association of grain yield with quality characteristics and other yield components in rice. *Oryza*. 43(4): 320-322.

Panwar LL. 2006. Character association and path analysis in rice (*Oryza sativa* L.). *Annals Agricultural Research New series*. 27(3): 257-260.

Patel JR, Saiyad MR, Prajapati KN, Patel RA and Bhavani RT. 2014. Genetic variability and character association studies in rainfed upland rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*. 5(3): 531-537.

Pratap N, Singh PK, Shekhar R, Soni SK and Mall AK. 2012. Genetic variability, character association and diversity analyses for economic traits in rice (*Oryza sativa* L.). *SAARC Journal of Agriculture*. 10(2): 83-94.

Reena Bhattacharyya, Bindhan Roy, Kabi MC and Basev AK. 2007. Path analysis of seed yield in rice as influenced by *Azotobacter chroococcum* under tropical climate. *Crop Research*. 34(1,2,3): 160-165.

Sadasivam S and Manickam A.1996.*Biochemical Methods. Second edition*, New Age International (P) Limited, Publishers. 12- 34.

Siva Parvathi P. 2010. Genetic divergence in rice (*Oryza sativa* L.).M.Sc. (Ag) Thesis. Acharya N. G Ranga Agricultural University, Hyderabad, India.

Vijaya Lakshmi B, Vijay D, Raju PRK and Satyanarayana PV. 2008. Genetic divergence of qualitative and quantitative characters in lowland rice germplasm. *Crop Research*. 36(1, 2&3): 212-214.