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Research Article

GENETIC VARIABILITY AND SELECTION CRITERIA IN RICE

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Abstract

Genetic parameters, correlation and path analysis for 12 yield and quality traits were studied during rabi, 2009-10 in 21 genotypes of rice. High estimates of GCV were recorded for plant height, number of filled grains/panicle and grain yield/plant. Heritability in broad sense was high for all the characters except spikelet fertility. High heritability coupled with high genetic advance as per cent mean were recorded for number of productive tillers/plant, panicle density, number of filled grains/panicle, 1000-grain weight, grain yield/plant and kernel length. Grain yield/plant exhibited highly significant and positive correlation with days to 50 % flowering, plant height, productive tillers/plant, panicle length, panicle density and filled grains/panicle. Path coefficient studies indicated maximum direct positive effect of plant height, productive tillers, filled grains/panicle and kernel length and kernel breadth on grain yield/plant.

Keywords: Variability, Correlation, Genetic Advance, Heritability, Path analysis, Rice,

INTRODUCTION

Grain yield in rice is a quantitatively inherited trait and involve function of several components. Selection of superior genotypes for rabi (post rainy) based on yield is difficult due to the integrated structure of plant in which the component characters are interdependent and are governed by a large number of cumulative, duplicative and dominant genes. The presence and magnitude of genetic variability for important economic traits in a gene pool is a pre-requisite for any breeding programme. Availability of such natural variability can be assessed by employing certain tools. Heritability estimates provide the information on the proportion of variability that can be transmitted to the progenies in subsequent generations. Genetic Advance provides information on expected genetic gain resulting from selection of superior individuals. While, correlation study measures the association between characters and helps to identify important characters to be considered for making effective selection. Path analysis elucidates the intrinsic nature of the observed association and imparts confidence in selection scheme adopted for a given situation. Therefore, the present investigation was aimed to assess the variability and to ascertain the relative contribution of different yield attributes to grain yield and their interrelationships by estimating correlation, path analysis and coefficients of variability with heritability and genetic advance so as to select superior genotypes to suit for rabi season.

MATERIAL AND METHODS

The experimental material for the present investigation comprised of 21 released varieties, pre-release cultures and hybrids of rice (Table 1). The study was conducted in randomized complete block design with three replications at Regional Agricultural Research Station (RARS), Jagtial, Karimnagar during rabi, 2009-10. Thirty day old seedlings were transplanted in rows of 4.5 m length at 15 cm intra row spacing. Recommended package of practices were adopted to raise a healthy crop and need based plant protection measures were undertaken. The observations were recorded on five randomly selected plants for each entry and replication and data on 15 yield and quality characters *viz*., days to 50 % flowering, plant height (cm), number of productive tillers plant^{-1}, panicle length (cm), number of filled grains panicle^{-1}, panicle density, spikelet fertility per cent, 1000-grain weight (g), grain yield plant^{-1} (g) hulling per cent, milling per cent, head rice recovery per cent, kernel length (mm), kernel breadth (mm) and L/B ratio was generated. Analysis of variance was computed based on randomized block design as per standard statistical procedure[22]. The genotypic and phenotypic coefficients of variation were calculated using the formulae suggested by Burton[7]. Broad sense heritability was calculated as per Hanson *et al.*[10]. Genetic advance was estimated by the method suggested by Johnson *et al.*[11]. Correlations and path coefficients were worked out for 12 characters. Correlations were estimated according to the procedure of Weber and Moorthy[35]. Direct and indirect effects were calculated as per Dewey and Lu[8].

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among genotypes for the characters under study (Table 2). Hence, the genotypes possessed heritable genetic variability with respect to the characters studied.

Success of any crop improvement programme largely depends on the amount of genetic variability present for the characters under consideration for improvement. In the present study, the phenotypic coefficient variability (GCV) was higher than genotypic coefficient of variability (GCV) for all the characters which could be attributed to the role of the environment (Table 3). This was in conformity with earlier findings[5,31]. The estimates of phenotypic and genotypic coefficients of variability were high in case of number of filled grains/panicle followed by plant height and grain yield/plant. This indicated the presence of greater variability in respect of these attributes. High estimates of PCV and GCV for number of filled grains per panicle[14,20,23], for plant height[4] and for grain yield/plant[1,14] were reported earlier.

Moderate estimates of phenotypic and genotypic coefficients of variation were recorded for days to 50 % flowering, spikelet fertility per cent, 1000-grain weight and head rice recovery. The small differences between genotypic and phenotypic coefficients of variation indicated less influence of environment in the expression these characters. These results are in accordance with the earlier findings[20,29]. Low estimates of phenotypic and genotypic coefficients of variation were observed for number of productive tillers/plant, panicle length, panicle density, hulling per cent, milling per cent, kernel length, kernel breadth and L/B ratio indicating less variability among the genotypes studied for these traits. Similar results were also reported earlier[14,24]. The narrow difference between PCV and GCV for the milling quality traits suggested that these traits were less influenced by environment and hence, they could be improved through simple selection procedures. Heritability indicates the relative degree at which a character is transmitted from parent to off-spring. High heritability values indicated that the characters under study were less influenced by environment in their expression. The traits exhibiting high heritability could be improved by adopting simple selection methods. Heritability is considered to be high when the value is greater than 50 and medium between 20-50. Further, the information on genetic variation and genetic advance helps to predict the genetic gain that could be obtained in later generations, if proper selection is made for improving the particular trait under consideration. High heritability coupled with high genetic advance as per cent of mean was observed for productive tillers/plant, panicle density, filled grains/panicle, 1000-grain weight, grain yield/plant and kernel length. These traits were predominantly influenced by additive genetic effects, which offer better scope of isolation of pure lines through direct selection schemes. The results in similar lines were also reported earlier for productive tillers/plant[1,21,23], for number of filled grains/panicle[23], for 1000–grain weight[6,12] and for grain yield/plant[16,26]. High estimates of heritability in association with moderate genetic advance as per cent of mean for plant height, kernel breadth, L/B ratio suggested the role of both additive and non–additive gene actions in their inheritance. Hence adoption of breeding methods which could exploit both the gene actions would be a prospective approach[14,25,27,32]. High heritability coupled with low genetic advance as per cent of mean was recorded for days to 50 % flowering, panicle length, milling per cent and head rice recovery, which indicated limited scope for selection[17,19,23]. Moderate heritability with low genetic advance as per cent of mean for spikelet fertility per cent, hulling per cent indicated the preponderance of non–additive gene action in their expression. Therefore, further exploitation of these traits would be possible through heterosis breeding and recurrent selection procedures[19]. The efficiency of selection for yield mainly depends on the direction and magnitude of association between yield and its components and among themselves. Correlation analysis provides useful information on the nature and magnitude of association of different component characters with grain yield in addition to the nature of interrelation ships among the component traits themselves. In the present investigation, the association analysis (Table 4) indicated that grain yield was significantly associated with days to 50 % flowering, plant height, number of productive tillers/plant, panicle length, panicle density and number of filled grains/panicle. Similar kind of association were reported by earlier studies for days to 50 % flowering[14,26]; for plant height, number of productive tillers/plant and panicle length[9,14,28]; for panicle density[17,30] and for number of filled grains/panicle[3,17].

The grain yield/plant had non–significant and negative association with spikelet fertility per cent[15], 1000-grain weight[17,22], kernel length, kernel breadth and L/B ratio[14] indicated less importance of these components in reflecting final yield. Days to 50 % flowering had significant positive association with number of productive tillers/plant, number of filled grains per panicle[13], panicle density, 1000-grain weight, kernel length, kernel breadth and L/B ratio. The association of panicle length with number of filled grains/panicle, 1000-grain weight, L/B ratio[13,33], kernel length and kernel breadth was significantly positive. Whereas; number of productive tillers per plant had significant positive association with panicle density, kernel length and L/B ratio; Panicle density had significant positive association with number of filled grains per panicle[30], 1000–grain weight, kernel length, kernel breadth and L/B ratio. 1000–grain weight had significant positive association with kernel length, kernel breadth and L/B ratio[13]. Further, the association of kernel length with kernel breadth and L/B ratio was significantly positive. These results are in agreement with the earlier findings[14,15]. The correlation studies finally revealed that day to 50 % flowering, plant height, number of productive tillers/plant, panicle length, panicle density and number of filled grains/panicle showed positive and significant association with grain yield. Among these components, productive tillers/plant and filled grains/panicle played greater role in production of higher grain yield per plant. Hence, for rabi season, selection of genotypes with more number of productive tillers/plant, filled grains/panicle and increased panicle length duly balancing the plant height as per optimum plant type would be the best approach. Correlation gives only the idea about the extent and nature of association between two traits, whereas a combined study of path analysis and correlations helps to identify the exact components, which play greater role in yield contribution. Hence, in the present study path coefficient analysis was also performed to compute direct and indirect effects of 11 characters on grain yield (Table 5). The characters *viz.,* plant height, number of productive tillers/plant, and kernel breadth exhibited positive direct effect on grain yield. Whereas, days to 50 % flowering, number of filled grains/panicle (phenotypic level) and kernel length (phenotypic level), panicle length, panicle density, spikelet fertility per cent and L/B ratio (genotypic level) showed negative or positive effects at very low level, indicating less influence of these traits in yield performance. This indicated that among different components, plant height, productive tillers/plant and filled grains/panicle were major yield contributing characters as they exhibited high correlation and direct effects at genotypic level with yield. These results are in agreement with the earlier findings for plant height[9]; for productive tillers/plant[2,28]; for filled grains/panicle[33,34].

Table 1: Details of experimental material used in the study

Genotype	Parentage	Source
	Released Varieties	
IR 64	IR 5657-33-2-1/IR 2061-465-1-5-5	IRRI , Philippines
MTU 1010	MTU 2077/IR 64	APRRI, Maruteru
Krishnahamsa	Rasi/Fine Gora	DRR, Hyderabad
Tellahamsa	HR 12/TN 1	Rice section, Rajendranagar
Erramallelu	BC 5-55/W. 12708	RARS, Warangal
Rajendra	IJ 52/TN 1	Rice section, Rajendranagar
JGL 1798	BPT 5204/Kavya	RARS, Jagtial
JGL 3844	BPT5204/ARC 5984 // Kavya	RARS, Jagtial
NLR 34449	IR 72/BPT 5204	ARS, Nellore
Rasi	TN 1/CO.29	DRR, Hyderabad
	Pre-release cultures	
RNR C 28	IR 64/IET 9994	Rice section, Rajendranagar
RNR 2465	RNR M7/RNR 19994	Rice section, Rajendranagar
RNR 2354	RNR M7/RNR 19994	Rice section, Rajendranagar
JGL 11118	IET 8585/JGL 1798	RARS, Jagtial
JGL 13595	MTU 4870/JGL 418	RARS, Jagtial
WGL 32183	Orugallu/BPT 5204	RARS, Warangal
	Hybrids	
DRRH 2	IR 68897 A/DR 714-1-2R	Public sector hybrid
KRH 2	IR 58025 A/KMR-3	Public sector hybrid
DRRH 44	APMS 6A/1005	DRR, Hyderabad
PA 6201	6 CO2/6 MO1	Private sector hybrid
PA 6444	6 CO2/6 MO5	Private sector hybrid

Table 2: Analysis of variance for yield components and physical quality traits

S.No.	Character	Mean sum of squares		
		Replications	Treatments	Error
1	Days to 50 % flowering	34.429	31.167**	2.745
2	Plant height	0.353	83.506**	3.466
3	Productive tillers/plant	0.954	14.453**	0.88
4	Panicle length	4.155	6.040**	0.426
5	Panicle density	0.233	14.082**	0.474
6	Filled grains/ panicle	201.581	6567.584**	218.35
7	Spikelet fertility	61.361	12.365**	58.929
8	1000 grain weight	0.488	43.958**	0.519
9	Grain yield/ plant	1.476	59.084**	2.294
10	Hulling	2.469	9.403**	1.856
11	Milling	0.251	13.954**	1.526
12	Head Rice Recovery	67.204	91.062**	70.788
13	Kernel length	0.014	1.473	0.007
14	Kernel breadth	0.001	0.035	0.005
15	Kernel L/B ratio	0.007	0.475	0.023

Table 3: Genetic parameters for yield components and physical quality characters

Characters	GCV	PCV	Heritability (bs)	Genetic Advance	Genetic Advance as per cent of Mean
Days to 50 % flowering	9.47	12.22	78.0	5.58	4.81
Plant height (cm)	26.68	30.15	89.3	10.01	12.72
Productive tillers/plant	4.52	5.40	84.1	4.00	42.69
Panicle length (cm)	1.87	2.30	81.7	2.54	11.2
Panicle density	4.53	5.01	90.5	4.17	62.29
Filled grains/ panicle	32.99	35.55	90.6	95.55	63.14
Spikelet fertility (%)	15.52	13.41	36.0	4.85	5.72
1000 grain weight (g)	14.48	15.0	97.0	7.70	41.52
Grain yield/ plant (g)	18.93	21.22	89.0	8.46	41.37
Hulling recovery (%)	2.52	4.37	58.0	2.47	3.01
Milling recovery (%)	4.14	5.67	73.4	3.58	5.05
Head Rice Recovery (%)	11.56	14.96	77.2	6.15	9.67
Kernel length (mm)	0.49	0.50	99.0	1.42	24.63
Kernel breadth (mm)	0.01	0.02	64.0	0.16	10.72
Kernel L/B ratio	0.15	0.17	87.2	0.74	19.66

Table 4: Genotypic and Phenotypic correlation coefficients between yield and its component characters

Character		Days to 50% flowering	Plant height	Productive tillers / plant	Panicle Length	Panicle density	No. of filled grains / panicle	Spikelet fertility	1000 grain weight	Kernel length (mm)	Kernel breadth	L/B ratio	Grain yield / plant
Days to 50% flowering	G	**1.0000**	-0.1742	0.2556*	-0.1819	0.5392**	0.4334**	-0.0095	-0.7028**	-0.6121**	-0.5705**	-0.4011**	0.3840**
	P	**1.0000**	-0.1955	0.2231	-0.1409	0.4305**	0.3631**	0.0786	-0.6270**	-0.5208**	-0.4116**	-0.3123*	0.3125**
Plant height (cm)	G		**1.0000**	-0.0142	0.6796**	0.0261	0.1795	0.0497	0.3258**	0.1318	0.2565*	0.0300	0.5222**
	P		**1.0000**	-0.0370	0.5257**	0.0349	0.1852	0.0070	0.3114*	0.1265	0.1788	0.0276	0.4980**
Productive tillers/ plant	G			**1.0000**	0.0162	-0.2589*	-0.2317	-0.1886	0.1977	0.3303**	-0.0864	0.4403**	0.4924**
	P			**1.0000**	0.0171	-0.2234	-0.2037	0.2120	0.1855	0.3044*	-0.0808	0.4082**	0.4632**
Panicle length (cm)	G				**1.0000**	-0.0406	0.2492**	-0.0974	0.3363**	0.4763**	0.3983**	0.2925*	0.3888**
	P				**1.0000**	-0.0711	0.1708	-0.0750	0.3080*	0.4144**	0.2787*	0.2591*	0.3264**
Panicle density	G					**1.0000**	0.9326**	0.0644	-0.8292**	-0.7531**	-0.5697**	-0.5354**	0.3786**
	P					**1.0000**	0.9206**	-0.0426	-0.7686**	-0.7126**	-0.4628**	-0.4692**	0.3603**
No. of filled grains / panicle	G						**1.0000**	0.0201	-0.6587**	-0.5582**	-0.4189**	-0.4093**	0.4194**
	P						**1.0000**	-0.0375	-0.6158**	-0.5308**	-0.3284**	-0.3658**	0.4115**
Spikelet fertility (%)	G							**1.0000**	-0.0037	-0.0509	0.0079	-0.0766	-0.0898
	P							**1.0000**	0.0391	0.0754	-0.0961	0.1124	0.0666
1000 grain weight (g)	G								**1.0000**	0.8264**	0.7389**	0.5351**	-0.2348
	P								**1.0000**	0.8106**	0.5577**	0.5185**	-0.2101
Kernel length (mm)	G									**1.0000**	0.5181**	0.8620**	-0.1506
	P									**1.0000**	0.4181**	0.8055**	-0.1440
Kernel breadth (mm)	G										**1.0000**	0.0267	-0.1867
	P										**1.0000**	-0.1420	-0.1039
L/B ratio	G											**1.0000**	0.0054
	P											**1.0000**	-0.0191
Grain yield / plant (g)	G												**1.0000**
	P												**1.0000**

G = Genotypic correlation coefficient *Significant at 5 % level
P = Phenotypic correlation coefficient **Significant at 1 % level

Table 5: Direct and Indirect effects for yield and its component characters

Character		Days to 50% flowering	Plant height	Productive tillers / plant	Panicle length	Panicle density	No. of filled grains/ panicle	Spikelet fertility	1000 grain weight	Kernel length	Kernel breadth	L/B ratio	Correlation with grain yield / plant
Days to 50% flowering	G	**0.2728**	-0.0475	0.0697	-0.0496	0.1471	0.1182	-0.0026	-0.1917	-0.1670	-0.1556	-0.1094	0.3840**
	P	**-0.0100**	0.0020	-0.0022	0.0014	-0.0043	-0.0036	-0.0008	0.0063	0.0052	0.0041	0.0031	0.3125*
Plant height	G	-0.3203	**1.8391**	-0.0260	1.298	0.0480	0.3301	0.0914	0.5991	0.2423	0.4718	0.0552	0.5222**
	P	0.1097	**0.5612**	-0.0207	0.2950	0.0196	0.1039	0.0039	0.1747	0.0710	0.1004	0.0155	0.4980**
Productive tillers / plant	G	0.1120	-0.0062	**0.4383**	0.0071	-0.1135	-0.1015	-0.0827	0.0867	0.1447	-0.0379	0.1930	0.4924**
	P	0.1347	-0.0223	**0.6036**	0.0103	-0.1348	-0.1229	0.1280	0.1120	0.1838	-0.0487	0.2464	0.4632**
Panicle length	G	0.3099	-1.1577	-0.0275	**-1.7035**	0.0692	-0.4246	0.1659	-0.5730	-0.8115	-0.6786	-0.4984	0.3888**
	P	-0.0237	0.0884	0.0029	**0.1681**	-0.0120	0.0287	-0.0126	0.0518	0.0697	0.0469	0.0436	0.3264**
Panicle density	G	-0.3795	-0.0184	0.1822	0.0286	**-0.7037**	-0.6563	-0.0453	0.5836	0.5300	0.4009	0.3768	0.3786**
	P	0.1106	0.0090	-0.0574	-0.0183	**0.2569**	0.2365	-0.0109	-0.1975	-0.1831	-0.1189	-0.1205	0.3603**
No. of filled grains / panicle	G	0.4787	0.1982	-0.2559	0.2753	1.0300	**1.1045**	0.0222	-0.7275	-0.6165	-0.4627	-0.4521	0.4194**
	P	-0.0298	-0.0152	0.0167	-0.0140	-0.0756	**-0.0821**	0.0031	0.0505	0.0436	0.0270	0.0300	0.4115**
Spikelet fertility	G	0.0016	-0.0082	0.0313	0.0161	-0.0107	-0.0033	**-0.1658**	0.0006	0.0084	-0.0013	0.0127	-0.0898
	P	0.0003	0.0000	0.0009	-0.0003	-0.0002	-0.0002	**0.0040**	0.0002	0.0003	-0.0004	0.0005	0.0666
1000 grain weight	G	1.6858	-0.7813	-0.4743	-0.8067	1.9890	1.5799	0.0089	**-2.3985**	-1.9822	-1.7723	-1.2834	-0.2348
	P	0.3070	-0.1524	-0.0908	-0.1508	0.3763	0.3015	-0.0191	**-0.4896**	-0.3969	-0.2731	-0.2539	-0.2101
Kernel length	G	-1.7620	0.3793	0.9507	1.3712	-2.1678	-1.6068	-0.1466	2.3790	**2.8787**	1.4914	2.4814	-0.1506
	P	0.3216	-0.0781	-0.1880	-0.2559	0.4400	0.3277	-0.0465	-0.5006	**-0.6175**	-0.2581	-0.4974	-0.1440
Kernel breadth	G	-0.3301	0.1484	-0.0500	0.2305	-0.3296	-0.2424	0.0046	0.4275	0.2997	**0.5786**	0.0154	-0.1867
	P	-0.2058	0.0894	-0.0404	0.1394	-0.2314	-0.1642	-0.0481	0.2789	0.2091	**0.5001**	-0.0710	-0.1039
L/B ratio	G	0.3152	-0.0236	-0.3460	-0.2299	0.4207	0.3217	0.0602	-0.4205	-0.6773	-0.0210	**-0.7858**	0.0054
	P	-0.1825	0.0161	0.2387	0.1515	-0.2743	-0.2138	0.0657	0.3031	0.4709	-0.0830	**0.5846**	-0.0191

* Significant at 5 % level Bold values - Direct effects Phenotypic residual effect = 0.4489 **Significant at 1 % level Normal values - Indirect effects Genotypic residual effect = 0.3906

Plant height showed positive indirect effect through days to 50 % flowering (phenotypic level), productive tillers/plant, panicle length, panicle density, number of filled grains/panicle, spikelet fertility per cent, 1000–grain weight, kernel length, kernel breadth and L/B ratio on grain yield. These results are in consonance with the earlier findings[9,14,18]. Productive tillers/plant exhibited positive indirect effect through spikelet fertility per cent (phenotypic level), days to 50 % flowering, panicle length, 1000–grain weight, kernel length and L/B ratio on grain yield, which is in conformity with the earlier reports[2,14,22].

Filled grains/panicle showed positive indirect effect through days to 50 % flowering, plant height, panicle length, panicle density (genotypic level), productive tillers/plant, 1000 – grain weight, kernel length, kernel breadth and L/B ratio (phenotypic level) and spikelet fertility on grain yield which was also reported earlier[2,14,22].

CONCLUSION

Critical analysis of results by path analysis revealed that the characters plant height followed by productive tillers/plant and filled grains/panicle were directly influencing the grain yield. A comprehensive perusal of correlation and direct and indirect effects indicated that selection towards the genotypes having more number of productive tillers/plant coupled with higher number of filled grains/panicle would be more rewarding to evolve potential varieties for rabi season. As grain yield in turn is dependent on panicle length and plant height, plants with optimum height, sturdy culm with increased panicle length, filled grains/panicle coupled with more productive tillers would be considered as high yielding types.

REFERENCES

1. Anbanandan V, Saravanan K and Sahesan T. Variability, heritability and genetic advance in rice. International Journal of Plant Sciences 2009; 4(1): 61-63.
2. Anbumalarmathi J and Nadarajan N. Association analysis of yield and drought tolerant characters in rice (*Oryza sativa* L.) under drought stress. Agriculture Sciences digest 2008; 28(2): 89-92.
3. Annadurai A. Association analysis in hybrid rice. Annals of Agricultural Research 2001; 22(3): 420–422.
4. Awasthi LP and Pandey VK. Genetic variation in morphological traits of aromatic rice. Crop Research, Hisar 2000; 19(2): 361-363.
5. Bhadru D, Tirumala Rao V, Chandra Mohan Y and Bharathi D. Genetic variability and diversity studies in yield and its component traits in Rice (*Oryza sativa* L.). Sabrao Journal of Breeding and Genetics 2012; 44(1): 129-137.
6. Bharadwaj C, Mishra Rajesh, Satyavathi CT, Rao SK and Kumar KS. Genetic variability, heritability and genetic advance in some new plant type based crosses of rice (*Oryza sativa* L.) Indian Journal of Agricultural Research 2007; 41(3): 189-194.
7. Burton GW. Quantitative inheritance in grasses proceedings 6th international Grassland Congress 1952; 1: 277-283.
8. Dewey DR and Lu KH. A coefficient analysis of components of created wheat grass seed production. Agronomy Journal 1959; 51: 515-518. http://dx.doi.org/10.2134/agronj1959.00021962005100090002x
9. Eradasappa E, Nadarajan N, Ganapathy KN, Shanthala J and Satish RG. Correlation and path analysis for yield and its attributing traits in rice (*Oryza sativa* L.). Crop research 2007; 34(1, 2): 156-159.
10. Hanson GM, Robinsons HF and Comstock RE. Biometrical studies of yield in segregating populations of Koren lespodoza. Agronomy Journal 1956; 48: 267–282. http://dx.doi.org/10.2134/agronj1956.00021962004800060008x
11. Johnson GM, Robinsons HF and Comstock RE. Estimates of genetic and environmental variability in Soybean. Agronomy Journal 1955; 7: 314-318. http://dx.doi.org/10.2134/agronj1955.00021962004700070009x
12. Karad SR and Pol KM. Character association, genetic variability and path coefficient analysis in rice (*Oryza sativa* L.) International Journal of Agricultural Sciences 2008; 4(2): 663-666.
13. Kavitha S and Sree Rama Reddi N. Correlation and path analysis of yield components in Rice. The Andhra Agricultural Journal 2001; 48(3-4): 311-314.
14. Krishna L, Raju Ch D and Raju Ch S. Genetic variability and correlation in yield and grain quality characters of rice germplasm. The Andhra Agriculture Journal 2008; 55(3): 276-279.
15. Krishna Veni B and Shobha Rani N. Association and path analysis for yield components in F_2 generation of rice. The Andhra Agriculture Journal 2005; 52(1, 2): 290-292.
16. Kumar P and Ramesh B. Genetic variability and character association in rice. Progressive Agriculture 2008; 8(2): 260-262.
17. Madhavi Latha L, Sekhar MR, Suneetha Y and Srinivas T. Genetic variability, correlation and path analysis for yield and quality traits in rice (*Oryza sativa* L.). Research on Crops 2005; 6(3): 527-537.
18. Manna M, Nasim Ali MD and Sasmal BG. Variability, correlation and path coefficient analysis in some important traits of low land rice. Crop Research 2006; 31(1): 153-156.
19. Manonmani S and Ranganathan TB. Path analysis in very early crosses of rice. *Oryza* 2006; 43(1): 62-63.
20. Nagajyothi B. Studies on performance and heterosis of rice hybrids for yield. Yield components and certain grain quality characters. M.Sc. (Ag.) Thesis, Acharya N.G. Ranga Agricultural University, Hyderabad; 2001.
21. Nayak AR, Chaudhary D and Reddy JN. Genetic variability, heritability and genetic advance in scented rice. Indian Agriculturist 2002; 46 (1, 2): 45-47.
22. Nayudu KSR, Varline YA and Vennila S. Studies on variability, heritability and genetic advance for certain yield compounds in rice. Crop improvement 2007; 34(2): 142-144.
23. Panse VG and Sukhatme PV. Statistical methods for Agricultural Workers. ICAR, New Delhi; 1978. p. 235-246.
24. Panwar LL and Mashiat Ali. Correlation and path analysis of yield and yield components in transplanted rice. *Oryza* 2007; 44(2): 115-120.
25. Patil PV and Sarawgi AK. Studies on Genetic variability, correlation and path analysis in traditional aromatic rice accessions. Annals of plant physiology 2005; 19(1): 92 – 95.
26. Patil PV, Sarawgi AK and Shrivastava MN. Genetic analysis of yield and quality traits in traditional aromatic accessions of rice. Journal of Maharashtra Agricultural Universities 2003; 28(3): 255-258.
27. Singh Sangam Kumar, Singh Chandra Mohan, Gil GM. Assessment of genetic variability for yield and its component character in rice. Research in Plant Biol 2011; 1(4): 73-76.
28. Sankar PD, Sheeba A and Anbumalarnathi J. Variability and character association studies in rice (*Oryza sativa* L.) Agricultural Science Digest 2006; 26(3): 182-184.
29. Sarawgi AK, Rastogi NK and Soni DK. Studies on some quality parameters of indigenous rice in Madhya Pradesh. Annals of Agricultural Research 2000; 21(2): 258-261.
30. Satish Chandra B, Reddy Dayakar T, Ansari NA and Kumar Sudheer S. Correlation and path analysis for yield components in rice (*Oryza sativa* L.). Agricultural Science Digest 2009; 29(1): 45 – 47.
31. Satya Priya Lalitha V and Sreedhar N. Estimates of genetic parameters for quality traits in rice. Annals of Agricultural Research 1999; 20(1): 18-22.
32. Swain B and Reddy JN. Correlation and path analysis of yield and its components in rainfed lowland rice genotypes under normal and delayed planting conditions. *Oryza* 2006; 43(1): 58-61.
33. Venkata Subbaiah P, Reddi Sekhar M, Reddy KHP and Reddy Eswara NP. Variability and genetic parameters for grain yield and its components and kernel quality attributes in cms based rice hybrids (*Oryza sativa* L.). International Journal of applied biology and pharmaceutical technology 2011; 2(3): 603-609.
34. Verma U. Genetic diversity analysis in exotic rice genotypes. M.Sc. thesis, Dept. of GPB, Allahabad; 2010.
35. Yogameenakshi P, Nadarajan N and Anbumalarmathi J. Correlation and path analysis on yield and drought tolerant attributes in rice (*Oryza sativa* L.) under drought stress. *Oryza* 2004; 41(3, 4): 68-70.
36. Reddy Yugandhar M, Yaddav Subhash Chandra, Reddy Suresh B, Lavanya GR and Babu Suresh G. Character association and component analysis in rice. *Oryza* 2008; 45(3): 239-241.
37. Weber CR and Moorthy BR. Heritability and non heritability relationships and variability of soil content and agronomic characters in the F2 generation of soybean crosses. Agronomy Journal 1952; 44(4): 202-209. http://dx.doi.org/10.2134/agronj1952.00021962004400040010x

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