Scientia Agriculturae
www.pscipub.com/SA
E-ISSN: 2310-953X / P-ISSN: 2311-0228
DOI: 10.15192/PSCP.SA.2015.10.1.4448

Sci. Agri.
10 (1), 2015: 44-48

Genetic Variability, Distance and Traits Interrelationship Analysis of Nerica and Inpari Rice Varieties

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Paper Information

Received: 17 February, 2015

Accepted: 9 April, 2015

Published: 20 April, 2015

Citation

Sikder RK, Rahman MA, Asif MI, Jamal Uddin AFM, Mehraj H. 2015. Genetic Variability, Distance and Traits Interrelationship Analysis of Nerica and Inpari Rice Varieties. Scientia Agriculturae, 10 (1), 44-48. Retrieved from www.pscipub.com (DOI: 10.15192/PSCP.SA.2015.10.1.4448)

A B S T R A C T

Rice (Oryza sativa) is one of the most important cereal crops in Bangladesh. NERICA and INPARI have been recognized widely as a promising high yielding upland rice variety. This study attempts to assess some characteristics of three NERICA (V_1: NERICA-1; V_2: NERICA-10 and V_3: NERICA-19) and three INPARI (V_4: INPARI 12; V_5: INPARI 13 and V_6: INPARI 14) varieties. Different rice varieties had significant effects on plant height, leaf area, flag leaf area, number of tillers, days to flowering and harvesting, number of panicles, number of grains, 1000-grain weight, yield and moisture of seed. Maximum number of tiller was found from V_4 (24.4/plant) while minimum from V_2 (16.6/plant). Maximum flag leaf area (19.1 cm^2), number of panicle (22.0/plant), 1000-grains weight (25.3/plant), yield/plot (11.9 kg) and yield/ha (6.8 t) was found from V_4 followed by V_6 (19.0 cm^2, 20.2/plant, 24.6 g, 10.9 kg and 6.2 t respectively). From the study it was found that INPARI 12 and INPARI 14 was the best performing variety. Both positive and negative relationship was found among the traits. It was observed maximum proximity dissimilarity was 37.0 while minimum was 8.0.

Key words: *Oryza sativa, phenotypic traits, correlation and proximity dissimilarity*

Introduction

Rice (Oryza sativa), is the most dominant crop in Bangladesh. Food deficit has been increasing in Bangladesh due to the increases of the population and decreasing of the agricultural land. The productions of rice about 25.18 million metric tons from about 10.77 million hectares of land (BBS, 2003) in 2003 while about 33.542 million metric tons from 11.53 million hectares of land (BBS, 2012) in 2012. Yield components are directly related to genetic factor and variety itself is a genetic factor (Roy et al., 2014) which contributes much in producing yield and yield components of a particular crop. Bangladesh Rice Research Institute (BRRI) has released more 60 high yielding rice varieties for different climatic conditions. These varieties have higher yield potentiality compared to local varieties. NERICA and INPARI are newly developed superior hybrid rice variety in the world. NERICA are crosses between Oryza sativa and oryza glaberima has the potentiality of high yielding (Nwanze et al., 2006), resistant to drought and diseases (Fujii et al., 2006; Onyango et al., 2007), short phenological phase and rich in protein (Matsunami et al., 2009). INPARI having good color, aroma, taste, texture and general appearance (Yani and Utomo, 2014). Rice breeders have been trying varieties to increase the yield to increase in domestic production. NERICA and INPARI have high yield potentiality and adoption of these varieties would help for future sustainability for rice production in Bangladesh. Study on the performance of NERICA and INPARI rice varieties may be helpful in breeding for the development of high yielding rice varieties by identifying morphological and yield features. The aim of the present study is to provide information on growth, yield components and yield of NERICA and INPARI rice varieties.

Materials And Methods

Experiment was conducted at Dashmina Seed Multiplication Farm, Dashmina, Patuakhali, Bangladesh from December 2013 to May 2014. Six rice varieties viz. NERICA-1 (V_1), NERICA-10 (V_2), NERICA-19 (V_3), INPARI 12 (V_4),

INPARI 13 (V_5) and INPARI 14 (V_6) were used for the experiment following completely randomized block design with three replications. The unit plot size was 17.2 m^2. The fertilizers N, P, K, S, Zn and B in the form of urea (150 $kgha^{-1}$), TSP (100 $kgha^{-1}$), MP ($kgha^{-1}$), gypsum (60 $kgha^{-1}$), zinc sulphate (10 $kgha^{-1}$) and borax (10 $kgha^{-1}$) respectively were applied. Entire amount of TSP, MP, gypsum, zinc sulphate and borax were applied during final preparation of plot land. Mixture of cowdung and compost (10 tha^{-1}) was applied during 15 days before transplantation. Urea was applied in three equal installments at after recovery, tillering and before panicle initiation (BRRI, 2012). Data were collected on plant height, leaf area, flag leaf area, number of tillers, days to flowering, days to harvesting, number of panicles, number of grains, 1000-grain weight, yield and moisture of seed. Plant height, leaf area, flag leaf area and number of tillers were measured at 90 DAT. Collected data were analyzed statistically using MSTAT-C computer package program and significance of the difference among the treatment means was estimated by the Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984). Interrelationship and Genetic divergence (genetic distance) among varieties was measured by Euclidian distance method (Cruz and Regazzi, 1994) using SPSS software.

Results And Discussion

Plant height: Plant height showed a significant variation among the variety. Tallest plant was found from V_3 (117.8 cm) followed by V_6 (116.6 cm) whereas minimum from V_2 (105.2 cm) which was statistically identical with V_4 (105.4 cm) (Table 1). Plant height varied among the varieties (Mehraj et al., 2014b; Sawant et al., 1986; Shamsuddin et al., 1988; Hossain et al., 1991; Khatun, 2001) which may be mostly due to the genetic variation. Differences in plant height of the varieties are varietal characteristics, which are controlled and expressed by certain genes (Fayaz et al., 2007; Olaniyi et al., 2010).

Leaf area and flag leaf area: Leaf area and flag leaf area of rice varieties varied significantly. Maximum leaf area was found from V_3 (48.4 cm^2) followed by V_4 (34.8 cm^2) while minimum from V_1 (22.0 cm^2) (Table 1). However, maximum flag leaf area was found from V_4 (19.1 cm^2) which was statistically identical with V_6 (19.0 cm^2) while minimum from V_1 (14.1 cm^2) (Table 1). Yield components positively correlated with flag leaf area (Ashrafuzzaman et al., 2009).

Number of tillers: Maximum number of tiller was found from V_4 (24.4/plant) followed by V_6 (21.8/plant) whereas minimum from V_2 (16.6/plant) which was statistically identical with V_3 (16.8/plant) (Table 1). Significant variation was found among twelve rice genotypes in number of effective tillers (Zahid et al., 2005) which was depended upon the genetic potentiality of rice (Hossain, 2007; Mannan, 2005; Roy et al., 2004). Similarly Ramasamy et al. (1987) and Chowdhury et al. (1993) reported that number of tillers differed due to varietal variation. Numbers of tillers are responsible for yield (Padmavathi et al., 1996).

Days to flowering and harvesting: Days to flowering and harvesting showed a significant variation among the varieties. Early flowering was found from V_2 (48.4 days) whereas late flowering from V_1 (55.5 days) (Table 1). On the other hand, early harvesting was observed from V_2 (104.4 days) which was statistically identical with V_1 (104.5 days) while late harvesting was observed in V_3 (117.0 days) (Table 1). Early or late maturity is attributed as genotypic characters, and somewhat influenced by the environmental factors, varietal difference and agronomic practices (Fayaz et al., 2007).

Table 1. Response of NERICA and INPARI rice verities to different growth characters [X]

Variety [Y]	Plant height (cm)		Leaf area (cm^2)		Flag leaf area (cm^2)		Number of tiller/plant		Days to flowering		Days to harvesting	
V_1	108.1	d	22.0	f	14.1	d	18.3	d	55.5	a	104.5	d
V_2	105.2	e	31.1	d	16.2	c	16.6	e	48.4	d	104.4	d
V_3	117.8	a	48.4	a	17.3	b	16.8	e	54.0	b	117.0	a
V_4	105.4	e	34.8	b	19.1	a	24.4	a	52.4	c	112.4	c
V_5	114.5	c	29.2	e	17.5	b	19.7	c	54.7	b	114.7	b
V_6	116.6	b	32.5	c	19.0	a	21.8	b	52.8	c	112.8	c
LSD 0.05	0.7		0.7		1.0		1.3		0.4		1.8	
CV (%)	0.4		1.2		2.3		2.0		0.8		0.4	

[X] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.01 level of probability

[Y] NERICA-1 (V_1), NERICA-10 (V_2), NERICA-19 (V_3), INPARI 12 (V_4), INPARI 13 (V_5) and INPARI B4 (V_6)

Number of panicles and grains: Significant variation was found in panicle number among the rice varieties. Maximum number of panicle was found from V_4 (22.0/plant) followed by V_6 (20.2/plant) while minimum from V_2 (14.6/plant) (Table 2). Number of grain showed significant variation among the rice varieties. However, maximum number of grains was found from V_1 (157.9/panicle) while minimum from V_4 (128.8/panicle) (Table 2). Rahman et al. (2014) found significant variation in number of panicles and grains among the different rice lines.

1000-grains weight: 1000-grain weight of rice varieties showed a significant variation. Maximum 1000-grain weight was found from V_4 (25.3 g) which was statistically identical with V_6 (24.6 g) while minimum from V_5 (22.2 g) which was statistically identical with V_3 (22.3 g) and V_1 (22.6 g) (Table 2). 1000-seed weight was varied from variety to variety (Mondal

and Wahhab, 2001; Munir and McNeilly, 1992). 1000-seed weight varied to different rice varieties (Tahir et al., 2002), mustard lines (Mehraj et al., 2014b) and wheat lines (Mehraj et al., 2014c).

Yield: Yield of rice varieties showed a significant variation. Maximum yield was found from V_4 (11.9 kg/plot and 6.8 t/ha) which was statistically identical and V_6 (10.9 kg/plot and 6.2 t/ha) while minimum from V_3 (4.2 kg/plot and 2.3 t/ha) which was statistically identical with V_1 (4.8 kg/plot and 2.7 t/ha) (Table 2). Yield variations may depend on to genetic differences among the varieties grown under same environmental conditions (Olaniyi and Fagbayide, 1999). Similarly yield variations among different genetic materials were also found in rice (Rahman et al., 2014; Zahid, et al., 2005), chilli (Mehraj et al., 2014a), mustard (Mehraj et al., 2014b), wheat (Mehraj et al., 2014c).

Moisture of seed (%): Significant variation was found in moisture of seed among the rice varieties. Maximum moisture of seed was found from V_5 (16.1%) which was statistically identical with V_1 (15.5%) followed by V_4 (14.8%) while minimum from V_3 (12.9%) (Table 2).

Table 2. Response of NERICA and INPARI rice verities to different yield characters [X]

Variety [Y]	Number of panicle/plant		grains/panicle		1000-grains weight (g)		Yield (kg)/plot		Yield (t)/ha		Moisture of seed (%)	
V_1	16.1	d	157.9	a	22.6	bc	4.8	a	2.7	c	15.5	ab
V_2	14.6	e	132.4	e	23.2	b	7.3	b	4.1	b	14.2	cd
V_3	15.6	d	138.2	b	22.3	c	4.2	c	2.3	c	12.9	e
V_4	22.0	a	128.8	f	25.3	a	11.9	a	6.8	a	14.8	bc
V_5	17.7	c	133.5	d	22.2	c	7.2	b	4.1	b	16.1	a
V_6	20.2	b	135.0	c	24.6	a	10.9	a	6.2	a	13.9	d
LSD 0.05	1.1		0.6		0.7		2.3		2.3		0.7	
CV (%)	2.3		0.3		1.7		5.1		4.9		2.7	

[X] In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.01 level of probability

[Y] NERICA-1 (V_1), NERICA-10 (V_2), NERICA-19 (V_3), INPARI 12 (V_4), INPARI 13 (V_5) and INPARI 14 (V_6)

Interpretation of correlations of varietal means: Highest correlation was found (0.991**) among tiller number and panicle number which was followed by flag leaf area and days to harvesting (0.837*). Tiller number was also significantly related with 1000-grain weight (0.831*) while 1000-grain weight was significantly related with panicle number (0.830*) (Table 3).

Table 3. Correlations among the phenotypic traits of the rice varieties

	1	2	3	4	5	6	7	8	9	10	11
1	1	0.489	0.371	-0.134	0.485	0.748	-0.017	-0.015	-0.314	-0.312	-0.346
2		1	0.833*	-0.114	-0.094	0.710	-0.013	-0.449	0.004	-0.184	-0.804
3			1	0.393	-0.088	0.837*	0.473	-0.754	0.363	0.359	-0.491
4				1	0.125	0.281	0.991**	-0.385	0.831*	0.718	0.257
5					1	0.382	0.146	0.563	-0.334	-0.149	0.341
6						1	0.380	-0.458	0.018	0.213	-0.282
7							1	-0.415	0.830*	0.67	0.159
8								1	-0.458	-0.665	0.217
9									1	0.483	-0.136
10										1	0.528
11											1

*. Correlation is significant at the 0.05 level (2-tailed) and **. Correlation is significant at the 0.01 level (2-tailed)

1. Plant Height (cm), 2. Leaf area (cm2), 3. Flag area (cm2), 4. Tiller Number, 5. Days to flowering, 6. Days to harvesting, 7. Panicle number, 8. Grain number/Panicle, 9. 1000-grain weight (g), 10. Yield (kg)/plot, 11. Moisture of seed (%)

Functional relationship by coefficient of determination: For simple linear regression, flag leaf area (cm^2), number of tiller/plant, number of panicle/plant, number of grains/panicle and 1000-grain weight were used as independent variable whereas yield (kg)/plot as dependent variable. Flag leaf area (cm^2), number of tiller/plant and number of panicle/plant showed a positive but non significant relationship with yield (kg)/plot (Fig. 1a, 1b, 1c). The value of R^2 (0.59, 0.77 and 0.76) indicates that about 59.0%, 77.0% and 76.0% variation in yield could be explained by the variation in flag leaf area, number of tiller and number of panicle respectively. While grains/panicle and yield (kg)/plot showed a negative relationship (Fig. 1d) suggesting that number of grains/panicle increased, yield (kg)/plot of the varieties decreased. On the other hand, 1000-grain weight and yield (kg)/plot showed a significant positive linear relationship (Fig. 1e) which indicates that as 1000-grain weight increased, yield (kg)/plot also increased. The value of R^2 (0.85) indicates that about 85.0% variation in yield could be explained by the variation in panicle length. Similar relationship was also determined on brinjal (Nalini et al., 2009) and on strawberry (Mehraj and Jamal Uddin, 2014d).

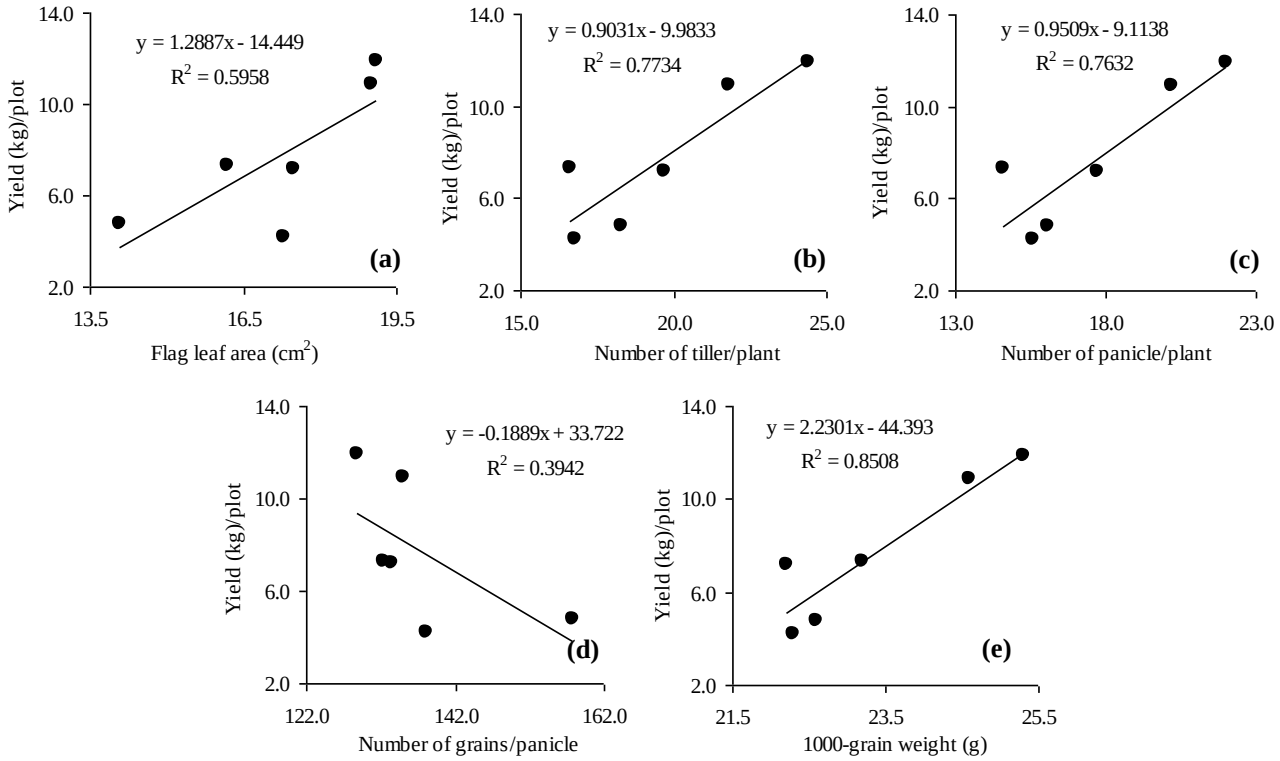

Figure 1. Functional relationship of yield (kg)/plot with (a) flag leaf area, (b) number of tiller, (c) number of panicle, (d) number of grains and (e) 1000-grain weight of six rice varieties

Genetic distance: The maximum proximity dissimilarity was found between NERICA-1 and NERICA-19 (37.0) while minimum was found from INPARI 13 and INPARI 14 (8.0) (Table 4). Similarly genetic distance was also analyzed using Euclidean Distance method by Adewale et al. (2011). For the determination of phylogenetic relationship and evolutionary pattern among genotypes, genetic distance and proximity of genotypes for different characters are very important (Hoque and Rahman, 2007) and they also analyzed genetic distance and proximity of genotypes on rice.

Table 4. Proximity dissimilarity matrix among the rice varieties by Euclidean Distance

	V_1	V_2	V_3	V_4	V_5	V_6
V_1	0	28.5	37.0	35.5	29.3	28.9
V_2		0	26.6	16.2	16.7	17.1
V_3			0	25.3	22.2	18.7
V_4				0	14.2	14.6
V_5					0	8.0
V_6						0

NERICA-1 (V_1), NERICA-10 (V_2), NERICA-19 (V_3), INPARI 12 (V_4), INPARI 13 (V_5) and INPARI 14 (V_6)

Conclusion

Adopting NERICA and INPARI would only be of great benefit to our agricultural economy. INPARI rice varieties responsive to higher yield as than NERICA rice varieties. Among the tested rice varieties, INPARI 12 and INPARI 14 were best in respect of yield. The expected long term impact of this participatory research on INPARI (specifically INPARI 12 and INPARI 14) cultivation would be able for development and adoption of rice cultivation by farmers in Bangladesh.

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