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Screening of early maturing rice varieties against rice earhead bug, *Leptocorisa oratorius* Fabricius (Hemiptera: Alydidae) in IRD Center Jhapa, Nepal

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Abstract
A trial for screening early maturing rice varieties against insect pests was conducted in the field of Innovative Research and Development Center, Jhapa during the period from April to July, 2019 to identify resistance hybrid rice varieties against rice earhead bug. The trial was designed in randomized complete block design with three replications. A set of eleven rice varieties (10 Chinese hybrid variety developed by Hi-tech Seed Co. Ltd., China and 1 Nepalese variety improved by NARC, Nepal) were evaluated in the field trial. Rice ear-head bug was found as the major insect pests of rice in the trial field and caused significant damage on all rice varieties. The percentage of grain damaged by rice earhead bug was highest in G-119 (40.03%) and found to be highly susceptible. Similarly, lower damaged in G-112 (10.62%) and found to be moderately susceptible among other the screened varieties. The highest yield (5.032 ton/ha) was produced by G-112, whereas the lowest (3.290 ton/ha) by G-119 hybrid rice varieties.

Keywords: Ear-head bug, resistant, susceptible, hybrid rice, grain yield

Introduction
Rice is the major cereal crop of Nepal followed by maize and wheat. According to the Krishi Diary (2076) [6], rice is cultivated in 1.46 million ha of the cultivable land area of the country with the production of 5.15 million tons (i.e., 3.52 mt/ha productivity). Rice holds a vital role in the national economy, as the share of rice in AGDP is 17.21% (CBS, 2013/14) [1] and provides 50% of the total calorie requirement of the Nepalese people. Rice is indigenous to humid area of tropical and sub-tropical region. It is grown from the Terai belt (60 masl) up to high mountains (3050 masl) in Nepal (Mallick, 1981/82) [8]. In Nepal, rice is produced all-round the year. Farmers prefer high yielding early maturing varieties as they find open window for other crop inclusion in the cropping system. In modern agricultural system, high yielding rice varieties are extensively grown with the intensive use of fertilizers and manures. Such rice cultivation practices are infested by a large number of insect pests, which results into severe loss in crop yields (Neeta *et al*., 2013) [10]. Khan and Pathak (1987) [4] mentioned that the rice crop is subjected to the persistent pressure of more than 100 different insect species. And 20% of them are of major economic significance (Pathak and Khan, 1994) [11]. Pathak and Khan (1994) [11] also reported that average yield loss due to various insect pests was estimated to be 31.5% in Asia (excluding mainland China). Among nine species of Leptocorisa rice bugs in Asia and Oceania *L. oratorius* is the most important in tropical climates whereas *L. acuta* and *L. chinensis* prevail in upland area or temperate climates (Litsinger *et al.*,2015) [7]. The rice earhead bugs both nymphs and adults cause damage by feeding on the sap of milky grain and turns them chaffy (Morrill, 1997) [9].
In this approach, natural factors such as increasing number of natural enemies that prevent pest species are emphasized, and also use of resistant varieties are being successfully utilized in reducing the damage caused by various insect pests and diseases of rice (Khush, 1997) [5]. The cultivation of high yielding hybrid rice varieties is getting popular in Nepal to meet the present rice demand in the market. Huge numbers of hybrid rice varieties are being cultivated in Nepal without field testing and proper evaluation. Due to which, rice farmers are facing havoc damage caused by ear-head bug. Considering this situation, the present study was conducted to identify resistance hybrid rice varieties against rice ear-head bug.

Methodology

A field trial was conducted at the experimental station of the Innovative Research and Development Center, Jhapa during the period from February to July, 2019. Geographically, it is located at 88.059º E and 26.451º N. The area has subtropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in hot wet season (April-September) and scanty rainfall associated with moderately low temperature during the cold dry season (October-March). In Jhapa, soil texture is loamy one with the pH 6.8 and EC 0.36 mS/cm. The experiment was laid out in Randomized Complete Block Design (RCBD) consisting of eleven rice varieties as treatments that were replicated three times. Each plot size was 4 m^2 (2m X 2m) consisting of 100 plants that were planted at 20 cm X 20 cm spacing. Nursery beds were prepared separately for each variety on 6 February, 2019. A month-old seedling was transplanted per hill on 9 March 2019. The crop was raised following standard agronomic practices. Akanee 150 kg/ha and Hercules Utah Zn 15 kg/ha together with NPK 140:60:40 kg/ha were applied as recommended fertilizer dose for the hybrid rice cultivation practices. Full dose of Phosphorus, Potassium, Akanee and Hercules Utah Zn and one third of N was applied at the time of final land preparation as basal dose application. Remaining dose of N was applied in two split doses at the time of active tillering and during panicle initiation stages. 2-3 days after rice transplanting, King Clean (Simetryn 25% WP) herbicide was applied at the rate of 1 gm/liter of water. Until grain filling stage irrigation was given as per requirement to maintain about 5 cm water table. As plant protection measures, fungicides were applied against false smut. For specific data recording, 10 hills were randomly selected from each plot and tagged. These 10 hills were observed regularly for data collection on insect pest infestations especially for rice earhead bug. Data collection was started from the 15 day after transplanting (DAT). All the data were collected at the interval of 15^{th} days. Data were collected for different parameters such as number of rice ear-head bugs by sweep net; number of damaged grains per five panicles, weight of actual yield per meter square. Recorded data were statistically analyzed by using Agricole package in R software. Microsoft excel was used for tabulation and curation of recorded data before statistical analysis. Means were separated by Duncan's multiple range test (DMRT) at 5% level of significance (Gomez and Gomez, 1984) [3]. The rice earhead bug infestation and reaction for resistance/susceptibility were judged by using 0-9 scale separately (Table 1).

Table 1: Scale showing resistance and susceptible score as per Standard Evaluation System for Rice, IRRI, 2002 [2].

S. N.	% damaged grains per panicle	Scale	Reaction
1.	No damage	0	HR(Highly Resistant)
2.	Less than 3%	1	R (Resistant)
3.	4-7%	3	MR (Moderately Resistant)
4.	8-15%	5	MS (Moderately Susceptible)
5.	16-25%	7	S (Susceptible)
6.	26-100%	9	HS (Highly Susceptible)

Result and Discussion

The highest incidence of rice earhead bug was observed in hybrid rice variety G-119 which was at par with G-117, G-118 and G-116 (Table 1). The lowest incidence was observed in G-112. The highest yield was recorded in G-112 (5.032 t/ha) whereas the lowest yield was recorded in G-119 (3.29 t/ha). Hybrid rice varieties G-110, G-111, G-112, G-113, G-114 and G-115 had higher yield and the varieties G-116, G-117, G-118 and G-119 had lower yield. Whereas, Nepalese hybrid rice which was used as check variety medium yield.

Table 2: Response of different rice genotypes against the rice earhead bug and grain yield at Jhapa, Nepal in 2019.

Treatment	75 DAT		90DAT		Mean		Grain yield (ton/ha)	
G-110	6.66 ± 1.15 (2.65)	abc	6.00 ± 1.8 (2.46)	b	6.33 ± 0.62 (2.60)	de	4.93 ± 0.25	a
G-111	5.66 ± 2.58 (2.29)	bc	14.00 ± 3.5 (3.73)	ab	9.83 ± 2.12 (3.16)	bcd	4.81 ± 0.23	a
G-112	3.66 ± 0.57 (2.02)	c	6.33 ± 1.62 (2.56)	b	5.00 ± 0.65 (2.33)	e	5.032 ± 0.25	a
G-113	5.33 ± 2.25 (2.27)	bc	11.66 ± 1.62 (3.46)	ab	8.50 ± 1.32 (2.97)	cde	4.67 ± 0.27	a
G-114	4.00 ± 1.32 (2.06)	bc	11.66 ± 1.04 (3.47)	ab	7.83 ± 0.80 (2.87)	cde	4.92 ± 0.085	a
G-115	5.00 ± 0.5 (2.33)	bc	13.00 ± 4.53 (3.52)	ab	9.00 ± 2.26 (3.00)	cde	4.86 ± 0.30	a
G-116	6.33 ± 2.08 (2.53)	abc	17.33 ± 2.36 (4.19)	a	11.83 ± 0.14 (3.51)	abc	3.49 ± 0.5	b
G-117	9.66 ± 0.75 (3.18)	abc	18.33 ± 1.60 (4.32)	a	14.00 ± 0.50 (3.80)	ab	3.33 ± 0.5	b
G-118	7.66 ± 1.75 (2.80)	abc	15.66 ± 1.89 (4.00)	a	11.66 ± 0.50 (3.48)	abc	3.35 ± 0.30	b
G-119	12.00 ± 2.65 (3.48)	a	17.00 ± 3.04 (4.13)	a	14.50 ± 0.43 (3.87)	a	3.29 ± 0.51	b
Hardinath-1	5.33 ± 1.04 (2.38)	bc	14.66 ± 4.07 (3.80)	ab	10.00 ± 1.50 (3.21)	bcd	4.27 ± 0.05	ab
F value	*		*		**		*	
LSD	5.12		9.27		4.30		1.15	

CV%	16.41%	14.54%	12.93%	8.04%

DAS: Days after transplanting, CV: Coefficient of variation, LSD: Least significant difference, *: significant value with the same letters in a column is not significantly different at 5% by DMRT and figures after ±indicate standard error. The figures in parentheses are square root transformation.

None of the variety was found free from rice earhead bug attack (Table 3). Significant difference was observed between varieties in terms of percentage of damaged grains per panicle. The lowest percentage of damaged grain was found in G-112 (10.62%), which was at par with G-110 (22.95%), G-113 (23.74%) and Hardinath-1 (23.98%). Similarly, the highest percentage of damaged grains per panicle was observed in G-119 (40.03%). Among tested varieties only one variety G-112 was found to be moderately susceptible, four varieties were susceptible and 6 varieties were found highly susceptible. None of the variety was found resistant to the rice earhead bug.

Table 3: Screening of rice varieties against ear-head bug.

Treatment	Percentage of damaged grain per panicle		Scale		Reaction
G-110	22.95 ± 5.8 (1.32)	bc	6.33 ± 1.2	b	S
G-111	30.36 ± 2.50 (1.47)	ab	8.33 ± 0.57	ab	HS
G-112	10.62 ± 1.32 (1.01)	c	3.66 ± 0.57	c	MS
G-113	23.74 ± 3.25 (1.36)	bc	7.66 ± 0.57	ab	S
G-114	28.99 ± 3.29 (1.43)	ab	7.00 ± 1.00	ab	HS
G-115	23.58 ± 3.51 (1.35)	bc	7.66 ± 1.1	ab	S
G-116	25.82 ± 2.51 (1.40)	abc	7.66 ± 0.57	ab	HS
G-117	35.66 ± 5.01 (1.53)	ab	8.33 ± 0.57	ab	HS
G-118	37.56 ± 9.51 (1.53)	ab	8.33 ± 0.57	ab	HS
G-119	40.037 ± 0.57 (1.60)	a	9.00 ± 0.00	a	HS
Hardinath-1	23.98 ± 1.77 (1.37)	bc	7.66 ± 0.57	ab	S
F test	*		*		
LSD 0.05	15.69		2.5		
C.V	9.72%		9.89%		

CV: Coefficient of variation, LSD: Least significant difference, *: significant value with the same letters in a column is not significantly different at 5% by DMRT and figures after ±indicate standard error. The figures in parentheses are log transformation.

Relationship between grain yield and rice earhead bug population

Figure 1 shows the relationship between grain yield and ear-head bug infestation. The linear relationship shows that higher the infestation lowers the harvested grain yield with the regression coefficient $R^2 = 0.79$. Rice earhead bug becomes serious problem when infestation occurs at the flowering stage. Higher incidence is observed when rainfalls during higher air temperature (Venkatesh *et al*., 2009) [13]. Yield of rice is directly correlated with rice earhead bug population capture in sweeping net. We observed strong and negative correlation between rice ear-head population and rice grain yield at harvest. Similar relation also exists with the increment of both adult and nymphs of rice ear head bug at the milking stage as these bugs also feed on grain. Singh and Singh (2017) [12] also found similar result where rice ear head bug reduced yield up to 30%.

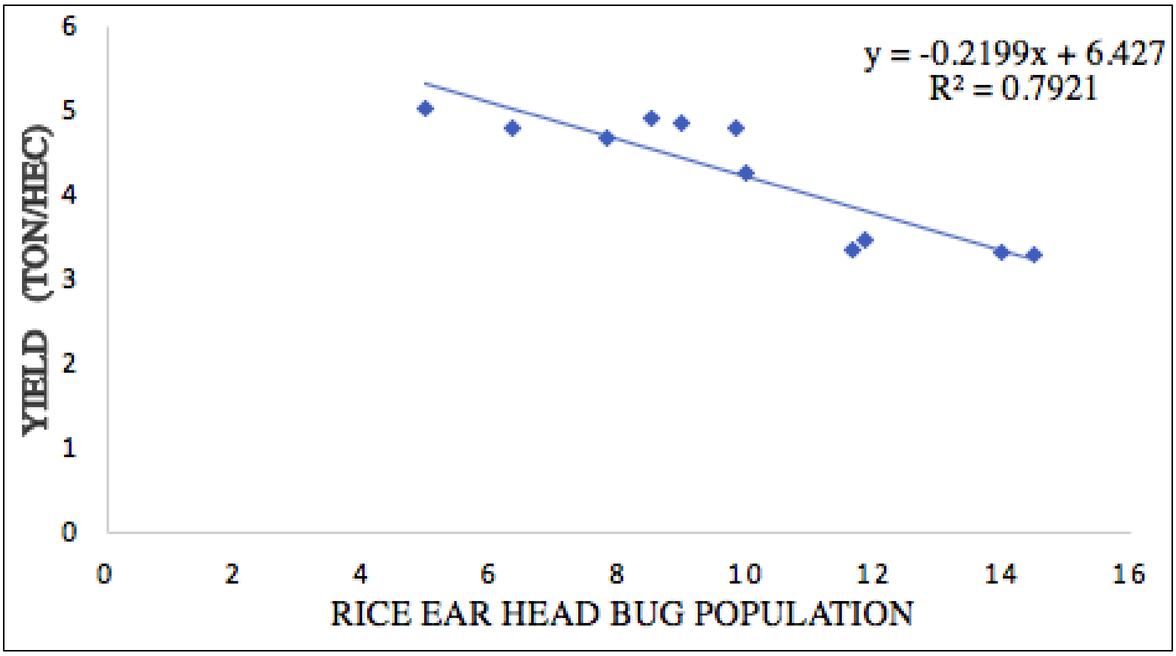

Fig 1: Relationship between grain yield and rice ear head bug population in early rice maturing varieties.

Conclusion

There is huge problem of insects in early maturing rice hybrid varieties in Jhapa . Among other such insects, rice earhead bug is the major problem in those area. Grain yield of rice had negative correlation with the rice earhead bug population. G-112 Chinese hybrid rice variety was found to be superior compare to other existing hybrid rice varieties. It is recommended to test other pipeline varieties to identify resistant one.

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