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MORPHOLOGICAL VARIATION IN OFFSPRING DERIVED FROM SINGLE PANICLE OF WEEDY RICE

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ABSTRACT

Weedy rice (*Oryza sativa* L *f spontanea*) is a troublesome weed in direct-seeded rice. It has close morphological and physiological similarities to cultivated rice and managing weedy rice is a challenging problem for farmers in Sri Lanka. The objective of this study was to determine the morphological variation of offspring derived from panicles of different weedy rice biotypes collected from "*Hathamuna Yaya*", an area heavily infested with weedy rice in the Matara District of Sri Lanka. Panicles of seven morphologically different weedy rice biotypes were collected, twelve seeds of each panicle were selected at random, germinated and grown in pots separately. Identification of each biotype was done using the characterization catalogue of the Rice Research and Development Institute, Batalagoda, Sri Lanka. Statistical analysis was performed using SPSS PC, Ver. 16.0. The seven dendrograms (one per panicle) showed a varying number of clusters (3 to 6 at 75 % phenon level). The significant morphological variation observed was a result of wide segregation in the off-springs derived from seeds of the same panicle. There is a higher possibility of cross-pollination in weedy rice, which explains the reason for higher level of other distinguishable varieties (ODV) in the seed samples collected from rice fields infested with weedy rice. Extra care is thus needed to ensure that the seed paddy producing fields are free from weedy rice.

KEYWORDS: Morphological variations, Panicles, Weedy rice, Sri Lanka

INTRODUCTION

The term weedy rice is generally used to describe plants of the genus *Oryza*, which share some characteristics of the rice crop but behave as weeds with easily shattering grains and variable seed dormancy. Weedy rice populations have been reported in many rice-growing areas in the world. (Parker and Dean, 1976; Ferrero and Finassi, 1995), and in many areas has become a significant problem after the shift from transplanting of rice to direct seeding. Weedy rice infestations are reported for 40-75% of the rice area in European countries, 40% in Brazil (De Souza, 1989), 55% in Senegal (Diallo, 1999), 80% in Cuba (Garcia de la Osa and Rivero, 1999) and 60% in Costa Rica (Fletes, 1999). Weedy rice is a troublesome weed of rice in Malaysia, Thailand and Vietnam (Azmi *et al.*, 2005).

In Sri Lanka, weedy rice was first observed in 1992 at Addalachchani of the Samanthurai area in the Ampara District of Sri Lanka. (Annual Report, 1995). Though it was not considered a major issue initially, the problem of weed rice in Sri Lanka has gradually increased with further records in Sri Lanka in 1997 in the same district (Marambe and Amarasinghe, 2000). Weedy rice was later identified in different rice growing districts of Sri Lanka namely, Puttlam in 2000, Matara in 2002, Polonnaruwa in 2004 and Kurunegala in 2005, and has spread in all rice growing areas in the country at alarming rate during the period between 2005-2009 (Abeysekara *et al.*, 2010).

The origins of weedy rice in Asia are unclear though it is suggested that these are natural hybrids of cultivated rice (*O. sativa*) and wild rice species (*O. rufipogon* and *O. nivara*) (Chen *et al.*, 2004). Phylogenetic origins of the weedy forms in Bangladesh were shown to be closely related to that of cultivated rice (Tensaout *et al.*, 2009), and many weedy plants share most of the features of the two cultivated species *O. sativa* and *O. glaberrima* (Khush, 1997). Morphologically, weedy rice is highly variable and often appears to be intermediate between wild and cultivated rice. Studies carried out in Sri Lanka have shown clear taxonomic differentiation of weedy rice from wild rice but a close relationship with cultivated rice (Marambe, 2009). Subasinghe *et al.* (2007), using morphological and molecular techniques reported that weedy rice accessions collected from Sri Lanka are positioned between the cultivated and annual wild type (*O. nivara*) thus, suggesting the potential of the occurrence of a cross between wild and cultivated rice. Information on out-crossing rates of rice varieties is important in seed paddy production programs, due to its influence on the percentage of Other Distinguishable Varieties (ODV) in seed samples.

To select suitable rice establishment methods such as transplanting, water seeding, parachute method and raw seeding with effective cultural management practices have been recommended to mitigate for control the weedy rice problem in Sri Lanka. In addition, weedy rice has a severe impact on seed paddy production due to its wide variation and wide segregation in the offspring. Therefore, farmers need to take extra care to make sure that the seed paddy producing fields are free from weedy rice.

The presence of weedy rice, which is morphologically similar to the cultivated rice, aggravates the already existing weed problems in direct-seeded rice fields in Sri Lanka. Amarasinghe and Marambe (1998) reported that under Sri Lankan conditions, the high weed pressure could cause a loss of 80 % of the rice yield. The resistance of weedy rice to selective herbicides now in use poses a

serious threat to the country's rice production system. Thus, urgent measures have to be taken to educate farmers on the potential danger of weedy rice and on possible mechanisms to reduce its impact. However, little is known on variation in morphological characteristics of weedy rice plants derived from single panicles of weedy rice under local conditions. A better understanding of this variation may help to understand the high degree of dissimilarities in weedy rice that has been observed in rice fields and would help in adopting better management practices especially in seed paddy production programs in farmer fields. Therefore, the objective of this study was to determine the morphological variation of offspring derived from individual panicles of different weedy rice biotypes found in Sri Lanka.

MATERIALS AND METHODS

This study was carried out in the "*Hathamuna Yaya*" at the Matara District in Sri Lanka, which is a highly infested area with weedy rice, and located in the Low Country Wet Zone of the country. Panicles (Plate 1) of seven morphologically different biotypes of weedy rice (labeled from A to G) were collected and twelve seeds tagged 1 to 12 (e.g. A1-A12; B1-B12; C1-C12; D1-D12; E1-E12; F1-F12; G1-G12), of each panicle were selected at random. Pre-germinated seeds were separately grown in pots at the Rice Research and Development Institute (RRDI), Batalagoda, Sri Lanka. The observations on seedling height, length and width of the leaf blade, leaf blade pubescence, leaf blade color, basal leaf sheath color, panicle length, panicle shattering, and awn color were recorded according to the characterization catalogue prepared by the RRDI. Cluster analysis was performed using the SPSS computer software package (ver. 16.0).

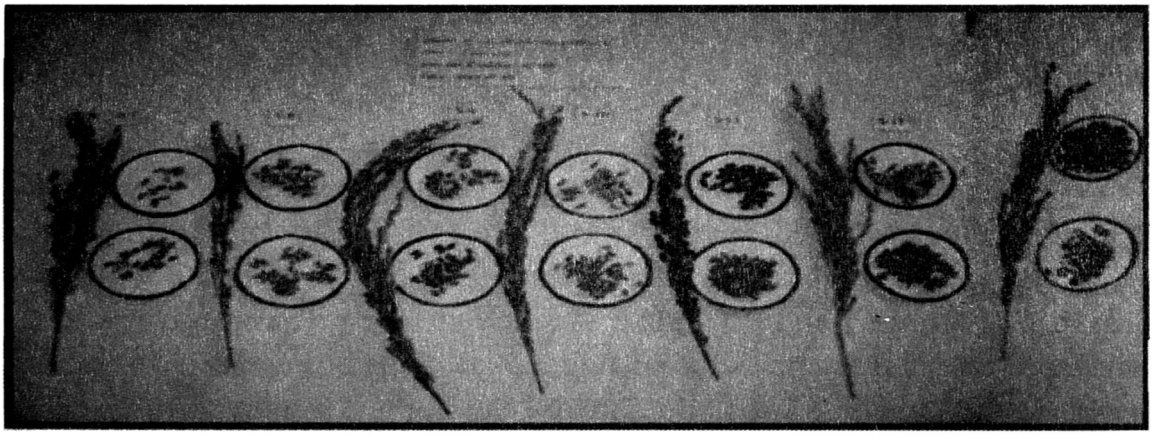

Plate 1. Weedy rice panicles collected from "Hathamuna Yaya"

RESULTS AND DISCUSSION

Figure 1 illustrates that there were three groups of the offspring from the seeds of panicle 1 namely, (a) A8, (b) A12 and A4 and (c) A11, A2, A9, A 10, A6, A7, A5, A1, A3 and A12, which are morphologically different at 75 % phenon level(Identified sub-groups at 75% of similarity) showing three different bio-types of weedy rice. However, at 80 % phenon level, there were only two groups of morphologically similar offspring. The offspring of the seed number A8 possessed the highest dissimilarity among the rest of the seeds. The dissimilarity at 75% phenon level can possibly be used as the comparison point of each other panicles collected from the same locality.

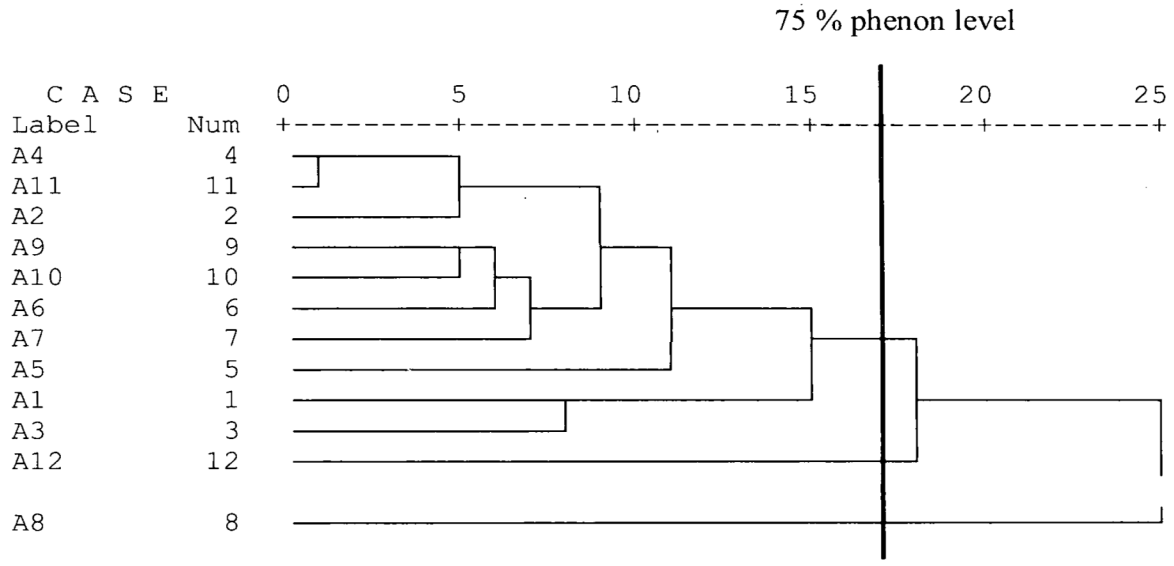

Figure 1. Dendrogram of panicle No. 1

The dendrogram derived from the data obtained from offspring of the panicle number 2 (Figure 2) indicated that there were four morphologically dissimilar groups at the 75 % phenon level. However, at 95 % phenon level, the number of groups reduced to two morphologically different groups. Similarly, panicle 3 resulted in four different groups of offspring (Figure 3), while panicles 4 (Figure 4), 5 (Figure 5) and 6 (Figure 6) showed four different groups at the 75 % phenon level. Seeds from panicle 7 produced six morphologically different types of offspring at 75 % phenon level and showed the highest number of morphologically variable offspring among the test samples.

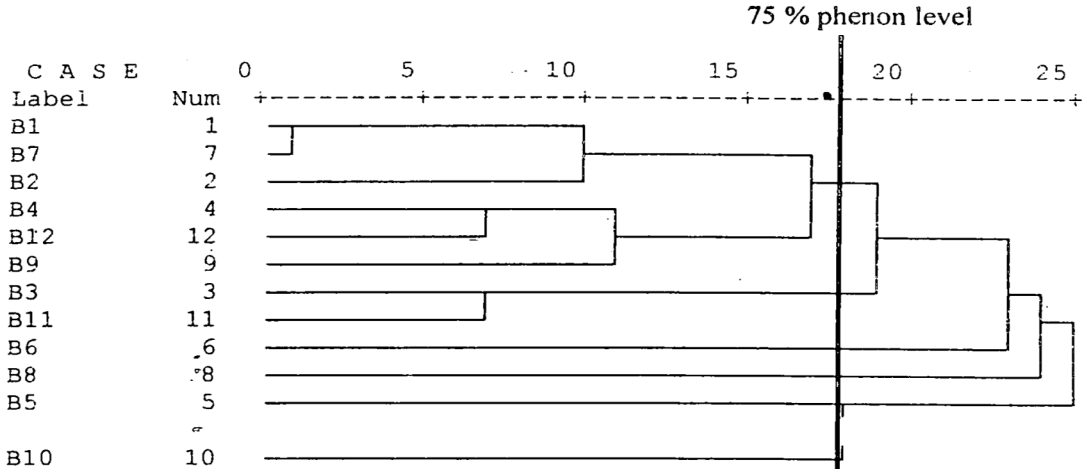

Figure 2. Dendrogram of panicle No. 2

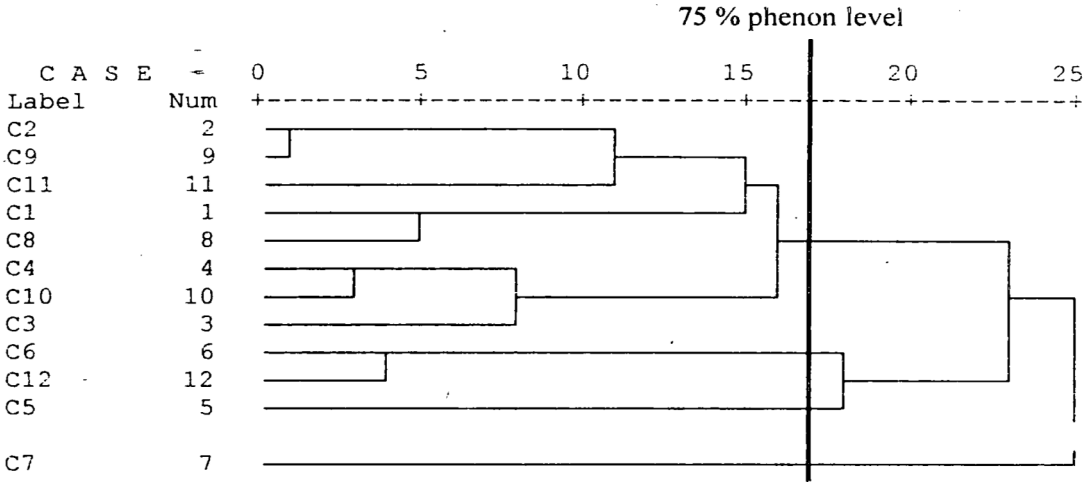

Figure 3. Dendrogram of panicle No. 3

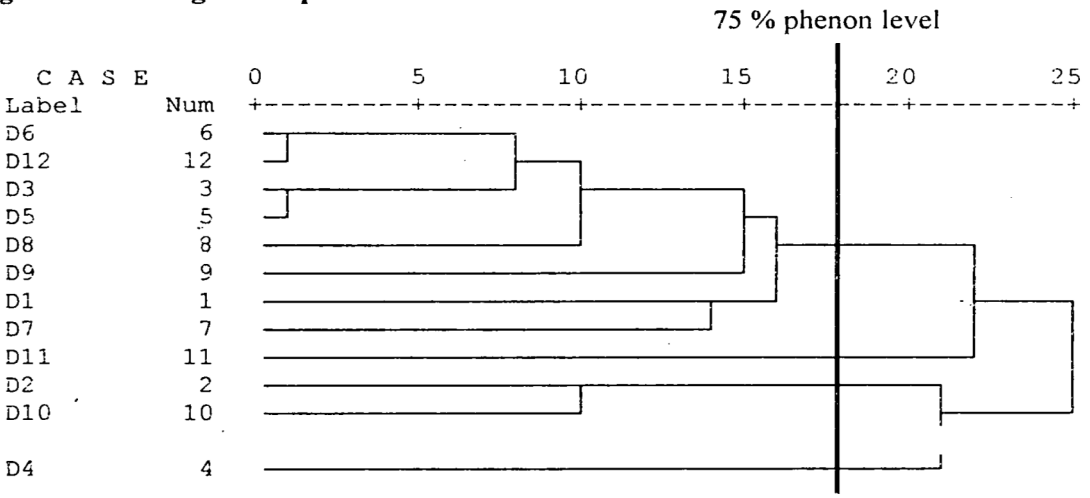

Figure 4. Dendrogram of panicle No. 4

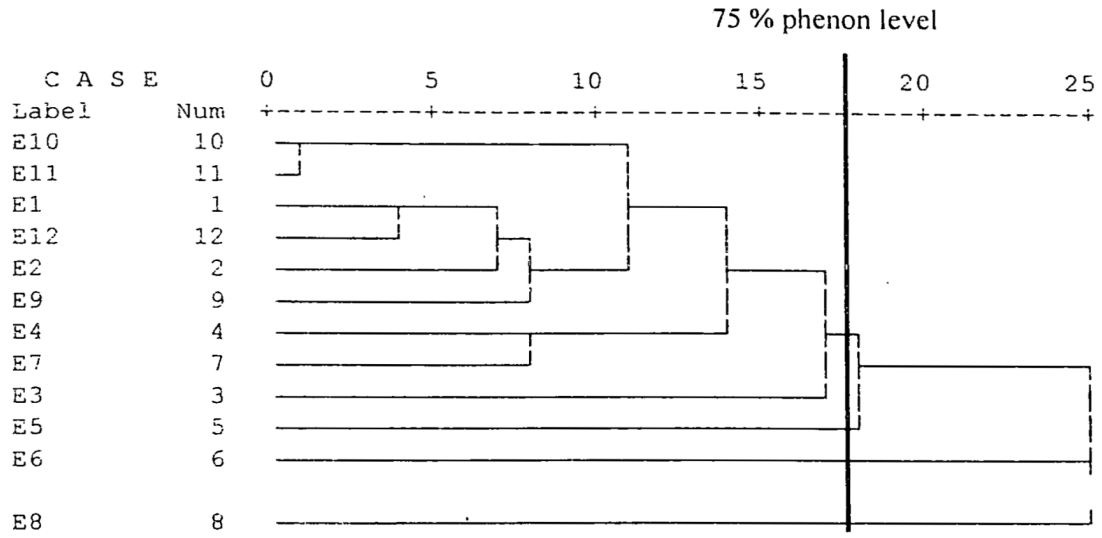

Figure 5. Dendrogram of panicle No. 5

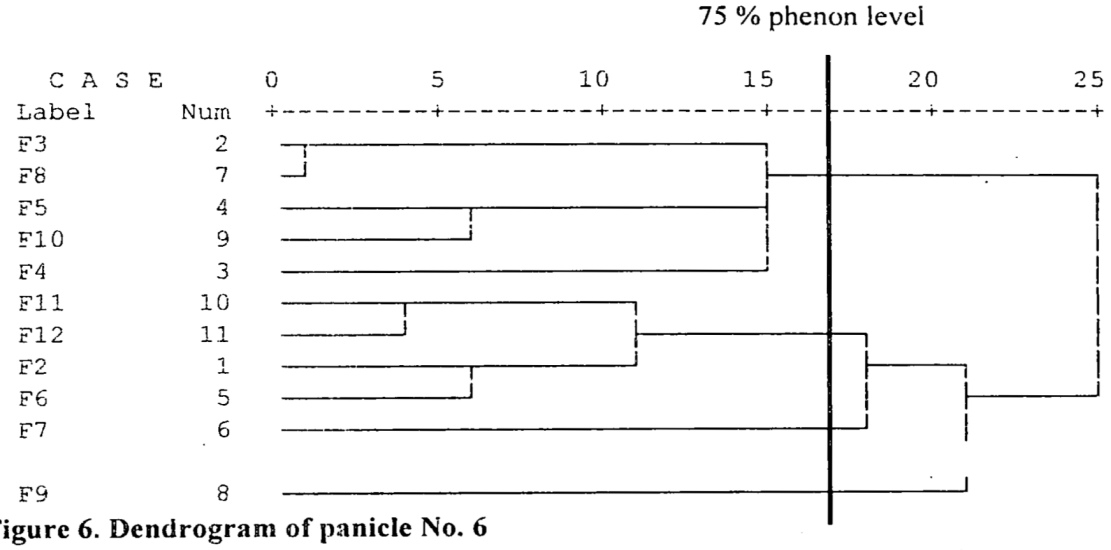

Figure 6. Dendrogram of panicle No. 6

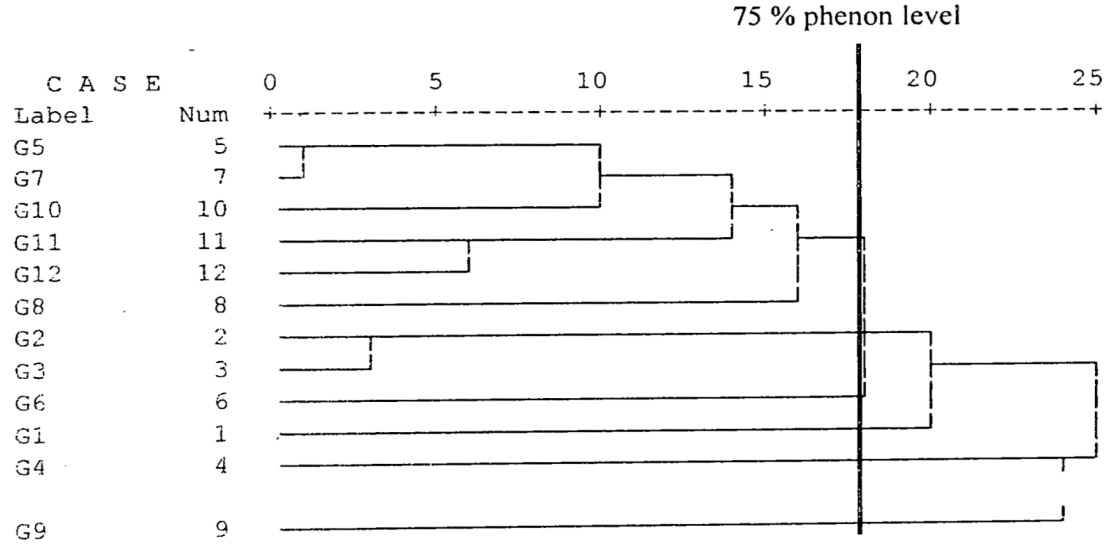

Figure 7. Dendrogram of panicle No. 7

The seven dendrograms (Figures 1-7) each representing one panicle, showed 3-6 clusters at 75 % phenon level indicating dissimilarity among the seeds in each panicle. This was reflected in the morphological characters of seedlings indicating a considerable within-panicle variation among the seeds. The results showed the presence of significant morphological variation and wide segregation in the offspring derived from the selected seeds of the same panicles. The high degree of variation found in rice fields infested with weedy rice could result in high levels of ODV due to cross-pollination of weedy rice with cultivated rice.

Weedy rice plants have shown a wide variability of anatomical, biological and physiological features (Craigmiles, 1978; Tang *et al.*, 1997, Vaughan *et al.*, 2001). A study carried out in Sri Lanka showed that the florets of weedy rice and cultivated rice open between 08:00 and 10:30 hrs during the day but, those of weedy rice remain open for a longer period and provide a greater possibility for cross-pollination with cultivated rice (Priyantha and Wickramaratne, 2009). The longer duration of anthesis in combination with acropetal nature of weedy rice flowers would provide higher possibilities of cross pollination, which may have resulted in higher degree of morphological variation of the plants generating from seeds within a panicle. Such a wide variation in the morphology of weedy rice could lead to high adaptive capacity to a particular crop environment, where certain traits such as height, growth habit, etc., may give certain weedy rice plants an advantage over the cultivated rice. This adaptability of weedy rice to different environments would likely to result in a shift in the weedy rice population favoring a particular morphology or biotype.

CONCLUSIONS

The wide variation observed among the weedy rice populations confirms the significance of the weed in rice fields. The presence of weedy rice may be the main reason for mixed paddy (due to ODV), which is common in rice fields of Sri Lanka. Higher possibility of cross-pollination in weedy rice may have resulted in a wider segregation in the offspring derived from seeds of the same panicle, rendering the control of this weed more difficult.

Further studies are being conducted with the offspring derived from the present research for few consecutive generations. These studies are showing a more segregation in the consecutive generations in terms of morphological characters, which would help to estimate the nature of genetic diversity among weedy rice populations. Such information is vital to educate the farmers to avoid further spreading of weedy rice in farmer fields.

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