Genetic variation within Malawi wild rice species

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Abstract

The genus Oryza, consists of two cultivated rice and twenty related other species in the grass family Poaceae. In Malawi, there are three wild rice species, Oryza barthii, O. longistaminata and O. Punctata. Worldwide, breeding programmes have made advances through the use of wild relatives of rice that are known to contain certain beneficial traits. Detailed work on characterization of the wild materials is necessary in order to be able to differentiate the available samples as well as to know their breeding systems and other essential characteristics. Thus, this characterization work was initiated in order to gain an insight into the growth characteristics of the available wild rice species. In this work, thirty-six (36) rice samples were characterized, including three wild rice species, O. barthii, O. longistaminata and O. punctata and two cultivated rice species. Among the wild rice species, the height of O. longistaminata and O. barthii ranged from 82 to 140 cm and 89.8 to 136.8 cm, respectively, whereas that of O. punctata ranged from 70.4 to 102.4 cm. Similarly, the ligule length of O. punctata was shorter, ranging from 3 mm to 5 mm, whilst that for O. barthii and O. longistaminata ranged from 16 to 38 mm and 20 to 40 mm, respectively. Panicle exertion was much shorter in O. sativa compared with the three wild rice species. O. punctata had weaker culm length type compared with the two wild species. All the wild rice species had a higher degree of panicle shattering when compared with the cultivated rice species, which did not exhibit any shattering at all. There was one rice species that was identified as a natural hybrid that falls between O. sativa and any of the other wild rice species. This species had more tillers, has sturdy stems and large grains.

Keywords: Poaceae, Oryza barthii, O. longistaminata, O. punctata, genetic variation

Introduction

The genus Oryza comprises two cultivated rice species, O. sativa, which is exotic to Africa, and O. glaberrum, which is indigenous to Africa, and other twenty related species in the grass family Poaceae (Vaughan, 1994). Rice is more like bamboo than the other Poaceae family species. The cultivated rice has the AA genome while the wild types have a varying range of genome types, as well as species complexes and/or forms. For example, the wild rice species found in Malawi, O. barthii and O. longistaminata, have the AA genome, whereas O. punctata can either be diploid or tetraploid, with genome types as BB or BBCC, respectively (Ng, et al., 1988).

The differences in genome type give rise to different phenotypic appearance as well as varying degrees of ease of crossing between the wild and cultivated species. Breeding programmes have made advances through the use of those wild relatives of rice that are known to contain certain beneficial traits. Further, through the use of modern techniques, success in making such crosses has greatly improved over the last twenty years. Some of the known essential traits in wild rice include excellent resistance to insect pests and diseases. For example O. barthii and O. punctata are known to be resistant to green leaf hoppers and zigzag leaf hoppers, respectively (Heinrich et al., 1985), whilst O. longistaminata is resistant to bacterial blight (Khush et al., 1990). Therefore, possible tapping of these traits can improve the performance of cultivated rice.

In 1997 and 1998, a collection exercise of Malawi's wild rice species was undertaken because it was noted that some of the habitats where these species exist are getting disturbed and the likelihood of losing some of the genotypes of these species was impending. Detailed work on the characterization of wild rice species is necessary in order to be able to differentiate the available types as well as knowing their breeding systems and other essential characteristics. Therefore, the characterization work was initiated in order to gain an insight into the growth characteristics of the available rice species.
Materials and Methods

The Malawi Plant Genetic Resources Centre (MPGRC) planted thirty-six (36) species of Oryza, comprising thirty-three (33) wild and three (3) cultivated rice species. The wild species included O. barthii, O. longistaminata and O. punctata. The samples were planted in an unreplicated trial at Lifuwu Agricultural Experiment Station in Salima, central Malawi. Different characters, including culm height and culm strength were recorded using the International Board of Plant Genetic Resources (IBPGR) descriptor booklet as outlined by Vaughan (1994).

Results and Discussion

The wild rice species had much taller culm height than the cultivated rice species. Among the wild three species, O. longistaminata and O. barthii had relatively taller heights of 82 to 140 cm and 89.8 to 136.8 cm, respectively, compared with O. punctata whose height ranged from 70.4 to 102.4 cm. Similarly, O. punctata had a short ligule length that ranged from 3 to 5 mm compared with that of O. barthii and O. longistaminata which ranged from 16 to 38 mm and 20 to 40 mm, respectively. Panicle excision was much shorter in O. sativa than in the wild species. Figs. 1-3 show the variation of the culm length, ear exertion and ligule length, respectively, whereas Fig. 4 exhibits ligule structure.

O. punctata had a weak culm strength type compared with the other two species O. sativa did not exhibit any shattering at all, whereas all the wild rice species showed a high degree of shattering. O. longistaminata and O. barthii had a very extensive tillering systems through rhizome formation, unlike O. punctata and O. sativa whose tillers were confined to the culm.

There was one rice species that was identified as a natural hybrid between O. sativa and either O. longistaminata or O. barthii. It had more tillers than O. sativa but less rhizomes, and had very sturdy (thick) stems and large grains. Testing of this rice species using molecular technique would probably yield more information relating to its heredity (lineage). Figs 5 and 6 show culm forms of O. longistaminata and O. barthii and a natural hybrid, respectively. Fig. 7 shows a rice species with plants of different node colours, indicating possible genotype difference within a species.

Summary

The characterization work on Malawi’s wild rice species has revealed the existence of some marked differences within the cultivated rice species. Morphological variations were observed among wild rice species. However, further evaluation, in terms of disease and pest reaction may be required in order to exploit the full potential of these rice species.

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Fig. 1. Culm length (cm) of wild rice and domesticated rice

Fig. 2. Panicle exertion (cm) of different rice species

Fig. 3. Ligule length (mm) of different rice species

Fig. 4: Ligule length (mm) of O. longistaminata

Fig. 5: Culm of O. longistaminata

Fig. 6: Culm of Natural hybrid of wild rice