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Analysis of genetics variability in interspecific backcross inbred lines in rice (*Oryza sativa* L.)

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Abstract: Backcross inbred line (BIL) population developed from an inter-specific cross between *Oryza sativa* cv. *indica* and NERICA-L-20 (New Rice for Africa) was used in an randomized completely block design with 2 replications to create and assess genetic variability for yield and its component traits. The mean sum of squares for backcross inbred lines (BILs) were highly significant for yield and its component traits, indicating presence of sufficient amount of variability among each back cross inbred line studied. It is observed that, phenotypic coefficients of variance and genotypic coefficients of variance for most of the traits were either high or moderate except for productivity trait like days to heading, days to 50 per cent flowering, panicle length and plant height at maturity. BILs exhibited high heritability (heritability above 60%) coupled with high genetic advance (genetic advance above 20%) for all the characters under study except in case of days to heading, days to 50% flowering, plant height at maturity, panicle length and grain yield per plant, it was moderate to low in these traits.

Key words : Rice, backcross inbred lines, variability, genetic advance, heritability

Introduction

Rice (*Oryza sativa* L.) has a renowned relationship with the human since ages. It is the world's second most widely grown cereal crop after wheat and presently, more than half of the world's population depends on it as a staple food. 'Rice is life' for human beings especially in Asian subcontinent, Asia can be considered as "Rice Basket" of the world, as 90 per cent of world's rice is grown and consumed with 60 per cent of population and where about two-thirds of world's poor live (Khush and Virk, 2000). Only 4-5 per cent of world rice production enters the global market. Hence, any shortfall in rice production in the major rice growing countries could be disaster for food security. It is expected that the world population increase by about 2 billion in the next two decades and half of this increase will in Asia where rice is the staple food (Grigory *et al*., 2000). To feed this increasing population, 35% more rice will be required than the present level of rice production globally (Duwayrie *et al*., 1999). The chief rice production countries are; China, India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, Philippine, Brazil, Japan, U.S.A and Pakistan. China is the prime producer of rice. Pakistan is an important rice growing and exporting country. In India rice is cultivated in an area of 43.7 million ha, with a production of 136.5 million t/ha and productivity of 3.1t/ha (www.fao.org). Rice occupies pivotal role in Indian agriculture. It is the staple food for more than 70 per cent Indians and source of livelihood for 120-150 million rural households. It contributes 43 per cent to the total food grain and 53 per cent to the cereal production and thus holds the key to sustain food sufficiency in the country (Siddiq *et al*., 2004). Yield is a complex character and various morphological and physiological characters contribute to grain yield. The plateau in yield levels of existing rice varieties and the adverse effects of climate and deteriorating soil health on crop yield are the major cause of concern, so rice varieties with increased yield potential in adverse conditions as well as in normal conditions have to be developed in order to sustain the rice production across wide range of environments and over the years. Different breeding strategies such as introduction, selection, recombination breeding, heterosis breeding etc were practiced during and after green revolution to increase the yield levels of rice. Although, yield was improved using these breeding strategies, the yield levels have stagnated subsequently. NERICA rice varieties are also called as interspecifics (though in the strict sense of the word these are not interspecific hybrids, i.e. F1s, but lines derived from interspecific hybrids) because they bridge the genetic gap between two distinct species of rice. These were developed to combine the superior traits of *O. glaberrima* and *O. sativa*. Thus lines which resemble *O. glaberrima* during early growth stages and *O. sativa* during later stages were developed. Significantly the selected recombined new plants expressed the weed competitive ability of *O. glaberrima* at the vegetative stage and high-yielding capacity of *O. sativa* at the reproductive stage. The NERICAs are a good example of transgressive segregation for various traits (Sarla and Mallikarjun swamy, 2005).To meet the ever growing domestic needs of food and enhance exports and to achieve sustainability and stability of rice production the research in varietal improvement, evaluation, modification of plant architecture, development of hybrid rice technology, wide-hybridization, soil and nutrient management and integrated pest management would receive priority.

Material and methods

The experimental material for the present investigation comprised of backcross population (BC_1F_5) which was developed at Barwale Foundation farm, Hyderabad using Swarna (a high yielding widely adapted indica variety developed at ARS, Maruteru, Andra Pradesh) as recurrent parent with NERICA-L-20 (interspecific line derived from *Oryza glaberrima* and *Oryza sativa* at African Rice Centre, WARDA) as donor. One hundred eighty eight Back-crossed inbreed Lines (BILs) from Swarna x

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NERICA-L-20 were evaluated preliminarily during *Kharif* 2008 for their flowering duration and in-turn seeds were multiplied. These BILs were evaluated along with parents and most popular checks with two replications in randomized complete block design during *rabi* 2008 under irrigation. The BILs of each maturity group were planted in compact block. Each BIL was planted in two rows of 2m length with row spacing of 20cm and 10cm between plants. The recommended package of practice was followed for raising a good and healthy crop. The data on morphological, physiological and productivity traits were recorded from three randomly selected representative plants in all the genotypes in each replication on plant height at vegetative stage (cm), chlorophyll meter reading (SPAD), days to 50% flowering, plant height at maturity (cm), number of productive tillers per plant, panicle length (cm), panicle weight (g), number of grains per panicle, 1000 grain weight (g) and grain yield per plant (g).The analysis of variance, test of significance of variance components and broad sense heritability were carried out as suggested by Panse and Sukhatme (1961). PCV and GCV were classified as low, moderate or high following Sivasubramanian and Menon (1973). The heritability percentage was categorized by following Robinson *et al*. (1949). The GA as per cent of mean was categorized as low, moderate or high as suggested by Johnson *et al*. (1955).

Results and discussion

One of the main objectives of any breeding program is to produce high yielding and better quality lines for release as cultivars to farmers. The prerequisite to achieve this goal is the presence of sufficient amount of variability, in which desired lines are to be selected for further manipulation to achieve the target. Introduction of new populations can be made from one region to the other easily and may be used for further manipulation to develop breeding lines. The present study was conducted to evaluate the performance of 188 BILs lines in order to assess the presence of variability for desired traits and a significant amount of variation for different parameters was conducted. Analysis of variance showed highly significant variations among the BILs for all the traits, plant height at vegetative stage (cm), chlorophyll meter reading (SPAD), days to 50% flowering, plant height at maturity (cm), number of productive tillers per plant, panicle length (cm), panicle weight

Table 1. Analysis of variance for ten agronomically important traits in backcrossed inbred lines

Sl. No.	Traits	Swarna x NERICA-20-L(BILs) GMS	EMSS
1	Plant height at vegetative stage (cm)	207.40**	23.19
2	Chlorophyll meter reading (SPAD)	38.59**	4.34
3	Days to 50% flowering	149.42**	12.58
4	Plant height at maturity (cm)	124.69**	0.46
5	Number of productive tillers per plant	36.48**	7.91
6	Panicle length (cm)	5.37**	6.25
7	Panicle weight (g)	0.42**	.075
8	Number of grains per panicle	827.14**	109.48
9	1000 grain weight (g)	14.72**	1.57
10	Grain yield per plant (g)	109.65**	9.54

* - Significantly at 0.05; ** - Significant at 0.01 probability

Table 2. Trait means, range and standard deviation for agronomically important traits in backcrossed inbred lines

Sl. No.	Trait	Mean Swarna	Mean Population	Range Max.	Range Min.	SD	NERICA -L-20	Checks ARB 6	Checks Jaya	Checks Prasanna	Checks Rasi	PCV	GCV	Herit ability	Genetic analysis as % of mean
1	Plant height at vegetative stage (cm)	55.50	63.60	119.34	46.67	10.74	108.50	93.17	73.00	97.50	86.83	15.28	13.14	74	23.30
2	Chlorophyll meter reading (SPAD)	42.17	38.10	53	25.67	4.85	27.50	39.17	35.50	20.50	33.17	11.49	11.32	97	22.99
3	Days to 50% flowering	97	87.80	108	62.50	8.98	76.00	70.00	101	59.00	73.00	9.80	8.92	82	16.71
4	Plant height at maturity (cm)	75.84	77.95	121.84	64.50	7.90	110.67	96.00	88.17	102	88.34	9.45	9.41	97	19.30
5	Number of productive tillers per plant	24.67	19.60	31.50	5.33	4.70	7.83	20.53	24.12	21.82	19.00	23.64	18.78	63	30.73
6	Panicle length (cm)	19.17	19.38	26.00	15.67	1.67	18.83	22.50	22.54	20.17	19.63	8.66	8.25	91	16.24
7	Panicle weight (g)	2.19	1.98	4.24	1.14	0.51	3.85	2.19	3.46	2.48	3.04	23.40	18.75	64	30.94
8	Number of grains per panicle	147.50	96.54	156.00	55.50	21.64	133.00	85.63	137.00	109.67	148.67	21.55	18.54	73	32.85
9	1000 grain weight (g)	19.95	19.39	34.33	12.29	2.85	32.12	22.21	25.60	19.87	20.33	13.92	12.30	78	22.40
10	Grain yield per plant (g)	34.58	27.46	48.42	12.50	7.67	20.90	29.93	27.07	24.66	32.77	25.85	18.73	53	27.97

(g), number of grains per panicle, 1000 grain weight (g) and grain yield per plant (g) (Table 1). The mean plant height at vegetative stage was 63.60 cm with a range from 46.67 cm to 119.34 cm. Among parents and checks, chlorophyll meter reading (SPAD) was highest in Swarna (42.17) and (check) ARB-6 (39.17), respectively. The mean SPAD reading was 38.10 with a range from 25.67 to 53.00. Among the parents and checks, Jaya (101 days) was late in flowering, whereas, Prasanna (59 days) was earliest to flower. In BILs, number of days to 50 per cent flowering was 87.80 with a range from 62.50 to 108 days. Maximum plant height at maturity was recorded in NERICA-L-20 (110.67 cm) followed by Prasanna (102 cm). The mean plant height at maturity was 77.95 cm with a range from 64.50 cm to 121.84 cm. Swarna recorded maximum number of productive tillers per plant (24.67) whereas, NERICA-L-20 recorded the lowest number of productive tillers per plant (7.83). In BILs, mean productive tillers per plant was 19.60 with a range from 5.33 to 31.50. Jaya (22.54) and ARB-6 (22.50) recorded maximum panicle length. Mean panicle length was 19.38 cm with a range from 15.67 cm to 26 cm BILs. Among parents and checks, NERICA-L-20 recorded maximum panicle weight (3.85). In BILs, mean panicle weight was 1.98 g with a range from 1.14 to 4.24 g. Among parents and checks, swarna recorded maximum number of grains per panicle (147.50). Mean grain number per panicle was 96.54 with a range from 55.50 to 156.00 in BILs. NERICA-L-20 donor (32.12g) recorded the highest test weight, among all the parents and checks. Mean test weight in BILs was 19.39g with a range from 12.29 to 34.33 g. Swarna a recurrent parent recorded highest grain yield of 34.58 g per plant among the parents and checks. Mean grain yield per plant was 27.46 g with a range of 12.50 to 48.42 g in BILs.

The phenotypic coefficient of variance (PCV) were slightly higher than genotypic coefficient of variance (GCV) for almost all the traits except number of grains per panicle, panicle weight and number of productive tillers per plant indicating lower environmental effect for these traits (Table 2). Grain yield per plant, number of grains per panicle, panicle weight and number of productive tillers per plant showed considerable difference between PCV and GCV, reflecting considerable environmental effect on the traits (Table 2).

High heritability (> 60 %) and high genetic advance in percentage of mean (> 20 %) were showed by the traits chlorophyll meter reading (SPAD), number of productive tillers per plant, panicle weight and number of grains per panicle, 1000 grain weight. For grain yield per plant moderate heritability (53.00) with high genetic advance in percentage of mean (27.97) was observed. In the present study, considerably high genetic variability, heritability and genetic advance in percentage of mean (GAM) were observed in the BILs for most of morphological, physiological and productivity traits studied under irrigated condition. This indicated that, backcross breeding combined with direct selection for yield along with important productivity and physiological traits in irrigated condition could be highly effective in improvement of yield in rice (Lafitte *et al*., 2006). Moderately to higher heritability was also reported by Babu *et al*. (2003), Atlin *et al*. (2004), Lafitte *et al*. (2004), Wang *et al*. (2005), Venuprasad et al. (2007), Kovuch and McCouch (2008) and Jamal *et al*.(2009).The highly heritable characters with high genetic advance in percentage of mean could be further improved through individual line selection.

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