



Impact of Angoumois Grain Moth, *Sitotroga cerealella* Olivier (Lepidoptera: Gelechiidae) on the Viability of Maize Seed

Shahab-U-Din¹, Azhar A. Khan^{2*}, Khalid Mehmood³, Ata-Ul-Mohsin¹,
Arif M. Khan⁴ and Muhammad Afzal²

¹Department of Entomology, PMAS Arid Agriculture University, Rawalpindi, Pakistan.

²Department of Entomology, University of Sargodha, Sargodha, Pakistan.

³Department of Plant Protection, King Saud University Riyadh, Saudi Arabia.

⁴Nuclear Institute for Biotechnology and genetic Engineering, Faislaabad, Pakistan.

Authors' contributions

This work was carried out in collaboration between all authors. Author SD designed the study and performed laboratory analysis, author AAK wrote the protocol and wrote the first draft of the manuscript. Author KM managed the literature searches, author AM managed experimental procedure, author AMK done statistical analyses of the study and author MA identified the species of insects. All authors read and approved the final manuscript.

Short Communication

Received 27th February 2013

Accepted 11th May 2013

Published 16th June 2013

ABSTRACT

The current study was conducted to determine the viability of maize seed infested with Angoumois Grain Moth *Sitotroga cerealella* (Olivier). The aim was to see how different cultivars of maize are resistant to this pest. Seeds of four cultivars of maize viz. Pop 2006, Soan, Margalla and Islamabad gold were examined in Stored Product Laboratory of Department of Entomology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi during the year 2009-2010. The Pop-2006 appeared susceptible for *S. cerealella* egg hatching with 91.66% hatchability and minimum percent hatchability in Margla with 89.33%. Maximum and minimum percent infestation 9.30 ± 0.35 and 6.30 ± 0.58 in Islamabad gold and Pop 2006 respectively. Results indicated that maximum percent grain losses in Islamabad gold and minimum in Pop 2006, i.e. 51.91 ± 1.91 , and 30.06 ± 0.70 (mean \pm SE) respectively. The cultivars Pop 2006 and Marglla are considered as important part in IPM tools to control the store grain losses in maize crop. Present study

*Corresponding author: E-mail: azhar512@gmail.com;

was conducted to evaluate the resistance of different maize cultivars against the *S. Cerealella*. The finding may improve the good quality store of the products with minimal use of synthetic chemicals.

Keywords: Host plant resistance; maize cultivars; stored grains.

1. INTRODUCTION

Maize is an important grain widely used as food products and provides raw material for food industry in Pakistan. Maize is an important cereal and has been grown all over the Pakistan, however considered as minor crop. The area under cultivation for maize is 939 thousand hectares and total annual production is 3341 thousand tones with average 280kg/hectare [1]. Recently, the alarming population growth rate in Pakistan has evidently marked the food security problem. Comparing the total increase in human population (3%) in the last two decades has not only nullified the increased cereal production but also urged the nation to import substantial quantities of food to supplement the domestic supplies [2]. Maize like other food grains is infested by a number of insect pests; Angoumois grain moth, weevils, confused beetle, saw- toothed grain beetle and mites are the main storage pests of maize and the germination loss due to the attack of storage pests on cereals and pulse grains ranges from 37% to 88%, respectively at the same time the weight loss for these grains also ranges from 14% to 29% for cereals and pulses, respectively [3]. A single larva of *S. cerealella* per kernel is responsible for 13-24 percent economic losses in grain weight [4] and also decreases the nutritive value of grain. The eggs which are laid on/near the grain hatch into minute white larvae which bore into the kernel of grain and begin feeding on its content [5]. Larval feeding of *S. cerealella* causes a reduction in grain weight and quality. Heavily infested grains smell bad and are less attractive for consumption. Corn infested with this insect contains ears with small holes on individual kernels. In bins, however, only the top few inches of grains were found infested [6]. All stored grain insect pests have the fact of liking/ disliking for the grains which helps the plant breeders to develop the new varieties which are less susceptible to attack of the insect pest [7]. Being a safer and economical IPM tool, host plant resistance is a sector which needs more focus in exploring and evolving relatively more resistance cultivars of different cereal crops to overcome the food deficiency threats. The finding may be useful as a baseline to perform any genetic studies for seed viability under influence of store grains insect pests.

2. MATERIALS AND METHODS

The present study was conducted in the Stored Product Laboratory of Department of Entomology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi during the year 2009-2010. The egg culture of *Sitotroga cerealella* was obtained from the insect rearing laboratory, CABI (Centre for Agriculture and Biosciences International) South Asia, Rawalpindi, Pakistan. Maize seeds of four cultivars; Pop 2006, Soan, Margalla and Islamabad gold were obtained from National Agricultural Research Center, Islamabad. The collected grains were subjected to slight heat treatment for 4-5 minutes to avoid any risk of external variable. 200 gm grains of each cultivar were used as treatment with three replicates. 200 ml jars were sterilized at 100°C to avoid any contamination and weighed empty and 200 gm grains of each maize cultivar put into each of the jar. After that, 100 eggs of *S. cerealella* glued on paper card were placed in each jar and the hatched larvae were allowed to infest maize grains. The jars were covered with muslin cloth and placed in the

Growth Chamber 16:08 day light, $29 \pm 1^\circ\text{C}$ temperature and $70 \pm 5\%$ RH. All treatments were observed on daily basis if there is any mortality of *S. cerealella* larvae. Data regarding percent weight loss, infestation and germination was observed with interval of 30, 60 and 90 days by using following equations.

- $\text{Weight losses \%} = \frac{W_i - W_f}{W_f} \times 100$

Where,

W_i = Initial weight of gains

W_f = Final weight of grains

- $\% \text{ Infestation} = (\text{Infested grains} / \text{Total grains}) 100$

The data was analyzed statistically by using ANOVA and LSD test to know the statistical difference among treatments. Simple correlation between parameters related to viability of maize seed against *S. cerealella* was also calculated.

3. RESULT AND DISCUSSION

The hatchability percentage of *S. cerealella* eggs was checked for each maize variety under observations after a week interval (Table 1). The minimum mean value for total number of eggs hatched per jar was 89.33 in Margalla and maximum number of 91.66 in Pop 2006. The average hatchability *S. cerealella* eggs was 91.66, 90.66, 89.33, and 90.33 percent on Pop 2006, Soan, Margalla and Islamabad gold, respectively. Results showed similarities with the findings of [8]. They related an arrestment in the development of *S. cerealella* when reared on 71 corn varieties. No relation was found between the grain hardness and hatchability or other biological factors. It was observed that biology of the insect under study remained same on all varieties.

There was observed the maximum percent infestation (9.30 ± 0.35) in Islamabad gold and Pop 2006 as minimum as 6.30 ± 0.58 (Table 3). Soan and Margalla did not show any significant difference in mean \pm SE values, 7.13 ± 0.67 and 7.83 ± 0.20 , respectively while Islamabad gold showed a highly significant difference from Pop 2006 as 6.30 ± 0.58 and 9.30 ± 0.35 , respectively at 0.05 level of confidence and [$F_{(3, 11)} = 24.4$, $P < 0.002$] level of significance. The results showed Pop 2006 as relatively resistant and Islamabad gold as relatively susceptible variety after 30 days of infestation.

The observations showed maximum percent weight losses in Islamabad gold and minimum in Pop 2006, i.e. 51.91 ± 1.91 , and 30.06 ± 0.70 (mean \pm SE) respectively. Margalla and Soan were not significantly different from each other (Table 3). Islamabad gold, Pop 2006 and Margalla showed significant difference among them at [$F_{(3, 11)} = 31.3$, $P < 0.0001$] level of significance. The maximum and minimum percent infestation observed after 90 days of infestation showed the mean \pm SE value as 86.27 ± 3.40 and 60.23 ± 0.70 by Islamabad gold and Pop 2006, respectively. Least Significant Difference (LSD) test showed highly significant difference among Pop 2006, Soan and Islamabad gold, while Soan with mean \pm SE, 64.12 ± 0.67 showed least significant difference with Pop 2006 and Margalla (Table 3). Statistically, the level of significance was [$F_{(3, 11)} = 14.8$, $P < 0.0013$]. These results revealed that Islamabad gold was susceptible, Margalla less susceptible, Soan as moderately resistant and Pop 2006 as resistant variety among the four maize varieties under study. During this study Pop 2006 showed the minimum percent weight losses after 30 days of

infestation with mean \pm SE as 2.91 ± 0.36 and Islamabad gold showed the maximum infestation at 9.60 ± 0.66 (Table 2). The statistical analysis showed a significant value as $[F_{(3, 11)} = 6.09, P < 0.0184]$. It was observed that all the four varieties showed highly significant difference among them. Results revealed that Islamabad gold is relatively susceptible, Margalla as less susceptible, Soan as relatively resistant and Pop 2006 as highly resistant variety. After 60 days of infestation Margalla showed the maximum percent weight loss with mean \pm SE value 40.18 ± 1.45 and Soan showed minimum losses at 27.24 ± 1.48 . The LSD indicated no significant difference between all varieties (Table 2). The statistical analysis showed $[F_{(3, 11)} = 2.38, P < 0.000]$ high level of significance. The results indicated Maragalla as relatively susceptible and Soan as relatively resistant variety. Table 2 showed maximum percent weight loss in maize variety Islamabad gold with mean \pm SE value as 79.04 ± 4.01 and minimum with 49.06 ± 3.58 in pop 2006. LSD test showed that Margalla and Islamabad Gold have no significant difference between them. Similarly, Pop 2006 and Soan were significantly not different as shown in Table 2. Statistically, they showed high level of significance $[F_{(14, 935)} = 17.0, P < 0.0008]$. According to the results, Islamabad gold and Margalla were found relatively susceptible while Pop 2006 and Soan was found relatively resistant varieties. Our results are in conformity with [9]. He proved that local varieties with good husk cover and hard grain are resistant against *S. cerealella* and showed significant difference among varieties sown in Malawi [10], also observed upto 21% losses due to borers in maize crop during 2000-2001.

Table 1. Percentage hatchability of *S. cerealella* eggs on maize varieties

Variety	Total eggs/card	Eggs hatched(% hatchability)
Pop 2006	100	91.66
Soan	100	90.66
Margalla	100	89.33
Islamabad Gold	100	90.33

The eggs laid by *S. cerealella* was put on the paper and place in controlled growth chamber as mentioned early. The eggs were allowed to be hatched and percent mortality was counted from total number of eggs.

Table 2. Percentage weight loss (Mean \pm SEM) in maize varieties after 30, 60 and 90 days of infestation by *S. cerealella*

Host variety	Percentage weight losses (% Mean \pm SE)		
	After 30 days	After 60 days	After 90 days
Pop 2006	2.91 ± 0.36 d	29.06 ± 1.64 a	49.06 ± 3.58 b
Soan	4.58 ± 0.50 c	27.24 ± 1.48 a	56.82 ± 3.42 b
Margalla	6.33 ± 0.44 b	40.18 ± 1.45 a	68.80 ± 1.17 a
Islamabad Gold	9.60 ± 0.66 a	38.79 ± 11.07 a	79.04 ± 4.01 a

Values are incorporated are means \pm SEM for three values. LSD results showed the means in a column with same letters are not significantly different ($P > 0.05$).

Table 3. Percent infestation (Mean \pm SEM) shown by maize varieties after 30, 60 and 90 days of infestation by *S. cerealella*

Host variety	Percent infestation (% Mean \pm SE)		
	after 30 days	after 60 days	after 90 days
Pop 2006	6.30 \pm 0.58 c	30.06 \pm 0.70 c	60.23 \pm 0.70 c
Soan	7.1 \pm 0.24 bc	38.83 \pm 0.69 b	64.12 \pm 0.67 bc
Margalla	7.83 \pm 0.20 a	41.22 \pm 0.78 b	69.93 \pm 2.75 b
Islamabad Gold	9.30 \pm 0.35 a	51.91 \pm 1.91 a	86.27 \pm 3.40 a

Values are incorporated means \pm SEM for three values. LSD results showed the means in a column with same letters are not significantly different ($P > 0.05$).

4. CONCLUSION

Our findings conclude that the maize cultivar Pop-2006 presented more reproductive suitability for *S. cerealella* with lesser percent weight losses, which indicate its resistance against damages caused by this pest. Thus the cultivar Pop-2006 can be used as resistant cultivar to increase quality stored grains of maize crop.

ACKNOWLEDGEMENT

We thank Centre for Agriculture and Biosciences International (CABI) South Asia, Rawalpindi, Pakistan for providing egg culture of *S. cerealella* and National Agricultural Research Center (NARC), Islamabad for providing maize seeds.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous. Agricultural Statistics of Pakistan, Ministry of Economic Affairs and Statistics, Govt. of Pakistan, Islamabad; 2011.
2. Jibran KZ, Farooq M. Maize cereals with a variety of uses. The Dawn. 21 March 2008.
3. Adugna HG, Dangnew Z, Biniam, Biniam A. On-farm storages studies in Eritrea. Dryland Coordination Group. 2003;14:27-33.
4. Moore S, Petty HB, Luckman WH, Byers JH. Losses caused by Angoumois grain moth in Dent Corn. J. Econ. Entomol. 1966;59(4):880-882.
5. Cotton RT. Pests of stored grains and stored products. Burgess Publ. Co. Minneapolis USA. 1960;34:105-112.
6. Rees D. Insects of stored products. CSIRO Publishing, Collingwood, Victoria, Australia; 2004.
7. Sarin K, Sharma A. Varietal resistance and suitability to *Tribolium castaneum* (Herbst) in wheat. Ind. J. Entomol. 1982;44(2):197-200.
8. Flores JD, Castro GD, Moss CS. Susceptibilidad relativa de variedades colombianas de maiz al ataque de *Sitotroga cerealella* (Oliver). Rev. Per. Em. 1970;13:15-23.
9. Schulten G. Losses in Stored Maize in Malawi (C. Africa) and Work Undertaken to Prevent them. EPPO Bulletin. 1975;5:113-120.

10. De Groote H, Bett C, Okuro JO, Odeno M, Mose L, Wekesa E. Direct estimation of maize crop losses due to stem borers in Kenya Preliminary results from 2000 and 2001. Seventh Eastern and southern Africa Regional maize conference. 2001;401-406.

© 2013 Shahab-U-Din et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sciencedomain.org/review-history.php?iid=187&id=24&aid=1528>