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Preliminary Characterisation of Lowland and Upland Rice from Sarawak, Malaysian Borneo

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ABSTRACT

Oryza sativa L. or commonly known as rice belongs to the family of Poaceae. In Malaysia, rice is normally cultivated either as lowland or upland rice. Sarawak is a state with diverse types of rice. All Sarawak rice are landraces. Despite the fact that Sarawak is rich in rice biodiversity, the assessment of the morphological traits which may provide basic information that is useful for the future breeding programs is still unavailable. The nomenclature of the landraces is based on the name given by the farmers. Problems arise when landraces having the same morphological characteristics were given different names and vice versa. In addition, the purity of seeds is unreliable. Common practices by the local farmers such as planting different rice landraces in the same field either in one plot or in different plots but very near to each other has contributed to the impurity of the seeds. The present study was undertaken with the objective to characterise the morphological traits of 22 lowland and 22 upland rice accessions from the North-Western region of Sarawak. The morphological traits observed on the 44 rice accessions *viz*., blade colour, ligule shape, ligule colour, auricle colour, heading days, flowering days, panicle type, culm length, panicle number, number of filled grain, seed length and grain colour exhibited variations. There are variations which may be considered in future Sarawak rice breeding programs.

Keywords: Lowland rice, *Oryza sativa*, rice breeding, Sarawak, upland rice

INTRODUCTION

Rice being the staple food of Malaysian is the country's most important crop. Food and Agriculture Organization reported that rice production in Malaysia for the year 2019 was 2.8 million tonnes, 3.6% more than the average rice production from the year 2014 to 2018 (Food and Agriculture Organization of the United Nations, 2019). Although the production shows an increasing trend, with the growing number of residents in Malaysia annually, the production of rice in the country is still considered insufficient to meet domestic demands. Malaysia still relies on the neighbouring countries such as Vietnam, Thailand, and Pakistan for importing rice (Khazanah Research Institute, 2019).

Sarawak is the country's fifth largest rice producing state, after Kedah, Perak, Kelantan and Perlis with 134, 260 ha of land planted with lowland and upland rice (Masni & Wasli, 2019). Rice is economically, socially and culturally important in Sarawak. There are two types of rice planted in Sarawak; lowland rice, which is grown in field that is either rain-fed or irrigated; and upland rice, which is grown in an area naturally well-drained without surface water accumulation (International Rice Research Institute [IRRI], n.d.). The state is very rich in the diversity of rice (Yeo *et al*., 2018). For example, Sarawak rice has different resistance towards *Pyricularia oryzae* (Lai *et al*., 2019; Yeo *et al*., 2024) and may have different defence mechanisms against *Scirpophaga incertulas* (Cheok *et al*., 2019;

Hamsein *et al*., 2020; Ling *et al*., 2020), and different toxicity response to antifungal nanoparticles (Tang *et al*., 2023), which are potential genetic resources for rice breeding.

Department of Agriculture, Sarawak has declared a total of 2011 rice accessions are currently deposited in the gene bank of Agriculture Research Centre (including imported accessions) (Department of Agriculture Sarawak, 2020). Sarawak rice accessions should be considered as landraces. The nomenclature of the landraces is based on the name given by the farmers. There is problem with identification when landraces having the same morphological characteristics were given different names or vice versa. The purity of farmer's seed is also unreliable because of the common practice of planting different rice landraces in the same field either in one plot or in different plots but very near to each other (Yeo *et al*., 2018).

Despite the fact that Sarawak is rich in rice biodiversity, the morphological characteristics of each Sarawak rice landrace are unclear. Thus far, no report is available describing the morphological characteristics of the Sarawak rice landraces. The information on morphological trait is useful for rice breeders in selecting parents of specific traits for breeding programs. Therefore, the objective of this study was to characterise the morphological traits of Sarawak rice landraces collected from the northwest region of Sarawak.

In order to allow unique individuals from each rice landrace collection (heterogenous population) to be assessed, Simple Sequence Repeats (SSR) marker was used in this study for genotyping and plant selection. SSR are commonly used for fingerprinting and effectively used for assessing the genetic diversity among closely related rice cultivar (Bhattarai *et al*., 2021) due to its ability to reveal polymorphism even in closely related varieties (Spada *et al*., 2004). Four SSR markers (RM1, RM279, RM489 and RM335) has been tested on 220 accessions. Out from 220 accessions, 44 accessions showed polymorphism.

MATERIALS AND METHODS

Collection and Pre-Selection of Rice Landrace

A total of 22 rice landraces (11 lowland and 11 upland landraces) were collected from different localities across different divisions in northwest region of Sarawak (Supplementary Table 1). A total of 10 seeds per landrace were germinated in different batches (Supplementary Table 2) in distilled water. Germinated seeds, were transplanted into trays containing planting medium of topsoil, compost and sand (3:2:1 ratio). Each seedling was considered as different accession (Total = 220 accessions). The seedlings were then genotyped using Simple Sequence Repeat (SSR) markers.

Young leaf samples, about 4-5 cm, were collected from the 220 accessions. Deoxyribonucleic acid (DNA) was extracted using Cetyltrimethylammonium Bromide protocol by Doyle and Doyle (1987). A total of 12 SSR markers were randomly chosen from RiceGenes database (www.gramene.org) representing the 12 chromosomes of rice. The 12 SSR markers were tested on two randomly selected accessions from different rice landrace. Four SSR markers (Supplementary Table 3) which showed polymorphisms were chosen for genotyping the 220 accessions. Polymerase Chain Reaction (PCR) amplification was performed by following Zhu *et al.* (2012). After electrophoresis, the agarose gel was stained with ethidium bromide and visualized.

From the 10 seedlings of each landrace, individuals with polymorphic genotype based on the four SSR markers were chosen for morphological characterisation without