Electronic Journal of Plant Breeding, 1(4): 903-907 (July 2010)

Research Article

Role of secondary and putative traits for improvement of upland rice

A.Sheeba, P.Vivekanandan, S. Banumathy, R.Manimaran and G.V.Ramasubramanian

Abstract :
Even though yield under stress is the primary trait for selection in breeding programmes for drought prone environments, low heritability of yield necessitates an alternative approach such as selection for secondary and putative traits. For a secondary or putative trait to be useful in a breeding programme, it must be genetically correlated with grain yield under stress condition. In the present investigation, single plant yield exhibited positive and significant association with spikelet fertility, panicle harvest index, days to attain 70 % RWC, root length, dry root weight and root: shoot ratio. Hence, these traits are to be given importance while selection. Since the traits spikelet fertility and panicle harvest index expressed exact correlation with each other, any one of these two traits may be considered during the selection process. The trait days to attain 70 % RWC positively correlated with root traits such as root length, dry root weight and root : shoot ratio suggesting that selection based on days to attain 70 % RWC is highly fruitful in developing drought tolerant genotypes as it will bring simultaneous improvement of these traits. Apportioning the correlation coefficients into direct and indirect effects revealed that the traits spikelet fertility, leaf drying and dry root weight had high direct effect with grain yield. The traits days to attain 70 % RWC, leaf drying, canopy temperature, drought recovery percentage, dry root weight and root: shoot ratio also showed low to high indirect effect via spikelet fertility. Likewise all traits except days to 50% flowering expressed moderate to high indirect effects via leaf drying and dry root weight. The study indicates that the traits spikelet fertility, leaf drying and dry root weight greatly influenced the grain yield both directly and indirectly and hence these three traits should be given more importance for enhancing grain yield under the drought stress situation.

Key words:
upland rice, drought, secondary and putative traits, association

Introduction

Yield improvement in water limited environments could be achieved by identifying and selecting secondary and putative traits that contribute drought resistance. An idea on the extent of association between traits conferring drought resistance will be much helpful to decide upon the traits to be given importance in selection for drought tolerance. A positive association between traits warrants the simultaneous improvement of both the traits while restricting selection to any one of the associated traits. On the other hand, a negative relationship between two traits necessitates equal weightage to be given on both the traits during selection process. Relative importance of drought tolerant attributes may be decided based on highly correlated trait with grain yield and with other major mechanisms of drought tolerance.

Hence, the present study was carried out to find association between grain yield and drought related secondary traits such as days to 50% flowering, spikelet fertility, panicle harvest index, days to attain 70% RWC, leaf rolling, leaf drying, canopy temperature; putative traits such as root length, dry root weight, root:shoot ratio and drought recovery percentage and the inter correlation among these traits under managed stress condition.

Agricultural College and Research Institute
Killikulam.

Materials and methods

Forty hybrids obtained by crossing four Thermo sensitive Genic Male Sterile (TGMS) Lines such as GD 98049, GD 99017, GD 99033 and GD 99036 and ten short duration, drought tolerant cultivars such as PM 01010, PM 01011(PMK 4), TM 97017, TM 97056, MDU 5, PMK 2, PMK 3, IR 36, Norungan, and Varappukudanchan were utilized for association analysis under managed stress condition. All the forty crosses were transplanted in a Randomized Block Design, replicated thrice adopting a spacing of 20cm between rows and 10cm between plants within a row. After transplanting, the stress was imposed at active tillering stage. Irrigation was stopped at 59th day after sowing and the stress was imposed for 16 days. During stress period, RWC was observed in both parents and hybrids daily until it reaches 70 per cent and the other traits such as days taken to attain 70 % RWC, canopy temperature, chlorophyll content, leaf rolling and leaf drying were recorded. The traits *viz.,* root length, dry root weight, root: shoot ratio and single plant yield were recorded at the time of harvest. The association analysis was carried out by the method suggested by Al-Jibouri *et al*. (1958) and Dewey and Lu (1959).

Results and discussion

Association analysis helps breeders to ascertain the nature of relationship between important traits. Single plant yield registered significant and positive association with spikelet fertility (0.696), panicle harvest index (0.690), relative

water content (0.569), root length (0.600), dry root weight (0.715) and root:shoot ratio (0.754) (Table 1). This was in conformity with the findings of Kumar *et al*. (2004) for spikelet fertility; Pushpa *et al*. (2004) for panicle harvest index; Singh *et al*. (2004a) for relative water content; Sinha *et al*. (2000) for root length, Michael Gomez and Rangasamy (2002) for dry root weight and Singh *et al*. (2004b) for root : shoot ratio.

A knowledge on inter relationship between drought tolerant traits may facilitate breeder to decide upon the intensity and direction of selection pressure to be given on related traits for the simultaneous improvement of these traits.

In the present study, days to 50% flowering had positive and significant association with canopy temperature (0.230). Similarly positive and significant relationship was observed between spikelet fertility and traits *viz*., panicle harvest index (0.995), days to attain 70% RWC(0.510), root length (0.274), dry root weight (0.412) and root : shoot ratio (0.628). The traits, days to attain 70% RWC (0.491), root length (0.240), dry root weight (0.425) and root : shoot ratio (0.617) showed positive and significant association with panicle harvest index (Table 1).

Days to attain 70 % RWC had negative and significant correlation with leaf rolling (-0.417), leaf drying (-0.549), canopy temperature (-0.628) and drought recovery percentage (-0.780). This was in accordance with the findings of Liu *et al*. (2004) for canopy temperature and Singh *et al*. (2004a) for leaf rolling, Where as, positive and significant association was found between this trait and root length, dry root weight and root:shoot ratio which was in conformity with the findings of Singh *et al*. (2004b) for root length. This association indicates the contribution of root traits to maintain high relative water content.

Leaf rolling showed positive and significant association with leaf drying (0.294), canopy temperature (0.147) and drought recovery percentage (0.579) while, leaf drying had positive and significant correlation with canopy temperature (0.564).

The root traits such as root length, dry root weight and root : shoot ratio had significant positive inter correlation with each other. This was in conformity with the findings of Sinha *et al*. (2000), Michael Gomez and Rangasamy (2002) and Yogameenakshi (2002) for root length and dry root weight.

From the above discussion, it may be inferred that, spikelet fertility and panicle harvest index among the secondary traits and days to attain 70% RWC, root length, dry root weight and root:shoot ratio among the putative traits are to be given importance while selection as they expressed positive and significant correlation with grain yield. Since, the traits spikelet fertility and panicle harvest index expressed exact correlation with each other, any one of these two traits may be considered during the selection programme. Days to attain 70% RWC positively correlated with root traits such as root length, dry root weight and root : shoot ratio suggesting that selection based on this trait will be highly fruitful in developing drought tolerant genotypes.

Path analysis partition the genotypic correlation coefficients of different characters on grain yield to direct and indirect effects. Thus, it gives an idea about how a trait influences grain yield directly and indirectly *via* other traits. In the present investigation, the traits spikelet fertility (0.641), leaf drying (-0.480) and dry root weight (0.370) expressed high direct effect on grain yield (Table 2). This was in conformity with the findings of Michael Gomez and Rangasamy (2002) for relative water content and Yogameenkshi *et al*. (2004) for root length and dry root weight.

Conclusion

The traits spikelet fertility and panicle harvest index expressed perfect correlation with each other and hence their indirect effects were almost similar. Further spikelet fertility showed more direct effect than panicle harvest index and also had high indirect effect through this trait. Several other traits like days to attain 70% RWC, leaf drying, canopy temperature, drought recovery percentage, dry root weight and root:shoot ratio also showed low to high indirect effects *via* spikelet fertility. Likewise, all traits except days to 50% flowering expressed moderate to high indirect effects *via* leaf drying and dry root weight. However, the direct effect of leaf drying was negative on grain yield in line with its negative correlation with grain yield. Hence, leaf drying should be less to get higher grain yield. The study indicates that these three traits *viz.,* spikelet fertility, leaf drying and dry root weight greatly influenced the grain yield both directly and indirectly hence should be given priority during selection for enhancing grain yield under drought stress situation.

References

Al-Jibouri, H. R., P. A. Miller and H. F. Robinson. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. *Agron. J., 50*: 633-636.

Dewey, D.R. and K.H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J., 51*: 515-518.

Kumar, R., G. Atlin and R. Lafitte. 2004. Evaluation of rapid drought stress protocol to predict field performance of rice under drought stress condition. In: *Proc. workshop on resilient crops for water limited environments*. Cuernavaca, Mexico, pp. 167-168.

Liu, H.Y., H.W. Mei, G.H. Zou, S.P. Hu, G.L. Liu, X.Q. Yu, J. Li, P. Long and Lijun Luo. 2004. Studies on phenotype of Zhenchan 97B / IRTA 109 RILs population in field screen facility. In: *Proc. workshop on resilient crops for water limited environments*. Cuernavaca, Mexico, pp.171-172.

Michael Gomez, S. and P. Rangasamy. 2002. Correlation and path analysis of yield and physiological characters in drought resistant rice (*Oryza sativa* L.). *Int. J. Mendel, 19*(1-2): 33-34.

Pushpa, R., R. Manimaran., S. Robin, P. Jayaprakash, S. Mahendran, L. Mahalingam, S. Shanmugasundram, R. Chandra Babu and K. Thiyagarajan. 2004. Direct selection for grain yield under on-season natural moisture stress condition: Results from a large scale screening nursery. In: *Proc. workshop on resilient crops for water limited environments*. Cuernavaca, Mexico, pp.191-192.

Singh, A. K., S. Prasad, V. N. Singh, G. S. Chaturvedi and B. B. Singh. 2004a. Morphological traits for vegetative stage drought tolerance in rice (*Oryza sativa* L.). In: *Proc. workshop on resilient crops for water limited environments*. Cuernavaca, Mexico, pp. 188-189.

Singh, V. N., A. K. Singh, B. B. Singh, G. S. Chaturvedi, O. P. Verma and G. Atlin. 2004b. Genetic analysis of IR 64 introgression lines of rice under irrigated and water stressed field conditions. In: *Proc. workshop on resilient crops for water limited environments*. Cuernavaca, Mexico, pp. 68-69.

Sinha P. K., K. Prasad and G. N. Mishra. 2000. Studies on root characters related to drought resistance and their association in selected upland rice genotypes. *Oryza*, *37*(1): 29-31.

Yogameenakshi, P. 2002. Genetic analysis and *in vitro* studies for drought tolerance in rice (*Oryza sativa* L). *M.Sc (Ag.) Thesis*. TNAU, Coimbatore.

Yogameenakshi, P., N. Nadarajan and J. Anbumalarmathi. 2004. Correlation and path analysis on yield and drought tolerant attributes in rice (*Oryza sativa* L.) under drought stress. *Oryza, 41*(3&4): 68-70.

Table 1. Correlation coefficients for drought related traits and single plant yield.

Characters	DFF	SF	PHI	DAR	LR	LD	CT	DRP	RL	DRW	R:S	SPY
DFF	1.000	-0.230*	-0.231*	0.017	0.131	0.103	0.230*	0.113	0.220	0.080	-0.026	0.030
SF		1.000	0.995*	0.510*	-0.306*	-0.663*	-0.507*	-0.726*	0.274*	0.412*	0.628*	0.696*
PHI			1.000	0.491*	-0.310*	-0.659*	-0.500*	-0.727*	0.240*	0.425*	0.617*	0.690*
DAR				1.000	-0.417*	-0.549*	-0.628*	-0.780*	0.638*	0.596*	0.745*	0.569*
LR					1.000	0.294*	0.147*	0.579*	-0.218	-0.599*	-0.542*	-0.351*
LD						1.000	0.564*	0.628*	-0.578*	-0.543*	-0.705*	-0.838*
CT							1.000	0.630*	-0.465*	-0.548*	-0.637*	-0.595*
DRP								1.000	-0.488*	-0.762*	-0.841*	-0.713*
RL									1.000	0.567*	0.538*	0.600*
DRW										1.000	0.793*	0.715*
R:S											1.000	0.754*
SPY												1.000

* - significance at 5% level

DFF : Days to 50% flowering
SF : Spikelet fertility
PHI : Panicle harvest index
DAR : Days to attain 70% RWC
LR : Leaf rolling
LD : Leaf drying
CT : Canopy Temperature
DRP : Drought Recovery Percentage
RL : Root length
DRW : Dry root weight
R:S : Root : Shoot ratio
SPY : Single Plant Yield

Table 2. Direct and indirect effects of drought related traits on Single plant yield

Characters	DFF	SF	PHI	DAR	LR	LD	CT	DRP	RL	DRW	R:S	SPY
DFF	**0.110**	-0.147	0.084	-0.002	0.006	-0.050	-0.015	-0.001	0.014	0.030	0.001	0.030
SF	-0.025	**0.641**	-0.361	-0.057	-0.015	0.318	0.032	0.003	0.017	0.156	-0.014	0.696*
PHI	-0.025	0.638	**-0.362**	-0.055	0.015	0.316	0.032	0.003	0.015	0.157	-0.014	0.690*
DAR	0.002	0.327	-0.178	**-0.112**	-0.020	0.263	0.040	0.004	0.040	0.222	-0.017	0.569*
LR	0.014	-0.196	0.112	0.047	**0.048**	-0.141	-0.009	-0.003	-0.014	-0.220	0.012	-0.351*
LD	0.011	-0.425	0.239	0.061	0.014	**-0.480**	-0.036	-0.003	-0.036	-0.201	0.016	-0.838*
CT	0.025	-0.325	0.181	0.070	0.007	-0.270	**-0.063**	-0.003	-0.029	-0.203	0.014	-0.595*
DRP	0.012	-0.465	0.263	0.087	0.028	-0.301	-0.040	**-0.004**	-0.030	-0.282	0.019	-0.713*
RL	0.024	0.176	-0.087	-0.071	-0.010	0.277	0.029	0.002	**0.062**	0.210	-0.012	0.600*
DRW	0.009	0.270	-0.154	-0.067	-0.029	0.260	0.035	0.003	0.035	**0.370**	-0.018	0.715*
R:S	-0.003	0.403	-0.223	-0.083	-0.026	0.338	0.040	0.004	0.033	0.293	**-0.023**	0.754*

* - significance at 5% level Residual effect = 0.15 Diagonal values denote the direct effects

- **Note**

DFF	: Days to 50% flowering	LR	:	Leaf rolling	RL	:	Root length
SF	: Spikelet fertility	LD	:	Leaf drying	DRW	:	Dry root weight
PHI	: Panicle harvest index	CT	:	Canopy Temperature	R:S	:	Root : Shoot ratio
DAR	: Days to attain 70% RWC	DRP	:	Drought Recovery Percentage	SPY	:	Single Plant Yield