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Short communication

Oviposition Behavior of *Scirpophaga incertulas*, the Yellow Stemborer (Lepidoptera: Crambidae) in A Non-Choice Study

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ABSTRACT

Scirpophaga incertulas, or the yellow stemborer, is a dominant paddy pest in Asia and contributes to great yield loss in paddy cultivation. Breeding paddy varieties that are resistant to yellow stemborer is an eco-friendly alternative for managing this pest rather than using hazardous chemical insecticides. In this non-choice study, the oviposition behaviour of female yellow stemborers on three different local Sarawak paddy landraces was observed. The number and size of egg masses found on the three local paddy landraces, namely Bajong, Bubok, and Bario, were similar. In general, the yellow stemborers of this study preferred to oviposit on the leaves instead of stems. On leaves, the number of egg masses oviposited on the abaxial side and adaxial side of leaves was comparable. Based on this preliminary data, the three local paddy landraces may not be good candidates in a paddy breeding program that resists towards yellow stemborers.

Keywords: Antixenosis resistance, egg mass position, paddy plant, yellow stemborer

INTRODUCTION

Rice stemborers are a group of dominant paddy pests. In Sarawak, a statewide rice pests survey carried out from 2009 to 2011 in 166 rice fields showed that 11.4 % of rice damage in the fields was caused by rice stemborers (Gumbek & Hamsein, 2011). The damages are caused by the larvae of rice stemborers that bore into paddy tillers and feed on the inner cells. Eventually, the infestation will cause whitehead and

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deadhearts, *i.e.*, grain reduction per plant/hill. One of the rice stemborer species causing yield reduction is the yellow stemborer (*Scirpophaga incertulas* Walker).

Paddy landraces that resist to yellow stemborers are valuable genetic resources. They can be good candidates for a resistance breeding program. Generally, a plant variety is said to be resistant toward certain insect pests when they have heritable traits that contribute to the avoidance of pests from the plant (antixenosis), a reduction in the survival rate of the pest (antibiosis) or tolerance to the infestation of the pest (Smith & Clement, 2012). Sarawak is blessed with diverse paddy landraces that not only vary in the colours of their husks and grains and their aroma, but they are also known to be more resistance to various biotic and abiotic stresses (Yeo et al., 2018). These are precious genetic resources for rice breeding in Sarawak. Their resistance towards yellow stemborer is understudied, not to mention the oviposition behaviour of yellow stemborer on these paddy landraces. In order to study the resistance of Sarawak paddy landraces against yellow stemborer, the oviposition behaviour of yellow stemborer on three Sarawak paddy landraces was investigated in a non-choice test.

METHODS

Three local paddy landraces were selected for this study, *viz.* Bajong (Husk: dark brown; Kernel: black), Bario (Husk: yellow; Kernel: white), and Bubok (Husk: yellow; Kernel: white). These paddy landraces are among the famous landraces planted in Sarawak. They are socially and economically important to the local farmers. Local farmers plant these paddy landraces as their main food source (Teo, 2010). Among the three paddy landraces, Bario rice has high export potential with high nutritive values (Nicholas et al., 2014).

The paddy seeds were provided by the Agriculture Research Centre, Semongok, Sarawak. They were soaked in water to promote germination. Approximately 50 germinated seeds were transferred into trays (30 cm x 20 cm) containing planting medium (2 topsoil: 1 sand). One-month-old seedlings (three-leaf stage) were transplanted into pots (3 gallons) with five seedlings per pot. Nitrogen-phosphorus-potassium compound growth-promoting fertilizer was applied to each of the paddy plant pots once in every two weeks following the manufacturer's instruction. Two-month-old paddy plants were later used for the experiment. Three paddy landraces, each with 25 replicates, were planted, totaling to 75 pots.

The paddy field in Kampung Skuduk-Chupak (1°15'07.5"N, 110°26'17.2"E) was chosen as the stemborer sampling site. The 75 pots of paddy plants were brought to the field in a random order. Each pot was covered with a high-density polyethylene (HDPE) plastic mesh (diameter = 3 mm). A white screen light trap was set up next to the paddy field from 7 pm to 10 pm. Adult females of yellow stemborer were picked from the white screen. Ten were released into each pot of paddy plants through a small opening on the HDPE plastic mesh. Infested pots were brought back from the paddy field and arranged randomly in the designated open field area for plant experimental studies on campus. Yellow stemborer sampling was completed within one month in order to infest all 75 pots of paddy plants with yellow stemborers.

The number of egg masses laid (oviposition) for each pot was counted at the fifth day of the experiment. A one-way ANOVA test (α=0.05) was conducted by using SPSS software to test the difference between the number of egg masses deposited on the plants of three paddy landraces. The positions of the egg masses were recorded and categorized into egg masses laid on either plant surfaces or on non-plant surfaces. Eggs laid on plant surfaces were further divided into stems and leaves (abaxial or adaxial). The egg masses found on the walls of the pot or the plastic mesh were counted as egg mass laid on non-plant surface. The significant difference between the mean of egg masses deposited on plant surface versus non-plant surface, leaves versus stems, and abaxial versus adaxial side on the leaves, were determined by using a two-sample t-test (α=0.05) in SPSS software, regardless of the paddy landraces. In the analysis, only 73 pots were considered while two pots from the Bubok landrace were unsuccessful in infestation.

RESULTS AND DISCUSSION

A total of 810 egg masses were counted on plant surfaces and another 77 egg masses were found on the non-plant surfaces. Most of the egg masses were similar in size, with a diameter between 3 mm and 6 mm. All the egg masses found on the plant were intact, and the abnormalities described by Hilker and Meiners (2006) were not observed on the egg masses (mortality) as well as on the contact sites of the egg masses and leaf surface (necrosis and neoplasm). This may indicate that there was no egg-induced response or antibiosis resistance among the three paddy landraces. Further investigation can be done to study the hatching rate of the egg masses, survival rate and growth of larvae to understand more about the antibiosis resistance of these local paddy landraces.

There was no significant difference in the total number of egg masses laid on the three paddy landraces (One-way ANOVA; $F_{2,70} = 0.648$; p-value = 0.526) (Table 1). *i.e.,* there were no paddy landraces preferred by the yellow stemborer for ovipositioning. Antixenosis resistance of paddy is expected to influence the oviposition behaviour of the yellow stemborer – selection of landrace for oviposition. In this study, however, antixenosis resistance is possibly not present in all three landraces. Alternatively, a weak level of antixenosis resistance may be present in all three landraces. Unfortunately, under the non-choice test, the resistance is insufficient to deter the female yellow stemborer from oviposition on the paddy plants. A choice test with a larger sample size may further confirm the antixenosis property of these three landraces.

Based on the result, female yellow stemborers clearly preferred to oviposit (based on the average number of egg masses laid) on plant surface (10.14 ± 5.81) instead

Table 1
Mean of egg masses laid by a total of ten females yellow stemborers in each pot planted with paddy plants

Oviposition		Average number of egg masses produced/pot ±SE		
	Landrace	Bajong (n=25)	Bubok (n=23)	Bario (n=25)
Non-plant parts		1.16±0.29	0.91±0.24	1.08±0.35
Plant parts		8.88±1.04	11.00±1.19	10.60±1.28
Stem		1.92±0.41	1.74±0.36	2.32±0.48
Leave	Abaxial	3.92±0.59	5.39±0.96	3.68±0.59
	Adaxial	3.04±0.52	3.87±0.50	4.60±0.56
	Total	6.96±0.92	9.26±1.20	8.28±0.98
Total*		10.04±1.16[a]	11.91±1.31[a]	11.68±1.35[a]

All values were computed by using SPSS software. *Means ±SE within columns followed by the same letter in superscript are not significantly different (One-way ANOVA; P > 0.05)

of on non-plant surfaces (1.06 ± 1.44), regardless of the paddy landraces [two sample t-test; t=12.97; p-value = 0.000]. On plant surfaces, female yellow stemborers were more likely to lay their eggs on the leaves (8.14 ± 5) than stems (2.00 ± 2.06) [two sample t-test; t=9.537; p-value = 0.000]. This is consistent with a study done in Hong Kong, where 94% of the yellow stemborer egg masses were laid on paddy leaves (Thornton et al., 1975). Previous studies also showed that female yellow stemborers preferred to lay their egg masses on leaf blade tip (Karim & Riazuddin, 1999; Pathak & Khan, 1994). The small numbers of egg masses that were oviposited on stem and non-plant surfaces observed in this study may cause by the high saturation of egg masses on the leaf. Previous studies on Lepidopteran indicated that oviposition of females was affected by the presence of egg masses on leaf surfaces. In field observation of Lepidopterans (Nufio & Papaj, 2001; Sielezniew & Stankiewicz-Fiedurek, 2013), adult females tend to avoid ovipositing on a leaf which has egg mass oviposited by females of the same species. Such behaviour is yet to be reported specifically for yellow stemborers, but it is possible that yellow stemborer, a Lepidopteran, may behave similary which resulting in ovipositing on stem and non-plant surface as observed in this study.

In this study, the average numbers of egg masses counted on adaxial was 3.84 ± 2.66 while on abaxial was 4.30 ± 3.59. Between the adaxial and abaxial of a leaf, this study shows an equal likelihood of the female yellow stemborers to oviposit on either side [no significant difference based on two sample t-test; t=-0.892; p-value=0.374]. The result in this study is inconsistent with both Shahjahan (2002) and Thornton et al. (1975), in which the former study showed that the yellow stemborer preferred to oviposit on abaxial surface while the later claimed that the adaxial side of a leaf was a better choice for oviposition by female yellow stemborers. The finding by Shahjahan (2002) is comparable to Renwick and Chew (1994) that explained the abaxial side of a leaf provided protection for the egg masses against predation and parasitism. Moreover, the uneven surface on the abaxial side may provide a suitable footing stage for moths (Renwick & Chew, 1994; Rojas et al., 2018; Teles Pontes et al., 2010). However, no oviposition preference on either the abaxial or adaxial side by female stemborers was observed using a small sample size tested in this study.

CONCLUSION

To summarize, under the non-choice study, there was no significant difference in ovipositional preference of yellow stemborers on the three Sarawak paddy landraces (*i.e.* Bajong, Bario and Bubok). This study provides a preliminary insight to the antixenosis resistance of the three paddy landraces towards the yellow stemborer. The three Sarawak paddy landraces may not be good candidates for breeding a yellow stemborer resistant paddy variety. This study also reveals that the female yellow stemborers preferred to oviposit on the leaves of the paddy instead of the stems. Their ovipositioning preference, however, was not clear between the abaxial or adaxial surface of the leaves.

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