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TRAIT ASSOCIATIONS' ANALYSIS OF BLAST RESISTANT SEGREGATING POPULATIONS OF RICE

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Abstract

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Improvement of blast resistance hybrid rice parents is one of main target of rice breeding in blast endemic areas. The three F_2 blast resistant introgressed segregating populations were used to study the association and the effects of yield related traits on single plant yield in rice. Thousand grain weight was strongly correlated with the single plant yield (r = 0.84**, $p < 0.01$) in CB 87R × Zenith > (r = 0.46**, $p < 0.01$) in TNAU CMS 2B × Zenith. Plant height was the important yield determining component for CB 174 R × Zenith (0.34), thousand grain weight for CB 87 R × Zenith (0.74) and number of productive tillers for (0.54) TNAU CMS 2B × Zenith showing a direct effect. The obtained genetic information from the present study indicated that variation exists in available material, thus allowing the selection of desirable segregants for further improvement in future rice breeding program.

Key words: correlation coefficient; direct and indirect effects; early generation; yield components

Introduction

Rice is one of the most important cereal staple food crops in the world. In India, estimated rice production is 103.61 million tonnes during 2015-16, which was 1.87 million tonnes lower as compared as estimated in the year 2014-15 (Department of Agriculture, India). Rice blast fungus (*Magnaporthe grisea*) is one of most devasting disease in rice, caused severe yield reduction up to 65% in yield under conductive condition (Li et al., 2007). Marker assisted selection is an important tool to pyramid resistance genes into elite breeding materials (Collard et al., 2008). Using marker assisted selection, blast resistant lines could be identified within the short breeding cycle. Knowledge about parental divergence is a prime for before initiating successful experiments. Genetic improvement for any trait in crop breeding program could be achieved by using F_2 individuals to fix desirable segregants for further improvement. Correlation coefficient is an important method used to determine the relative importance of independent variables towards dependent variable (Panse, 1957). Path coefficient analysis permits partitioning of correlation into direct and indirect effects of traits on main traits (Dewey and Lu, 1959). The present study was planned to study the genetic associations between the yield and yield contributing characters in the gene introgressed segregating populations in rice.

Materials and Methods

Experimental materials were comprised of parents of the recently released hybrids in TNAU. CB 174 R is the restorer line of rice hybrid CORH 4 (COMS 23A / CB 174 R) well known for a medium slender grain type, which matures in 135 days. Similarly, TNAUCMS 2B and CB 87 R are the maintainer and restorer lines of released rice hybrid CORH 3 (TNAU CMS 2B / CB 87 R) having the

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features of non-sticky, non-aromatic and short duration nature. Zenith is the donor parent for blast resistant gene Pi_z. The present study was conducted at the Department of Rice, Tamil Nadu Agricultural University, Coimbatore. The area was located at latitude 11° 00′ N and longitude of 77° 00′ and an elevation of 427.00 meters above mean sea level. Standard cultural practices were followed to grow a healthy crop.

Data collection and statistical analysis

Data were recorded from each population on the basis of single plant at the time of harvest on plant height (cm), number of productive tillers, panicle length (cm), number of grains, thousand grain weight (g) and single plant yield (g). Agro-morphological data of each F_2 individuals of each population were used directly for statistical analysis. Correlation coefficient analysis was done using GENSTAT release 14.1 (Payne et al., 2011). Coefficient of correlation is partitioned into direct and indirect effects components were calculated as described by Dewey and Lu, (1959) and was carried out by using R programme.

Result and Discussion

Wide ranges of variability, moderate to high heritability, low to high genetic advance as percent of mean, skewness and kurtosis was found among these crosses for all the traits were reported earlier by Ponnaiah Govintharaj et al. (2016 and 2017).

Correlation for CB 174 R × Zenith

The Pearson correlation coefficient of yield and yield contributing traits for the cross CB 174 R × Zenith were given in Table 1. Significant correlation coefficient was found for all traits except between plant height with panicle length and number of grains and, number of productive tillers with panicle length were positively non-significant, while negatively non-significant for plant height with thousand grain weight. Single plant yield showed significant and positive association with plant height (r = 0.56**, $p < 0.01$), number of productive tillers (r = 0.54**, $p < 0.01$), panicle length (r = 0.53**, $p < 0.01$) and number of grains (r = 0.68**, $p < 0.01$). This finding was concluded that simultaneous improvement of both the trait is possible. Panicle length (r = -0.61**, p < 0.01) had negatively significant with thousand grain weight. Number of grains (r = –0.55**, p < 0.01) was significantly negative associated with thousand grain weight. Similar findings were reported by Biswas et al. (2000).

Table 1

Correlation among yield and yield related contributing traits for the cross of CB 174 R × Zenith

Characters	PH	NPT	PL	NG	TGW
PH					
NPT	0.34*				
PL	0.32	0.39			
NG	0.23	0.42**	0.47**		
TGW	-0.32	-0.37*	-0.61**	-0.55**	
SPY	0.56**	0.53**	0.53**	0.68**	-0.56**

*,** significant at P < 0.05 and P < 0.01, respectively

Note: PH: Plant height (cm), NPT: Number of productive tillers, PL: Panicle length (cm), NG: Number of grains per panicle, TGW: Thousand grain weight (g), SPY: Single plant yield (g)

Path for CB 174 R × Zenith

The direct and indirect effects of yield and yield contributing traits for the cross CB 174 R × Zenith were given in Table 2. Most of the studied traits exhibited positive direct effect except thousand grain weight. Among all, number of grains revealed highest direct effect (0.42) (Liu et al., 2001). But the number of grains and plant height with single plant yield showed highest indirect effect. Number of grains showed important yield determining component in this CB 174 R × Zenith. The residual effect was 0.57 indicating that 43% of the variability was contributed by yield related traits on single plant yield.

Table 2

Direct and indirect effect of path coefficient matrix for yield and yield contributing traits of CB 174 R × Zenith

Characters	PH	NPT	PL	NG	TGW	SPY
PH	0.34	0.06	0.04	0.10	0.03	0.56**
NPT	0.12	0.17	0.04	0.18	0.03	0.54**
PL	0.11	0.05	0.11	0.20	0.06	0.53**
NG	0.08	0.07	0.05	0.42	0.05	0.68**
TGW	-0.11	-0.06	-0.07	-0.23	-0.09	-0.56**

*,** significant at P < 0.05 and P < 0.01, respectively

Note: PH: Plant height (cm), NPT: Number of productive tillers, PL: Panicle length (cm), NG: Number of grains per panicle, TGW: Thousand grain weight (g), SPY: Single plant yield (g)

Correlation for CB 87 R × Zenith

The Pearson correlation coefficient of yield and yield contributing traits for the cross CB 87 R × Zenith were given in Table 3. Simple correlation coefficient was significant for all the studied traits except plant height and number of productive tillers with panicle length. Traits like plant height (r = 0.40**, $p < 0.01$), number of productive tillers (r = 0.52**, $p < 0.01$), panicle length (r = 0.28*, $p < 0.01$), number of

grains (r = 0.49**, $p < 0.01$) and thousand grain weight (r = 0.84**, $p < 0.01$) revealed significantly positive association with single plant yield. In agreement with this finding were the studies of Kennedy and Rangasamy, (1998) for thousand grain weight; Eradasappa et al. (2007) for plant height; Krishna et al. (2008) for number of productive tillers and Sankar et al. (2006) for panicle length. Plant height highly correlated with number of grains (r = 0.79**, $p < 0.01$). This finding suggests that taller plants usually had long panicle and thus could leads to more number of grains.

Table 3
Correlation among yield and yield related contributing traits for the cross of CB 87 R × Zenith

Characters	PH	NPT	PL	NG	TGW
PH					
NPT	0.27*				
PL	0.21	0.17			
NG	0.79**	0.34**	0.24*		
TGW	0.30*	0.40**	0.37**	0.43**	
SPY	0.40**	0.52**	0.28*	0.49**	0.84**

*,** significant at P < 0.05 and P < 0.01, respectively
Note: PH: Plant height (cm), NPT: Number of productive tillers, PL: Panicle length (cm), NG: Number of grains per panicle, TGW: Thousand grain weight (g), SPY: Single plant yield (g)

Path for CB 87 R × Zenith

The direct and indirect effects of yield and yield contributing traits for the cross CB 87 R × Zenith were given in Table 4. Most of the studied traits exhibited positive direct effect except panicle length. Among all, thousand grain weight revealed highest direct effect (0.74) (Li et al. 1991; Ram 1992). Whereas indirect effect revealed thousand grain weight and number of productive tillers with single plant yield. Thousand grain weight showed important yield determining component in CB 87 R × Zenith.

Table 4
Direct and indirect effect of path coefficient matrix for yield and yield related contributing traits of CB 87 R × Zenith

Characters	PH	NPT	PL	NG	TGW	SPY
PH	0.12	0.05	-0.01	0.02	0.22	0.40**
NPT	0.03	0.19	-0.01	0.01	0.29	0.52**
PL	0.02	0.03	-0.06	0.01	0.27	0.28*
NG	0.09	0.07	-0.01	0.03	0.32	0.49**
TGW	0.04	0.08	-0.02	0.01	0.74	0.84**

*,** significant at P < 0.05 and P < 0.01, respectively
Note: PH: Plant height (cm), NPT: Number of productive tillers, PL: Panicle length (cm), NG: Number of grains per panicle, TGW: Thousand grain weight (g), SPY: Single plant yield (g)

The residual effect was 0.24 indicating that 76% of the variability was contributed by yield contributing traits on single plant yield.

Correlation for TNAU CMS 2B × Zenith

The Pearson correlation coefficient of yield and yield contributing traits for the cross TNAU CMS 2B × Zenith were given in Table 5. Plant height was positively non-significant associated with number of grains, thousand grain weight and single plant yield. The traits, viz. number of productive tillers (r = 0.62**, $p < 0.01$), panicle length (r = 0.19*, $p < 0.05$), number of grains (r = 0.28**, $p < 0.05$) and thousand grain weight (r = 0.46**, $p < 0.01$) were showed to be positively significantly associated with single plant yield. This finding was in agreement with the studies of Hasan et al. (2013); Reddy et al. (2013) and Vanisree et al. (2013) for plant height; Minnie et al. (2013) for panicle length; Basavaraja et al. (2013) for number of productive tillers. Significant positive association between any of the two traits suggested that simultaneous improvement is possible for both the traits.

Table 5
Correlation among yield and yield related contributing traits for the cross of TNAU CMS 2B × Zenith

Characters	PH	NPT	PL	NG	TGW
PH					
NPT	0.18*				
PL	0.33**	0.26**			
NG	0.04	0.20**	0.22**		
TGW	0.03	0.41**	0.40**	0.43**	
SPY	0.00	0.62**	0.19*	0.28**	0.46**

*,** significant at P < 0.05 and P < 0.01, respectively
Note: PH: Plant height (cm), NPT: Number of productive tillers, PL: Panicle length (cm), NG: Number of grains per panicle, TGW: Thousand grain weight (g), SPY: Single plant yield (g)

Path for TNAU CMS 2B × Zenith

The direct and indirect effects of yield and yield contributing traits for the cross TNAU CMS 2B × Zenith were given in Table 6. Number of productive tillers showed highest direct (Panwar and Mashiat Ali, 2007; Chakraborti et al., 2009) while the number of productive tillers exhibited positive high indirect effect on single plant yield (0.62). Among studied traits, number of productive tillers was important yield determining components for single plant yield. The observed residual effect was 0.55 indicating that 45% of the variability in single plant yield was depended on yield component traits only.

Table 6
Direct and indirect effect of path coefficient matrix for yield and yield related contributing traits of TNAU CMS 2B × Zenith

Characters	PH	NPT	PL	NG	TGW	SPY
PH	-0.10	0.10	-0.01	0.00	0.01	0.00
NPT	-0.02	0.54	-0.01	0.02	0.09	0.62**
PL	-0.03	0.14	-0.02	0.02	0.08	0.19*
NG	0.00	0.11	0.00	0.09	0.09	0.28**
TGW	0.00	0.22	-0.01	0.04	0.21	0.46**

*,** significant at P < 0.05 and P < 0.01, respectively
Note: PH: Plant height (cm), NPT: Number of productive tillers, PL: Panicle length (cm), NG: Number of grains per panicle, TGW: Thousand grain weight (g), SPY: Single plant yield (g)

Conclusion

Genetic improvement of polygenic/quantitative traits can be attained from understanding the magnitude and amount of genetic variability available from the genetic material. Our experimental results revealed that thousand grain weight, number of productive tillers and plant height showed highest direct effect on rice grain yield in early generation crosses.

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