

Association Studies in Rice (*Oryza sativa* L.) Hybrids under Saline Alkaline Environment

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Abstract

The association among yield and its 11 components and direct and indirect effects of yield components on the expression of grain yield was investigated using 63 genotypes of rice comprising 45 single crosses of a line × tester set and their 18 parents (15 lines + 3 testers) during wet season, 2008-09. Grain yield per plant was positively and significantly associated with biological yield per plant, panicle bearing tillers per plant, spikelets per panicle, spikelet fertility (%), 1000-grain weight and harvest-index. Path-coefficient analysis revealed that biological yield per plant, followed by harvest-index were most important direct yield contributing traits, while spikelets per panicle, panicle bearing tillers per plant, spikelet fertility (%), plant height, panicle length and 1000-grain weight emerged as important indirect contributions towards grain yield per plant. Majority of the yield contributing traits had high order of positive indirect effects on grain per plant via biological yield per plant. Therefore due emphasis should be given to these quantitative traits identified as important direct and indirect yield components for devising effective selection strategy to enhance rice yield potential in saline-alkali soil.

Key words : Rice (*Oryza sativa* L.), Yield components, Phenotypic correlation, Path coefficient, Saline-alkaline environment.

Yield is a complex quantitative trait and greatly influenced by environment. Hence, it is necessary to assess the association of component characters with grain yield in various cross combinations to formulate selection indices. In the present study, correlation analysis was carried out with 66 genotypes (45 crosses involving 18 parents and three check varieties). Association of plant characters, determined by correlation coefficient, is useful as the basis of selecting the desirable plant. This permits evaluation of relative influence of various characters on grain yield. Path coefficient analysis is helpful in partitioning the correlation coefficient into direct and indirect effects, so that the relative contribution of each component character to the end product “yield” could be assured. The correlation of economic yield components with yield and partitioning of the correlation coefficient into its components of direct and indirect effects have been extensively discussed. The study revealed that genetic improvement of grain yield in rice is admissible by selecting characters having high positive correlation and positive direct effect.

Methods

The experimental material for this investigation comprised of three viz., Jaya, CSR 10, Narendra Usar Dhan-2 salinity and alkalinity resistant/tolerant rice varieties/genotypes as testers (males), 15 diverse varieties as lines (females) and 45 F₁'s hybrids crosses obtained by crossing them in a “line × tester” mating design (Kempthorne, 1957). All the 45 crosses (F₁'s) along with their 18 parents (15 lines + 3 testers) and check varieties Narendra Usar Dhan 2 (tolerant) and Jaya (susceptible) were included already in 63 genotype for assessing standard heterosis. These were evaluated in randomized complete block design with three replications during *kharif* of 2008-09. Single seedling per hill of each treatment transplanted at 20 × 15 cm distance between row to row and plant to plant, respectively. Each plot consisted of 3 rows with 3 m length. These diverse elite strains were selected from the collection of genetic stock available in Rice Section of the Department of Genetics and Plant Breeding, N. D. University of Agriculture & Technol-

Table 1. Estimates of phenotypic correlation coefficient between different characters in rice (*Oryza sativa* L.).

Characters	Days to 50% flowering	Flag leaf area (cm)	Plant height (cm)	Panicle length	Panicle bearing tillers/plant	Spike let/panicle
Days to 50% flowering	1.000	0.175	0.165	0.033	-0.072	0.248
Flag leaf area		1.000	0.155	0.234	-0.095	-0.033
Plant height (cm)			1.000	0.297*	0.053	0.271*
Panicle length (cm)				1.000	-0.167	0.127
Panicle bearing tillers/plant					1.000	0.226
Spikelet/panicle						1.000
No. of grains/panicle						
Spikelet fertility (%)						
1000-grain weight (g)						
Biological yield/plant (g)						
Harvest index (%)						
Grain yield/plant (g)						

Table 1. Contined.

Characters	No. of grains/panicle	Spike let fertility (%)	1000-grain weight (g)	Biological yield/plant (g)	Harvest index (%)	Grain yield/plant
Days to 50% flowering	0.190	-0.004	0.211	0.134	0.52	0.125
Flag leaf area	-0.200	-0.303*	0.330**	0.078	-0.020	0.070
Plant height (cm)	0.283*	0.169	0.200	0.297*	0.155	0.303
Panicle length (cm)	0.127	0.068	0.234	0.158	-0.057	0.132
Panicle bearing tillers/plant	0.374**	0.393**	-0.161	0.597**	0.343**	0.624**
Spikelet/panicle	0.816**	0.255*	0.196	0.589**	0.092	0.545**
No. of grains/panicle	1.000	0.764**	0.147	0.635**	0.199	0.615**
Spikelet fertility (%)		1.000	0.025	0.418**	0.253*	0.439**
1000-grain weight (g)			1.000	0.400**	0.166	0.403**
Biological yield/plant (g)				1.000	0.277*	0.970**
Harvest index (%)					1.000	0.494**
Grain yield/plant (g)						1.000

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The observations were recorded on five randomly selected plants in each replication for each entry for 12 characters viz., days to 50% flowering, flag leaf length, plant height, panicle bearing tillers/ plant, panicle length, spikelets/panicle, filled spikelet, spikelet fertility, test weight, biological yield/plant, grain yield/plant, and harvest index. Correlation coefficients were worked out as per Panse and Sukhatme (1) and Falconer (2), while path coefficient following Dewey and Lu (3).

Results and Discussion

Analysis of variance revealed highly significant

differences among entries for all the 12 characters. In general, the magnitudes of genotypic correlations were invariably higher than their corresponding phenotypic correlations. Correlations between characters are generally due to linkage or pleiotropic effects of genes or due to both. Therefore, selection made for one trait influences the other linked or pleiotropically affected traits. Correlation coefficients help us in understanding the nature and magnitude or association among different characters. Correlation coefficient and detection of direct and indirect effects of yield contributing traits on economic yield are very useful for developing efficient selection strategy for evolving high yielding varieties of saline-alkaline situation and has already been emphasized as an aid for selection.

The result pertaining to phenotypic and genotypic correlation coefficients between 12 characters are presented in Table 1. Grain yield per plant exhibited very strong positive association with biological yield, panicle bearing tillers per plant, filled spikelets per panicle, spikelets per panicle, spikelets fertility, harvest-index and test weight at phenotypic and genotypic level. Biological yield and harvest index also had strong positive correlations with grain yield per plant at phenotypic and genotypic level. Thus, the seven characters mentioned above, emerged as most important associates to seed yield in rice. Therefore, it can be inferred that selection based on these characters either in combination or alone will help in identifying the strains having high yield potential. Panicle bearing tillers per plant, filled spikelets per panicle, spikelets per panicle, spikelets fertility and test weight showed significant positive association with biological yield at both levels. These five traits also had strong positive association with grain yield to which panicle bearing tillers per plant had strongest positive correlation at both levels. Thus, highly positive association of panicle bearing tillers per plant, filled spikelets per panicle, spikelets per panicle, spikelets fertility, harvest-index and test weight with grain yield and biological yield is highly desirable condition which would lead to correlated response for simultaneous improvement of grain yield and biological yield if selection is practiced for any one or more of these five traits. Such positive associations between important yield components represent a favorable situ-

ation for simultaneous improvement in the one character when selection is practiced for other. The phenotypic and genotypic correlation coefficients between important yield components were either positively significant or non-significant. This reveals a less complex situation in attaining a proper balance between yield and its important components in context of rice genotypes used in present study as compared to complexities that arise due to existence of strong negative and positive associations between various characters in this as well as in many other crops. Highly significant associations of grain yield with 1000-grain weight and no. of tillers per plant (4) and harvest index (4, 5), with spikelet number/panicle (6) with all characters except total number of unfilled spikelets per panicle (7, 8) have been reported earlier.

Path-coefficient analysis is a tool to partition the observed correlation coefficient into direct and indirect effects of yield components on grain yield to provide clearer picture of character associations for formulation efficient selection strategy. In the present study, the path-coefficient analysis was carried out at phenotypic level (Table 2). Biological yield per plant followed by harvest-index exerted very high positive direct effects on grain yield. Thus, biological yield and harvest-index emerged as important direct yield contributing characters. Days to 50% flowering, spikelets fertility, flag leaf length and plant height and 1000-grain weight appeared as indirect yield component of secondary importance. Thus 1000-grain weight affected grain yield indirectly (7). Results of path-coef-

Table 2. Direct (diagonal bold) and indirect effect of 11 characters on grain yield/plant at phenotypic level in rice (*Oryza sativa* L.).

Characters	Days to 50% flowering	Flag leaf area (cm)	Plant height (cm)	Panicle length	Panicle bearing tillers/plant	Spikelet/panicle
Days to 50% flowering	-0.009	0.001	-0.001	0.000	0.000	-0.016
Flag leaf area	-0.002	0.004	-0.001	0.001	0.000	-0.002
Plant height	-0.002	0.001	-0.003	0.001	0.000	-0.018
panicle length (cm)	0.000	0.001	-0.001	0.004	0.000	-0.008
Panicle bearing tillers/plant	0.001	0.000	0.000	-0.001	0.001	-0.015
Spikelet/panicle	-0.002	0.000	-0.001	0.001	0.000	-0.065
No. of grains/panicle	-0.002	-0.001	-0.001	0.001	0.000	-0.053
Spikelet fertility (%)	0.000	-0.001	-0.001	0.000	0.001	-0.017
1000-grain weight (g)	-0.002	0.001	-0.001	0.001	0.000	-0.013
Biological yield/plant (g)	-0.001	0.000	-0.001	0.001	0.001	-0.038
Harvest index	0.000	0.000	-0.001	0.000	0.000	-0.006

Table 2. Continued.

Characters	No. of grains/panicle	Spike let fertility (%)	1000-grain weight (g)	Biological yield/plant (g)	Harvest index (%)	Correlation with grain yield/plant
Days to 50% flowering	0.016	0.000	0.000	0.122	0.013	0.125
Flag leaf area	-0.016	0.015	0.000	0.071	-0.005	0.070
Plant height	-0.023	-0.008	0.000	0.270	0.038	0.303
Panicle length (cm)	0.010	-0.003	0.000	0.143	-0.014	0.132
Panicle bearing tillers/plant	0.030	-0.019	0.000	0.543	0.084	0.624
Spikelet/panicle	0.067	-0.012	0.000	0.536	0.023	0.545
No. of grains/panicle	0.082	-0.037	0.000	0.577	0.049	0.615
Spikelet fertility (%)	0.062	-0.048	0.000	0.380	0.062	0.439
1000-grain weight (g)	0.012	-0.001	0.001	0.364	0.041	0.403
Biological yield/plant (g)	0.052	-0.020	0.000	0.909	0.068	0.970
Harvest index	-0.016	-0.012	0.000	0.252	0.245	0.494

ficient analysis revealed that productive tillers per plant had the highest positive direct effect on grain yield followed by harvest index and spikelet fertility (%) (9). Therefore, it may be concluded that biological yield followed by harvest-index and number of grains per panicle are the important traits of choice which would receive priority emphasis for developing ideotype (s) for saline-alkaline environment. Similar findings have also been reported by Verma and Srivastava (7).

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