

Morphological Diversity of Wild Rice (*O. nivara* S.D. Sharma and Shastry) Accessions in Sri Lanka

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Abstract

Rice (*Oryza sativa* L.) has been cultivated as a major crop for about thousands of years, and it currently sustains nearly one-half of the world population. Wild relatives of rice are an invaluable resource for rice upgrading by widening genetic diversity and incorporating useful traits to modern cultivars. In this context, phenotypic variations of *O. nivara* accessions exist in Sri Lanka were studied, based on thirteen quantitative morphological traits. The results revealed high phenotypic diversity among *O. nivara* accessions tested. Among the vegetative traits studied, a huge variability was observed for the plant height (138.70 ± 6.1 - 93.00 ± 3.0 cm) and seedling height (55.50 ± 3.8 - 27.10 ± 1.8 cm). Among the reproductive traits observed, panicle length (31.5 ± 0.3 - 12.2 ± 0.3 cm), panicle-bearing tillers/plant (25.3 ± 1.2 - 11.7 ± 2.5), number of spikelets/ panicle (123 ± 5.3 - 47 ± 3.6), filled grains/panicle (98.7 ± 3.1 - 24.3 ± 4.0) and shattered seeds/panicle (105.33 ± 7.6 - 44 ± 1.7) showed remarkable variability among accessions. This study highlights the phenotypic diversity of *O. nivara* accessions exist in Sri Lanka and the potential of using them in rice improvement program in future.

Keywords: Morphological divergence, Quantitative morphological traits, Wild relatives of rice

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Introduction

Rice is the staple food in Sri Lanka, and is cultivated in almost all parts of the island. Interest on development of high yielding cultivars with the green revolution has narrowed down the genetic diversity of cultivated rice. Hence, diversity of wild species of rice has been considered as a very important resource for rice improvement. Wild rice species have been identified as potential sources of genes, against many biotic and abiotic stresses.

Wild relatives are considered as the ancestors of the cultivated rice species, *O. sativa* (Asian rice) and *O. glaberrima* (African rice), which include 22 species. From these 22, five species are reported in Sri Lanka; *O. nivara*, *O. rufipogon*, *O. eichingeri*, *O. rhyzomatis* (endemic to Sri Lanka) and *O. granulata* which indicative of the wealth of unexploited biodiversity in Sri Lanka.

Oryza nivara is the most common and widely distributed wild rice species found in Sri Lanka (Hemachandra *et al.*, 2010). It possesses AA genome and the ploidy level is $2n=24$ (Bautista *et al.*, 2006) which is similar to the cultivated rice and therefore, having greatest potential to be used in rice variety improvement programs. Morphological traits of plants are generally influenced by genotype, environment and management (Richards, 2000). Therefore, assessment of morphological diversity of them under favorable environment and best management practices is important.

In the present study 13 vegetative and reproductive quantitative characteristics of *O. nivara* accessions were investigated in common garden to determine the extent and pattern of variation of 13 traits in six *O. nivara* accessions collected across the country.

Materials and Methods

Plant materials

Six *O. nivara* accessions collected from different locations in Sri Lanka and maintained by the Department of Agricultural Biology were used for the study (Table 1).

Study site and experimental design

The study was carried out in the Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka (latitude $6^{\circ} 08'$ N and longitude $80^{\circ} 56'$ E) during the Maha, 2014/2015 cropping season. Dormancy broken (50°C , 5 days) hull removed *O. nivara* seeds were allowed to germinate on wetted tissue papers at 35°C . Germinated seeds were planted in $16' \times 16' \times 18'$ cm diameter cement pots. The pots were arranged in a randomized complete block design (RCBD) with three replicates.

Estimation of morphological variation

Quantitative traits; seedling height, leaf length, leaf width, ligule length, culm length, plant height, panicle length, grain bearing tillers per plant, non bearing tillers per plant, number of spikelets per panicle, unfilled grains per panicle, filled grains per panicle, shattered seeds per

panicle, filled shattered seeds per panicle, 100 grain weight were recorded based on descriptors of rice developed by the International Rice Research Institute (IRRI), 1980. As time of planting being same for all the populations, measurements were done at different time periods parallel to their maturity.

A Considerable variation of characteristics was found among accessions for most of the traits measured. The mean and variability exhibited by the vegetative and reproductive quantitative traits through standard deviation (SD) are presented in Table 2&3 respectively. The tallest plants at seedling stage were observed in P-1

(55.50±3.8) from Anuradhapura district while shorted were found in P-5 (27.10±1.8) in Mannar district. At the maturity stage, the highest plants were recorded in P-4 (139.70±6.1) from Kilinochchi district while shortest were recorded in P-6 (81.30±1.5) from Baticaloa district. In general, morphological characterization based on quantitative traits showed the tested populations were mostly tall with vigorous growth habit and high seed shattering. Hence, results of the present study are comparable with the findings of Caldo *et al.* (1996).

Table 1: *O. nivara* accessions used for the study

| Accession No | District | Longitude(N) | Latitude(E) |
|--------------|--------------|---------------|----------------|
| P1 | Anuradhapura | 08°07' 44.95" | 80° 33' 46.87" |
| P2 | Polonnaruwa | 08° 02' 15.5" | 80° 45' 48.36" |
| P3 | Vavuniya | 08°51' 06.0" | 80°29' 06.04" |
| P4 | Kilinochchi | 09°25' 55.2" | 80°29' 56.5" |
| P5 | Mannar | 08°54' 36.4" | 79°57' 42.3" |
| P6 | Baticaloa | 07°30' 33.1" | 81°43' 55.1" |

Table 2: Means of different vegetative characteristics of *O. nivara* accessions

| Population | SH (±SD) (cm) | LL (±SD) (cm) | LW(±SD) (cm) | LGL(±SD) (cm) | PH(±SD) (cm) |
|------------|------------------|------------------|-----------------|------------------|-----------------|
| P-1 | 55.50±3.8 | 51.90±1.0 | 0.80±0 | 2.40±0.1 | 99.50±5.9 |
| P-2 | 48.00±1.0 | 57.00±1.0 | 0.90±0.1 | 3.30±0.2 | 93.00±3.0 |
| P-3 | 48.10±0.8 | 66.00±3.4 | 0.90±0 | 3.10±0.1 | 132.00±6.9 |
| P-4 | 50.00±1.0 | 65.40±1.3 | 1.00±0.1 | 2.40±0.2 | 139.70±6.1 |
| P-5 | 27.10±1.8 | 31.80±0.7 | 0.80±0.1 | 2.20±0.1 | 83.70±1.2 |
| P-6 | 31.10±0.8 | 59.10±1.0 | 0.90±0.1 | 3.30±0.1 | 81.30±1.5 |

Table 3: Means of different reproductive characteristics of *O. nivara* accessions

| Population | PL(±SD) (cm) | PBT(±SD) /PL | NBT(±SD) /PL | NOS(±SD) /PN | UG(±SD) /PN | FG(±SD) /PN | SS(±SD) /PN | 100GW (±SD)(g) |
|------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|-------------------|
| P-1 | 15.0±1.0 | 25.3±1.2 | 3.7±0.6 | 100±2.0 | 46.7±0.6 | 53.3±2.5 | 50±2.0 | 1.50±0.1 |
| P-2 | 17.6±0.4 | 17±1.7 | 2.3±1.5 | 87.3±4.6 | 37.7±2.5 | 49.7±2.5 | 86±5.3 | 1.47±0.04 |
| P-3 | 18.9±0.4 | 20.7±3.1 | 2.7±1.2 | 109.7±3.8 | 47.7±0.6 | 62±4.4 | 105.33±7.6 | 1.28±0.03 |
| P-4 | 31.5±0.3 | 11.7±2.5 | 0±0 | 123±5.3 | 24.3±5.6 | 98.7±3.1 | 47.33±2.1 | 2.1±0.09 |
| P-5 | 19.6±1.3 | 18.7±1.2 | 2.3±0.6 | 47±3.6 | 22.7±2.5 | 24.3±4.0 | 44±1.7 | 1.63±0.06 |
| P-6 | 12.2±0.3 | 16.3±1.5 | 2±1.0 | 51.3±5.1 | 20.7±1.2 | 30.7±4.0 | 51.33±5.1 | 1.60±0.08 |

PL = Panicle length, PBT/PL = Panicle bearing tillers per plant, NBT/PL = Non bearing tillers per plant, NOS/PN = Number of spikelets per panicle, UG/PN = Unfilled grains per panicle, FG/PN = Filled grains per panicle, SS/PN = Shattered seeds per panicle, 100GW = 100 grain weight

As reported by Maduakor and Lal (1989), morphological traits are vital as a tool for assessing the extent of genetic diversity of plant genetic resources. Therefore, the variability observed among populations is indicative of the divergence of populations studied. Among the vegetative traits studied, a huge variability was observed for the plant height, leaf length and seedling height.

Among the reproductive traits observed, panicle length, panicle-bearing tillers/plant, number of spikelets/ panicle, filled grains/panicle and shattered seeds/panicle showed remarkable variability among accessions. The highest length of panicles was observed in P-4 (31.5 ± 0.3) from Kilinochchi district while shortest panicles were found in P-6 (12.2 ± 0.3) from Bataloa district. The highest number of panicle bearing tillers was recorded in P-1 (25.3 ± 1.2) whereas lowest number of panicle bearing tillers was noted in P-4 (11.7 ± 2.5). The highest number of spikelets/panicle was detected in P-4 and lowest was seen in P-5. In P-4, the highest number of filled grains/panicle was observed while in P-5, the lowest was recorded. The highest number of shattered seeds was detected in P-3 accession from Vavuniya district. Among the reproductive traits observed high diversity was observed among accessions showing huge diversity in Sri Lankan *O.nivara* accessions.

Conclusion

Results clearly showed a broad phenotypic diversity among *O.nivara* accessions. High degree of variability was found in most of the vegetative and reproductive traits recorded. From 13 quantitative traits studied seedling height, leaf length, number of spikelets per panicle, number of filled seeds per panicle, panicle length, 100 grain weight and plant height were identified as the most important traits which accounted for the overall morphological variation observed in *O.nivara* collection. This study highlights the morphological diversity of *O. nivara* accessions collected from Sri Lanka and the potential use of this valuable source to improve cultivated rice in future.

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