Plant Protection Journal
(Islamic Azad University, Shiraz Branch)
2018 – **9** (**4**) : 285-297

Evaluation of promising rice genotypes for resistance to rice striped stem borer, *Chilo suppressalis* (Lepidoptera: Crambidae) in paddy field conditions

Farzad Majidi-Shilsar*, **Mehrzad Allagholipour**

Rice Research Institute of Iran, Rasht; Agricultural Research, Education and Extension Organization (AREEO), Tehran, Iran, (*) majidi14@yahoo.com

Accepted: 23 July 2019 **Received: 8 August 2019**

Abstract

The striped stem borer, *Chilo suppresalis* (Walker, 1863) (Lepidoptera: Crambidae) is one of the most devastating pests of rice and reducing its yield in the world wide too. Todays, the use of resistance cultivars remains one of the most reliable methods to integrated pests management. The objective of this study was to identify rice lines (genotypes) resistant to striped stem borer and to determine plant characteristics associated with resistance. In this research, a total of 63 rice lines were evaluated in the field under natural infestation conditions during 2016- 2017. The lines exhibited considerable variation for plant height (84.30-149 cm), stem diameter (3.7-6.3 mm), panicle length (21.1-32.9 cm), number of larvae (3.83-69.50), growth period (108-138 days), white heads infestation (1.11-11.72 %) and grain yield (3.7-8.2 t.ha^{-1}) in relation to the mentioned pest. The results showed that the white heads infestation percent had significantly correlated with plant height stem diameter and panicle length. And also, there was a significantly correlated the decrease of grain yield by increasing the stem diameter, more infestation and white heads. The cluster analysis based on the studied morphological characteristics showed that all genotypes were classified into three groups. So that, 8, 26 and 29 genotypes was located in A, B and C classes, respectively. Among all the genotypes, the lines of the third group (Class C) can be used as a source for breeding programs to achieve the new rice cultivars which is to be tolerant to rice striped stem borer pest.

Key words: Integrated management, Rice, Striped stem borer, Resistant

Introduction

Rice (*Oryza sativa* L.) is the food source for billions of people in the world, which rely on this crop for more than 20% of daily calorie intake (IRRI, 2010). Almost 90 percent of the rice is grown and consumed in Asia (Ghule *et al.*, 2008). In Iran rice occupies about 0.6 million hectares with a production of 2.5 million tones and it constitute 86 percent of total food grain production for Iranian people. Nearly 300 species of insect pests are attacking the paddy crop at various stages and among them only 23 species cause notable damage (Pasalu & Katti, 2006). The striped stem borer, (*Chilo suppressalis*

(Walker) (Lepidoptera: Crambidae) is one of the most important rice pests in Asia. Rice stem borers cause damage to the crop at the larval stages. The rice stem borer, which infest the rice from seedling to maturity, act as a major constraint for the rice production the larvae borer into the plant stems and feed on plant nutrients causing, in many cases, severe crop loss (Pathak,1975). The striped stem borer, *C. suppressalis* is a major pest if it isn't controlled. Rice plants are most likely sensitive to stem borer infestation at the tillering and flowering stages (Viajante & Heinrichs, 1987). Therefore, efforts to find resistant rice varieties to this pest are very important. The mechanism of tolerance depends on many factors. Among all factors, temporal and environmental conditions are so important and effective. In rice, resistance to stem borers governed by polygenic heritability (Khush, 1984). Many morphological, anatomical, physiological and biochemical factors have been reported to be associated with resistance, so that each one of these factors were controlled by different sets of genes (Chaudhary *et al.*, 1984). However, there are many ways to combat this pest. In between, chemical methods such as insecticide to control the insect have been efficiently had negative effect upon quality of maize (Sfakianakis *et al.*, 1981). Therefore, it is important to improve rice cultivars with adequate levels of resistance to striped stem borer. Resistant rice cultivars provide insect control at no additional cost for farmers and this way is also compatible with other control methods in an integrated pest control programs. The damage symptoms due to stem borer larvae on affected plants differ with the development period at which plant infestation is initiated. The feeding of larva cause 'dead hearts' symptoms at the vegetative stage and the rice plants may be able to recompense the damage during the maximum tillering stage. During reproductive stage, feeding of larvae particularly in panicle initiation and ear head emergence, cause 'white heads' symptoms and with heavy infestation resulting profound loss in grain yield (Sarwar, 2012). Farmers frequently use chemical pesticides for the control of this pest (Kudagamage & Nugaliyadde, 1995). This reliance on use of insecticides leads to numerous undesirable consequences. Application of pesticides resulted many dangers including environmental contamination, pest resistant to pesticides, eliminating of fishes and poisoning of marines (Majidi-Shilsar & Ebadi, 2013). The varietals resistant is mainly inexpensive, least problematical and ecological friendly approach and major tactic in integrated pest management. Hence, present study undertaken to identify the new sources of resistant /tolerance genotypes for management of rice striped stem borer in paddy fields condition in Iran.

Material and Motheds

The experiments were carried out in Rice Research Institute of Iran, Rasht (37°16′51″N, 49°34′59″E), in two years consecutively 2014-2015. A total of 63 promising rice lines were tested in the paddy field for resistance to striped stem borer (*C. suppressalis*) under natural infestation conditions (Table 1). The seeds of all genotypes were sown on 5 April 2014 and 2015 by hand broadcasting, at approximately 300g of seeds per each genotype. Seeds had been soaked in water for 24 hours before sowing. Transplanting was done on 5 May 2014 and 2015. In each year, all genotypes were arranged based on a Randomized Block Design with three replications for evaluation. During both the years the nurseries were sown on well prepared raised beds and about a month old seedlings were transplanted in the field with spacing of 20×20 cm, 3 seedlings per hill in a single row of 20 hills for each entry with two replications. The field was fertilized with 150 kg. of N ha^{-1} in three increments, 50 kg. of P $ha^{-1}$and 100 kg. K ha^{-1}. At first, 70 kg ha^{-1} increment of N and the whole amount of phosphorus and potassium were applied before sowing. And then 50 kg ha^{-1} increment of N was applied at tillering stage and eventually 30 kg ha^{-1} increment of N was used at prior to the panicle initiation. Standard water management practices were applied in this experiment. The field was flooded for 2 days before sowing and maintained about 5 cm deep until 10 days before harvest. No plant protection coverage was provided in the test material to create optimum condition for pest multiplication. All the recommended agronomic practices were adopted during the experimentation. Incidence of stem borer was recorded on all the 20 hills per culture. Observations were noted at peak incidence at pre harvest stage. The total tillers and number of white heads at pre harvest stage were noted and percent white heads were recorded based on the following formula (Gomez & Gomez, 1984).

$$\text{White heads\%} = \frac{\text{No. of infested tillers in hills}}{\text{Total tillers in hills}} \times \frac{\text{No. of hills}}{\text{Total hills}} \times 100$$

In this study some important characters such as grain yield (kg. ha^{-1}), days from the panicles emergence to 50% heading (day), plant height (cm) and stem diameter (mm) were measured in the maturity stage. Plant height was measured from the soil surface to the tip of the panicle and stem diameter was measured between the first and second nodes with micrometer, both based on three individual measurements in each plot. Panicle length was measured with a ruler from the tail to the tip of the panicle. The number of larvae in the infected stems and white head percentage were counted and measured during the growing season from nursery to harvesting time for all genotypes. The number of tillers and panicles with infestation symptoms by the striped stem borer were separately measured.

Table 1. List of the different rice genotypes used in the field screening for resistance to the *Chilo suppressalis*

No	Genotypes	Parents (Female ×Male)	No	Genotypes	Parents (Female ×Male)
1	RI 18430-1	Saleh×Hashemi	33	RI8435-28	Saleh× Ahlamitarom
2	RI 18430-5	Saleh×Hashemi	34	RI18435-2	Saleh× Ahlamitarom
3	RI18430-12	Saleh×Hashemi	35	RI18436-33	Saleh×Hassansaraiei
4	RI8430-21	Saleh×Hashemi	36	RI18436-34	Saleh×Hassansaraiei
5	RI18430-27	Saleh×Hashemi	37	RI18436-35	Saleh×Hassansaraiei
6	RI18430-41	Saleh×Hashemi	38	RI18437-33	Saleh×Salari
7	RI18430-47	Saleh×Hashemi	39	RI18437-39	Saleh×Salari
8	RI18430-56	Saleh×Hashemi	40	RI18437-54	Saleh×Salari
9	RI18430-60	Saleh×Hashemi	41	RI18437-58	Saleh×Salari
10	RI18430-72	Saleh×Hashemi	42	RI18437-65	Saleh×Salari
11	RI18430-75	Saleh×Hashemi	43	RI18437-92	Saleh×Salari
12	RI18430-77	Saleh×Hashemi	44	RI18437-105	Saleh×Salari
13	RI18430-83	Saleh×Hashemi	45	RI18437-116	Saleh×Salari
14	RI18430-87	Saleh×Hashemi	46	RI18437-14	Saleh×Salari
15	RI18431-1	Saleh×Abjiboji	47	RI18439-89	Saleh×Gharib
16	RI18431-28	Saleh×Abjiboji	48	RI18441-24-1	Sepidrood×Hashemi
17	RI18431-39	Saleh×Abjiboji	49	RI18437-25	Sepidrood×Hashemi
18	RI18431-47	Saleh×Abjiboji	50	RI18441-24-2	Sepidrood×Hashemi
19	RI18431-53	Saleh×Abjiboji	51	RI18442-66	Sepidrood×Hassansaraiei
20	RI18432-1	Saleh×Mohamadi	52	RI18442-48	Sepidrood×Hassansaraiei
21	RI18432-8	Saleh×Mohamadi	53	RI18444-53	Sepidrod×Ahlamitarom

22	RI18434-34	Saleh×Hassani	54	RI18444-35	Sepidrod×Ahlamitarom
23	RI18434-38	Saleh×Hassani	55	RI18446-13	Sepidrod×Salari
24	RIR18434-42	Saleh×Hassani	56	RI18446-37	Sepidrod×Salari
25	RI18434-63	Saleh×Hassani	57	RI18446-89	Sepidrod×Salari
26	RI18434-64	Saleh×Hassani	58	RI18446-96	Sepidrod×Salari
27	RI18434-79	Saleh×Hassani	59	RI18447-2	Sepidrod×Ghrib
28	RI18435-2	Saleh× Ahlamitarom	60	RRII1(Improved RiceCultir)	Gilaneh
29	RI18435-13	Saleh× Ahlamitarom	61	RRII2(ImprovedRiceCultir)	Gohar
30	RI18435-1	Saleh× Ahlamitarom	62	RRII3 (Local Rice Cultivar)	Hashemi
31	RI18435-21	Saleh× Ahlamitarom	63	RRII4 (LocalRice Cultivar)	Abjiboji
32	RI18435-25	Saleh× Ahlamitarom			

RRII: Rice Research Institute of Iran

During the reproductive phase of the plant, larval feeding causes "white heads". Larval damage at early booting stage can cause empty panicle, erect and white panicles, which remain enclosed in the sheath. The proportion of the infested stems and panicles to the total harvested stems were calculated. The damage rating and scale the status of rice culture were determined by following the Standard Evaluation System (SES) for rice (IRRI, 2010). International Rice Research, Philippines has developed standard procedures for measuring the nature of damage. The degree of infestation by the insect was coded according to the following descriptor (Table 3). The data recorded in this study were analyzed. The means of the all traits under natural infestation conditions were compared and classified using Duncan’s Multiple Range Test (DMRT). Simple correlation coefficient was calculated among plant characteristics and infestation percentage. The ranking of the cultivars according to the infestation percentage were compared using Pearson's correlation coefficient (Steel & Torrie, 1980). All analyses were applied by using SPSS ver. 16 software.

Result and Discussion

There were significant differences among the genotypes for some characters under natural infestation conditions by rice striped stem borer (Table 2). The white heads percentage varied among genotypes and variation range was from 1.11% to 11.66 % for this trait in two genotypes (RI18430-5 and RI18430-21) (Table 3). In this study, the highest plant height was related to eight genotypes including RRII4 (Local) (149 cm), RI18430-21 (141.8 cm), RI18432-1 (141.7 cm), RI18442-48 (129.9 cm), RI18430-12-1 (127.6 cm), RI18430-1 (123.7 cm), RRII3 (Local) (122.8 cm) and RI18447-2 (119.3 cm) respectively. In contrast, three genotypes RI18434-34, RI18431-47 and RI18436-35 had the lowest plant height. The two genotypes RRII3 (Local) and RI18437-92 had the highest and lowest stem diameter stem with 6.26 and 3.7 mm, respectively. Also, the two genotypes RI18447-2 and RRII1 (Improved) had the highest panicle length and also the lowest panicle length was observed in two genotypes RI18431-53 and RI18446-89. The maximum larvae number was observed in three genotypes RI18432-1, RI18447-2 and RRII3 (Local) and the least number of larvae was perceived in two genotypes RI18437-54 and RI 18437-92. In this evaluation, genotypes of RI18435-25, RI18436-33 and RI18446-37 showed that most growing period. Among the all genotypes the least white heads percentage was observed in 38 lines i. e RI18430-5, RI18430-41, RI18430-56, RI18430-60, RI18430-72, RI18430-77, RI18431-1, RI18431-28, RI18431-39, RI18431-53, RI18434-34, RI18434-38, RI18434-42, RI18434-63, RI18434-64, RI18434-64, RI18435-13, RI18435-1-18, RI18435-25, RI18435-28, RI18435-2-18,

RI18436-35, RI18437-39, RI18437-54, RI18437-92, RI18437-116, RI18437-14, RI18439-89, RI18441-24-1, RI18441-25, RI18441-24-2, RI18444-35, RI18446-13, RI18446-37, RI18446-89, RI18446-96, RRII1 (Improved) and RRII2 (Improved) with scale '1' (incidence ranged between 1-5% W.h) based on resistant category (Table 4). The genotypes RI18430-1, RI18430-12-1, RI18430-27, RI18430-47, RI18430-75, RI18430-77, RI18431-47, RI18432-8, RI18435-2, RI18435-21, RI18436-33, RI18436-34, RI18437-33, RI18437-58, RI18437-65, RI18437-105, RI18442-66 and RI18442-48 with scale '3' (incidence ranged between 6-10% W.h) based on moderately resistant category, also the genotypes RI18430-21, RI18430-87, RI18432-1 and RRII4(Local) had the most white heads with scale '5' (incidence ranged between 11-16% W.h) under moderately susceptible category (Table 4). Results of this study showed that the four genotypes, RI18435-25, RI18435-28, RI18446-37 and RRII3 (Local) had the longest growth period and the lowest stage of development was related to two lines RI18436-35 and RRII3 (Local). In this experiment, line No. 23 was the high yielding genotype with 8.235 t/ha and the low yielding genotype was line RRII3 (Local) with 3.650 $t.ha^{-1}$. The generally, the plant resistance mechanism to insects is distinguished as antibiosis, tolerance and anti-xenosis (Abro *et al.,* 2003). Although the all three categories of resistance are observed against stem borers in rice (Sarwar, 2013), but differential behavior of rice genotypes to stem borer infestation was observed (Khan *et al.*, 2010). A positive significant correlation is observed among different corrected damage ratings, leaf width and chlorophyll content in rice leaves (Xu *et al.*, 2010). A factor which represents the sensitivity of rice genotypes to striped stem borer is stem thickness. In this study, the infestation percentage had positive significant correlation with the stem diameter. The infestation of the lines by this pest was correlated with the plant height. The highest plant heights were presented by IR2 (Local) in that order this genotype had the highest white heads percentage. And also, there was a positive correlation between white heads infestation percentages and stem diameter. In this study, there was a positive correlation between panicle lengths and plant height too (Table 5). The results showed that there was a positive correlation between white heads infestation percentages and panicle length (Table 5).

In this connection, Ntanos and Koutroubas, (2000) a report that as the height and diameter of the rice plant increased, so did the contamination of white clusters. In another experiment, Hosseini *et al.*, (2010) showed that there was a significant positive correlation between white heads with rice stem height and diameter. Also, Amooghli-Tabari *et al.*, (2016) showed that there was a significant positive correlation between white heads and rice stem diameter at the rice reproductive stage. By studying the results of the experiment, it can be concluded that the rice plant infection in the reproductive stage is directly related to the plant height and diameter. Two factors of panicle length and growth period of rice plant are less important in the infestation of rice plant to stem borer. The results of the present study are in agreement with the reports of the above researchers. The infestation of the lines was correlated with the plant height (Table 5). In this study, there was also a positive correlation between plant heights and white heads infestation percentages (Table 5). In addition, there was a positive correlation between the white heads percentages and stem diameter, both panicle lengths. The results showed that the stem diameter and panicle length are important for percentage of infestation in rice lines, so that there was a positive significant correlation between them. Therefore, five rice lines (RI18434-34, RI18431-47, RI18436-35, RI18431-53 and RI18446-89) were selected with smaller panicle length and fewer stem diameter. For this reason, these five rice lines will have been resistant to this serious pest. These results agree with those reported for the effect of stem diameter on infestation of rice cultivars by the stem borer (Rubia-Sanchez *et al.,* 1998). Various plant morphological, anatomical, biochemical and physiology factors have been suggested as important resistance to the rice striped stem borer and the yellow stem borer (Chaudhary *et al.*, 1984). Several plant morphological factors have been reported. Plant height, stem diameter and length and width of the flag leaf were positively correlated with number of eggs laid by stem bore moths. In addition, resistance cultivars possessed tight leaf sheaths that totally covered the internodes whereas susceptible cultivars had loose leaf sheaths that partially covered the internodes. A positive correlation between stem size and borer infestation was reported (Jodon and Ingram, 1948). Tall plants with wide and long leaves and a larger number of tillers appeared most susceptible (Israel, 1967). Awn less cultivars were more susceptible than those with awns (Shiraki, 1917). Anatomical studies of stem borer resistance cultivars indicated that the stems had four to five layers of sclerenchymatous tissue that apparently offer resistance to larvae boring inside the stem (Van and Guan, 1959). Also, cultivars with a narrow stem lumen were less susceptible to borer.

Silica content has been associated with resistance to rice stem borers. High amounts of silica in rice plant adversely affected larval survival and reduced "dead hearts" formation (Pathak *et al.*, 1971). Studies on the chemical bases of resistance to stem borers and to other rice pests have received relatively little attention and much is left to be discovered. Although, some of the reported factors are correlated with resistance, they may not actually be resistance mechanisms (Heinriches, 1994). In some studies have been reported that the several plant morphological factors like plant height, stem diameter and flag leaf length and width were positively correlated with number of eggs laid by stem borer moths (Patanakamjorn & Pathak, 1967). Non-preference of stem borers for oviposition is considered being at least partially of a biochemical nature. A stem borer attractant, oryzanone (p-methylacetophenone) attracts ovipositing moths and larvae by its odor (Munakata *et al.*, 1959). Non-preference of the rice stem borer, *C. suppressalis* for TKM6 is due to the presence of allomones which inhibit oviposition and adversely affect egg hatching, larval survival, and larval development (IRRI, 1978). In present study, genotypes of RI18430-21, RI18430-83, RI18430-87, RI18432-1, RI18435-2, RI18437-58, RI18442-48, RI18444-53, RI18447-2, RRII3 (Local) and RRII4 (Local) had highest larvae number and also, genotypes of RI18434-42, RI18430-87, RI18432-1, RI18444-53, RI18447-2, RRII3 (Local) and RRII4 (Local) had highest white heads infection percentage. Therefore, the high number of larvae and white heads infection in genotypes may result from biochemical compounds evaporable the existing plant. The taller lines were more susceptible than the shorter ones. The greater infestation of the taller lines was probably associated with preference by the striped stem borer for oviposition (Smith, 1989). Also, lines with more stem diameter were more susceptible than the lower stem diameter lines, this may be because the development and movement of larvae are facilitated in broader stems between infestation of rice by the striped stem borer and morphological and agronomical characteristics such as plant height and stem diameter. These characteristics should be an important consideration in screening rice lines for resistance to striped stem borer. In this regard, Hosseini *et al.*, (2010) in the evaluation of rice plants resistant to rice striped stem borer, some traits such as plant height, leaf length, tiller number, leaf width and stem diameter were examined. They showed that the plant height, stem diameter in clusters of white pollution was higher than other traits and the correlation was more minimal. Amooghli-Tabari *et al.* (2015) has shown that the rice genotypes such as Novator, Estrella, Rashtline-1 were found to be less sensitive to *C. suppressalis.* Also, in this study, 19 rice genotypes were recognized as resistant genotypes at field condition. He showed that some of them can be tested in further experiments. Viaisalakshmi *et al.* (2014) suggested that the resistant varieties is mainly inexpensive, least problematical and ecological friendly approach and major tactic in integrated pest management. Hence, present study undertaken to identify the new sources of resistant genotypes for management of yellow stem borer. The results suggest that, under the local conditions rice cultivars with short plant height (<105 cm), narrow stem diameter (<4mm) and high tillering ability should be preferred in reducing infestation by the striped stem borer. Work Hosseini, *et al.*, (2010) has shown that the genetic material used for this evaluation was diverse and not necessarily adapted to local conditions. Also, they showed that, under the local conditions rice cultivars with short plant height (<100 cm), narrow stem diameter (<4 mm) and high tillering ability should be preferred in reducing infestation by the striped stem borer. This study presents a preliminary evaluation of rice lines for natural infestation by striped stem borer. The infestation under natural conditions could be affected by many factors not related to the plant (e.g. the population of the insect), In order to obtain more efficient evaluation, artificial infestation are needed, but this is not feasible when evaluating a large number of lines. The cluster analysis (Ward's procedure) and grouping of studied morphological characteristics showed that genotypes were classified into three groups (Figure 1). So that, 8 genotypes in group A, 26 genotypes in group B and 29 genotypes were in group C. However, the 63 genotypes tested, genotypes of group C can be developed in breeding programs as a source of resistance to rice striped stem borer are used.

Table 2. Analysis of variance for different traits under natural infestation conditions

S.O.V	d.f	MS						
		Plant height	Stem diameter	Panicle length	Number of larvae	Period growth	White head percentage	Yield
Year	1	20.28*	3.30*	47.28*	2714.73 *	1718.61**	0.13 ^{ns}	1.48*
Error 1	4	0.58	0.05	1.03	223.61	26.79	4.77	0.04
Genotype	62	1119.31**	1.68 ^{ns}	29.24**	1990.65 **	189.48**	52.07**	5.25**
Genotype × Year	62	6.33**	0.70**	4.87 **	895.45**	35.77 ^{ns}	12.81**	0.15**
Error 2	248	1.41	0.02	0.06	151.88	28.67	3.66	0.02
C.v(%)		1.14	2.58	0.97	49.55	4.43	42.02	2.68

ns, * and **: Not-significant and significant at 5% and 1% probability levels, respectively.

Table 3. Comparison of mean (±SD) plant height, stem diameter, panicle length, number of larvae/ hill, period growth, percent of white head and yield/ton of rice genotypes that were used to *Chilo suppressalis*.

Gen.	Plant height	Stem diameter	Panicle length	Number of larvae	Period of growth	White head percentage	Yield/ton
1	123.7±0.42 ^{e}	4.93±0.3$^{h\text{-}m}$	27.35±0.31^{d}	26±18.48$^{h\text{-}q}$	114±1.67^{hij}	9.18±0.05 ^{abcde}	5.662±0.1^{ijkl}
2	93.3±0.6 $^{\text{Ø*}}$	¢4.02±0.05	25.88±1.17^{g}	2.67±4.18 ^{r}	115.5±2.07^{fghij}	1.11±0.2 ^{s}	5.650±0.22^{jklm}
3	127.6±0.64 ^{d}	5.17±0.3 ^{fgh}	23.48±0.38^{wxyz}	27.33±17.37$^{h\text{-}p}$	113.5±3.02 ^{ijk}	9.58±0.8^{abcd}	5.568±0.24^{jklmo}
4	141.8±0.33 ^{b}	4.84±0.41$^{i\text{-}p}$	25.44±1.6^{hij}	54.83±27.07^{bcde}	120.5±2.07$^{c\text{-}i}$	11.07±0.8 ^{a}	5.479±0.2^{lmno}
5	114.6±0.88 ^{g}	4.61±0.46 $^{o\text{-}x}$	24.08±1.08^{pqrs}	14.33±3.83$^{l\text{-}r}$	123.5±3.02$^{c\text{-}i}$	7.2±3.17$^{b\text{-}g}$	4.793± 0.14^{r}
6	100.3±0.86$^{s\text{-}w}$	4.36±0.1$^{\text{xyzØ}}$	21.66±0.44$^{\text{©}}$	10.5±5.47 $^{m\text{-}r}$	122±3.52$^{c\text{-}i}$	2.02± 0.98^{opqrs}	6.005±0.28^{fgh}
7	85.07± 1.01^	4±0.47 $^{\text{¢}}$	22.01±0.27$^{\text{£}}$	6.5±5.01 ^{opqr}	118±2.28^{defghij}	5.25±4.5$^{f\text{-}q}$	4.689±0.39 ^{rs}
8	94.97±0.54^{y}	4.45±0.51$^{\text{vwxyz[}\backslash}$	25.31±0.2^{ij}	12.17±9.02$^{m\text{-}r}$	125.2±3.25^{cdef}	2.63±0.93$^{k\text{-}s}$	5.625±0.16^{jklmn}
9	94.94±0.6 ^{y}	4.4±0.08$^{\text{wxyzØ}}$	23.13±0.35$^{\text{zØ}}$	4.67±5.65 ^{pqr}	119.5±4.28^{defghi}	1.39±0.17 ^{rs}	5.900±0.11^{ghi}
10	106.1±0.6^{lmn}	4.50±0.04 $^{s\text{-}z}$	25.71±0.28^{gh}	20±12.52$^{i\text{-}r}$	119.5±3.07^{defghi}	2.83±1.04 $^{j\text{-}s}$	4.787±0.14 ^{r}
11	112.6±0.62 ^{h}	4.98±0.07 ^{hijkl}	24.58±2.1^{mno}	19.33±5.5 $^{j\text{-}r}$	118.5±3.88^{defghi}	6.07±3.24 $^{e\text{-}k}$	6.063±0.11^{efg}
12	89.9±0.37 ^{vwx}	4.48±0.19 $^{\text{tuvwxtz[}}$	24.78±0.21^{klm}	11.33±12.17^{mnopqf}	118.5±4.04^{defghi}	2.18±1.02 ^{nopqrs}	6.253±0.06 ^{e}
13	109.7±0.71 ^{i}	5.33± 1.11^{def}	23.35±2.16$^{xyz\Delta}$	46.23±43.72^{cdefgh}	117.5±1.76 $^{d\text{-}j}$	6.24±3.54 ^{efghij}	4.587±0.07 ^{rst}
14	112.5±0.73 ^{h}	5.89±0.44^{b}	25.98±1.12^{g}	60.17±24.17 ^{abc}	125.5±2.79^{cdef}	11.66±0.98 ^{a}	5.376±0.11 ^{op}
15	102.1±0.52^{qrs}	4.6± 0.21$^{p\text{-}x}$	25.87±0.16^{g}	19.33±7.76$^{j\text{-}r}$	116±3.52 ^{efghij}	3.75±3.06 $^{g\text{-}s}$	5.734±0.23^{ijk}
16	103.2±0.94^{pqr}	4.63±0.35 $^{o\text{-}w}$	24.15±0.24^{pqr}	11.5±4.64 ^{mnopqr}	129.5±1.76 ^{bc}	3.3±0.22$^{h\text{-}s}$	5.225±0.11 ^{pq}
17	107.3±0.28 ^{klm}	4.89±0.09^{ijklm}	23.86±2.17^{rstuvw}	7.17±5.98^{opqr}	120.5±3.02$^{c\text{-}i}$	3.41±0.21$^{h\text{-}s}$	4.284±0.08 ^{uv}
18	103.8±0.91 ^{opq}	4.9±0.41^{ijklm}	22.07±0.06$^{\text{£}}$	21.5±19.81$^{i\text{-}r}$	114.5±3.02^{ghijk}	5.49±3.41$^{f\text{-}o}$	5.681±0.13^{jklmo}

19	98.2±2.85^{x}	4.22±0.05^{Ø}	21.01±0.14§	10.17±7.49^{mnopqr}	118±1.26^{d-j}	3.22±2.9^{i-s}	5.584±0.1^{jklmnp}
20	141.7±3.41^{b}	5.01±0.53^{hijk}	27.16±0.29^{de}	77.83±29.3^{a}	124±2.28^{cdefgh}	11.07±0.79^{a}	4.563±0.17^{rst}
21	100.4±0.44^{stuv}	5.3±0.42^{defg}	26.84±0.25^{e}	38.67±28.61^{d-k}	119±3.52^{defghi}	6.47±4.13^{defghi}	6.115±0.09^{efg}
22	85.8±0.17$^{\wedge}$	4.21±0.19^{Ø}	22.90±0.34$^{¥}$	6.5±8.8^{opqr}	118.5±1.38^{defghi}	1.3±0.27^{rs}	5.069±0.1^{q}
23	102±0.08^{qrst}	4.8±0.14^{j-q}	23.02±1.93^{Ø*}	25.17±10.52^{h-r}	120.5±3.89^{cdefghi}	3.29±0.22^{h-s}	8.235±0.25^{a}
24	101.7±1.02^{rstu}	4.23±0.05$^{\wedge Ø}$	23.23±2.62^{yzØ}	13.67±15.11^{l-r}	116±2.53^{efghij}	2.3±1.13^{m-s}	4.409±0.09^{stu}
25	100±1.01^{tuvwx}	4.62±0.03^{o-w}	23.95±1.04^{qrst}	20.67±6.89^{i-r}	124±1.9^{cdefgh}	2.41±0.82^{l-s}	6.506±0.16^{d}
26	107.3±0.47^{klm}	4.65±0.5^{n-v}	24.19±1.46^{opqr}	39.33±35.55^{c-l}	118.5±2.07^{defghi}	4.73±4.31^{f-r}	6.524±0.2^{d}
27	101±0.46^{stu}	4.7±0.35^{m-u}	26.91±0.23^{e}	16.83±4.58^{k-r}	123±6.69^{c-i}	2.77±0.91^{j-s}	6.133±0.15^{efg}
28	104.4±0.36^{nop}	5.30±0.34^{def}	23.71±1.6^{stuvwx}	51.67±36.97^{bcdefg}	118±2.53^{d-j}	5.84±3.9^{f-m}	3.651±0.13^{w}
29	92.4±0.26^{z}	4.2±0.11$^{¥}$	22.93±0.17$^{¥}$	8.5±9.47^{nopqr}	125.5±2.07^{c-i}	1.57±0.75^{rs}	5.803±0.82^{hij}
30	92±0^{ZØ}	4.29±0.05^{yzØ}	23.17±0.39^{yzØ}	11.33±6.22^{mnopqr}	118±2.28^{d-j}	1.37±0.26^{rs}	5.062±0.19$^{q،}$
31	107.4±0.08^{jkl}	5.02±0.73^{hij}	25.88±0.24^{g}	35.17±23.41^{e-l}	119.5±3.01^{defghi}	6.77±4.26^{cdefgh}	5.121±0.16^{q}
32	109.3±0.11^{ij}	4.76±0.26^{l-r}	24.32±1.21^{nopq}	18.33±2.5^{j-r}	138±2.28^{a}	4.58±3.36^{f-s}	4.767±0.26^{r}
33	98.3±0.11^{wx}	4.72±0.18^{m-t}	21.78±0.16$^{¢}$	13±7.31^{l-r}	118.5±1.38^{defghi}	2.46±1.25^{l-s}	4.621±0.11^{rst}
34	100.1±0.5^{s-x}	4.47±0.14$^{uvwxyz[}$	23.52±1.59^{vwxyz}	10.67±7.69^{mnopqr}	117.5±1.76^{defghij}	2.64±0.84^{k-s}	6.226±0.17^{ef}
35	99.9±0.22^{uvwx}	5.16±0.41^{fgh}	23.69±0.38^{stuvwx}	38.17±19.63^{defghijk}	136.5±2.81^{ab}	5.95±3.38^{efghijkl}	6.055±0.4^{efg}
36	102.1±0.18^{qrs}	5.27±0.57^{efg}	24.39±0.59^{mnop}	34.17±10.87^{efghijkl}	118.5±1.38^{defghi}	6.42±3.52^{defghi}	4.626±0.12^{rst}
37	84.3±0.61$^{\wedge\wedge}$	4.2±0.89$^{¥}$	22.71±1.23$^{€}$	18.5±12.61^{jklmnopqr}	105.8±3.02^{k}	1.75±1.07^{qrs}	5.804±0.09^{hij}
38	109.5±0.28^{i}	5.06±0.08^{ghi}	24.60±1.78^{mn}	30.67±25.96^{g-n}	118±2.53^{d-j}	5.68±2.79^{f-n}	5.721±0.21^{ijk}
39	101.5±0.36^{rstu}	4.24±0.11^{Ø}	23.37±1.13$^{xyz\Delta}$	14±10.86^{l-r}	125±2.53^{cdef}	3.33±0.21^{h-s}	6.076±0.35^{efg}
40	87.7±0.37$^{€}$	3.37±0.1§	23.53±1.22^{u-z}	3.83±2.95^{qr}	119.5±2.81^{c-i}	1.47±0.78^{rs}	6.082±0.41^{efg}
41	107.4±0.52^{jkl}	4.94±0.61^{hijklm}	25.06±0.49^{jkl}	40.17±35.7^{c-j}	118±1.67^{d-j}	5.2±3.83^{f-q}	5.090±0.15^{q}
42	103.7±0.61^{opq}	4.61±0.43^{p-x}	22.34±1.65^	33±12.93^{f-m}	118±2.9^{d-j}	6.15±3.21^{e-k}	5.512±0.27^{klmno}
43	89.9±0.44*	3.7± 0.34§	21.77±0.1$^{¢}$	3.83±4.42^{qr}	118.5±2.07^{defghi}	1.2±0.2^{rs}	4.761±0.29^{r}
44	109.3±0.57^{ij}	5.17±0.63^{fgh}	24.06±2.13^{pqrs}	39.50±40.16^{c-j}	123.5±2.07^{c-i}	5.31±3.78^{f-p}	5.366±0.15^{op}
45	96.13±0.69^{y}	4.41±0.13$^{vwxyz[\backslash]}$	24.61±0.16^{mn}	12±9.06^{mnopqr}	124.5±1.76^{cdefg}	1.38±0.11^{rs}	5.411±0.19^{mnop}
46	92.2±0.32^{zØ}	4.27±0.43^{zØ}	23.91±0.28^{qrstuv}	9.17±11.8^{nopqr}	119.5±2.51^{defghi}	2.52±3.31^{l-s}	6.636±0.17^{cd}
47	94.97±0.33^{y}	4±0.57$^{¢}$	23.94±0.24^{qrstu}	7.17±7.07^{opqr}	122.5±5.09^{c-i}	1.22±0.16^{rs}	4.428±0.22^{tuv}
48	91.2±0.42^{ZØ*}	4.59± 0.18^{q-x}	23.56±0.16^{tuvwxy}	19.33±10.95^{j-r}	127±2.9^{cd}	3.88±2.8^{g-s}	5.736±0.14^{ijk}
49	77.5±0.18$^{£}$	4.46±0.18$^{uvwxyz[}$	21.56±0.12$^{®}$	16.5±16.2^{k-r}	121.5±2.07^{c-i}	2.89±3.3^{j-s}	6.693±0.19^{cd}
50	96.3±0.42^{y}	4.73±0.46^{m-s}	25.13±0.56^{d}	11.5±8.46^{m-r}	121.5±2.51^{c-i}	1.49± 0.35^{rs}	7.139±0.14^{b}
51	105±0.65^{nop}	5.01±0.14^{hij}	25.13±0.1^{ij}	31.17±15.82^{g-n}	123.5±3.02^{c-i}	5.28±4.04^{f-q}	7.127±0.26^{b}
52	129.9±0.13^{c}	5.36±0.15^{def}	27.43±0.08^{d}	27.43±0.08^{abcd}	122.5±1.38^{c-i}	9.82±0.6^{abc}	5.235±0.36^{pq}
53	108.7±0.3^{ijk}	5.53±0.14^{cd}	27.05±0.61^{de}	54.50±8.94^{bcdef}	121±2.53^{cdefghi}	10.28±0.74^{ab}	4.491±0.24^{stuv}
54	107.8±0.23^{ijkl}	4.77±0.26^{k-q}	25.55±0.72^{ghi}	28.67±22.01^{h-o}	121±2.53^{c-i}	3.02±0.56^{i-s}	5.034±0.07^{q}
55	100.5±0.43^{stuv}	4.52±0.12^{r-y}	24.42±0.19^{mnop}	13.17±12.27^{l-r}	119.5±1.38^{defghi}	4±2.63^{f-s}	6.790±0.27^{c}

56	95 ± 0.54^{y}	$4.08\pm0.11^{£}$	$22.15\pm0.09^{£}$	$15.33\pm6.56^{l-r}$	138.5 ± 2.07^{a}	$2.87\pm3.42^{j-s}$	5.406 ± 0.26^{nop}
57	$87.6\pm0.42^{€}$	$4.07\pm0.24^{£}$	$20.73\pm0.25^{§}$	10.83 ± 4.71^{mnopqr}	$122\pm1.26^{c-i}$	1.4 ± 0.24^{rs}	5.970 ± 0.12^{gh}
58	96.23 ± 0.57^{y}	$4.16\pm0.07^{€}$	24.71 ± 0.13^{lmn}	15.5 ± 5.24^{lmnopqr}	119 ± 1.26^{defghi}	1.76 ± 0.04^{pqrs}	6.646 ± 0.25^{cd}
59	119.3 ± 0.21^{f}	5.72 ± 0.22^{bc}	32.39 ± 0.14^{a}	69.50 ± 10.93^{ab}	126 ± 1.26^{cde}	10.16 ± 0.75^{ab}	4.273 ± 0.11^{v}
60	120.5 ± 6.88^{ef}	4.27 ± 0.03^{zØ}	30.12 ± 0.22^{b}	$22\pm13.36^{i-r}$	119.5 ± 3.02^{defghi}	$3.3\pm2.9^{h-s}$	5.680 ± 0.17^{ijkl}
61	105.4 ± 1.06^{mno}	6.26 ± 0.73^{a}	28.74 ± 1.82^{c}	$31.33\pm22.9^{g-n}$	130 ± 1.38^{abc}	$4.44\pm2.24^{f-s}$	6.736 ± 0.17^{cd}
62	122.8 ± 0.54^{e}	$4.86\pm0.44^{i-o}$	28.81 ± 2.79^{c}	69.50 ± 23.91^{ab}	108.5 ± 2.53^{jk}	10.07 ± 0.19^{ab}	3.650 ± 0.18^{w}
63	149 ± 0.52^{a}	5.47 ± 1.11^{de}	26.44 ± 0.31^{f}	$41.83\pm33.14^{c-i}$	126 ± 2.28^{cde}	11.72 ± 3.63^{a}	5.617 ± 0.43^{jklmn}

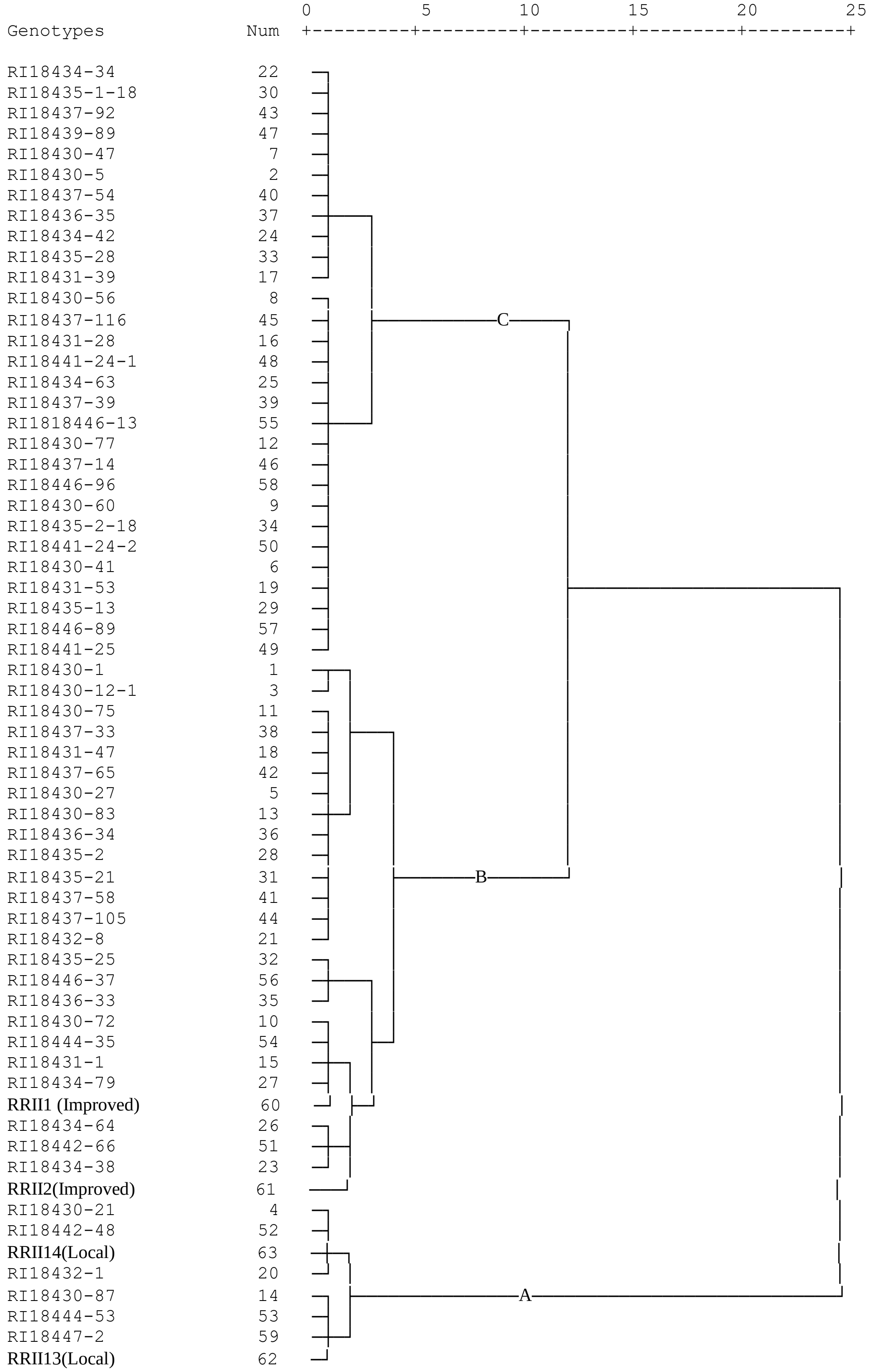
–Different letters at the same column show significant difference at $P < 0.01$ Dunkan test

Table 4. Standard Evaluation System

Status	Scale	Damage rating %
Highly Resistant	0	0
Resistant	1	1-5
Moderately Resistant	3	6-10
Moderately Susceptible	5	11-15
Susceptible	7	16-25
Highly Susceptible	9	26 and above

Table 5. Simple correlation coefficients between various traits for the genotypes tested during

	Period growth	Number of larvae	Yield	White heads %	Stem diameter	Panicle length	Plant height
Period growth	1						
Number of larvae	0.16^{ns}	1					
Yield	-0.07^{ns}	-0.25^{ns}	1				
White heads %	0.12^{ns}	0.86^{**}	$-0.\ 3^{*}$	1			
Stem diameter	0.18^{ns}	0.83^{**}	0.22^{ns}	0.81^{**}	1		
Panicle length	0.06^{ns}	0.56^{**}	0.01^{ns}	0.48^{**}	0.53^{**}	1	
Plant height	0.14^{ns}	0.73^{**}	0.26^{ns}-	0.97^{**}	0.66^{**}	0.57^{**}	1



1 Rice Research Institute, Rasht-IRAN

Fig. 1. Dendrogram of 63 rice genotypes to *Chilo suppressalis* as means of traits Plant height, Stem diameter, Panicle length, Number of larvae/hill, Period growth, White head (%) and Yield/ton/ha.

Acknowledgements

We are highly thankful to Agricultural Research, Education and Extension Organization (AREEO) for providing financial assistant and to Director General of Rice Research Institute of Iran, Rasht for providing facilities for carrying out this research.

References

Abro, G.H., Lakho, G.M. & Syed, T.S. 2003. Relative resistance of some rice cultivars to yellow, *Scripophaga incertulas* (Walk) and pink, *Sesamia inferens* (Walk) stem borers. *Pakistan Journal* of *Zoology*, 35: 85-90.

Amooghli-Tabari, M., Nouri-Ganblani,G., Fathi, S.A.A., Moumeni, A., Razmjou, G., & Nabipour, A.R. 2015. Mass screening of different rice genotypes to rice Striped stem borer, *Chilo suppressalis* (Walker) (Lep.: Pyralidae), under the field condition. *Journal of Entomology Society of Iran*, 35(2): 49-61. (In Persian with English abstract).

Chaudhary, R.C., Khush, G.S. & Heinrichs, E. A. 1984. Varietal resistance to rice Stem-borers in Asia. *Insect Science and its Application*, 5(6): 447–463.

Ghule, S.D., Patel, K.G. & Pandya, H.V. 2008. Seasonal incidence of Rice ear head bug (*Leptocorisa acuta* Thun.) of paddy in south Gujarat. *Insect Environment*, 14(1): 7-8.

Gomez, K.A. & Gomez, A.A. 1984. Crop Loss Assessment in Rice, pp. 55-65. In: Walker, P.T. (ed.) *Statistical Procedures for Agricultural research*. International Rice Research Institute, Manila (Philippines), Wiley, London and New York.

Henrichs, E.A. 1994. Host plant resistance, pp. 517- 548. In: Heinrichs, E.A. (ed.), *Biology and Management of rice insects*. IRRI. Wily Eastern Ltd.

Hosseini, S.Z., Babaeian–Jelodar, N. & Bagheri, N. 2010. Evaluation of resistance to striped stem borer in rice. *Journal of Biharean Biologist*, 4(1): 67-71.

IRRI (International Rice Research Institute), 1978. Annual report for 1977. (IRRI) Los Banos, Philippines.

IRRI (International Rice Research Institute),2010. Standard evaluation system for rice. International Rice Research Institute, Manila, Philippines (IRRI). Available online in: http://beta.irri.org/index.php/Home/Welcome/FrontPage.

Israel, P. 1967. Varietal resistance to rice stem borers in India. pp. 391-403, In: *The Major Insect Pests of the Rice Plant*, Johns Hopkins University Press, Baltimore.

Jodon, N.E. & Ingram, J.W. 1948. Survey of rice varieties for possible resistance to stalk borers *Sogatodes oryzicola* (Muir). *Crop Science*, 10: 687-689.

Khan, S., Murtaza, M.G. & Mir, H. 2010. Screening of Six Rice Varieties against Yellow Stem Borer, *Scirpophaga incetulas* Walker. *Sarhad Journal of Agriculture*, 29(4): 591-594.

Khush, G.S., 1984. Breeding rice for resistance to insects. *Protection* Ecology, 7: 147-165.

Kudagamage, C. & Nugaliyadde, L. 1995. Present status and future directions of insect pest management in rice, pp. 39-54, In: Amarasiri, S.L., Nagarajah, S. & Perera, M.B.K. (Eds.) *Proceeding Rice Symposium*, Kandy (Sri Lanka): DOASL Rice Congress.

Majidi-Shilsar, F. & Ebady, A.A., 2013. Management of striped stem borer, *Chilo suppressalis* Walker on hybrid rice in the paddy field. *Journal of Plant Protection*, 26: 416-423. (In Persian with English abstract).

Munakata, K., Saito, S., Ogawa, T. & Ishii, S. 1959. Oryzanone an attractant to the rice stem borer. *Bulletin* of the *Chemical Society of Japan*, 23: 64–65.

Ntanos, D.A. & Koutroubas, S.D. 2000. Evaluation of rice for resistance to pink stem borer *Sesamia nonagrioides* Lefebre. *Field Crops Research*, 66: 63-71.

Pasalu, I.C. & Katii, G. 2006. Advances in eco friendly approaches in rice IPM. *Journal* of *Rice Research*, 1(1): 83-90.

Patanakamjorn, S. & Pathak, M.D. 1967. Varietal resistance to Asiatic rice stem borer, *Chilo suppressalis* (Walker) in rice and its association with various plant characters. *Annals of the Entomological Society of America*, 50: 287-292.

Pathak, M.D., Andres, F. Galacgac, N. & Ramos, R. 1971. Resistance of rice varieties to striped rice borer. *IRRI Technical Bulletin*, 11.

Pathak, M.D. 1975. *Insect Pests of Rice*. International Rice Research Institute, Phillippines.

Rubia-Sanchez, E.G., Sigit, D.W., Heang, K.L., Zalucki, M.P. & Norton, G.A. 1998. Some factors affecting white stem borer *Scirpophaga innotata* (Walker) (Lepidoptera: Pyralidae) injury to rice. *Crop Protection*, 17: 529-534.

Sarwar, M. 2012. Management of rice stem borers (Lepidoptera: Pyralidae) through host plant resistance in early, medium and late plantings of rice (*Oryza sativa* L.). *Journal of Cereals and Oilseeds*, 3(1): 10-14.

Sarwar, M. 2013. Valuation of some Aromatic Rice (*Oryza sativa*) Genetic Materials to Achieve Tolerant Resources for Rice Stem Borers (Lepidoptera: Pyralidae). *International Journal* of *Scientific Research in Environmental Sciences*, 1(10): 285-290.

Sfakianakis, I.N., Vimplis, I., Staurakis, G. & Fytizas, E. 1981.Insecticide evaluation for control of *Sesamia nonagrioides* in maize. *Benaki Phytopathological Institute*, 13: 73- 79.

Shiraki, T. 1917. Paddy borer, *Schoenobius incertulas* Walk. Taikiku Agriculture Experimental Statistical.

Smith, C.M. 1989. *Plant Resistance to Insects: A Fundamental Approach*. John Wiley and Sons. New York.

Steel, R.G.D. & Torrie, J.H. 1980. *Principles and Procedures of Statistics: A Biometrical Approach*. 2nd Edition. McGraw-Hill. New York.

Van, T.K. & Guan, G.K. 1959. The resistance of *Oryza ridleyi* Hook to paddy stem borer (*Chilo suppressalis* Walk.) attack, *Malayan Agriculture Journal*, 207-210.

Viajante, V. & Heinrichs, E. A. 1987. Plant age effects of rice cultivar IR46 on the susceptibility to the yellow stem borer *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae). *Crop Protection*, 6: 33–37.

Visalakshmi, V., Harisatyanarayna, N.,Jyothula, D.P.B., Raju, M.R.B. & Ramana Murthy, K.V. 2014.Screening of rice germplasms for resistance to yellow stem borer *Scirpophaga incertulas* (Walker). *International Journal of Plant, Animal and Environmental Sciences*, 4: 129-133.

Xu, J., Qi-Xinag , W. & Jin Cal, W. 2010. Resistance of cultivated rice varieties to *Cnaphalocrosis medinalis* (Lepidoptera: Pyralidae). *Journal of Economic Entomology*, 103(4): 1166-1171.

فصلنامه گیاه‌پزشکی
دانشگاه آزاد اسلامی شیراز
۱۳۹۷ - ۹ (۴) : ۲۸٤-۲۹۷

ارزیابی ژنوتیپ های برنج امید بخش برای مقاومت کرم ساقه خوار نواری برنج *Chilo suppressalis* (Lepidoptera: Crambidae) در شرایط مزرعه

فرزاد مجیدی شیل سر*، مهرزاد اله قلی پور
موسسه تحقیقات برنج کشور، رشت، سازمان تحقیقات، آموزش و ترویج کشاورزی، تهران، ایران
(*) majidi14@yahoo.com

چکیده

کرم ساقه خوار نواری برنج، *Chilo suppresalis* یکی از مخربترین آفات برنج در سراسر جهان از جمله ایران است و موجب کاهش عملکرد آن می شود. امروزه استفاده از ارقام مقاوم به آفت مذکور، یکی از روش های قابل اطمینان برای مدیریت تلفیقی آفات برنج است. هدف از این مطالعه شناسایی لاین‌ها (ژنوتیپ‌های) برنج مقاوم به ساقه-خوار نواری برنج و تعیین خصوصیات گیاهی مرتبط با مقاومت است. در این پژوهش از مجموع ٦٣ لاین برنج در طول سال های ١٣٩٦-١٣٩٥ تحت شرایط آلودگی طبیعی مورد ارزیابی قرار گرفت. این لاین ها دارای تغییرات قابل توجهی در ارتفاع گیاه (١٤٩-٨٤/٣٩ سانتی متر)، قطر ساقه (٦/٣-٣/٧ میلی متر)، طول خوشه (٣٢/٩-٢١/١سانتی متر)، تعداد لارو (٦٩/٥٠-٣/٨٣ عدد)، دوره رشد (١٣٨-١٠٨روز)، درصد خوشه های سفید شده (١١/٧٢-١/١١ درصد) و عملکرد دانه (٨/٢-٣/٧ تن در هکتار) در ارتباط با آفت مذکور از خود نشان دادند. نتایج نشان داد که درصد آلودگی خوشه های سفید شده به طور معنی‌داری با ارتفاع گیاه، قطر ساقه و طول خوشه رابطه دارد. همچنین کاهش عملکرد دانه با افزایش قطر ساقه، افزایش آلودگی و سفید شده خوشه ها ارتباط معنی‌داری وجود داشت. تجزیه خوشه ای بر اساس ویژگی های مورفولوژیکی مورد مطالعه نشان داد که تمام ژنوتیپ ها به سه گروه تقسیم شدند. به طوری که، ژنوتیپ‌های ٨، ٢٦ و ٢٩ به ترتیب در کلاس های A، B و C قرار گرفتند. در میان تمام ژنوتیپ ها، لاین گروه سوم (کلاس C) می تواند به عنوان ژنوتیپ‌هایی برای برنامه‌های اصلاحی برای دستیابی به ارقام برنج جدید متحمل به کرم ساقه‌خوار نواری استفاده شوند.

واژه‌های کلیدی: مدیریت تلفیقی، برنج، ساقه-خوارنواری، مقاومت