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Quantitative Genetic Analysis for Yield and Yield Components in Boro Rice (*Oryza sativa* L.)

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Abstract

Twenty-nine genotypes of boro rice (*Oryza sativa* L.) were grown in a randomized block design with three replications in plots of 4m x 1m with a crop geometry of 20 cm x 20 cm between November-April, in Regional Agricultural Research Station, Nagaon, India. Quantitative data were collected on five randomly selected plants of each genotype per replication for yield/plant, and six other yield components, namely plant height, panicles/plant, panicle length, effective grains/panicle, 100 grain weight and harvest index. Mean values of the characters for each genotype were used for analysis of variance and covariance to obtain information on genotypic and phenotypic correlation along with coheritability between two characters. Path analyses were carried out to estimate the direct and indirect effects of boro rice's yield components. The objective of the study was to identify the characters that mostly influence the yield for increasing boro rice productivity through breeding program. Correlation analysis revealed significant positive genotypic correlation of yield/plant with plant height (0.21), panicles/plant (0.53), panicle length (0.53), effective grains/panicle (0.57) and harvest index (0.86). Path analysis based on genotypic correlation coefficients elucidated high positive direct effect of harvest index (0.8631), panicle length (0.2560) and 100 grain weight (0.1632) on yield/plant with a residual effect of 0.33. Plant height and panicles/plant recorded high positive indirect effect on yield/plant via harvest index whereas effective grains/panicle on yield/plant via harvest index and panicle length. Results of the present study suggested that five component characters, namely harvest index, effective grains/plant, panicle length, panicles/plant and plant height influenced the yield of boro rice. A genotype with higher magnitude of these component characters could be either selected from the existing genotypes or evolved by breeding program for genetic improvement of yield in boro rice.

Keywords: boro rice, correlation, path analysis, yield, components

Introduction

Boro rice (*Oryza sativa* L.) is widely grown during winter (November-April) in the flood prone areas in Assam. Heavy rainfall in the rainy season (June-September) causes flood every year in the low lying rice growing areas and makes rice cultivation a nightmare to the resource poor farmers. The farmers of this region prefer to grow boro rice in winter with assured irrigation for better yield. But the average productivity of boro rice (Ca 1.5 t/ha) in Assam is much lower than its potential (Ca 7t/ha). This calls for urgent attention of the rice breeders to develop high yielding genotypes of boro rice catering to such conditions. The development of a high yielding genotype through breeding rice, an autogamic species, requires a thorough knowledge of the association of the yield components (Kishor *et al.*, 2008). Grain yield in rice is a complex character, quantitative in nature and an integrated function of a number of component traits (Sharma and Sharma, 2007). Therefore, selection for yield per se may not be much rewarding unless yield components are taken into consideration. Correlation analysis provides a good measure of the association between characters and helps to identify the most important character(s) to be considered for effective selection for increasing yield. The extent of direct and indirect effects of component characters on yield, elucidated through path coefficient analysis using correlations, helps further to choose the right characters as selection criteria. Such information referring to the genetic resources of boro rice of Assam is scanty. Therefore, the present study was undertaken with an objective to elucidate the basic genetic information on genetic correlation, coheritability and path coefficients of yield components on grain yield in boro rice.

Materials and methods

Twenty nine boro rice genotypes (Tab. 1) were grown in a randomized block design with three replications at Regional Agricultural Research Station, Nagaon, Assam during November-April. Each genotype was transplanted in lines in a small plot of size 4 m x 1 m per replication with crop geometry of 20 cm x 20 cm and recommended agronomic practice. Data were collected from five ran-

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domly selected plants of each genotype per replication for yield/plant (g) and six yield components [*viz.* plant height (cm), panicles/plant, panicle length (cm), effective grains/panicle, 100 grain weight (g) and harvest index].

Mean values of the characters for each genotype per replication were used for analysis of variance and covariance as per Singh and Chaudhary (1985). Genotypic and phenotypic correlation coefficients between any two characters were estimated according to Panse and Sukhatme (1957); coheritability between two characters as per Nei (1960). Direct and indirect effects through path analysis were estimated as per the procedure outlined by Dewey

Tab. 1. Name of the boro rice genotypes included in the experiment

Sl. No.	Genotype	Sl. No.	Genotype
1	'Boro-1'	16	'TR-118'
2	'Boro-2'	17	'TRB-10 '
3	'Tepi'	18	'TRB-12'
4	'Sonari'	19	'TRB-9'
5	'Gazi'	20	'TRB-7'
6	'Mugsali-1'	21	'TRB-15-1'
7	'Mugsali-2'	22	'TRB-14-1'
8	'Sunamukhi'	23	'TTB-1'
9	'Madhab boro'	24	'TTB-10 '
10	'China-5'	25	'IET-8021'
11	'Pusa-5'	26	'IET-9188'
12	'IR-50'	27	'IET-9095'
13	'Joymati'	28	'IET-9981'
14	'Bishnu'	29	'Krishna'
15	'NDR-1001'		

and Lu (1959). Variances and correlation coefficients were tested for significance by "F" and "t" tests, respectively.

Results and discussion

The analysis of variance for each character revealed that the boro rice genotypes in the present study differed amongst themselves at p = 0.01. This indicated the presence of ample genetic variation among the genotypes for each quantitative character.

Correlation
The estimates of genotypic and phenotypic correlation coefficients along with coheritability among all the seven quantitative characters are presented in Tab. 2. In general the estimates of genotypic correlation were higher in magnitude than those of phenotypic correlation indicating strong inherent association between each pair of characters. The trend of correlation was identical at both genotypic and phenotypic planes indicated by the same sign in almost all the character pairs revealed identical direction

of correlation at both the planes. It would certainly increase the efficiency of phenotypic selection.

In this study, yield/plant showed significant positive genotypic correlation with plant height (0.21), panicles/plant (0.27), panicle length (0.53), effective grains/panicle (0.57) and harvest index (0.86) but significant negative correlation with 100 seed weight (- 0.35). Phenotypic correlations between seed yield/plant and other characters showed similar trend like genotypic correlations. Harvest index exhibited significant positive genotypic correlation with plant height (0.30), panicles/plant (0.43), panicle length (0.30) and effective grains/panicle (0.53) in addition to seed yield/plant. Effective grains/panicle revealed significant positive genotypic correlation with plant height (0.32), panicle length (0.89) and 100 grain weight (0.35) in addition to yield/plant. Like the present study, yield/plant was reported to be positively correlated with plant height and panicles/plant by Singh *et al.* (1979); with panicle length by Sarma and Dwivedi (1980); with grains/panicle and 100 grain weight by Sharma and Sharma (2007). But negative genotypic correlation of yield/plant was reported with panicle length by Saini and Gagneja (1975); with harvest index by Kishor *et al.* (2008). Positive correlation of harvest index with panicles/plant, panicle length, grains/panicle and 100 grain weight was observed by Ganesan *et al.* (1998).

Coheritability
Coheritability measures the possibility of the joint transmission of two characters and permits the study of simultaneous changes in two correlated characters through selection on one character. For effective selection, coheritability is usually studied with genotypic correlation in the absence of G-E interaction but with phenotypic correlation in presence of G-E effect. Coheritability estimates of different character pairs based on linkage are evanescent and reverse sign with crossing over. Such coheritability estimates are usually low unless linkage between character pairs is strong. In the present study, yield/plant showed high positive coheritability with harvest index (0.57), effective grains/panicle (0.36) and panicle length (0.35). Large magnitude of coheritability estimate in a character pair could be due to low environmental effect.

Path analysis
Yield is a complex resultant character and influenced by several components and environment. Due to internal adjustments among the components, increase in one component results in a decrease in other component(s) and hence does not affect the resultant like yield. Path analysis is very useful in such complex situation to analyze the direct effect of each character and the indirect effects via other characters on yield.

Path analysis carried out on the basis of genotypic correlations revealed that harvest index, panicle length and 100 grain weight had shown high positive direct effect

Tab. 2. Estimates of genotypic (r_g) and phenotypic (r_p) correlation coefficients and coheritability (coh) among different characters in boro rice

Characters	Correlation and coheritability	Panicles/ plant	Panicle length (cm)	Effective grains/ panicle	100 grain weight (g)	Harvest index	Yield/ plant
Plant height (cm)	r_g	0.23*	0.10	0.32**	-0.98**	0.30**	0.21*
	r_p	0.20	0.03	0.22*	0.48**	0.22*	0.19
	coh	0.18	0.07	0.22	-0.54	0.02	0.18
Panicles/plant	r_g		-0.32**	0.02	-0.62**	0.43**	0.27**
	r_p		-0.12	0.05	-0.23*	0.28**	0.23*
	coh		-0.19	0.01	-0.29	0.24	0.19
Panicle length (cm)	r_g			0.89**	0.57**	0.30**	0.53**
	r_p			0.68**	0.25**	0.18	0.35**
	coh			0.48	0.24	0.17	0.35
Effective grains/ panicle	r_g				0.35**	0.53**	0.57**
	r_p				0.17	0.27*	0.40**
	coh				0.14	0.27	0.36
100 grain weight (g)	r_g					-0.58**	-0.35**
	r_p					-0.17	-0.12
	coh					-0.24	-0.18
Harvest index	r_g						0.86**
	r_p						0.69**
	coh						0.57

*, ** - - Significant at 5% and 1% levels, respectively

with a magnitude of 0.8631, 0.2560 and 0.1632 respectively on yield/plant. Similar results of harvest index on yield/plant were reported by Ganesan *et al.* (1998) and Chaturvedi *et al.* (2008); of panicle length on yield/plant by Kishor *et al.* (2008); of grain weight on yield/plant by

length, panicles/plant and plant height influenced yield in boro rice either directly or indirectly. Thus a genotype with higher magnitude of these traits could be either selected from existing genotypes or evolved by breeding program for genetic improvement of yield in boro rice.

Tab. 3. Direct (diagonal values) and indirect effects of different characters on yield/plant at genotypic level

Characters	Plant height	Panicles/ Plant	Panicle length	Effective Grains/ Panicle	100 grain weight	Harvest index	Genotypic correlation with yield/ plant
Plant height (cm)	0.0956	0.0141	0.0256	-0.0245	-0.1599	0.2589	0.21
Panicles/plant	0.0220	0.0615	-0.0819	-0.0015	-0.1012	0.3711	0.27
Panicle length (cm)	0.0096	-0.0197	0.2560	-0.0678	0.0930	0.2589	0.53
Effective grains/panicle	0.0306	0.0012	0.2279	-0.0762	0.0571	0.3294	0.57
100 grain weight (g)	-0.0937	-0.0937	0.1459	-0.0267	0.1632	-0.5006	-0.35
Harvest index	0.0287	0.0264	0.0768	-0.0404	-0.0946	0.8631	0.86

Chaturvedi *et al.* (2008) and Luzi Kihupi (1998).

Plant height and panicles/plant resulted high positive indirect effect on yield/plant via harvest index. Effective grains/panicle showed high positive indirect effect on yield/plant via harvest index and panicle length. The value of residual effect was 0.33 indicating that nearly 67% of genetic variability in yield could be accounted for by the components.

Conclusions

The results of the present study suggested that the characters viz. harvest index, effective grains/panicle, panicle

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