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RESEARCH ARTICLE

Evaluation of Rice Genotypes Resistance to Yellow Stem Borer, *Scirpophaga incertulas* (Walker) through Sex Pheromone Trap

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Highlights

- Seven rice varieties were selected to monitor the preference of yellow stem borer.
- Research design selected was Randomized Complete Block Design (RCBD) with three replications in three different locations.
- Sex pheromone trap was installed in each experimental plot to capture the male moths attracted towards the volatile artificial pheromones of the trap.
- From the trap catches of adult male moths of yellow stem borer of rice, it is evident that US 312 i.e. hybrid variety of rice attracted higher number insects whereas, Sarju 52 attaracted less number of insects.

Abstract

Yellow stem borer, Scirpophaga incertulas (Walker) is monophagous insect pest causing serious damage to rice growers of plain regions of Nepal. This study was done to evaluate the host preference of yellow stem borer to the various genotypes of rice. The research design employed was Randomized Complete Block Design (RCBD) with seven treatments and three replications and done in kharif season of 2021. Rice varieties selected were Sabitri, Sarju 52, US 312, Radha 4, Sawa Mansuli, Silki and Hardinath 3, which are popularly cultivated in Kailali. Sex pheromone trap (scirpolure) was installed to monitor the preference of yellow stem borer for various rice varieties, especially at the panicle initiation stage of rice. Statistical analysis of four weeks data of adult male moths trapped on different cultivars of rice revealed that the yellow stem borer adult moths were highly attracted to the US 312 and less attracted to Sarju 52 and Silki varieties. This research implied that the adoption of popular rice variety Sarju 52 could safeguard the farmers from the notorious pest i.e. yellow stem borer of rice.

Key words: *yellow stem borer, variety, US 312, Sarju 52, scirpolure*

Introduction

Rice is grown on 1.47 million hectares in Nepal with the average productivity of 3.81 Mt/ha [1]. It is reported that more than hundred species of insects feed on rice but rice borer complex are responsible for crop losses up to 60% [2]. Yellow stem borer, *Scirpophaga incertulas* (Walker) is one of the major insect pests of rice, causing 11% damage in vegetative stage and 13.8% in reproductive stage [3]. This pest is monophagous in nature and feeds specifically on rice [4]. Stem borer larvae bore at the base of the plants during vegetative stage. Larval feeding of yellow stem borer from base of stem (internal) of central tiller results in drying of the central whorl, mainly due to blockage in nutrient translocation from root to leaf sheath. The insect feeding eventually makes the tiller non-productive, known as dead heart (DH). Similar nature of damage is seen at heading or reproductive stage in which the panicle becomes chaffy (with empty grains) and this is known as white ear head (WE) [5]. It is

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reported that stem borer infestation at vegetative stage is not much damaging as the rice plants could compensate the damage up to 30%. But, the damage at reproductive stage of rice is more economically costlier to the farmers since it yields white head and could not be compensated by any means [6].

Insecticide is one of the widely used methods to manage yellow stem borer of rice, which requires multiple number of sprays in the rice field. Pesticides are costlier to the farmers, their health and could also be peril to the ecosystem and other living communities [7, 8]. Furthermore, success of insecticide application depends on the ability to detect the insect pests' incidence and their intensity. For the insect pest monitoring, insect sex pheromones could be used and also to minimize pesticide load in rice ecosystem.

Sex pheromone is mating disruptions strategy which is done by releasing synthetic pheromone volatiles throughout the field. This results in the saturation of pheromone throughout the field, which ultimately attracts the male moths for trapping and ultimately prevents the females to get male ones for mating [9]. Sex pheromone trap is also used to assess the preference of the insects to the particular crop or variety and hence also the resistance to the particular insect pests. Rice varieties with resistance to yellow stem borer of rice obviously require minimum applications of insecticide compared to susceptible varieties [10]. This experiment has been setup with keeping the assumption that preferred rice varieties to yellow stem borer adult moths could be screened in terms of abundance and movement of these insects to the particular rice variety based on the trap catches of male moths. Preference or non-preference of insects to the particular host is associated with the Host Plant Resistance (HPR) [11] and the trap catches of male moths based on the preference or non-preference is used to categorize the resistance traits of different rice cultivars.

Categorization of rice genotypes based on the host plant preference or resistance mechanism is crucial to minimize the rice yield losses due to the notorious pest i.e. yellow stem borer of rice. Conventional measures in addition with the use of insecticides to reduce the damage or to manage this insect pest are not effective, economical and environmental friendly. Therefore, it is imperative to compare different rice cultivars in terms of preference or non-preference of yellow stem borer.

Materials and Methods

The experiment was laid out in Randomized Complete Block Design (RCBD), having seven treatments and three replications. Seven different cultivars of rice were selected based on the rice grower's preference in the region (Table 1). One hybrid variety of rice i.e. US 312 was selected as the standard check and popular improved varieties were selected in addition with the Indian registered variety i.e. Silki. Block was selected in three locations i.e. Tikapur Municipality-1 (Faculty of Agriculture, Far Western University), Tikapur Municipality- 9 and Janaki Rural Municipality-3. Farmer's fields were selected for Tikapur Municipality-9 and Janakai Rural Municipality-3. Planting of rice was done on July 2-4 of 2021. Fertilizer dose was followed as compost at the rate of 10 mt/ha and 100:40:40 Kg (NPK)/ha and applied as recommended. Spacing of rice planting was maintained as 20X15 cm and plot spacing for each cultivar was maintained of minimum 50 m.

Table 1. Treatment details of the experiment, Tikapur, Kailali, 2021

Treatment	Rice variety	Cultivar type
T1	Sabitri	Improved
T2	Sarju 52	Improved
T3	US 312	Hybrid
T4	Radha 4	Improved
T5	Sawa Mansuli	Improved
T6	Silki	Improved
T7	Hardinath 3	Improved

Fig 1. Installation of scripolure at rice research field, Faculty of Agriculture, FWU, Tikapur

Dispenser for pheromone was rubber septa containing (Z)-11 hexadecinal and (Z)-9 hexadecinal, manufactured from Green Revolution, India and purchased in nearby pesticide retailer shop (Fig. 1). Pheromone traps were tied to the bamboo sticks of 1.5 m length. Then, installation of trap was done on 1 September, 2021. Such sticks were fixed and placed in the middle of transplanted field. One trap was installed for one plot of the rice field and altogether 21 traps were installed in the entire research field of three locations. Trap height was adjusted just above the crop canopy so that the flying moths could come easily to the trap (Fig. 1). Weekly captured moths were brought (from 1 September to 1 October) to the Plant Protection Laboratory of Faculty of Agriculture, Far Western University by collecting insects in plastic bag from the pheromone trap. Collected insects were later counted and number of insects' data was entered in Microsoft Excel sheet. Data collected was statistically analyzed using one-way analysis of variance (ANOVA) with R software (version 3.0.3) and means were separated using least significant difference test (LSD) at $P \leq 0.05$.

Weather data of experimental site (Tikapur, Kailali) i.e. temperature (^{0}C), relative humidity (%) and precipitation (mm) were recorded from September 1 to October 1 of 2021. These data were utilized to study the effect of environmental parameters on mean number of male moths' capture of yellow stem borer of rice.

Results and Discussion

For the first week, US 312 variety of rice attracted higher number of adult male moths compared to Sawa Mansuli, Sabitri, Hardinath 3, Radha 4, Sarju 52 and Silki (Table 2). Sarju 52 and Silki varieties showed resistance to adult male moths compared to US 312, Sawa Mansuli and Sabitri. For the second week, statistical analysis revealed that US 312 and Hardinath 3 attracted higher number of insects compared to Sabitri, Silki, Sarju 52 and Radha 4. For the third week, US 312 attracted higher number of insects than remaining other varieties. Moreover, Sabitri, Silki, Sarju 52 and Radha 4 varieties attracted least number of insects than US-312, Sawa Mansuli and Hardinath 3. For the fourth week, US 312 attracted higher number of insects than rest of other varieties. For the same data, in terms of resistance to yellow stem borer, Sarju 52, Silki, Radha 4 and Sabitri were statistically at par and showed higher resistance compared to US 312, Sawa Mansuli and Hardinath 3.

From all the data, results could be summarized that yellow stem borer adult male moths were highly attracted to US 312 variety of rice, which is hybrid variety. Our result is supported by the fact that high input demand (fertilizer) of hybrid variety makes the tissue soft and enables the larvae to bore into the stem [12]. Fine varieties of rice are highly susceptible to the yellow stem borer compared to the coarse varieties [13].

Furthermore, statistical analysis revealed that US 312 variety of rice was followed by Sawa Mansuli. Sawa Mansuli was again followed by Hardinath 3 rice variety in terms of attracting higher number of male moths of yellow stem borer. These both varieties were again followed by Sabitri and Radha 4. Most importantly, except for the first week, Sarju 52 and Silki varieties of rice were resistant to yellow stem borer attack compared to US 312, Hardinath 3 and Sawa Mansuli. But for the first week, Sarju 52 and Silki varieties of rice were superior in yellow stem borer resistance against US 312, Sawa Mansuli and Sabitri variety. In terms of resistance to male moths of yellow stem borer, Sarju 52 and Silki varieties of rice were statistically at par with Radha 4 variety of rice whereas, except for the first week, similar was the case for Sabitri variety. This research showed that the adoption of popular rice variety Sarju 52 variety could safeguard the rice farmers of plain regions from the notorious pest i.e. yellow stem borer of rice. Although Silki variety of rice is also statistically at par with the Sarju 52 in resistance to yellow stem borer and also popularly cultivated by the farmers of Kailali, this is not recommended by the Government of Nepal yet. This variety of rice could not be recommended to grow due to unprecedented consequences of this variety in Nepali bio-climate.

Our results further showed that with the proceeding of the stages of rice, yellow rice stem borer infestation rate is in decreasing trend for all the varieties of rice (Fig. 2). Additionally, Sarju 52 and Silki varieties of rice showed least differences in the yellow rice stem borer infestation over the weeks. Other varieties of rice i.e. US 312, Sawa Mansuli, Sabitri and Radha 4 showed abrupt decline in yellow stem borer capture to second week. It is also interesting to mention that yellow stem borer adult male moth catches were higher for third week compared to second week for US 312 variety of rice. For the fourth week, all the rice varieties showed the least catches of insect population. These Results collected from our experiment suggest that with the maturity of the rice i.e. from panicle initiation stage, the chances of yellow stem borer infestation lowers down. But the trend of increase of yellow stem borer infestation over the second week to third week for US 312 variety of rice, suggest that the chances of this insect's infestation is equally high with onset of reproductive growth stages for this particular variety. This could also apply true to other high yielding hybrid varieties which encompass similar genetic makeup.

Environmental parameters of the research site demonstrated that temperature, relative humidity and precipitation were optimum for the yellow stem borer adult moths and their other life stages (Fig. 3) . Predictive modeling of optimum climatic conditions for yellow stem borer of rice is reported 23.2-24.2^{0}C as minimum temperature and 32.9-35.0^{0}C as maximum temperature. For relative humidity, minimum and maximum condition is reported as 44.5-64.9% and 78.1-93.7% [14]. Growth stages of rice and ambient environmental parameters, especially the temperature allow the yellow stem borer to infest the rice [15]. Precipitation was recorded highest (at around 10 mm) for the third week and also the relative humidity (Fig. 3). It is interesting to mention that captured male moths were higher for third week compared to second week for US 312 variety of rice. This could be justified by the research statement that higher humidity and precipitation around 5-50 mm per week is the most ideal condition for reproduction and other vital activities of yellow stem borer [14]. For the fourth week, number of male moths captured declined significantly for all the rice varieties and this might be due to depleting pheromone odour, environmental factors and matured growth stage of rice.

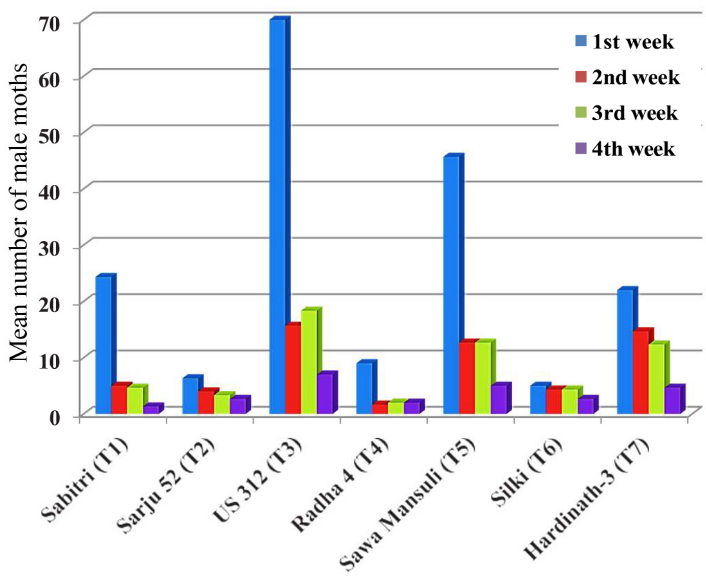

Fig 2. Mean number of male moths captured in scirpolure over the week of data collection, 2021

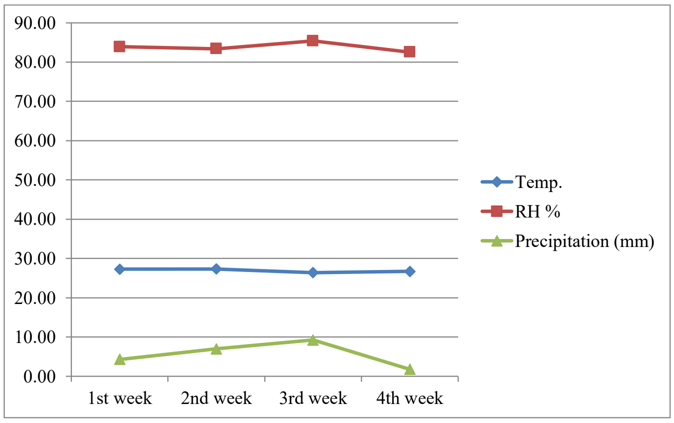

Fig 3. Average temperature (^{0}C), relative humidity (%) and precipitation (mm), September 1, 2021- October 1, 2021, Tikapur, Kailali (Source: POWER | Data Access Viewer (nasa.gov))

Table 2. No. of yellow stem borer adult male moths catch at scirpolure, Tikapur, Kailali, 2021

Rice varieties	1st week	2nd week	3rd week	4th week
Sabitri (T1)	24.33^{c}	5.00^{bc}	4.66^{c}	1.33^{c}
Sarju 52 (T2)	6.33^{d}	4.00^{c}	3.33^{c}	2.66^{c}
US 312 (T3)	70.00^{a}	15.66^{a}	18.33^{a}	7.00^{a}
Radha 4 (T4)	9.00^{cd}	1.66^{c}	2.00^{c}	2.00^{c}
Sawa Mansuli (T5)	45.66^{b}	12.66^{ab}	12.66^{b}	5.00^{b}
Silki (T6)	5.00^{d}	4.33^{c}	4.33^{c}	2.66^{c}
Hardinath 3 (T7)	22.00^{cd}	14.66^{a}	12.33^{b}	4.66^{b}
CV	38.56%	55.10%	35.91%	27.95%
LSD	17.87	8.12	5.26	1.80
Probability	0.0001	0.0096	0.0001	0.0002
F test(α=0.05)	s	s	s	s

CV: Coefficient of variation, LSD: Least significant difference. Values with the same letters in a column are not significantly different at 5% by LSD. (s) indicates significant at 5 % level of significance.

Conclusions

It can be concluded that hybrid variety of rice i.e. US 312 is the most susceptible variety to yellow stem borer of rice. US 312 variety was followed by fine to medium textured variety i.e. Sawa Mansuli and Hardinath 3 in terms of yellow stem borer preference. Sarju 52 and Silki varieties showed higher resistance against yellow stem borer by exhibiting least preference to those insects. These varieties were statistically at par with Radha 4 variety of rice. Since Silki variety of rice is not recommended variety in Nepal, Sarju 52 could be recommended to rice growers of plain regions of Nepal. Alternatively, Radha 4 could also be recommended to those geographical regions where Sarju 52 could not be grown. Since this research sorted the cultivars in terms of yellow stem borer preference, this knowledge could be helpful to the rice growers to minimize yield losses of rice grains by adopting the most resistant cultivar. Since Sarju 52 showed higher and US 312 showed lower resistance to yellow stem borer infestation, further research regarding the causes of resistance should be evaluated by chemical analysis of these cultivars.

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