Original Research Article  

Characterization of African Rice Germplasm for Morphological and Yield Attributing Traits

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A B S T R A C T

For the establishment of the distinctness among 31 accessions of Oryza glaberrima, eight morphological traits following Distinctness, Uniformity and Stability test (DUS) studied. Out of 31 accessions studied, two accessions viz., EC861804, EC861805 were found to be highly distinct as they possessed distinct traits namely purple split ligule, medium green leaves, erect flag leaf, presence of awn along with lodging tolerance indicating their usefulness as donors for crop improvement programmes. Analysis of variance revealed significant differences for all the characters studied. Phenotypic coefficient variation was higher than genotypic coefficient variation and magnitude of PCV and GCV was high for number of productive tillers and spikelets per panicle. High heritability coupled with high genetic advance was observed for days to 50 per cent flowering and number of spikelets per panicle which suggested the presence of high additive gene action which would respond to selection owing their high genetic variability and transmissibility.

Keywords: Oryza glaberrima, DUS, Genetic variability, Heritability, Genetic advance

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Introduction

Rice (Oryza sativa L.) is the principal food grain crop in India and it is being cultivated in 43.9 million ha with total of production of 109.6 million tonnes (Indiastat, 2016-17). Since the release of semi dwarf rice varieties in 1960’s in India and elsewhere, the genetic gain of yield potentiality among widely cultivated semi dwarf rice varieties is stagnated due to narrow genetic base. Therefore, it is inevitable to broaden the genetic base of modern rice varieties by infusing genomic regions from related species of Oryza. Oryza glaberrima, endemic to Africa, is reported to have many useful traits
such as resistance to biotic, abiotic stresses (Fofana and Cloutier, 2008) along with early maturity. In addition, *O. glaberrima* is also a potential source of genes to enhance milling, cooking, eating qualities of *indica* rice. In India, *O. glaberrima* is used in limited extent for genetic improvement of *indica* rice as very less systematic efforts have been undertaken in India to utilize the wealth of African species for genetic improvement of *indica* rice varieties (Sarla and Swamy, 2005).

Characterization of a variety is useful to identify and avoid duplication, enabling rice breeders to exploit a wide range of genotypic diversities for further crop improvement practices to increase the rice productivity. Generally, the morphological traits are qualitative in nature and are stable over generations (Raut, 2003), making them more reliable as morphological markers for the characterization of varieties. Development of high yielding cultivars with wide adaptability is the ultimate aim of plant breeders. Knowledge of genetic variability present in a given crop species for the character under improvement is of paramount importance for the success of any plant breeding program for broadening the gene pool of crops (Ahmad et al., 2011). Heritability provides information on the extent to which a particular morphogenetic character can be transmitted to successive generations and also influences the choice of selection procedures used by the plant breeder to decide which selection methods would be most useful to improve the character (waqar et al., 2008). Characters with high heritability can easily be fixed with simple selection, resulting in quick progress. However, it has been accentuated that heritability alone has no practical importance without genetic advance (Najeeb et al., 2009). A systematic study analysis of genetic diversity is essential to exploit the inherent variability and to broaden the genetic base of rice cultivars (Rout et al., 2017). Thus, the present study was conducted to characterize understand the performance of African rice germplasm for eight morphological traits along with a study on genetic variability, heritability and genetic advance for grain yield and its component characters. The knowledge gained in the present study is will be useful for exploitation of genetic wealth of African rice for genetic improvement of Indian cultivars.

**Materials and Methods**

Thirty one *O. glaberrima* lines received from IRRI (International Rice Research Institute) were sown in dry bed during Khairi 2017 at the ICAR-Indian Institute of Rice Research, Hyderabad. Twenty one days old seedlings of each accession were transplanted by adopting a spacing of 20 cm between rows and 15 cm between plants in a Randomized Block Design with two replications. Morphological characterization was carried out using eight DUS characters. Visual observations were recorded on single plant basis on five randomly selected plants in each accession at appropriate growth stages on eight qualitative characters *viz.*, Coleoptile colour, leaf intensity of green colour, culm type, leaf anthocyanin colouration, leaf ligue, flag leaf characteristics, panicle awn and stem anthocyanin colouration. Data was recorded on 10 quantitative characters namely, days to 50% flowering, plant height (cm), panicle length (cm), number of productive tillers, number of spikelets per panicle, 1000seed weight (g) and grain yield per plant (g), kernel length (mm), kernel breadth (mm) and L/B ratio. Replicated mean data of each character was subjected to analysis of variance following Panse and Sukatme (1985). Genotypic, phenotypic and environmental variance along with heritability and genetic advance were estimated for all the characters. The phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (broad sense) and genetic advance were estimated by
the formulae suggested by Burton et al., (1952) and Johnson et al., (1955).

Results and Discussion

Among the eight qualitative characters studied in morphological characterization of the accessions (Table 1), three characters (Table 2) viz., absence of coleoptile colour, leaf anthocyanin colouration and presence of leaf ligule were common in all the 31 accessions of *O. glaberrima*. Remaining five characters were unique and distinct among the accessions. The coleoptile was colourless in all the accessions of *O. glaberrima*. Regarding leaf characteristics, intensity of green colour in leaves was light in 18 accessions (58.06%) and medium green in the remaining 13 accessions. The anthocyanin colouration of leaves was absent in all the accessions of *O. glaberrima*, while all the 31 accessions of *O. glaberrima* had the leaf ligule with split shape in two accessions (EC 861804 and 861814 and acute in the remaining 29 accessions. The colour of ligule was also distinct across the accessions as it was white in 26 and purple in five accessions (EC861791, EC861796, EC861805, EC861819 and EC861817). With respect to the culm type, out of the 31 accessions of *O. glaberrima*, 27 accessions (87.09%) showed erect culm, one accession (EC861791) had semi erect culm, while spreading culm was observed in three accessions (EC861807, EC861812 and EC861813). The *O. glaberrima* accessions having erect type of culm can show lodging resistance. Regarding the attitude of the flag leaf blade, it was erect in six accessions (EC 861799, EC861804, EC861807, EC861810, EC861814 and EC861816), semi-erect in 19 and horizontal in the remaining six accessions (EC861792, EC816794, EC861797, EC861784, EC861811 and EC861815). The six accessions of *O. glaberrima* having erect flag leaf can serve as donor lines for improvement in rice breeding programmes.

For the panicle awn, nine accessions (EC861795, EC861799, EC861803, EC861812, EC861813, EC861814, EC861815, EC861817 and EC861818) recorded the presence of awn while it was absent in the remaining 22 accessions. With regard to the stem anthocyanin colouration, 13 accessions (41.93%) recorded the purple colouration while 18 accessions did not show anthocyanin colouration on stem. Two accessions viz., EC861804, EC861805 were found to be highly distinct as they possessed distinct traits namely purple split ligule, medium green leaves, erect flag leaf, presence of awn along with lodging tolerance indicating their usefulness as donors for crop improvement programmes (Table 3).

Analysis of variance (Table 4) revealed significant differences among the accessions under study for all the ten traits indicating the presence of considerable genetic variability in the experimental material. A study of genetic parameters (Table 5) revealed that phenotypic and genotypic coefficients of variation were high for number of productive tillers per plant and spikelets per panicle The values of GCV and PCV were moderate for days to 50 per cent flowering, plant height, productive tillers, 1000 seed weight, grain yield per plant and kernel length while low for panicle length, kernel breadth and L/B ratio. These results are in accordance with findings of Rusdiansyah et al., (2017) for high GCV and PCV, Abebe et al., (2017) for moderate GCV, PCV and Edukondalu et al., (2017) for low GCV and PCV in rice (*O. sativa* L.). High heritability coupled with high genetic advance was observed for days to 50 per cent flowering, plant height and number of spikelets per panicle indicated the preponderance of high additive type of gene action in the inheritance of these characters which can be further improved by following simple selection procedure as suggested by Abebe et al., (2017) (Fig. 1 and Table 6).
Table 1 List of *Oryza glaberrima* accessions used in the present study

| S.No | Accession No. | Origin     | Biological status of accession |
|------|--------------|------------|-------------------------------|
| 1    | EC861784     | Guinea     | Traditional cultivar/Landrace |
| 2    | EC861785     | Guinea     | Traditional cultivar/Landrace |
| 3    | EC861786     | Guinea     | Traditional cultivar/Landrace |
| 4    | EC861787     | Guinea     | Traditional cultivar/Landrace |
| 5    | EC861790     | Guinea     | Traditional cultivar/Landrace |
| 6    | EC861791     | Guinea     | Traditional cultivar/Landrace |
| 7    | EC861792     | Guinea     | Traditional cultivar/Landrace |
| 8    | EC861794     | Guinea     | Traditional cultivar/Landrace |
| 9    | EC861795     | Guinea     | Traditional cultivar/Landrace |
| 10   | EC861796     | Guinea     | Traditional cultivar/Landrace |
| 11   | EC861797     | Guinea     | Traditional cultivar/Landrace |
| 12   | EC861799     | Guinea     | Traditional cultivar/Landrace |
| 13   | EC861801     | Guinea     | Traditional cultivar/Landrace |
| 14   | EC861802     | Guinea     | Traditional cultivar/Landrace |
| 15   | EC861803     | Guinea     | Traditional cultivar/Landrace |
| 16   | EC861804     | Guinea     | Traditional cultivar/Landrace |
| 17   | EC861805     | Guinea     | Traditional cultivar/Landrace |
| 18   | EC861807     | Guinea     | Traditional cultivar/Landrace |
| 19   | EC861808     | Guinea     | Traditional cultivar/Landrace |
| 20   | EC861809     | Guinea     | Traditional cultivar/Landrace |
| 21   | EC861810     | Guinea     | Traditional cultivar/Landrace |
| 22   | EC861811     | Guinea     | Traditional cultivar/Landrace |
| 23   | EC861812     | Guinea     | Traditional cultivar/Landrace |
| 24   | EC861813     | Guinea     | Traditional cultivar/Landrace |
| 25   | EC861814     | Guinea     | Traditional cultivar/Landrace |
| 26   | EC861815     | Guinea     | Traditional cultivar/Landrace |
| 27   | EC861816     | Guinea     | Traditional cultivar/Landrace |
| 28   | EC861817     | Guinea     | Traditional cultivar/Landrace |
| 29   | EC861818     | Guinea     | Traditional cultivar/Landrace |
| 30   | EC861819     | Malaysia   | Wild                          |
| 31   | EC861820     | Malaysia   | Wild                          |
**Table 2** Characterization of 31 accessions of *O. glaberrima* for morphological traits

| S.NO. | Accession | Coleoptile colour | Intensity of green colour in leaves | Leaf anthocyanin colouration | Leaf ligule | Culm type | Flag leaf attitude | Panicle awn | Stem anthocyanin colouration |
|-------|-----------|-------------------|------------------------------------|-----------------------------|-------------|-----------|-------------------|-----------|-----------------------------|
| 1     | EC 861784 | colourless        | light                             | absent                       | present     | erect     | horizontal        | absent     | absent                       |
| 2     | EC 861785 | colourless        | light                             | absent                       | present     | erect     | semi erect        | absent     | absent                       |
| 3     | EC 861786 | colourless        | light                             | absent                       | present     | erect     | semi erect        | absent     | absent                       |
| 4     | EC 861787 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | absent     | absent                       |
| 5     | EC 861790 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | absent     | absent                       |
| 6     | EC 861791 | colourless        | medium                            | absent                       | present     | semi erect | semi erect        | absent     | absent                       |
| 7     | EC 861792 | colourless        | light                             | absent                       | present     | erect     | horizontal        | absent     | absent                       |
| 8     | EC 861794 | colourless        | medium                            | absent                       | present     | erect     | horizontal        | absent     | present                      |
| 9     | EC 861795 | colourless        | light                             | absent                       | present     | erect     | semi erect        | present    | present                      |
| 10    | EC 861796 | colourless        | light                             | absent                       | present     | erect     | semi erect        | absent     | present                      |
| 11    | EC 861797 | colourless        | light                             | absent                       | present     | erect     | horizontal        | absent     | absent                       |
| 12    | EC 861799 | colourless        | light                             | absent                       | present     | erect     | present           | present    | present                      |
| 13    | EC 861801 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | absent     | present                      |
| 14    | EC 861802 | colourless        | light                             | absent                       | present     | erect     | semi erect        | present    | present                      |
| 15    | EC 861803 | colourless        | light                             | absent                       | present     | erect     | semi erect        | present    | present                      |
| 16    | EC 861804 | colourless        | medium                            | absent                       | present     | erect     | erect             | absent     | absent                       |
| 17    | EC 861805 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | absent     | present                      |
| 18    | EC 861807 | colourless        | medium                            | absent                       | present     | spreading | semi erect        | present    | present                      |
| 19    | EC 861808 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | absent     | absent                       |
| 20    | EC 861809 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | present    | present                      |
| 21    | EC 861810 | colourless        | light                             | absent                       | present     | erect     | erect             | absent     | absent                       |
| 22    | EC 861811 | colourless        | light                             | absent                       | present     | erect     | horizontal        | absent     | absent                       |
| 23    | EC 861812 | colourless        | medium                            | absent                       | present     | spreading | semi erect        | present    | present                      |
| 24    | EC 861813 | colourless        | light                             | absent                       | present     | spreading | semi erect        | present    | present                      |
| 25    | EC 861814 | colourless        | light                             | absent                       | present     | erect     | present           | present    | present                      |
| 26    | EC 861815 | colourless        | light                             | absent                       | present     | erect     | horizontal        | present    | absent                       |
| 27    | EC 861816 | colourless        | medium                            | absent                       | present     | erect     | erect             | absent     | absent                       |
| 28    | EC 861817 | colourless        | medium                            | absent                       | present     | erect     | semi erect        | present    | present                      |
| 29    | EC 861818 | colourless        | light                             | absent                       | present     | erect     | semi erect        | present    | present                      |
| 30    | EC 861819 | colourless        | light                             | absent                       | present     | erect     | semi erect        | present    | present                      |
| 31    | EC 861820 | colourless        | light                             | absent                       | present     | erect     | semi erect        | absent     | absent                       |
Table 3 Frequency distribution of morphological traits in 31 accessions of *O. glaberrima*

| S.No. | Character                                | Status            | No. of accessions | Frequency | Accessions                                                                 |
|-------|------------------------------------------|-------------------|-------------------|-----------|---------------------------------------------------------------------------|
| 1     | Coleoptile colour                        | Colourless        | 31                | 100%      | EC 861784, 861785, 861786, 861787, 861790, 861791, 861792, 861794, 861795, 861796, 861797, 861799, 861801, 861802, 861803, 861804, 861805, 861807, 861808, 861809, 861810, 861811, 861812, 861813, 861814, 861815, 861816, 861817, 861818, 861819, 861820 |
| 2     | Intensity of green colour in leaves       | Light             | 18                | 58.06%    | EC 861784, 861785, 861786, 861792, 861795, 861796, 861797, 861799, 861802, 861803, 861810, 861811, 861813, 861814, 861815, 861818, 861819, 861820 |
|       |                                          | Medium            | 13                | 41.93%    | EC 861787, 861790, 861791, 861794, 861801, 861804, 861805, 861807, 861808, 861809, 861812, 861816, 861817 |
| 3     | Leaf anthocyanin colouration              | Present           | 0                 | 0%        | -                                                                         |
|       |                                          | Absent            | 31                | 100%      | EC 861784, 861785, 861786, 861787, 861790, 861791, 861792, 861794, 861795, 861796, 861797, 861799, 861801, 861802, 861803, 861804, 861805, 861807, 861808, 861809, 861810, 861811, 861812, 861813, 861814, 861815, 861816, 861817, 861818, 861819, 861820 |
| S.No. | Character               | Status     | No. of accessions | Frequency  | Accessions                                      |
|-------|-------------------------|------------|-------------------|------------|------------------------------------------------|
| 4     | Leaf ligule             | Present    | 31                | 100%       | EC 861784, 861785, 861786, 861787, 861790, 861791, 861782, 861794, 861795, 861796, 861797, 861799, 861801, 861802, 861803, 861804, 861805, 861807, 861808, 861809, 861810, 861811, 861812, 861813, 861814, 861815, 861816, 861817, 861818, 861819, 861820 |
|       |                         | Absent     | 0                 | 0%         |                                                |
| 5     | Culm type               | Erect      | 27                | 87.09%     | EC 861784, 861785, 861786, 861787, 861790, 861792, 861795, 861796, 861797, 861799, 861801, 861802, 861803, 861804, 861805, 861808, 861810, 861811, 861813, 861814, 861815, 861816, 861817, 861818, 861819, 861820 |
|       |                         | Semi erect  | 1                 | 0.03%      | EC 861791                                      |
|       |                         | Spreading   | 3                 | 0.09%      | EC 861807, 861812, 861813                      |
| 6     | Flag leaf attitude      | Erect      | 6                 | 19.35%     | EC 861799, 861804, 861807, 861810, 861814, 861816 |
|       |                         | Semi erect  | 19                | 61.29%     | EC 861785, 861786, 861787, 861790, 861791, 861795, 861796, 861801, 861802, 861803, 861805, 861808, 861810, 861811, 861814, 861816, 861817, 861818, 861819, 861820 |
|       |                         | Horizontal | 6                 | 19.35%     | EC 861784, 861787, 861794, 861799, 861811, 861815 |
| 7     | Panicle awn             | Present    | 9                 | 29.03%     | EC 861795, 861799, 861803, 861812, 861813, 861814, 861815, 861817, 861818 |
|       |                         | Absent     | 22                | 70.96%     | EC 861784, 861785, 861786, 861787, 861790, 861791, 861792, 861794, 861796, 861797, 861801, 861802, 861804, 861805, 861807, 861808, 861809, 861811, 861810, 861816, 861819, 861820 |
| 8     | Stem anthocyanin colouration | Present  | 13                | 41.93%     | EC 861794, 861795, 861799, 861801, 861802, 861803, 861805, 861807, 861809, 861813, 861814, 861818, 861819 |
|       |                         | Absent     | 18                | 58.06%     | EC 861784, 861785, 861786, 861787, 861790, 861791, 861792, 861796, 861797, 861804, 861808, 861810, 861811, 861812, 861815, 861816, 861817, 861820 |
Table 4 Analysis of variance for yield and yield attributing traits in rice *Oryza glaberrima* accessions

| S. No. | Character                          | Replication (d.f.=1) | Treatment (d.f.=30) | Error (d.f.=30) |
|--------|-----------------------------------|----------------------|---------------------|-----------------|
| 1      | Days to 50% flowering             | 41.30                | 283.00**            | 12.58           |
| 2      | Plant height (cm)                  | 0.16                 | 476.159**           | 57.39           |
| 3      | Number of productive tillers       | 1.19                 | 36.29**             | 2.21            |
| 4      | Panicle length (cm)                | 3.71                 | 8.64**              | 3.63            |
| 5      | No. of spikelets per panicle       | 71.85                | 2257.44**           | 279.08          |
| 6      | 1000 grain weight (g)              | 17.80                | 16.12**             | 5.06            |
| 7      | Grain yield per plant (g)          | 1.45                 | 3.54**              | 0.36            |
| 8      | Kernel length (mm)                 | 0.11                 | 0.48**              | 0.18            |
| 9      | Kernel breadth (mm)                | 0.03                 | 0.09**              | 0.02            |
| 10     | L/B ratio                          | 0.01                 | 0.13**              | 0.05            |

** Significant at 1% level  * Significant at 5% level

Table 5 Magnitude of variability, heritability and genetic advance for yield and yield attributing traits in *Oryza glaberrima* accessions

| Characters                          | PCV (%) | GCV (%) | Heritability in broad sense(h²)(%) | Genetic Advance (at 5%) |
|-------------------------------------|---------|---------|-----------------------------------|-------------------------|
| Days to 50% flowering               | 10.38   | 9.93    | 91.49                             | 22.91                   |
| Plant height (cm)                    | 12.32   | 10.92   | 78.49                             | 26.41                   |
| No. of productive tillers per plant | 34.38   | 32.35   | 88.51                             | 8.00                    |
| Panicle length (cm)                  | 9.33    | 6.35    | 40.84                             | 2.08                    |
| No. of spikelets per panicle         | 29.98   | 26.48   | 77.99                             | 57.22                   |
| 1000 grain weight (g)                | 18.45   | 13.33   | 52.19                             | 3.4                     |
| Grain yield per plant (g)            | 16.58   | 14.98   | 81.63                             | 2.35                    |
| Kernel length (mm)                   | 16.36   | 15.33   | 87.86                             | 2.51                    |
| Kernel breadth (mm)                  | 8.55    | 6.13    | 51.54                             | 0.26                    |
| L/B ratio                           | 10.34   | 7.00    | 45.86                             | 0.28                    |
Table 6: Mean performance of *O. glaberrima* accessions for yield and yield attributing traits

| S.NO. | Accession | Days to 50% flowering | Plant height (cm) | Productive tillers | Panicle length (cm) | Spikelets/Panicle | 1000 seed weight (g) | Yield/Plant (g) | Kernel length (mm) | Kernel breadth (mm) | L/B ratio |
|-------|-----------|------------------------|-------------------|-------------------|---------------------|-------------------|----------------------|-----------------|--------------------|--------------------|-----------|
| 1     | EC 861784 | 126.0                  | 127.0             | 12.0              | 26.7                | 110.0             | 15.9                 | 8.2             | 7.2                | 2.6                | 2.7       |
| 2     | EC 861785 | 125.0                  | 150.9             | 14.0              | 29.1                | 102.0             | 14.8                 | 7.2             | 8.0                | 3.4                | 2.3       |
| 3     | EC 861786 | 139.0                  | 138.8             | 14.0              | 24.2                | 110.0             | 13.7                 | 8.1             | 7.8                | 2.7                | 2.8       |
| 4     | EC 861787 | 120.0                  | 128.5             | 8.0               | 24.0                | 159.0             | 15.5                 | 7.2             | 7.3                | 3.0                | 2.4       |
| 5     | EC 861790 | 137.0                  | 122.2             | 14.0              | 27.0                | 119.0             | 16.3                 | 9.7             | 8.3                | 3.0                | 2.7       |
| 6     | EC 861791 | 146.0                  | 122.8             | 13.0              | 26.0                | 87.0              | 11.3                 | 6.5             | 7.5                | 2.7                | 2.7       |
| 7     | EC 861792 | 126.0                  | 132.9             | 14.0              | 23.4                | 107.0             | 14.6                 | 7.1             | 8.7                | 2.8                | 3.0       |
| 8     | EC 861794 | 116.0                  | 133.3             | 11.0              | 28.2                | 145.0             | 17.6                 | 8.5             | 7.9                | 2.7                | 2.8       |
| 9     | EC 861795 | 119.0                  | 144.6             | 9.0               | 23.3                | 120.0             | 18.7                 | 9.7             | 9.0                | 3.0                | 3.0       |
| 10    | EC 861796 | 113.0                  | 144.2             | 10.0              | 27.5                | 121.0             | 22.0                 | 7.3             | 8.4                | 2.8                | 2.9       |
| 11    | EC 861797 | 123.0                  | 122.7             | 8.0               | 25.4                | 113.0             | 17.6                 | 9.0             | 7.4                | 2.9                | 2.5       |
| 12    | EC 861799 | 117.0                  | 132.7             | 15.0              | 27.1                | 94.0              | 19.2                 | 9.1             | 8.3                | 2.9                | 2.8       |
| 13    | EC 861801 | 121.0                  | 136.9             | 7.0               | 27.3                | 98.0              | 16.2                 | 9.1             | 8.2                | 3.1                | 2.6       |
| 14    | EC 861802 | 120.0                  | 133.8             | 10.0              | 27.7                | 108.0             | 19.3                 | 9.4             | 8.3                | 2.9                | 2.8       |
| 15    | EC 861803 | 114.0                  | 140.6             | 13.0              | 23.8                | 84.0              | 15.8                 | 8.3             | 8.2                | 2.7                | 3.0       |
| 16    | EC 861804 | 100.0                  | 138.8             | 16.0              | 23.0                | 87.0              | 22.8                 | 8.2             | 8.3                | 3.2                | 2.5       |
| 17    | EC 861805 | 140.0                  | 140.1             | 9.0               | 24.4                | 80.0              | 12.1                 | 6.5             | 8.3                | 3.2                | 2.5       |
| 18    | EC 861807 | 112.0                  | 144.6             | 15.0              | 24.3                | 113.0             | 18.2                 | 8.2             | 8.1                | 3.2                | 2.5       |
| 19    | EC 861808 | 114.0                  | 130.7             | 14.0              | 23.3                | 118.0             | 18.4                 | 7.9             | 8.5                | 3.0                | 2.8       |
| 20    | EC 861809 | 104.0                  | 136.5             | 12.0              | 29.3                | 101.0             | 18.1                 | 10.8            | 8.4                | 2.9                | 2.9       |
| 21    | EC 861810 | 116.0                  | 118.0             | 12.0              | 24.2                | 138.0             | 19.2                 | 8.9             | 8.7                | 3.0                | 2.9       |
| 22    | EC 861811 | 112.0                  | 139.3             | 8.0               | 24.7                | 110.0             | 19.0                 | 10.1            | 8.5                | 2.9                | 2.9       |
| 23    | EC 861812 | 111.0                  | 124.3             | 10.0              | 22.6                | 110.0             | 22.1                 | 7.1             | 8.0                | 3.0                | 2.6       |
| 24    | EC 861813 | 131.0                  | 128.2             | 15.0              | 22.8                | 110.0             | 16.1                 | 12.8            | 8.8                | 2.4                | 3.6       |
| 25    | EC 861814 | 109.0                  | 138.2             | 7.0               | 24.4                | 102.0             | 20.7                 | 7.9             | 8.5                | 2.8                | 2.9       |
| 26    | EC 861815 | 104.0                  | 150.8             | 14.0              | 23.9                | 115.0             | 15.8                 | 7.8             | 9.0                | 2.8                | 3.2       |
| 27    | EC 861816 | 86.0                   | 117.3             | 7.0               | 23.0                | 117.0             | 19.8                 | 7.8             | 8.5                | 2.8                | 3.0       |
| 28    | EC 861817 | 106.0                  | 147.5             | 11.0              | 25.7                | 104.0             | 19.3                 | 8.2             | 8.1                | 2.7                | 2.9       |
| 29    | EC 861818 | 109.0                  | 155.2             | 7.0               | 23.6                | 126.0             | 17.9                 | 8.3             | 8.2                | 2.8                | 2.8       |
| 30    | EC 861819 | 103.0                  | 147.2             | 8.0               | 22.5                | 94.0              | 20.0                 | 8.0             | 8.7                | 2.9                | 3.0       |
| 31    | EC 861820 | 118.0                  | 152.0             | 13.0              | 27.2                | 91.0              | 19.8                 | 6.8             | 9.2                | 2.9                | 3.1       |
**Fig. 1** Bar graph for morphological characterization of 31 accessions of *O. glaberrima*
Plate 3 Variation in ligule colour and shape

Purple Ligule

Colourless Ligule

Acute Ligule

Split Ligule
Plate 4 Variation in culm attitude

Erect

Semi Erect

Spreading
Plate 5 Variation in attitude of flag leaf

Erect  Semi Erect  Horizontal
Plate.6a Variation in panicle awn

Short awned  Long awned  Awnless

Plate.6b Variation in stem anthocyanin colouration

Anthocyanin pigmentation on stem  Absence of Anthocyanin on stem
The high estimates of heritability coupled with low genetic advance for no. of productive tillers per plant, grain yield per plant, and kernel length indicated the presence of non-additive gene effects. In the present study, three superior accessions, viz., EC861785, EC861804 and EC861813 were found to be potential enough to be used as parents in various breeding programmes. These accessions recorded highest values for panicle length, productive tillers and grain yield per plant and hence their utilization in combination breeding may help in generating high yielding varieties by pyramiding all the favourable genes and keeping in view of the facts, much attention needs to be given for the components with high GCV, PCV and high heritability coupled with high genetic advance during selection for the further improvement of the remaining accessions.

In conclusion, among the eight morphological traits studied in the 31 accessions of *O. glaberrima*, three characters viz., absence of coleoptile colour, absence of leaf anthocyanin colouration and presence of leaf ligule were reported in all the 31 accessions. Remaining five characters were unique and distinct among the accessions. Out of 31 accessions of *O. glaberrima*, two accessions viz., EC 861804, EC 861805 were found to be highly distinct as they possessed distinct traits namely purple split ligule, medium green leaves, erect flag leaf, presence of awn along with lodging tolerance. Adequate genetic variability in the 31 accessions of *O. glaberrima* was observed.

The magnitude of PCV and GCV was high for number of productive tillers per plant, while high heritability coupled with high genetic advance was observed for days to 50 per cent flowering and number of spikelets per panicle. The accessions EC861785, EC861804 and EC861813 can be used as parental material in future rice breeding programme as they have recorded highest values for the important yield traits viz., for panicle length, productive tillers and grain yield per plant. The present study revealed sufficient genetic variability for yield related traits which could be exploited for genetic improvement of rice cultivars (*Oryza sativa* L.).
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