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Original Research Article

Correlation and Path Coefficient Analysis of Yield Components in Rice under Drought Condition

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A B S T R A C T

To study genetic variability in the thirty rice genotype were evaluated with the main aim to analyze yield component in rice under drought condition. The experiment was conducted in RBD with three replications in two sets one for drought and other under control condition. Observations were recorded on seedling vigour, leaf rolling, days to 50% flowering, plant height, panicles bearing tillers per plant, number of spikelets per panicle, number of grains per panicle, spikelet fertility (%), test weight (g), biological yield (g), grain yield (g), harvest index (%) and relative water content. The data obtained were analyzed for analysis of variance, mean performance of genotypes, coefficient of variability, heritability in broad sense, genetic advance in percent of mean, correlation coefficient, path analysis and genetic divergence. Experimental results revealed that Barani deep, Nagina-22, Shusk samrat and Nagobanyo Red Cover lines are being suggested for its cultivation in drought prone environment release and/or may be used in marker assisted breeding.

Keywords

Drought, Rice, Correlation coefficient, Path coefficient

Introduction

Rice is the world's most important food crop and a primary source of food for more than half the world's population (Khush, 2005). Rice-growing areas consist of the tropics, subtropics, semi-arid tropics, and temperate regions of the world. Rice (*Oryza sativa* L.) is one of the three major food crops of the world. Being grown worldwide, it is the staple food for more than half of the world's population. Drought is the most important limiting factor for crop production in many regions of the world (Passioura, 1996, 2007). It is a worldwide problem that seriously influences grain production and quality. It is often unpredictable and does not occur in all years in a target environment (Lafitte *et al.*, 2002). Drought is defined as water stress mainly due to lack of rain during crop growing period. Shortage of water is the main obstacle for rice production in rainfed ecosystems since most of the rice varieties are susceptible to water stress (Mostajeran; Rahimi-Eichi, 2009). Identifying rice varieties and breeding lines with high levels of drought tolerance for use as donors in breeding and gene discovery is one of the main challenges for rice research (Serraj and Atlin, 2008). So developing drought resistant cultivars especially with good performance under drought stress is one of the major objective in rice breeding programs. Therefore, the present study was conducted to screen out the varieties that perform better under drought condition and

to find out all the morphological parameters, both under control and drought related traits that are more effective in favor of plant under drought condition at the same time.

Materials and Methods

The experiment was carried out in the field of Student Instructional Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad.

Method

The thirty rice genotypes were sown in nursery bed. After 21 days single seedling per hill were transplanted with 20 cm row to row and 15 cm plant to plant spacing in randomized complete block (RBD) design with three replications under drought stress and control (irrigated) condition. The crop was maintained properly at 120:60:60 kg/ha NPK level. The experiment was initially grown under irrigated condition.

Observations were recorded on randomly selected five plants from each entry line in each replication at maturity. These plants were harvested and threshed separately. The data were recorded on Seedling Vigour, Days to 50% flowering, Plant Height, Leaf Rolling, Relative Water Content, Panicle Bearing Tiller Per Plant, Number of Spikelet Per panicle, Number of Grain Per panicle, Spikelets Fertility, Test Weight, Biological Yield, Harvest Index and Grain yield.

Results and Discussion

Correlation coefficient

The phenotypic correlation coefficients were estimated among the ten characters under drought and twelve characters under control conditions are presented in Table 1(a) and 2(b), respectively.

Phenotypic correlation under drought condition

Grain yield per plant exhibited highly significant and positive correlation with harvest index (0.93), biological yield (0.92), panicle bearing tillers per plant (0.51),test weight (0.31),spikelet fertility (0.12), grains/ panicle (0.06) and spikelet/panicle (0.005).Days to 50% flowering (-0.37) exhibited highly significant and negative correlation with grain yield. The higher magnitude of phenotypic correlation for various characters in rice have also been reported by Gurudachalan (1972) and Bai *et al.,* (1992), Janardanam *et al.,* (2002) and Borbora *et al.,* (2005).Harvest index exhibited highly significant and positive correlation with biological yield (0.73), panicle bearing tillers per plant (0.52) and test weight (0.31). Days to 50% flowering (-0.42) and plant height (-0.26) exhibited significant and negative correlation with harvest index. However, Chand *et al.,* (2004) found significant positive correlation of grain yield with grains per panicle. Nabeela *et al.,* (2004) observed that days to 50% flowering were positively correlated with maturity. Biological yield exhibited significant and positive correlation with panicle bearing tillers per plant (0.42) and test weight (0.24). Days to 50% flowering (-0.27) exhibited highly significant and negative correlation with biological yield. Test weight exhibited non-significant correlation with all the traits. Spikelet fertility (%) exhibited significant and positive correlation with grains per panicle (0.28) and panicle bearing tillers per plant (0.20). Grains per panicle exhibited highly significant and positive correlation with spikelets per panicle (0.91), days to 50% flowering (0.42) and plant height (0.27). Spikelets per panicle exhibited highly significant and positive correlation with days to 50% flowering (0.46) and plant

height (0.39). Panicle bearing tillers per plant exhibited highly significant and negative correlation with plant height (-0.31) and days to 50% flowering (-0.29).Plant height exhibited highly significant and positive correlation with days to 50% flowering (0.60). Borbora *et al.*, (2005) observed that grain yield per plant showed significant and positive association with grain yield per panicle and significant negative correlation with plant height, panicle number per plant and chaffy grain number per panicle.

Phenotypic correlation under controlled

Grain yield exhibited highly significant and positive correlation with biological yield (0.84), harvest index (0.66), test weight (0.39), plant height (0.38) and RWC (0.36).

Harvest index exhibited highly significant and positive correlation with RWC (0.58). Biological yield exhibited highly significant and positive correlation with plant height (0.45), test weight (0.43) and days to 50% flowering (0.36) and significant and positive correlation with seedling vigour (0.26), spikelets per panicle (0.21) and grains per panicle (0.21).

Test weight exhibited highly significant and positive correlation with days to 50% flowering (0.28). Spikelet fertility (%) exhibited significant and positive correlation with days to 50% flowering (0.30) and grains per panicle (0.22).

Grains per panicle exhibited highly significant and positive correlation with spikelets per panicle (0.96), days to 50% flowering (0.61), plant height (0.55) and seedling vigour (0.43). Spikelets per panicle exhibited highly significant and positive correlation with plant height (0.53), days to 50% flowering (0.53) and seedling vigour (0.43). Panicle bearing tillers per plant exhibited significant and negative correlation with plant height (-0.24). RWC exhibited highly significant and positive correlation with plant height (0.29) and seedling vigour (0.28). Plant height exhibited highly significant and positive correlation with days to 50% flowering (0.56) and seedling vigour (0.44). Days to 50% flowering exhibited highly significant and positive correlation with seedling vigour (0.27).

Path coefficient analysis

Path coefficient analyses were estimated at phenotypic levels to resolve the direct and indirect effects of different characters on grain yield under drought and controlled conditions (Table 2a and 2b)

Phenotypic path coefficient analysis under drought condition

Harvest index (0.5484) showed maximum direct effect on grain yield followed by biological yield (0.5083) and test weight (0.0230). The contributions of other characters were too low to be considered important. Harvest index exhibited highest indirect effect on grain yield *via* biological yield per plant (0.4032) followed by panicle bearing tillers/plant (0.2866). Biological yield exhibited high indirect effect on grain yield *via* harvest index (0.3737) fallowed by panicle bearing tillers per plant (0.21) andtest weight (0.12).

The contributions of other characters were too low to be considered important. Bagali *et al.*, (1999) studied *indica* X *japonica* double haploid population of 114 homozygous lines in rice and reported a high positive indirect effect of panicle weight on grain yield through harvest-index and number of grains per panicle.

Table.1 (a) Estimates of phenotypic correlation coefficient between 10 characters in rice under drought condition

Characters	Days to 50% Flowering	Plant height (cm)	Panicle bearing Tiller/plant	Spiklets/ panicle	Grains/ Panicle	Spikelet Fertility (%)	Test weight (g)	Biological Yield	Harvest Index (%)	Grain yield/ Plant
Days to 50 % flowering	**1.00**	0.60**	-0.29**	0.46**	0.42**	-0.02	0.13	-0.27**	-0.42**	-0.37**
Plant height (cm)		**1.00**	-0.31**	0.39**	0.27**	-0.15	0.11	-0.04	-0.26*	-0.17
Panicle bearing tillers/ plant			**1.00**	0.08	0.13	0.20*	0.04	0.42**	0.52**	0.51**
Spiklets/panicle				**1.00**	0.91**	-0.18	-0.01	0.11	-0.09	0.005
Grains/Panicle					**1.00**	0.28*	-0.06	0.18	-0.06	0.06
Spikelet Fertility (%)						**1.00**	-0.10	0.18	0.03	0.12
Test weight (g)							**1.00**	0.24*	0.31**	0.31**
Biological Yield								**1.00**	0.73**	0.92**
Harvest Index (%)									**1.00**	0.93**

*=Significant, **= Highly significant

Table.1 (b) Estimates of phenotypic correlation coefficient between 12 characters in rice under controlled condition

Characters	Seedling vigour	Days to 50 % flowering	Plant height (cm)	R.W.C	Panicle bearing tillers/ plant	Test weight (g)	Spikelets/ panicle	Grains/ panicle	Spikelet fertility (%)	Bilogical yield (g)	Harvest index (%)	Grain yield/ plant
Seedling vigour	``	0.27**	0.44**	0.28**	-0.03	0.12	0.43**	0.43**	0.005	0.26*	0.11	0.23
Days to 50 % flowering		1.00	0.56**	0.14	0.05	0.28**	0.53**	0.61**	0.30**	0.36**	-0.03	0.24
Plant height (cm)			1.00	0.29	-0.24*	0.18	0.53**	0.55**	0.08	0.45**	0.12	0.38**
R.W.C				1.00	0.05	0.08	0.08	0.08	0.03	0.08	0.58**	0.36**
Panicle bearing tillers/ plant					1.00	-013	0.02	0.04	0.07	0.04	0.20	0.15
Test weight (g)						1.00	-0.02	-0.03	-0.08	0.43**	0.14	0.39**
Spikelets/ panicle							1.00	0.96**	-0.04	0.21*	0.02	0.13
Grains/ panicle								1.00	0.22*	0.21*	0.01	0.13
Spikelet fertility (%)									1.00	0.02	-0.03	0.01
Bilogical yield (g)										1.00	0.18	0.84**
Harvest index (%)											1.00	0.66**

*= Significant, **= Highly significant

Table.2 (a) Direct and indirect effects for different characters on grain yield per plant at phenotypic level in rice genotypes under drought conditions

Characters	Days to 50% Flowering	Plant height (cm)	Panicle bearing Tiller/plant	Spiklets/panicle	Grains/Panicle	Spikelet Fertility (%)	Test weight (g)	Biological Yield	Harvest Index (%)	Grain yield/Plant
Days to 50 % flowering	**-0.0139**	-0.0085	0.0040	-0.0065	-0.0059	0.0004	-0.0018	0.0038	0.0058	-0.3781*
Plant height (cm)	-0.0024	**-0.0039**	0.0012	-0.0015	-0.0011	0.0006	-0.0004	0.0002	0.0010	-0.1773
Panicle bearing tillers/ plant	0.0008	0.0009	**-0.0028**	-0.0001	-0.0004	-0.0006	-0.001	-0.0012	-0.0015	0.5100**
Spiklets/panicle	-0.0049	-0.0041	-0.0004	**-0.0105**	-0.0036	0.0015	0.0002	-0.0012	0.0009	0.0054
Grains/Panicle	0.0083	0.0053	-0.0026	0.0177	**0.0194**	0.0052	-0.0012	0.0037	-0.0013	0.0630
Spikelet Fertility (%)	-0.0002	-0.0009	0.0012	-0.0008	0.0016	**0.0059**	-0.0006	0.0011	0.0002	0.1267
Biological Yield	0.0030	0.0052	0.0011	-0.0004	-0.0014	-0.0024	**0.0230**	0.0057	0.0072	0.3179
Harvest Index (%)	-0.1383	-0.0237	0.2166	0.0569	0.0961	0.0960	0.1260	**0.5083**	0.3737	0.9236**
Grain yield/Plant	-0.2306	-0.1450	0.2866	-0.0494	-0.0357	0.0201	0.1730	0.4032	**0.5484**	0.9347**

Residual Effect= 0.0653.

Table.2 (b) Direct and indirect effects for different characters on grain yield per plant at phenotypic level in rice genotypes under control conditions

Characters	Seedling vigour	Days to 50 % flowering	Plant height (cm)	R.W.C	Panicle tillers/ plant	Test weight (g)	Spikelets/ panicle	Grains/ panicle	Spikelet fertility (%)	Bilogical yield (g)	Harvest index (%)	Grain yield/ plant
Seedling vigour	**-0.0116**	-0.0032	-0.0052	-0.0033	0.0004	-0.0015	-0.0051	-0.0051	-0.0001	-0.0031	-0.0013	0.2323
Days to 50 % flowering	0.0090	**0.0330**	0.0187	0.0046	0.0017	0.0093	0.0178	0.0201	0.0101	0.0119	-0.0012	0.2475
Plant height (cm)	-0.0087	-0.0110	**-0.0195**	-0.0058	0.0047	-0.0035	-0.0103	-0.0107	-0.0017	-0.0089	-0.0023	0.3848**
R.W.C	0.0010	0.0005	0.0010	**0.0034**	0.0002	0.0003	0.0003	0.0003	0.0001	0.0003	0.0020	0.3690*
Panicle tillers/ plant	-0.0002	0.0003	-0.0016	0.0004	**0.0065**	-0.0009	0.0002	0.0003	0.0005	0.0003	0.0013	0.1564
Test weight (g)	-0.0027	-0.0060	-0.0038	-0.0018	0.0029	**-0.0212**	0.0005	0.0008	0.0018	-0.0093	-0.0031	0.3972*
Spikelets/ panicle	-0.0361	-0.0443	-0.0436	-0.0073	-0.0022	0.0020	**-0.0822**	-0.0792	0.0035	-0.0175	-0.0023	0.1397
Grains/ panicle	0.0187	0.0260	0.0235	0.0038	0.0021	-0.0017	0.0410	**0.0426**	0.0094	0.0092	0.0004	0.1373
Spikelet fertility (%)	-0.0001	-0.0037	-0.0011	-0.0005	-0.0009	0.0010	0.0005	-0.0027	**-0.0122**	-0.0003	0.0004	0.0152
Bilogical yield (g)	0.2037	0.2760	0.3523	0.0631	0.0312	0.3351	0.1629	0.1663	0.0191	**0.7661**	0.1392	0.8452**
Harvest index (%)	0.0603	-0.0188	0.0647	0.3122	0.1100	0.0793	0.0152	0.0054	-0.0161	0.0975	**0.5366**	0.6688**

Residula Effect = 0.0931

Phenotypic path coefficient analysis under control condition

Biological yield (0.766) showed maximum direct effect on grain yield followed by harvest index (0.556). The contribution of other characters was too low to be considered important. Biological yield exhibited highest indirect effect on grain yield *via* plant height (0.352) followed by test weight (0.335), days to 50% flowering (0.276). Seedling vigour (0.223), grains per panicle (0.166), spikelets per panicle (0.162), and harvest index (0.139). Harvest index exhibited highest indirect effect on grain yield *via* RWC (0.312) fallowed by panicle bearing tillers per plant (0.11). The contributions of other characters were too low to be considered important.

Drought has been the single largest factor limiting the rice yield in rainfed areas. Developing rice cultivars with drought tolerance is the most effective way to solve this problem. Because of genetic complexity and physiology of drought tolerance in rice it is probably the most difficult trait to improve through conventional breeding. In present investigation thirty rice genotype were evaluated under drought and control condition. The genotypic correlations were generally similar in nature and higher in magnitude with the corresponding phenotypic correlation coefficients. Grain yield was positively and highly significantly correlated with harvest index, biological yield and seedling height under both conditions. The path coefficient analysis indicated that harvest index, biological yield and test weight had maximum direct effect on grain yield at phenotypic and genotypic level under drought condition. Biological yield and harvest index had maximum direct effect on grain yield at phenotypic level and grains per panicle and panicles per plant had maximum direct effect on grain yield at genotypic level under control condition. Biological exerted very high positive indirect effect on grain yield at phenotypic and genotypic level under control conditions *via* plant height.

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