Genetic Diversity in Rice Varieties of Singpho Community of Assam

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(Received: 03 March 2011; Revised: 27 November2011; Accepted: 24 December 2011)

Genetic variation for thirty two qualitative and quantitative characters was studied in few rice accesions of Singpho community of Tinsukia district in Assam. The accessions showed maximum variation for grains/plant and seed yield/plant. Maximum Euclidean distance was found between variety Keteki Joha and Khawlung, and a close proximity was observed between Chengkhow and Miatong. The utility of the landraces in rice breeding and variety conservation has been discussed.

Key Words: Assam rice, Genetic diversity, Landraces, Singpho community, Variability

Introduction

North East (NE) India including Assam is considered as one of the primary centres of origin of rice representing a rich source of genetic diversity and reservoir of valuable rice gene pool. Diverse agro-climatic conditions, migration and immigration of different ethnic groups through this region are considered responsible for such diversity (Pathak *et al*., 1996). Among various ethnic tribes of Assam, Singpho community is one of the most important agrarian tribe in Upper Assam. They are of Mongolian origin, having their roots in South East Asia, with rice as a principal crop. Being largely neglected from modern developments with very limited penetration of modern high yielding varieties (HYVs), the rice varieties grown by this tribe are unique in nature with use as food and in wine making. The different rice accessions grown by them might provide new genes/alleles for yield and adaptation. So, a systematic collection and characterization is a necessary prerequisite to exploit the genetic potential of these varieties. Again, their characterization is more crucial under the regime of the Protection of Plant Varieties and Farmers' Rights Act. Therefore, the present experiment was undertaken to study the different genetic parameters and their association among different yield attributing traits in few traditional varieties of Singpho tribes as a part of the effort towards conservation, characterization and genetic improvement of rice grown by different tribes of NE India.

Materials and Methods

Nine accessions of rice were collected from different villages of Singpho tribes and they were selfed for several generations to maintain genetic purity. Additionally three HYVs were included in this study for a comparison (Table 1). The experimental materials were transplanted in a Randomized Block Design (RBD) with three replications during *wet* season of Assam. Observations were recorded on the different morphological characters following International Union for Protection of New Plant Varieties guidelines (UPOV, 1985), and National guidelines (DRR, 2002), for DUS (Distinctiveness, Uniformity and Stability) test.

Analysis of variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) in broad sense and genetic advance (GA) as percentage of mean were calculated following the method of Singh and Choudhary (1985). The genotypic and phenotypic correlations were determined as per the method suggested by Johnson *et al.* (1955). Multivariate statistical methods namely cluster analysis was used to determine the genetic relationship of the 12 varieties. The genetic relationship as revealed by Euclidean distance was obtained through cluster analysis using unweighted pair group method using arithmetic average (UPGMA). For cluster analysis the SAHN module (Sokal and Sneath, 1963), which performs various clustering algorithms like Sequential Agglomerative Hierarchical and Nested clustering was used.

Results and Discussion

In the present experiment 12 rice varieties were characterized using 32 descriptor traits encompassing different grain and plant characters (Tables 2 and 3). The varieties were divided into two groups with respect to attitude of flag leaf at early observation, of which, varieties Khuntung and Ranjit belonged to semi erect

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Table 1. Rice varieties under investigation

Variety	Description
Miatong	Collected from village Maanmoumukh
Rongapikhi	Collected from village Pangna
Bogapikhi	Collected from village Pangna
Chengkhow	Collected from village Maanmoumukh
Khawlung	Collected from village Maanmoumukh
Dumung	Collected from village Maanmoumukh
Kulapikhi	Collected from village Pangna
Khuntung	Collected from village Maanmoumukh
Dolkochi	Collected from village Pangna
Keteki Joha	High yielding variety
Aghoni Bora	High yielding variety
Ranjit	High yielding variety

group, while remaining varieties belonged to erect type. In late observation, the variety Rongapikhi belonged to erect type while the remaining varieties belonged to semi erect type. Erect leaves are associated with better dry matter accumulation and increased yield Sinclair and Sheehy, 1999). Leaf length was found higher in Singpho varieties as compared to the high yielding varieties. In general leaves are wider in Singpho varieties than those of HYVs with the highest leaf width in Khawlung.

Panicle traits such as spikelets/panicle, secondary branches/panicle, length and weight have the direct bearing on the grain yield in rice. In this present study, lowest panicle number/plant was found in Kulapikhi and Aghoni Bora while the highest was found in Keteki Joha. Two distinct types were observed in respect to panicle length of which the varieties Miatong, Rongapikhi, Chengkhow, Dumung, Kulapikhi and Khuntung belonged to long group (26-30 cm) type and the remaining varieties belonged to medium group (21-25 cm). Regarding panicle secondary branching, the varieties Rongapikhi, Dumung, Kulapikhi and Keteki Joha belonged to the strong type of secondary branching while the remaining varieties belonged to weak type of secondary branching in the panicle. Attitude of secondary branching in the panicle also constituted a distinguishable character among the varieties. Varieties Rongapikhi, Chengkhow, Khawlung belonged to semi erect type while varieties Miatong, Kulapikhi, Khuntung, Dolkochi and Ranjit belonged to semi-erect type while the remaining varieties belonged to semi erect to spreading type of secondary branching.

Regarding Stem length, highest stem length was found in singpho variety Khawlung while lowest was found in the high yielding variety Aghoni Bora. Stem thickness was also found higher in the singpho varieties than the high yielding varieties in the present experiment.

For tip colour of lemma, seven varieties showed brown tip colour of lemma, three varieties Chengkhow, Dumung and Aghoni Bora showed yellowish and two varieties Kulapikhi and Khuntung showed purple tip colour of lemma. This character can be employed as diagnostic character for identification of rice varieties. Similarly for lemma palea colour, eight varieties were straw coloured, while two varieties (Rongapikhi and Khawlung) showed gold and gold furrows on straw background. Moreover, two varieties (Kulapikhi and Dolkochi) showed brown spot on straw coloured lemma palea. Awns were present only in Rongapikhi, Kulapikhi, Keteki Joha and Aghoni Bora. Among these, the variety Kulapikhi exhibited purple awn colour, while the other three varieties exhibited yellowish white colour awn. So, purple coloured awn can be considered as diagnostic marker for Kulapikhi.

Based on grain length, in the present investigation, varieties Bogapikhi, Dumung, Kulapikhi, Dolkochi, Keteki Joha and Ranjit belonged to the short type grain length while the remaining varieties belonged to medium type grain length. The varieties were categorized into two distinct groups based on decorticated grain length. Varieties Dumung, Dolkochi and Ranjit belonged to medium type, while the remaining varieties belonged to long type group of decorticated grain length. Three distinct groups were observed with respect to grain width. The varieties Rongapikhi, Keteki Joha belonged to narrow type of grain width while Miatong, Bogapikhi, Khawlung and Khuntung belonged to broad type and the remaining varieties belonged to medium type grain width. With respect to decorticated grain width three distinct groups were observed with respect to grain width in the present study. The HYV Keteki Joha belonged to narrow type while Chengkhow, Khawlung, Dumung, Khuntung and Dolkochi belonged to broad type. Remaining varieties belonged to medium type decorticated grain width. Decorticated grain colour in all the varieties was white. The grain length/ grain width ratio ranged from 2.47 in Bogapikhi and Khuntung to 3.55 in Rongapikhi. Based on 1000-grains weight of rice varieties, grain weight was found highest in the variety Khawlung and lowest was found in the high yielding variety Keteki Joha. In the relationship between grain weight and the length to width ratio revealed that varieties with high grain weight showed lower for length to width ratio. Grain shape and size are important quality characters in determining market value of rice. Four distinct types

Table 2. Mean performance of different quantitative traits

Varieties	Length of the leaf blade (cm)	Width of the leaf blade (cm)	Plant height (cm)	Panicle length (cm)	Stem length (cm)	Stem thickness (cm)	Panicle number per plant	Time of heading (days)	Number of grains per Plant	Grain length (mm)	Grain width (mm)	Grain length/ grain width	Decortic-ated grain length (mm)	Decortic-ated grain width (mm)	Decorticated grain length/ decorticated grain width	1000 grain weight (g)	Yield/ plant (g)
Aghoni Bora	48.87	1.30	110.65	24.83	85.82	0.53	10.00	136.67	1318.67	9.40	2.80	3.36	7.20	2.40	3.00	25.30	33.37
Bogapikhi	58.78	1.27	160.62	25.07	135.55	0.41	13.67	130.00	847.00	7.87	3.10	2.47	6.27	2.50	2.51	22.56	19.13
Chengkhow	64.55	1.31	175.40	27.20	148.20	0.47	11.33	127.33	903.67	8.83	3.03	2.91	6.63	2.67	2.49	25.11	22.70
Dolkochi	57.67	1.16	147.49	24.33	123.16	0.45	12.67	130.00	940.67	8.00	2.97	2.70	5.90	2.80	2.11	26.61	25.07
Dumung	67.67	1.29	172.78	28.92	143.87	0.50	12.67	129.67	807.33	8.37	3.00	2.79	5.90	2.60	2.27	24.89	20.08
Keteki Joha	43.83	1.12	129.46	23.43	106.03	0.40	18.33	136.00	1499.67	8.40	2.40	3.50	6.50	1.80	3.61	17.17	25.74
Khawlung	66.47	1.38	184.14	24.46	159.66	0.65	12.33	129.00	1018.67	9.13	3.43	2.66	6.43	3.03	2.12	32.90	33.50
Khuntung	61.35	1.25	162.03	28.72	133.32	0.46	13.00	133.00	780.33	8.57	3.47	2.47	6.87	2.87	2.39	31.16	24.30
Kulapikhi	60.18	1.18	166.02	28.31	137.71	0.48	9.67	131.67	983.33	8.00	2.90	2.76	6.60	2.50	2.64	23.39	23.00
Miatong	60.27	1.28	182.04	27.92	154.12	0.48	13.00	116.67	1027.33	8.53	3.23	2.64	6.63	2.37	2.81	26.05	27.44
Ranjit	56.05	1.13	135.12	24.32	110.8	0.40	13.67	128.33	974.33	8.03	2.83	2.84	5.53	2.43	2.28	19.34	18.84
Rongapikhi	65.63	1.17	176.03	27.33	148.70	0.42	13.33	135.00	1014.00	8.73	2.47	3.55	6.57	2.27	2.90	26.25	26.58
Mean	59.28	1.24	158.48	26.24	132.24	0.47	12.81	130.28	1009.58	8.49	2.97	2.89	6.42	2.52	2.59	25.06	24.98
C.V.	11.99	6.70	14.59	7.64	16.63	14.39	17.07	4.04	20.56	5.65	11.04	13.02	7.14	12.66	16.71	17.34	19.38
S.E.	0.76	0.016	0.91	0.23	0.96	0.01	0.34	0.34	20.49	0.04	0.04	0.04	0.03	0.04	0.03	0.01	0.54
C.D. 5%	2.23	0.046	2.68	0.68	2.81	0.02	0.99	1.01	60.12	0.11	0.10	0.12	0.10	0.11	0.09	0.04	1.57
C.D. 1%	3.03	0.06	3.64	0.92	3.82	0.03	1.35	1.37	81.71	0.14	0.14	0.16	0.14	0.15	0.12	0.05	2.13

Table 3. Performance of qualitative chsaracters

Varieties	Flag leaf attitude (Early stage)	Flag leaf attitude (late stage)	Anthocyanin colouration of keel	Presence/ absence of panicle secon-dary branching	Secondary branching	Attitude of the secondary branching	Panicle exertion	Lemma palea colour	Awn	Awn colour	Decorticated grain shape	Decorti-cated grain colou	Decorti-cated grain aroma	Phenol test	Colour tip of lemma
Aghoni bora	Erect	Semi-erect	Absent	Present	Weak	Erect to semi-srect	Mostly exerted	Straw	Present	Yellowish white	Long slender	White	Absent	Positive	Yellowish
Bogapikhi	Erect	Semi-erect	Absent	Present	Weak	Erect to Semi-erect	Partly exerted	Straw	Absent	Absent	Long slender	White	Absent	Positive	Brown
Chengkhow	Erect	Semi-erect	Absent	Present	Weak	Semi-erect	Mostly exerted	Straw	Absent	Absent	Long slender	White	Absent	Positive	Yellowish
Dolkochi	Erect	Semi-erect	Absent	Present	Weak	Semi-erect to spreading	Well exerted	Brown spot on straw	Absent	Absent	Short bold	White	Absent	Positive	Brown
Dumung	Erect	Semi-erect	Weak	Present	Strong	Erect to semi-erect	Partly exerted	Straw	Absent	Absent	Short bold	White	Absent	Positive	Yellowish
Keteki Joha	Erect	Semi-erect	Absent	Present	Strong	Erect to semi-erect	Well exerted	Straw	Present	Yellowish white	Long slender	White	Present	Negative	Brown
Khawlung	Erect	Semi-erect	Medium	Present	Weak	Semi-erect	Well exerted	Gold and golden furrows on straw background	Absent	Absent	Long slender	White	Absent	Positive	Brown
Khuntung	Semi-erect	Semi-erect	Absent	Present	Weak	Semi-erect to spreading	Well exerted	Straw	Absent	Absent	Long slender	White	Absent	Positive	Purple
Kulapikhi	Erect	Semi-erect	Strong	Present	Strong	Semi-erect to spreading	Well exerted	Brown spot on straw	Present	Purple	Long slender	White	Absent	Positive	Purple
Miatong	Erect	Semi-erect	Absent	Present	Weak	Semi-erect to spreading	Well exerted	Straw	Absent	Absent	Long slender	White	Absent	Positive	Brown
Ranjit	Semi-erect	Semi-erect	Absent	Present	Weak	Semi-erect to spreading	Well exerted	Straw	Absent	Absent	Medium slender	White	Absent	Positive	Brown
Rongapikhi	Erect	Erect	Absent	Present	Strong	Semi-erect	Mostly exerted	Gold and golden furrows on straw background	Present	Yellowish white	Long slender	White	Absent	Positive	Brown

Table 4. Variability of morphological characters

Characters	Genotypic variance	Phenotypic variance	GCV (%)	PCV (%)	Heritability (broad sense) (%)	Expected genetic advance as % mean
Length of leaf blade	50.02	51.75	11.93	12.14	96.7	24.16
Width of leaf blade	0.01	0.01	6.58	6.94	90.1	12.87
Plant height	533.94	536.44	14.58	14.61	99.5	29.97
Panicle length	3.97	4.13	7.60	7.75	96.2	15.34
Stem length	482.49	485.25	16.61	16.66	99.4	34.12
Stem thickness	0.01	0.01	14.33	14.52	97.4	29.12
Panicle no./Plant	4.66	5.01	16.86	17.48	93.1	33.51
Time of heading	27.62	27.97	4.03	4.06	98.7	8.26
No. of grains/panicle	9.82	22.59	2.94	4.47	43.5	3.99
No. of grains/Plant	42663.93	43924.33	20.46	20.76	97.1	41.54
Grain length	0.23	0.23	5.63	5.68	98.3	11.50
Grain width	0.11	0.11	10.98	11.17	96.6	22.23
Grain length/grain width	0.14	0.15	12.94	13.18	96.5	26.19
Length of decorticated grain	0.21	0.21	7.12	7.18	98.4	14.55
Decorticated grain length/decorticated Grain width	0.19	0.18	16.67	16.79	98.6	34.09
1000 grain weight	18.88	18.88	17.34	17.37	100.0	35.71

of were observed among the rice varieties based on decorticated grain shape. Most of the Singpho varieties were long slender in shape, except two varieties (Dumung and Dolkochi) which showed short bold shaped grain. This character can be used in identification of the rice varieties. The present findings corroborated the findings of Borah (2002) indicating sufficient variation in grain characters in Assam rice. Aroma could not be detected in traditional varieties. In phenol test, all accessions showed positive results except Keteki Joha.

Two distinct groups were observed with respect to time of heading, of which varieties Rongapikhi, Kulapikhi, Khuntung, Keteki Joha and Aghoni Bora belonged to very late group (>131days) while the remaining varieties belonged to the late group (111-130 days).

Regarding yield/plant, in the present study it ranged from 18.84 g in Ranjit to 33.50 g in Khawlung. Though high yielding varieties have more yield than traditional varieties, but in this present investigation it was observed that traditional varieties may have some characters which may lead to higher yield than modern varieties. The height of rice plants is another decisive factor in grain yield potential. All the Singpho varieties were taller than HYVs. Though the Singpho variety Khawlung was the tallest variety but it has highest yield, for which its highest grain weight and highest stem thickness may be attributed for.

In the present investigation, yield and yield attributing traits like number of grains/panicle, number of grains/plant, 1000-grain weight, stem thickness etc. revealed that varieties Khawlung, Miatong, Rongapikhi, Chengkhow and Kulapikhi are few promising traditional varieties that could be utilized in the development of HYVs.

Variability among the characters

The analysis of variance revealed the existence of significant variation among the varieties for grain yield/plant and all other yield attributing characters. In case of morphological characters a comparison of the genotypic and phenotypic variances of the characters clearly revealed that there was a close correspondence between the two estimates for all the characters. A better comparison of the extent of genetic variation in the traits could be made from the estimates of genotypic and phenotypic coefficients of variations (Table 4). The maximum GCV was reflected for number of grains per plant followed

by yield/plant and seed weight. For these characters GCV estimates had a close correspondence with PCV estimates along with their high heritability estimates. The high estimates (>80%) of heritability for these characters also indicated considerable genetic variation and lower influence of environment in the expression of these characters

Length of leaf blade, plant height, stem length, stem thickness, panicle number/plant, number of grains/plant, grain length/grain width ratio, width of decorticated grain, decorticated grain length/ decorticated grain width ratio, 1000 grain weight, yield/plant exhibited high heritability with high genetic advance, while number of grains/panicle exhibited low heritability with low genetic advance while time of heading, time of maturity exhibited high genetic advance. Remaining characters exhibited high heritability with moderate genetic advance. Amongst all the yield attributes, number of grains/ plant was found to possess maximum genetic variation apparently controlled by additive genes. Thus, this trait deserves top most priority in selection. These results indicated the involvement of increased additive gene action and therefore, selection to increase the frequency of additive gene will be effective to a certain extent.

High heritability with low genetic advance was found for time of heading. Low heritability with low genetic advance was observed for number of grains/panicle. This indicated that these characters might be under the control of non-additive (dominance and epistasis) gene action, ofering limited scope for improvement these traits through simple selection.

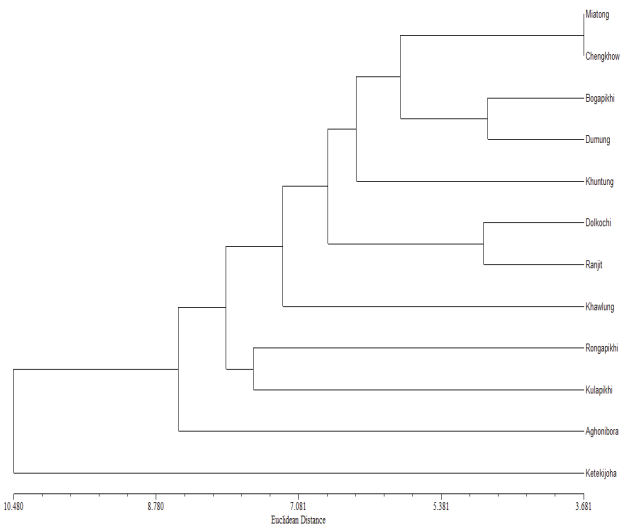

Fig. 1. Dendrogram based on all morphological haracters

Correlation coefficient at genotypic and phenotypic level

The correlation coefficient both at genotypic and phenotypic level were computed between all possible pairs of morphological characters presented in Table 5.

Grain yield/plant had positive relation with number of grains/plant, grain length and 1000 grain weight at genotypic level. Number of grains/plant positively correlated with grain length/grain width ratio, decorticated grain length/decorticated grain width ratio but negatively correlated with length leaf blade, plant height, panicle length, stem length, grain width, decorticated grain width at genotypic level. The 1000 grain weight showed positive correlation with length of leaf blade, width of leaf blade, stem thickness, number of grains/panicle, grain width and decorticated grain width at genotypic level. Grain length showed positive correlation with width of the leaf blade, number of grains/panicle, stem thickness and decorticated grain length.

Analysis of genetic diversity through cluster analysis

Euclidean distance analysis based on these traits among 12 varieties in all combinations revealed that highest distance was found between variety Keteki Joha and Khawlung indicating that they are highly diverse in nature. They can be distinguished based on a large number of characters *viz*. phenol, grain aroma, panicle secondary branching, presence/ absence of awn, lemma palea colour, panicle exertion, plant height, leaf characters etc. Lowest Euclidean distance was found between variety Chengkhow and Miatong, indicating genetic proximity among two varieties. However they can be distinguished based on the characters *viz.* attitude of panicle secondary branching, panicle exertion, colour tip of lemma. The dendrogram (Fig.1) revealed a separate identity of Aghoni Bora followed by Keteki Joha. The variety Keteki Joha possess grain aroma and showed negative result in phenol test might be a reason for such differentiation of this variety from the others. Rest of the varieties could be grouped in to three sub clusters.

This experiment revealed significant genetic variation and diversity among the genotypes of Singpho commumnity. The geneotype may be used for breeding HYVs as they may offer new gene/allelels for yield and adpatation. So a systemmatic effort for their characterization and DNA fingerprining will go in a long way for their IPR protection and conservation.

Table 5. Estimates of correlation coefficient of morphological characters

Character	Length of the leaf blade	Width of the leaf blade	Plant height	Panicle Length	Stem length	Stem thickness	Panicle no./plant	Time of heading	No. of grain/ panicle	No. of grain/ plant	Grain length	Grain width	Grain length/ Grain width	Decorticated grain length	Decorticated grain width	Decorticated grain length / decorticated grain width	1000 grain weight	Yield/ plant
Length of the leaf blade	1	0.489	0.878**	0.636*	0.866**	0.341	-0.417	-0.377	0.351	-0.813**	0.030	0.506	-0.449	-0.184	0.660*	-0.684*	0.625*	-0.155
Width of the leaf blade	0.468	1	0.441	0.247	0.441	0.802**	-0.464	-0.319	0.824**	-0.289	0.608*	0.702*	-0.378	0.368	0.597*	-0.354	0.680*	0.422
Plant height	0.866**	0.413	1	0.601*	0.997**	0.286	-0.167	-0.548	0.579*	-0.623*	-0.032	0.484	-0.434	-0.056	0.440	-0.410	0.527	-0.093
Panicle length	0.606*	0.215	0.587*	1	0.542	0.034	-0.432	-0.264	0.466	-0.588*	-0.011	0.316	-0.276	0.235	0.227	-0.173	0.347	-0.243
Stem length	0.854**	0.414	0.997**	0.525	1	0.298	-0.136	-0.553	0.567	-0.602*	-0.032	0.481	-0.431	-0.080	0.442	-0.416	0.522	-0.076
Stem thickness	0.326	0.740**	0.280	0.043	0.290	1	-0.487	-0.129	0.526	-0.014	0.639*	0.563	-0.215	0.297	0.600*	-0.339	0.700*	0.511
Panicle no./ plant	-0.419	-0.462	-0.159	-0.385	-0.132	-0.456	1	0.104	-0.270	0.389	-0.261	-0.371	0.270	-0.287	-0.563	0.451	-0.466	-0.193
Time of heading	-0.370	-0.298	-0.545	-0.264	-0.548	-0.130	0.098	1	-0.497	0.370	0.175	-0.509	0.564	0.238	-0.224	0.334	-0.143	0.140
No. of grain/ panicle	0.197	0.520	0.384	0.298	0.376	0.320	-0.143	-0.310	1	-0.136	0.658*	0.576*	-0.202	0.758**	0.286	0.093	0.584*	0.400
No. of grain/ plant	-0.798**	-0.270	-0.615*	-0.572	-0.594*	-0.007	0.369	0.372	-0.022	1	0.351	-0.629*	0.754**	0.339	-0.715**	0.821**	-0.458	0.696*
Grain length	0.036	0.583*	-0.030	-0.011	-0.030	0.626*	-0.263	0.171	0.408	0.340	1	0.092	0.407	0.659*	0.121	0.203	0.484	0.819**
Grain width	0.496	0.670*	0.476	0.302	0.472	0.534	-0.359	-0.502	0.445	-0.609*	0.088	1	-0.868**	0.072	0.832**	-0.676*	0.728**	0.088
Grain length/ Grain width	-0.431	-0.351	-0.428	-0.264	-0.426	-0.194	0.255	0.555	-0.187	0.732**	0.407	-0.864**	1	0.274	-0.715**	0.744**	-0.403	0.336
Decorticated grain length	-0.175	0.359	-0.055	0.225	-0.078	0.287	-0.291	0.233	0.505	0.333	0.662*	0.074	0.268	1	-0.094	0.505	0.331	0.509
Decorticated grain width	0.638*	0.577*	0.428	0.216	0.430	0.578*	-0.548	-0.221	0.224	-0.683*	0.132	0.813**	-0.684*	-0.072	1	-0.891**	0.816**	0.105
Decorticated grain length / Decorticated grain width	-0.668*	-0.347	-0.404	-0.168	-0.409	-0.332	0.436	0.331	0.041	0.800**	0.194	-0.667*	0.723**	0.491	-0.888**	1	-0.536	0.238
1000 grain weight	0.615*	0.646*	0.525	0.340	0.521	0.691*	-0.450*	-0.142	0.386	-0.451	0.479	0.716**	-0.396	0.328	0.799**	-0.532	1	0.627*
Yield/plant	-0.158	0.398	-0.093	-0.240	-0.076	0.524	-0.189	0.147	0.332	0.678*	0.795**	0.085	0.326	0.500	0.107	0.230	0.613*	1

* = Significant at 5% level of significance; ** = Significant at 1% level of significance; Upper matrix= Genotypic correlation coefficients; Lower matrix= Phenotypic correlation coefficient.

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