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Research Article

Assessing genetic divergence among rice germplasm based on qualitative traits

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Abstract

Rice is cultivated worldwide under wide range of ecological conditions and is a daily staple food crop for more than half of world's population. The morphological characterization is usually performed to select better genotypes. This type of characterization identifies elite genotypes based on qualitative as well as quantitative traits. In present study 45 diverse rice germplasm were screened for important qualitative traits. The experiment was designed as augmented and important qualitative traits including leaf related traits, lodging, panicle shape, seed coat color and awn related traits were studied. Significant variations were observed for all the examined traits. Majority of genotypes showed resistance to lodging, and only few showed slight lodging. The brown seed coat color was found dominant among genotypes. All the studied traits included in the study were found useful for the identification of improved genotypes and these traits have direct relation with yield or yield related traits. However, to elucidate the particular responsible genes for these traits, further molecular based studies are recommended.

Keywords: Genetic variability; Lodging; Morphological traits; Rice; Qualitative traits

Introduction

The rice belongs to important plant family Poaceae. The 22 species of rice has been identified, two species (*Oryza sativa* and *Oryza glaberrima*) are widely cultivated than rest ones **[1]**. It is the one of the major energy source for the world population and key contributor to world agriculture sector **[2]**. *Oryza sativa* cultivated worldwide, including Asia, North and South America, throughout Europe, Middle Eastern and African countries. *Oryza glaberrima* is grown in many parts of Africa due to higher yields **[3]**. Its cultivars are divided into three main types including Indica, Javanica and Japonica. The japonica grains are shorter and broaden as compared to Indica grain and become soft and sticky when cooked **[4]**.

Abiotic stresses affect both the morpho-biochemical, physiological and molecular

processes of crop species [5, 6]. The rice crop has been affected by both the biotic and abiotic environmental extremes. The low temperature stress decreases its yield many times. The japonica type shows resistance to low temperature (15 to 20^0C) as compared to other two types. However, low temperatures (below 18^0C) at night time produce sterile pollens [7]. The bacterial blight disease is one of the key diseases that significantly affect both qualitative and quantitative traits including yield [8].

Agro-morphological diversity studies play key role in the identification of improved genotypes for both qualitative and quantitative traits and to differentiate both local and exotic germplasm [9-13]. It also helps us to screen best genotypes among large population that can be further characterized in different location for both preliminary and advanced yield trails [14-17]. The rice genotypes can be characterized through various qualitative and quantitative traits like growth parameters, culms color, leaf blades types, grain color, height, diseases resistance and many more [18]. The panicle traits are important to measure genetic diversity in rice for both quantitative and qualitative traits [19, 20]. Ismaeel *et al.* [21] characterized 83 rice germplasm for 15 qualitative and 8 quantitative traits and recorded maximum variability among genotypes. Moukoumbi *et al.* [22] evaluated 78 rice genotypes for important qualitative traits including plant vigor, color of basal leaf sheath, and type of flag leaf, panicle exertion and habit of culm and recorded maximum diversity for all studied traits. In present study 45 diverse rice genotypes were evaluated for important qualitative traits and to identify climate smart genotypes for future use in rice breeding program.

Materials and methods

Plant materials and field layout

The current research work was conducted in Plant Genetic Resources Institute (PGRI), National Agricultural Research Centre (NARC), Islamabad, Pakistan. The seeds of 45 germplasm (Table 1 & 2) were sown in field by using augmented design. The row length was 4.5 meters, row to row distance 30 cm and plant to plant distance was 15 cm. Proper water treatment was applied and recommended cultural practices were followed from germination to till maturity. The following qualitative traits were measured at different growth stages.

1. Flag leaf angle

Four different types of flag leaves were studied like descending, horizontal, erect and semi-erect.

2. Leaf shape

The three different shapes of leaf (droopy, erect and semi-erect) were observed for 45 rice genotypes

3. Leaf appearance

Three different types of leaf (narrow, broaden and intermediate types) were checked for all tested genotypes.

4. Lodging

Three standard lodging categories (slight, heavy or no lodging) were used to note the different lodging ability among genotypes

5. Panicle type

The diversity in panicle types i.e. open type, compact and intermediate types were recorded.

6. Panicle exertion

The 5 different panicle exertion types (well, partly, just, moderate and enclosed) of rice were noted.

7. Awn type

The rice genotypes were divided for different awn related codes (awned, awnless and awnlated).

8. Awn color

Awn color (white, light and dark brown or red-black).

9. Seed coat color

The seed coat color is one the important qualitative traits. The rice genotypes were screened for different types of seed coat

colors (white, brown, light/ dark/ red/ speckled/ blackish brown).

Results and discussion

Morphological characterization of rice genotypes through qualitative traits

In present study 45 diverse rice germplasm were evaluated for nine important qualitative traits. The genotypes which belong to tropical, subtropical and temperate zones were analyzed under similar environmental condition at Plant Genetic Resources Institute (PGRI), National Agricultural Research Centre (NARC), Islamabad, Pakistan. All the studied genotypes showed considerable variability under similar environmental conditions. The data of following nine qualitative traits were recorded from five random selected samples.

In present study maximum diversity was observed among genotypes for flag leaf angle. Maximum genotypes (26) showed erect angle, 17 were semi-erect and 2 had horizontal type. Similar type of variability was observed for leaf shape trait. The leaf shape trait play key role in photosynthesis and the erect and semi-erect are considered more important. In our study, majority of genotypes showed erect and semi-erect leaf shape. In addition the different types of leaf appearance were observed in all 45 tested genotypes. Maximum genotypes (34) showed intermediate appearance, and 7 genotypes had broad leaves. The remaining genotypes were found narrow types (Table 1).

Lodging trait is one of the key traits that have direct impact on final yield. In present study the lodging was observed visually and majority of genotypes (37) showed resistance to lodging, 2 genotypes showed maximum lodging. While 6 genotypes showed slight lodging (Table 1).

The rice genotypes were characterized for compact, open and intermediate panicle types. Maximum genotypes (24) showed compact type. While, remaining 21 genotypes have intermediate appearance (Table 1). For panicle exertion trait, maximum genotypes (36) were found moderately and well exerted (Table 2).

Awn is one of the key qualitative traits that help in the identification of genotype and also protect grain from bird or other pest attack. In this study 26 genotypes were found awnless and 19 were awned. For awned panicle the brown color were predominantly observed (Table 2).

In current study maximum divergence was observed among genotypes for seed coat color. Majority of genotypes (23) showed light brown color. 20 genotypes had brown seed coat color, while other 2 genotypes had dark brown color (Table 2). Rice is one of the key cash crops of Pakistan and cultivated as one of the major crop. Therefore, Pakistan needs to further expand its export and improve its local consumption by improving grain quality as per the consumer demand around the globe and in the country. Agro-morphological based diversity helps in the identification of elite genotypes. In present study various qualitative traits of 45 rice genotypes were evaluated. High level of variability was recorded for all nine qualitative traits (Table 1 & 2). In previous studies Lei *et al.* [20] recorded maximum diversity in panicle related traits in Kam fragnant glutenious rice genotypes. They recorded maximum variability (CV >50%) In grain, husk and awn color. They observed 86 awned genotypes out of 95 samples. In addition they noted maximum milky green and light green grain color genotypes. Moukoumby *et al.* [22] also recorded higher diversity in basal leaf sheath color. They recorded maximum green color basal sheath genotypes. Similarly, Meshram *et al.* [23] noted dark green seed color and basal leaf sheath color rice genotypes. Jan *et al.* [24, 25] recorded maximum morphological and protein based variability for seed color trait of *B. rapa* genotypes (brown, yellow and Toraia types). In similar study, Ahmed *et al.* [26] evaluated 40 Balm rice landraces of Bangladesh for important qualitative traits and recorded maximum (35, 60 and 87%) colorless leaf sheath, awnless grain and green leaf blade genotypes, respectively.

Table. 1. Qualitative characters *i.e.* flag leaf angle, leaf shape, leaf appearance, lodging and panicle type of 45 rice genotypes

S. No	Genotype	Flag leaf angle	Leaf shape	Leaf appearance	Lodging	Panicle type
1	19-a	Erect	Erect	Narrow	No	Intermediate
2	24-b	Erect	Semi erect	Intermediate	No	Compact
3	97-b	Erect	Semi erect	Intermediate	No	Compact
4	108R	Erect	Semi erect	Intermediate	Slight	Compact
5	112L	Erect	Semi erect	Narrow	Slight	Compact
6	120	Semi erect	Erect	Intermediate	No	Compact
7	127	Erect	Erect	Intermediate	No	Compact
8	129-a	Erect	Semi erect	Narrow	No	Compact
9	130-b	Erect	Semi erect	Intermediate	No	Compact
10	131-2	Erect	Erect	Intermediate	No	Compact
11	133M	Erect	Erect	Intermediate	No	Compact
12	159	Erect	Semi erect	Intermediate	No	Intermediate
13	163	Erect	Semi erect	Intermediate	No	Compact
14	164-a	Semi erect	Semi erect	Intermediate	Slight	Intermediate
15	164-b	Erect	Erect	Intermediate	No	Compact
16	166-b	Semi erect	Semi erect	Intermediate	No	Compact
17	166-c	Semi erect	Semi erect	Intermediate	No	Compact
18	169	Semi erect	Semi erect	Broad	No	Compact
19	187-a	Erect	Droopy	Intermediate	No	Intermediate
20	187-b	Semi erect	Erect	Broad	Heavy	Compact
21	MR-13-3	Erect	Erect	Broad	No	Intermediate
22	NPT-156	Erect	Erect	Intermediate	Slight	Compact
23	101-213-216	Erect	Semi erect	Broad	No	Compact
24	102-205-314	Erect	Semi erect	Intermediate	No	Intermediate
25	103-208-326	Semi erect	Droopy	Broad	Heavy	Compact
26	104-207-309	Semi erect	Erect	Broad	Slight	Compact
27	107-217-313	Semi erect	Semi erect	Intermediate	Slight	Intermediate
28	108-223-301	Erect	Droopy	Intermediate	No	Compact
29	109-226-302	Erect	Erect	Broad	No	Compact
30	111-222-308	Erect	Erect	Intermediate	No	Intermediate
31	112-224-320	Semi erect	Erect	Intermediate	No	Intermediate
32	113-225-310	Semi erect	Semi erect	Intermediate	No	Intermediate
33	114-227-310	Semi erect	Semi erect	Intermediate	No	Intermediate
34	115-215-317	Semi erect	Erect	Intermediate	No	Intermediate
35	116-211-303	Semi erect	Erect	Intermediate	No	Intermediate
36	117-228-311	Semi erect	Erect	Intermediate	No	Compact
37	119-203-305	Semi erect	Semi erect	Intermediate	No	Compact
38	120-218-322	Semi erect	Erect	Intermediate	No	Intermediate
39	123-214-319	Erect	Semi erect	Intermediate	No	Intermediate
40	124-204-306	Erect	Erect	Intermediate	No	Intermediate
41	166-221-323	Erect	Semi erect	Intermediate	No	Intermediate
42	HH2-11-Y6-Y1	Erect	Semi erect	Intermediate	No	Intermediate
43	IR6	Droopy	Semi erect	Intermediate	No	Intermediate
44	JP5	Droopy	Erect	Intermediate	No	Intermediate
45	Super-Basmati	Erect	Erect	Narrow	No	Intermediate

Table.2. Qualitative characteristic *i.e.* panicle exertion, awning, awn color, seed coat color of 45 rice genotypes

S. No	Genotype	Panicle Exertion	Awning	Awn Color	Seed Coat Color
1	19-a	Enclosed	Awned	Brown	Brown
2	24-b	Moderate	Awnless	Awnless	Brown
3	97-b	Moderate	Awned	Brown	Brown
4	108R	Partially	Awned	Brown	Brown
5	112L	Moderate	Awned	Light brown	Brown
6	120	Moderate	Awnless	Awnless	Light Brown
7	127	Partially	Awned	Brown	Brown
8	129-a	Moderate	Awnless	Awnless	Light Brown
9	130-b	Well	Awned	Brown	Brown
10	131-2	Moderate	Awned	Brown	Brown
11	133M	Moderate	Awned	Light brown	Brown
12	159	Moderate	Awned	Light brown	Brown
13	163	Partially	Awned	Brown	Light Brown
14	164-a	Partially	Awned	Brown	Light Brown
15	164-b	Enclosed	Awned	Brown	Light Brown
16	166-b	Well	Awned	Dark brown	Light Brown
17	166-c	Moderate	Awned	Light brown	Light Brown
18	169	Moderate	Awnless	Awnless	Light Brown
19	187-a	Moderate	Awned	Brown	Dark Brown
20	187-b	Moderate	Awned	Brown	Dark Brown
21	MR-13-3	Moderate	Awned	Brown	Brown
22	NPT-156	Well	Awnless	Awnless	Brown
23	101-213-216	Well	Awnless	Awnless	Brown
24	102-205-314	Partially	Awnless	Awnless	Light Brown
25	103-208-326	Partially	Awnless	Awnless	Light Brown
26	104-207-309	Well	Awnless	Awnless	Light Brown
27	107-217-313	Moderate	Awnless	Awnless	Light Brown
28	108-223-301	Well	Awnless	Awnless	Light Brown
29	109-226-302	Well	Awnless	Awnless	Light Brown
30	111-222-308	Moderate	Awnless	Awnless	Brown
31	112-224-320	Moderate	Awnless	Awnless	Light Brown
32	113-225-310	Partially	Awnless	Awnless	Brown
33	114-227-310	Well	Awnless	Awnless	Light Brown
34	115-215-317	Moderate	Awnless	Awnless	Brown
35	116-211-303	Well	Awnless	Awnless	Light Brown
36	117-228-311	Well	Awnless	Awnless	Brown
37	119-203-305	Enclosed	Awnless	Awnless	Brown
38	120-218-322	Moderate	Awnless	Awnless	Light Brown
39	123-214-319	Well	Awnless	Awnless	Light Brown
40	124-204-306	Moderate	Awnless	Awnless	Light Brown
41	166-221-323	Well	Awned	Brown	Light Brown
42	HH2-11-Y6-Y1	Well	Awnless	Awnless	Brown
43	IR6	Moderate	Awnless	Awnless	Light Brown
44	JP5	Partly	Awnless	Awnless	Light Brown
45	Super-Basmati	Partly	Awned	Light Brown	Brown

Conclusion

Breeding is important practice for the improvement of rice germplasm. Genetic diversity study based on qualitative traits help in the identification of novel genotypes. Maximum diversity was recorded among

studied genotypes for key qualitative traits having direct relationship with yield. However a more in depth studies are needed to characterize these genotypes through biochemical and molecular markers.

Author's contributions

Wrote the manuscript: proof reading and formatting: SA Jan, I Hassan, AH Shah & M Ilyas, performed experimental work: A Qayyum, MF Abbasi, MI Ibrahim & SA Jan, conceived and designed the experiments: MA Rabbani.

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