Pakistan Entomologist

Journal homepage: www.pakentomol.com

STRAINING INDICA RICE GENOTYPES FOR RESISTANCE AGAINST PREVELENCE OF LEAFFOLDER *CNAPHALOCROCIS MEDINALIS* GUENEE AND STEM BORERS *SCRIPOPHAGA INCERTULAS* WALKER

Muhammad Akhter, Samta Zia, Zulqarnain Haider and Arshad Makhdoom Sabir

Rice Research Institute, Kala Shah Kaku, Lahore, Pakistan

ARTICLE INFORMATION

Received: April 27, 2014
Received in revised form: August 21, 2014
Accepted: January 20, 2015

***Corresponding Author**:
Muhammad Akhter
E-mail: director_rice@yahoo.com

ABSTRACT

Leaffolder and stem borers have been reported the most detrimental insect pests of rice and cause substantial yield losses at multiple stages during lifecycle of rice crop. Subsequently, a study was conducted to measure the levels of resistance present in different medium grain varieties and promising high yielding lines of rice, developed at Rice Research Institute, Kala Shah Kaku. Of all the twenty three genotypes studied, mostly showed significant difference in their level of resistance against all the three studied insect pests. Scatterplots against years 2012 and 2013 indicated high degree of stability of these genotypes for resistance against each insect during both the years. KSK-459 was found least susceptible against leaffolder during both the years, followed by line PK-8649, IR-77186 and IR-81852. KSK-459, KSK-460, KSK-461, KSK-462, KSK 454 and lines IR 77186, IR 81852 were found resistant and showed least occurrence of dead heart due to stem borers. Likewise, KSK-459, KSK-460 and KSK-462 and lines IR-77186, IR-81852 were found resistant and showed least occurrence of white head among all the studied genotypes. Therefore, KSK-459, IR-77186 and IR-81852 may be utilized in different breeding programs as reliable and stable source for resistance against all the three insect pests for development of insect resistant varieties/ hybrids.

Keywords: *Oryza sativa,* rice genotypes, leaffolder, stem borer, cluster analysis, scatterplots.

INTRODUCTION

Rice (*Oryza sativa* L.) is the second most important cereal crop of Pakistan after wheat and cotton. It plays an important role in economy of Pakistan. Total area of Pakistan under rice cultivation is 2891 (000) hectares giving average yield of 2423 Kg/ hectare (Anonymous, 2015). Rice crop yield is relentlessly reducing every year due to severe attack of a number of pest starting from nursery to harvest (Rehman *et al.,* 2002). Among these insect pests, rice stem borer (*Tryporyza incertulas)* and rice leaffolder (*Cnaphalocrocis medinalis)* are of prime importance. Rehman *et al.* (2002) further reported that rice stem borer (*Scirpophaga incertulus* and *S. innotata)* are serious pests of rice in south and West East Asia. Besides other insect pest of rice, stem borers, the most serious, about 20 species of which damage rice plant but only two of them are of serious concerns (*Tryporyza incertulus* & *Tryporyza innotata* Walker) (Nazir, 1986) including South and South East Asia (Rehman *et al*., 2002). Yellow stem borer alone causes yield losses up to 10 million tons and accounts for 50% of all insecticides used in rice fields (Huesing and English, 2004). Rice Leaffolder damages the crop at the larval stages by scraping as well as rolling the leaves (Bashir *et al.,* 2004). This activity results in the severe disturbance of photosynthetic activity of plant resulting in alarming yield losses (Alvi *et al.,* 2003). The leaves are then predisposed to bacterial and fungal infections (Sabir *et al.,* 2006; Sabir *et al*., 2012) resultantly more chances of fungal and viral diseases. Therefore, it has become of prime importance to find resistant sources and to develop resistant rice varieties that is also economical and environment friendly (Abro *et al*., 2003; Chaudhary *et al*., 1998). Cultivation of resistant varieties of rice will play a significant role in integrated management systems in rice (Sabir *et al*., 2014). So, the study was conducted with a specific objective to evaluate the performance of different medium grain rice varieties/ promising lines of Rice Research Institute, Kala Shah Kaku against RLF and stem borers of rice.

Cite this article as: Akhter, M., S. Zia, Z. Haider and A.M. Sabir, 2015. Straining indica rice genotypes for resistance against prevelence of leaffolder *Cnaphalocrocis medinalis* Guenee and stem borers *Scripophaga incertulas* Walker. Pak. Entomol., 37(1):61-66.

MATERIALS AND METHODS

Studies were conducted under the natural agro-climatic conditions of experimental farm of research area at Rice Research Institute, Kala Shah Kuku, Lahore during year 2012 and 2013.

Preliminary screening of medium grain rice genotypes was done to identify the genetic sources of resistance and susceptibility under natural conditions, against the RLF *Cnaphalocrocis medinalis* and stem borers (*Scirpophaga incertulus)*. Seeds of all the genotypes under study were obtained from the Rice genetic laboratory of the institute and sown in experimental trial following Randomized Complete Block Design (RCBD). The seeds of the varieties/ lines were sown in 2nd week of April, each measuring 3x6m^2. The nurseries were sown on well raised beds and forty days old nursery was transplanted in plots with normal spacing of 9 inches at the rate of two seedlings per hill. For all the entries, in each row, two rows with 15 hills, were grown i.e. R x R and P x Pwere kept approximately 25 cm. The treatment was replicated thrice and varieties were tested for their level of resistant to natural population/ incidence of rice stem borers and Rice Leffolder. The crop was left insecticides free throughout the cropping season to create optimum conditions for pest multiplication. All the recommended agronomic measures were adopted during the experimentation. Observations were taken after thirty days of transplanting. The observations were recorded on the basis of damaged/folded leaves.

Data collection

Data were collected randomly throughout the plots. The percentage of folded leaves by RLF, was calculated by following formula:

$$\text{Folded leaves (\%)} = \frac{\text{No. of infested leaves per hill}}{\text{Total No. of leaves per hill}} \times 100$$

Then plants were randomly selected from each plot for dead hearts and white head data. Dead hearts and white head data was recorded by using formula used by Marwat et al; 1985 as follows;

$$\text{Rating \% Dead Heart} = \frac{\text{No. of dead hearts}}{\text{Total No. of tillers}} \times 100$$

$$\text{Rating \% White Heads} = \frac{\text{No. of white heads}}{\text{Total No. of tillers with panicles}} \times 100$$

The obtained percentage damage was then adjusted according to the given formula by Standard Evaluation System (SES) by International Rice Research Institute, Philippines (Anonymous, 2002).

$$\text{Adjusted \% damage rating} = \frac{\text{Rating \% of test entry}}{\text{Rating \% of susceptible check}} \times 100$$

The infestation % status of rice genotypes was also converted to 0-9 scale according to SES as follows: (Standard Evaluation System (SES) by International Rice Research Institute, Philippines (IRRI).

Scale	Leaf folder	White-head	Dead-heart
0	No damage	No damage	No damage
1	1-10%	1-5%	1-10%
3	11-20%	6-10%	11-20%
5	21-35%	11-15%	21-30%
7	36-50%	16-25%	31-60%
9	51% and above	26% and above	61% and above

0-1=Highly resistant,
1-3=Resistant,
3-5=Moderately resistant,
5-7=Susceptible,
7-9=Moderately susceptible and above
9=Highly susceptible

Data analysis

Scatterplot gives mono-graphical presentation within same field that assist more in comparing performances of genotypes/ observations between two variables i.e. years in this case, at same plot. Plot area was further divided into subplots indicating groups and subgroups of genotypes according to their level of resistance during both the years. The differences in genotypic resistance of rice were identified by taking the criterions; (a) the occurrence percentage of dead hearts, (b) the occurrence percentage of whiteheads, and (c) the leaf folding/ infestation percentage of RLF. Pooled and average data calculated were analyzed statistically and treatment means were compared by cluster analysis using MiniTab statistical software v16. Genotypes were grouped using dendrograms in different clusters of observations to classify genotypes into same groups depending on level of similarity. The similarity (ij), between two clusters i and j was given by the following formula:

$$s(ij)=100\ (1 - d(ij)/d\ (max)$$

Where d(max) is the maximum value in the original distance matrix, D.

RESULTS AND DISCUSSION

(a) Percent Leaf-folder infestation

The results (Fig. 1-2) clearly showed that most of the genotypes showed significant difference in leaffolder infestation percentage, and it ranged from 57.85 to 106.94 % and 49.00 to 101.34 % during 2012 and 2013 respectively, also indicated by smaller values of similarities between groups of genotypes. The observations present in same cluster are considered non-significantly different in resistance while those present in different clusters are considered significantly different. dendrogram (Fig. 4) plotted against years and

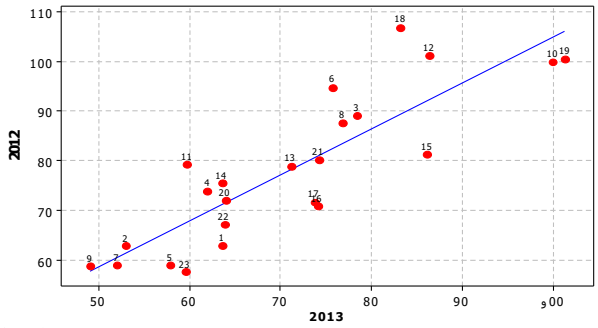

Fig. 1

Scatterplot showing performances of genotypes against leaffolder during both the years in comparison.

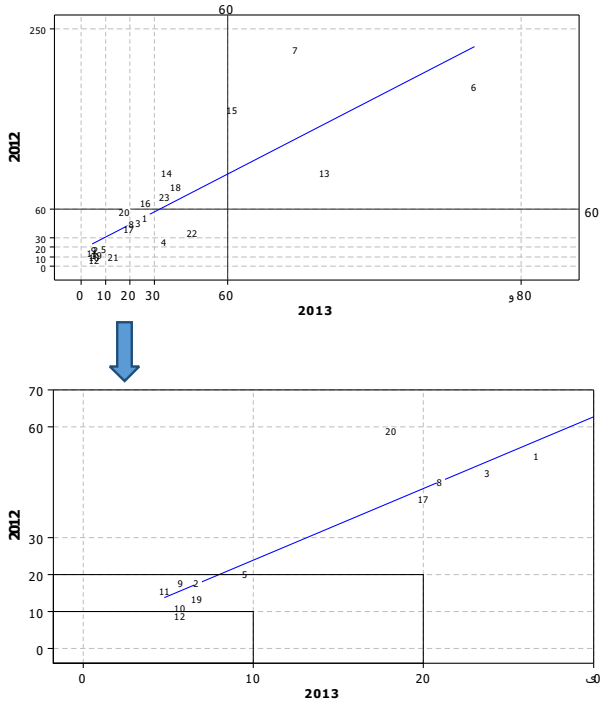

Fig. 2

Scatterplot showing performances of genotypes against stem borer (Dead heart) during both the years in comparison.

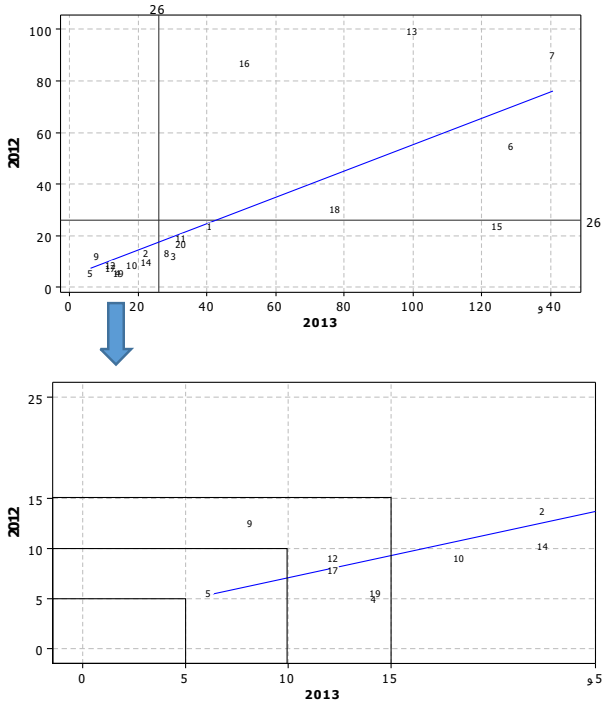

Fig. 3

Scatterplot showing performances of genotypes against stem borer (white head) during both the years in comparison.

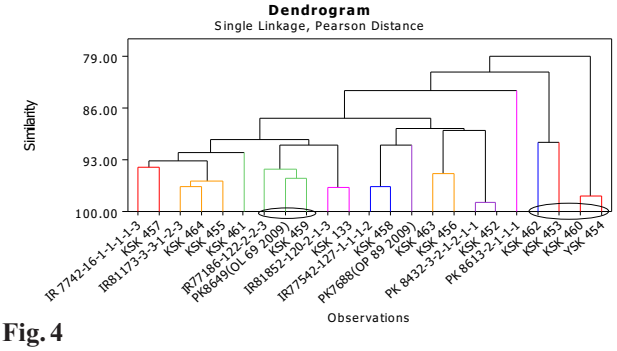

Fig. 4

Comparison of genotypes for their susceptibility to Leaffolder infestation (%) during 2012 and 2013.

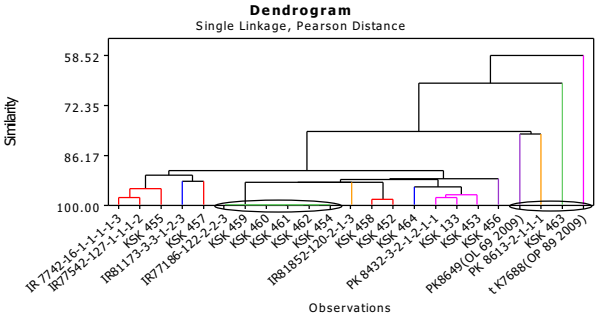

Fig. 5

Comparison of genotypes for their susceptibility to stem borer infestation (%) Dead heart during 2012-13.

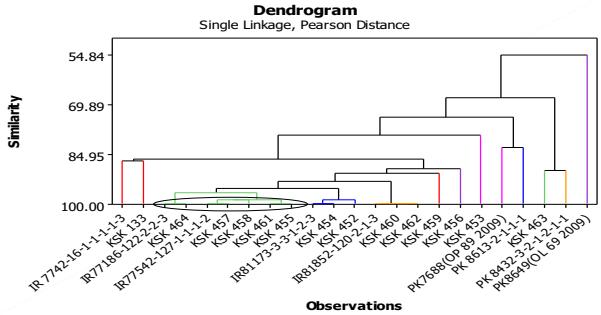

Fig. 6

Comparison of genotypes for their susceptibility to stem borer infestation (%) white head during 2012-13.

Table 1

Percentage Rating (R) of leaf infestation, dead heart and white head occurrences on the studied rice genotypes.

Genotypes	Leaf-folder infestation		Dead-heart		White-head	
	2012	2013	2012	2013	2012	2013
IR 7742	3.9	4.76	0.23	0.28	0.21	0.2
IR77186	3.89	3.97	0.08	0.07	0.12	0.11
IR77542	5.53	5.87	0.21	0.25	0.11	0.15
IR81173	4.58	4.64	0.12	0.36	0.05	0.07
IR81852	3.65	4.33	0.09	0.1	0.05	0.03
PK7688	5.88	5.67	0.84	1.69	0.48	0.63
PK8649	3.65	3.89	1.01	0.92	0.79	0.69
KSK 458	5.43	5.75	0.2	0.22	0.12	0.14
KSK 459	3.64	3.67	0.08	0.06	0.11	0.04
KSK 460	6.2	7.49	0.05	0.06	0.08	0.09
KSK 461	4.91	4.47	0.07	0.05	0.17	0.16
KSK 462	6.28	6.47	0.04	0.06	0.08	0.06
KSK 463	4.89	5.33	0.44	1.05	0.87	0.49
KSK 464	4.68	4.76	0.44	0.37	0.09	0.11
PK 8613	5.04	6.45	0.73	0.65	0.21	0.61
PK 8432	4.39	5.55	0.3	0.28	0.76	0.25
KSK 452	4.44	5.52	0.18	0.21	0.07	0.06
KSK 453	6.63	6.23	0.37	0.41	0.27	0.38
KSK 454	6.23	7.59	0.06	0.07	0.05	0.07
KSK 455	4.46	4.79	0.26	0.19	0.15	0.16
KSK 456	4.97	5.56	0.05	0.14	0.23	0.08
KSK 457	4.16	4.78	0.16	0.48	0.16	0.15
KSK 133	3.57	4.46	0.33	0.36	0.37	0.19

Table 2

Adjusted % Damage Rating (D) of leaf infestation, dead heart and white head occurrences on the studied rice genotypes.

Genotypes	Leaf-folder infestation (%)		Dead-heart (%)		White-head (%)	
	2012	2013	2012	2013	2013	2012
IR 7742	62.90	63.55	52.27	26.67	24.14	40.82
IR77186	62.74	53.00	18.18	6.67	13.79	22.45
IR77542	89.19	78.37	47.73	23.81	12.64	30.61
IR81173	73.87	61.95	27.27	34.29	5.75	14.29
IR81852	58.87	57.81	20.45	9.52	5.75	6.12
PK7688	94.84	75.70	190.91	160.95	55.17	128.57
PK8649	58.87	51.94	229.55	87.62	90.80	140.82
KSK 458	87.58	76.77	45.45	20.95	13.79	28.57
KSK 459	58.71	49.00	18.18	5.71	12.64	8.16
KSK 460	check	check	11.36	5.71	9.20	18.37
KSK 461	79.19	59.68	15.91	4.76	19.54	32.65
KSK 462	101.29	86.38	9.09	5.71	9.20	12.24
KSK 463	78.87	71.16	check	check	check	check
KSK 464	75.48	63.55	100.00	35.24	10.34	22.45
PK 8613	81.29	86.11	165.91	61.90	24.14	124.49
PK 8432	70.81	74.10	68.18	26.67	87.36	51.02
KSK 452	71.61	73.70	40.91	20.00	8.05	12.24
KSK 453	106.94	83.18	84.09	39.05	31.03	77.55
KSK 454	100.48	101.34	13.64	6.67	5.75	14.29
KSK 455	71.94	63.95	59.09	18.10	17.24	32.65
KSK 456	80.16	74.23	11.36	13.33	26.44	16.33
KSK 457	67.10	63.82	36.36	45.71	18.39	30.61
KSK 133	57.58	59.55	75.00	34.29	42.53	38.78
Min	57.58	49	9.09	4.76	5.75	6.12
Max	106.94	101.34	229.55	160.95	90.8	140.82

genotypes according to their levels of resistance against RLF during both the years, suggested KSK-459, PK8649 and IR77186 agglomerated in same cluster indicating their non-significantly different or almost similar level of resistance against the insect. Furthermore, all these genotypes showed highest resistance (ranging from 58.71-62.74% and 49.04-59.55% during 2012 and 2013 respectively) among all the genotypes. Likewise, two clusters KSK-454, KSK-460 and KSK-453, KSK-462 are at high similarity index showing highest leaffolder infestation (ranging from 100-106% and 100-101.34% during 2012 and 2013 respectively). During 2012, KSK-453 showed highest leaffolder infestation (D%) (106.94) and was highly susceptible followed by KSK-462 (101.29%), KSK-454 (100.48%) and KSK-460 (check), as indicated in table 2. Likewise, KSK-459 was least infested (58.71%) by leaf folder and showed highest resistance followed by lines PK8649 (58.87%), IR81852 (58.87%) and IR77186 (62.74%). During 2013, KSK 454 showed highest leaf folder infestation % (101.34) and was highly susceptible followed by KSK-460 (check), whereas, KSK-459 was again least infested (49.04%) by leaf folder and showed highest resistance followed by line PK8649 (51.94%), IR877186 (53.01%) and KSK-133 (59.55%).

(b) Stem borer (percent dead-heart)

The results given in Fig. 5 clearly showed that, the most of the genotypes showed non-significant differences for dead heart occurrence also indicated by higher values of similarity index (Fig. 5) except PK-7688, KSK-463, PK-8613, PK-8649 during both the years. Dendrogram (Fig. 5) clearly separated the clusters of genotypes on basis of their performances during both the years. IR-77186, KSK-459, KSK-460 (check), KSK-461 and KSK-462 are showed non-significant results and are present in same cluster. All these genotypes showed highest levels of resistance ranging from 4.76-18.18 during both the years.

During 2012, KSK-462, IR-77186, KSK-456, KSK-460, KSK-461, and KSK-454 showed least occurrence % of dead heart (D%). Whilst line PK-8649 (229.55%) showed highest occurrence of dead heart, followed by PK-7688 (190.91 %) and PK-8613 (165.91%). During 2013, KSK-461 (4.76%) showed highest infestation percentage followed by KSK 459, KSK 460 and KSK 462. Most of the other genotypes showed less occurrence of dead heart as compared to leaffolder infestation. Conversely, PK 7688 (160.95%) showed highest occurrence percentage followed by PK 8649 (87.62%) and PK 8613 (61.90%).

(c) Stem borer (Percent white head)

The results given in Fig. 6 clearly indicates that the most the genotypes showed non-significant difference in stem borer infestation percentage and it ranged from 5.75-90.8% and 6.12-140.82% during 2012- 2013, respectively. As indicated by dendrograms (Fig. 6), based on single linkage, showing clusters of genotypes on the basis of similarity, it is clear that PK 8649 lies in separate cluster and performed significantly different from other genotypes. Likewise, PK 7688 and PK 8613, lying in another cluster, were also significantly different from other varieties/ lines. During 2012, PK 8649 showed highest infestation percentage (90.8%), followed by PK 8432 (87.36%) and PK 7688 (55.17%) (Table 2). Likewise, PK 8649 (140.82%) showed highest infestation followed by PK 7688 (128.57%), PK 8613 (124.49%) during 2013 (table 2). almost all the other genotypes remained completely and partially un-attacked by the stem borer and showed nearly zero to moderate symptoms of white head occurrence (%). The results shows that percentage occurrence was significantly different for some of the genotypes due to their differential preference of the borers for some genotypes over other.

Scatterplots

Scatterplots (Fig. 1-3) represent plotting of studied genotypes against both the years 2012 and 2013 at y- and x-axis respectively pertaining to each insect separately. Upwards trend line (positive slope) shows that there is a positive association in data for both the years. It indicates similar mode of resistance of each genotypes during both the years against all the three insect pests. Scatterplots also provide a tool of easy prediction for the level of resistance of each genotype according to 0-9 scale (mentioned earlier) by separating genotypes in different groups as shown in Fig. 1-3.

CONCLUSION

Results indicate that these genotypes/ lines have significantly different level of resistance for the Leaffolder and borers. Genotypes showing high level of resistance can be used as a good source of resistant genes for the insects. Furthermore, variability in resistance among the genotypes indicates that resistance may be enhanced further to develop highly insect resistant cultivars of rice to reduce losses by these insects to its lower level. Scatterplots against year 2012 and 2013, indicates high degree of stability of all the genotypes against each insect. In case of leaf folder, none of the studied line showed dominant resistance against the insect. KSK 459 was found least susceptible against leaffolder, followed by lines PK 8649, IR 77186 and IR 81852. Likewise, KSK 459, KSK 460, KSK 461, KSK 462, KSK 454, lines IR 77186 and IR 81852 were found resistant and showed least occurrence of dead heart due to stem borers. Similarly, KSK 459, KSK 460, KSK 462, line IR 77186 and IR 81852 were found resistant and showed least occurrence of white head among all the studies genotypes. Therefore, KSK 459, IR 77186 and IR 81852 may be used in breeding program as reliable and stable source for resistance against all the three insect pests for insect resistant variety. It may further be concluded that scatterplot and cluster analysis give firm support to distinguish the performances of large number of genotypes and to find out best performing genotypes, to be used in future breeding programs. Percentage occurrence of insect attack was significantly different among the genotypes due to their differential preference of the insects for some genotypes over other.

REFERENCES

Abro, G.H., G.M. Lakho and T.S. Syed. 2003. Relative resistance of some rice cultivars to yellow, *Scirpophaga incertulus* and Pink, *Sesamia inferens* stem borers. Pak. J. Zool., 35(2): 85-90.

Alvi, S.M., M.A. Ali, S.U. Chaudhary and S. Iqbal. 2003. Population trends and chemical control of rice leaffolder (*Cnaphalocrocis medinalis*) on rice crop. Int. J. Agric. Biol. 5: 615- 617.

Anonymous, 2002. Standard Evaluation System for Rice (SES). Intern. Rice Res. Inst., Manila, Philippines.

Anonymous. 2015. Economic survey of agriculture 2014–15, Government of Pakistan, Finance Division, Economic Adviser's Wing, Islamabad, Pakistan pp: 28.

Bashir, K., H. Tayyab, F. Tahira, L. Zakia, S.A. Mehdi and R. Sheikh. 2004. Field evaluation and risk assessment of transgenic indica basmati rice. Mol. Breed., 13 (4): 301-312.

Chaudhary, J.C.S., M. Islam., M. Rahman and M.H. Khan, 1998. Threshold based application of insecticide: an important component of integrated pest management of rice. Bang. J. Entomol., 8(2): 109-121.

Huesing, J. and L. English. 2004. The impact of Bt crops on the developing world. Agric. Biol. Forum. 7(1-2) 84-95.

Marwat, N.K., U.K. Baloch and Abdul- Latif. 1985. Resistance of some new rice cultivars against the attack of *Trypoyza spp.* Stem borers. Pak. J. Zool., 17:357-361.

Nazir, H., 1986. Biology, population dynamics and control of *Cnaphalocrocis medinalis* (Gn.). M.Sc. Thesis, Deptt. Agric. Entomolo., Univ. Agric., Faisalabad, Pak.

Rehman, A., E.U. Haq and C. Inayatullah. 2002. Impact of tillage practices and cropping system on the survival of over wintering rice stem borer larvae. Pak. J. Agric. Res. 17(2): 163-169.

Sabir, A.M., S. Ahmed and A. Qadir, 2012. Role of weather on major pest insects of rice crop and their control. LAP LAMBERT Academic Publishing, Germany, p: 100.

Sabir, A.M., M. Akhter, A. Qadir, I. Haider, M. Rizwan and S. Zia, 2014. Feeding Behaviour of Leaffolder *(Cnaphlocrosis medinalis* Gn.) and rice germplasm preference. 34th Pak. Congr. Zool., BZU, Multan, Pak., February 25- 27. Abstr. PC- 15, pp: 132- 133.

Sabir, A.M., S. Ahmad, M. Hassan and A. Qadir, 2006. Pest weather interaction of major insect pests in rice ecosystem. SAARC J. Agric., 4: 203-212.