Progressive Agriculture 28 (1): 7-11, 2017 **ISSN: 1017 - 8139**

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Evaluation of yield and yield contributing traits for submergence tolerance of rice

W Afrin[1*], MA Hossain[2], MM Islam[3]

[1]Plant Breeding Division, Bangladesh Rice Research Institute, Gazipur 1701; [2]Department of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202; [3]Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh 2202

Abstract

Ten rice genotypes were evaluated for association studies of yield and its contributing traits to select the traits for yield improvement in submerged condition. An experiment was conducted in the experimental field of Bangladesh Institute of Nuclear Agriculture (BINA) and 15 morphological traits *Viz.* Days to flowering (days), plant height (cm), Tiller number plant^{-1} , (Nos.), effective tiller number plant^{-1} (Nos.), 100 seed weight (g), harvest index (%) etc. were studies to measure nature of association between these traits and yield. Correlation studies showed total tiller number plant^{-1} (0.661), effective tiller number plant^{-1} (0.694), flag leaf breadth (0.651), fresh weight (0.705), dry weight (0.700) and harvest index (0.689) had significantly positive relationship on yield. Path co-efficient studies indicated direct positive association of tiller number plant^{-1} (2.481), panicle length (2.431), Unfilled grain panicle^{-1} (0.033), fresh weight (0.0451), dry weight (0.166), harvest index (1.255) and chlorophyll content (1.72) with yield. Breeding for submergence tolerance of rice genotypes considering these characters could be useful for improvement yield in future.

Key words: Landraces, salinity stress, reproductive stage, phenotypic study

Progressive Agriculturists. All rights reserve

***Corresponding Author:** wazifaafrin@yahoo.com

Introduction

Rice, *Oryza sativa* L. (2n = 24) is an important crop of the world, with its wide geographic distribution extending from 50°N to 35°S, is expected to be most vulnerable cultivated crop to future changing climates (Mohanty *et al.,* 2013; Narciso and Hossain, 2002). It supplies staple food for nearly 50% of the global population and influences the livelihoods and economies of several billion people (USDA, 2016).

One-fifth of the world's population, more than 1 billion people, depends on rice cultivation for livelihood. Rice has been feeding the Southeast Asian population for well over 4000 years and has been the staple food of about 557 million people (Manzanilla *et al*., 2011). Changing world climate has an adverse effect on rice production. Flooding is one of the effects of climate change. An economic loss up to one billion US dollars has been estimated in South and south-east Asia due to loss of rice production caused by flash floods (Mackill *et al*., 2006). To cope with this environmental condition it is obvious to find out new breeding strategies to improve yield by changing and adopting characteristics that has direct relation to increase rice yield under submergence condition. Knowledge about yield and yield contributing traits is essential for yield improvement as well as evolving a new variety. Information about

interaction of different yield contributing characters which can be known through correlation study is always important for breeding of genotypes (Amin, 1979). Path coefficient study is necessary for identifying characters that have direct or indirect effect on yield (Dewey and Lu, 1959). The present study aimed at identifying some yield contributing characters for yield improvement of submergence tolerance of rice genotypes.

Materials and Methods

An experiment was conducted in the experimental field of Bangladesh Institute of Nuclear Agriculture (BINA). Ten rice genotypes were evaluated for submergence tolerance in a randomized complete block design with five replications from January to December, 2015. The seeds were raised in a seedbed of 6 x 1 m. thirty days old seedlings were transplanted in small perforated pots. Each pots contained soil with nitrogen (N), phosphorous (P) and potassium (K) containing fertilizer. The way that fertilizers were mixed with soil was 50 mg N, 25 mg P, and 25 mg K per kilogram (Kg) of soil. Data were collected from five randomly selected plants of each genotype. Fifteen morphological characters were recorded *Viz.* days to flowering (Days), tiller number plant^{-1} (Nos.), effective tiller number plant^{-1} (Nos.), flag leaf length (cm), flag leaf breadth(cm), panicle length (cm), filled grain panicle^{-1} (Nos.), unfilled grain panicle^{-1} (Nos.), fresh weight (g), dry weight (g), 100 seed weight (g), harvest index and yield plant^{-1} (g). MSTATC statistical software was used for analysis of data. Correlation coefficient between two characters was estimated according to Miller *et al.,* (1991)

$$\text{Phenotypic correlation, } r_{p_{1.2}} = \frac{C_O V.\ P_{1.2}}{\sqrt{\sigma^2 p_1 \times \sigma^2 p_2}}$$

Where,

σ^2_{p1} = Phenotypic variance of the trait X_1

σ^2_{p2} = Phenotypic variance of the trait X_2

C0V. $P_{1.2}$= Phenotypic covariance between the trait X_1 and X_2

Path coefficient was estimated according to Lynch and Walsh, (1998)

$$r_{yi} = P_{yi} + \sum_{\substack{i'=1 \\ i' \neq 1}}^{k} r_{ii'}\, p_{yi'} \quad \text{for i} \neq 1 \qquad .$$

Where,

r_{yi} is the correlation coefficient between the *i*-th causal variable (*Xi*) and effect variable (*y*),

$r_{ii'}$ is the correlation coefficient between the *i*-th and *i'*-th causal variables,

P_{yi} is the path coefficient (direct effect) of the *i*-th causal variable (*Xi*)

$r_{ii'}\, p_{yi'}$ is the indirect effect of the *i*-th causal variable via the *i'*-th causal

Table1. Name of ten rice genotypes used for the experiment

Sl. No.	Accession no./ variety	Characters	Source of collection
1	BRRI dhan28	High yielding variety and submergence susceptible	Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh
2	Binadhan-11	Check variety	
3	Binadhan-12	Check variety	
4	Binadhan-7	Early and submergence susceptible	
5	RC 192	Advanced line	
6	RC 193	Advanced line	
7	RC 225	Advanced line	
8	RC 227	Advanced line	
9	RC 249	Advanced line	
10	RC 251	Advanced line	

Results and Discussion

Correlation coefficient*:* Relationship between yield and yield contributing characters was studied through analysis of correlation among the yield and its associated traits were presented in Table 2. In the present study among 120 associations, 24 associations were highly significant and all of them were positively correlated. From the rest of associations 20 associations were significant and all of them were positively correlated. Besides 70

associations were positive and non-significant and 6 associations were non-significant and negatively correlated. The investigation revealed that yield plant^{-1} was positively and significantly correlated with days to flowering (0.661), tiller number plant^{-1} (0.694), effective tiller number plant^{-1} (0.698), flag leaf breadth (0.651), fresh weight (0.705), dry weight (0.700) and harvest index (0.689). Positive correlation of harvest index with panicles/plant, panicle length, grains/panicle and 100 grain weight was observed by Ganesan *et al.* (1998) in rice previously. Sharifi *et al.* (2013), found positive and significant correlation for harvest index, dry matter, flag leaf breadth with yield^{-1} in rice plant. The significant and positive correlations among characters suggest additive genetic model are less affected by the environment. The negative and non significant correlations revealed that there may be inherent relationship among the genotypes.

Path coefficient*:* Estimation of direct and indirect effect of 15 yield contributing characters is presented in Table 3. Yield plant^{-1} showed direct and positive effect with total tiller number plant^{-1} (2.481), panicle length (2.431), unfilled grain panicle^{-1} (0.033), fresh weight (0.0451), dry weight (0.166), harvest index (1.255) and chlorophyll content (1.72). Rai *et al.* (2014) found direct and positive effect of panicle length and harvest index in rice. Pandey *et al*. (2012) found effective tillers plant^{-1}; flag leaf length and panicle length were some of main contributors on yield of rice. Thus these characters have direct effect on yield thus may be selected for further breeding purposes for yield improvement.

Table 2. Correlation coefficient for different plant characters for ten rice genotypes

Characters	PH	TN	ET	FLL	FLB	PL	FG	UFG	FW	DW	100 SW	HI	Chlc	YP
DF	0.834**	0.554	0.484	0.874**	0.926**	0.840**	0.744*	0.221	0.599	0.664*	0.392	0.551	0.884**	0.661*
PH		0.326	0.295	0.789**	0.837**	0.834**	0.442	0.252	0.556	0.686*	0.677*	0.351	0.799**	0.554
TN			0.980**	0.337	0.590	0.328	0.383	-0.280	0.618	0.520	-0.073	0.562	0.519	0.694*
ET				0.277	0.572	0.305	0.340	-0.420	0.554	0.438	0.030	0.630	0.529	0.698*
FLL					0.879**	0.970**	0.805**	0.292	0.636*	0.655*	0.406	0.294	0.846**	0.480
FLB						0.909**	0.754*	0.092	0.619	0.640*	0.522	0.600	0.966**	0.651*
PL							0.732*	0.248	0.648*	0.680*	0.569	0.333	0.907**	0.526
FG								0.067	0.426	0.343	0.119	0.571	0.683*	0.508
UFG									0.365	0.509	-0.124	-0.484	0.043	-0.042
FW										0.930**	0.029	0.105	0.564	0.705*
DW											0.185	0.075	0.594	0.700*
100 SW												0.380	0.635*	0.271
HI													0.593	0.689*
Chlc														0.624

Note: ** = Significant at 1% level of probability, * = Significant at 5% level of probability, Here, DF= Days to flowering (Nos.), PH= Plant height (cm), TN= Tiller number plant^{-1} (Nos.), ET= Number of effective tiller (Nos.), FLL= Flag leaf length (cm), FLB= Flag leaf breadth (cm), PL= Panicle length (cm) , FG= Filled grain panicle^{-1} (Nos.), UFG= Unfilled grain panicle^{-1} (Nos.), FW= Fresh weight (g), DW= Dry weight (g), 100 SW= 100 seed weight (g), HI= Harvest index (%), YP= Yield plant^{-1} (g), Chlc= Chlorophyll content (SPAD unit).

Table 3. Partitioning of phenotypic correlations into direct and indirect effects of 15 characters by path analysis

Characters	DF	PH	TN	ET	FLL	FLB	PL	FG	UFG	FW	DW	100 SW	HI	Chlc	YP
DF	**-0.025**	-0.056	1.37	-1.13	-1.35	-0.682	2.04	-0.016	0.0071	0.271	0.110	-0.056	0.691	1.52	**0.661***
PH	-0.022	**-0.06**	0.809	-0.689	-1.22	-0.617	2.03	-0.010	0.008	0.251	0.114	-0.097	0.441	1.37	**0.554**
TN	-0.014	-0.021	**2.481**	-2.29	-0.523	-0.434	0.797	-0.009	-0.009	0.279	0.086	0.010	0.706	0.892	**0.694***
ET	-0.012	-0.019	2.43	**-2.33**	-0.429	-0.422	0.741	-0.008	-0.014	0.250	0.072	-0.004	0.791	0.909	**0.698***
FLL	-0.0219	-0.050	0.836	-0.647	**-1.552**	-0.648	2.36	-0.018	0.009	0.287	0.108	-0.058	0.369	1.45	**0.480**
FLB	-0.023	-0.053	1.46	-1.33	-1.36	**-0.737**	2.21	-0.017	0.002	0.279	0.106	-0.075	0.753	1.66	**0.651***
PL	-0.021	-0.053	0.814	-0.713	-1.51	-0.669	**2.431**	-0.016	0.008	0.293	0.113	-0.082	0.418	1.55	**0.526**
FG	-0.019	-0.028	0.951	-0.794	-1.24	-0.556	1.77	**-0.022**	0.002	0.192	0.057	-0.017	0.716	1.17	**-0.508**
UFG	-0.0055	-0.016	-0.694	0.982	-0.453	-0.068	0.603	-0.002	**0.033**	0.165	0.085	0.017	-0.608	0.073	**-0.042**
FW	-0.0150	-0.035	1.53	-1.30	-0.987	-0.457	1.58	-0.009	0.012	**0.451**	0.154	-0.004	0.132	0.969	**0.705***
DW	0.017	-0.044	1.29	-1.02	-1.02	-0.471	1.65	-0.008	0.017	0.420	**0.166**	-0.027	0.094	1.02	**0.700***
100 SW	-0.0098	-0.043	-0.181	-0.070	-0.630	-0.385	1.38	-0.003	-0.004	0.013	0.031	**-0.14**	0.477	1.09	**0.271**
HI	-0.014	-0.022	1.39	-1.47	-0.456	-0.442	0.809	-0.013	-0.016	0.047	0.012	-0.054	**1.255**	1.02	**0.689***
Chlc	-0.022	-0.051	1.29	-1.24	-1.31	-0.712	2.21	-0.015	0.001	0.255	0.098	-0.091	0.744	**1.72**	**0.624**

Diagonally bold figures indicate the direct effect **Residual effect: 0.000208**

Note: ** = Significant at 1% level of probability, * = Significant at 5% level of probability, Here, DF= Days to flowering (Nos.), PH= Plant height (cm), TN= Tiller number plant^{-1} (Nos.), ET= Number of effective tiller (Nos.), FLL= Flag leaf length (cm), FLB= Flag leaf breadth (cm), PL= Panicle length (cm) , FG= Filled grain panicle^{-1} (Nos.), UFG= Unfilled grain panicle^{-1} (Nos.), FW= Fresh weight (g), DW= Dry weight (g), 100 SW= 100 seed weight (g), HI= Harvest index (%), YP= Yield plant^{-1} (g), Chlc= Chlorophyll content (SPAD unit).

Conclusion

Breeding for any crop variety always aimed at higher yield. Understanding the relationship between yield and yield contributing traits, help better improvement of crop for higher yield for breeding purpose. Present study showed association of days to flowering, tiller number plant^{-1}, effective tiller number plant^{-1}, flag leaf breadth, fresh weight, dry weight and harvest index with yield. Furthermore direct effect on yield was found for tiller number plant^{-1}, panicle length, unfilled grain panicle^{-1}, fresh weight, dry weight, harvest index and chlorophyll content. These characters can be useful tools for further breeding program to improve rice yield under submergence condition.

Acknowledgement

The author is grateful to the Department of Genetics and plant Breeding, Bangladesh Agricultural University; Biotechnology Division, Bangladesh Institute of Nuclear Agriculture and Ministry of Science and Technology, Bangladesh for funding and providing other supports.

References

Amin EA (1979). Correlation and path coefficient analysis in some short stature rice cultivars and strains. International Commission newsletter, 28: 19-20

Dewey RD, Lu KH (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron j*., 51: 515-518.

Ganesan KM, Subramaniam, Wilfred MW, Sundaram T (1998). Correlation and path coefficient analysis of yield components in F2 and F3 generations of tall x dwarf rice cross. *Oryza*, 35(4): 329-332.

Lynch M, Walsh B (1998). Genetics and Analysis of Quantitative Traits. Sunderland, Massachusetts, Sinauer, 1: 823-831

Mackill D J, Collard B C Y, Neeraja C N, Rodriguez RM , Heuer S, Ismail AM (2006). QTLs in rice breeding: examples for abiotic stresses. In: Brar D S, Mackill D J, Hardy B, editors. Rice Genetics 5: Proceedings of International Rice Genetics Symposium. Manila: International Rice Research Institute: 155-167

Manzanilla DO, Paris TR, Vergara GV, Ismail AM, Pandey S, Labios RV, Tatlonghari GT, Acda RD, Chi TTN, Duoangsila K, Siliphouthone I, Manikmas MOA, Mackill DJ (2011). Submergence risks and farmers' preferences: Implications for breeding Sub1 rice in Southeast Asia. *Agric. Sys*., 104: 335-347

Miller BC, Hill JE, Roberts SR (1991). Plant population effects on growth and in water seeded rice. *Agron. J.,* 83(2): 291-297

Mohanty S, Wassmann R, Nelson A, Moya P, Jagadish SVK (2013). Rice and climate change: Significance for food security and vulnerability. International Rice Research Institute: 14

Narciso J, Hossain M (2002). In: World rice statistics. International Rice Research Institute.

Pandey VR, Singh PK, Verma OP, Pandey P (2012). Inter-relationship and path coefficient estimation in rice under salt stress environment. *Int. J. Agric. Res*., 7(4): 169-184

Rai SK, Suresh BG, Rai PK, Lavanya GR, Kumar RS (2014). Genetic Variability, Correlation and Path Coefficient Studies for Grain Yield and Other Yield Attributing Traits in Rice *(Oryza Sativa* L.). *IJLSR.*, 2(4): 229-234

Sharif P, Dehghani H, Momeni A, Moghadam M (2013). Study the genetic relations of some of rice agronomic traits with grain yield by using multivariate statistical methods. *Iranian Journal of Field Crop Science.* 44(2): 273-82

USDA (2016). *Grain*: World markets and trades: 13-62.