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وحماية المستهلك

ESTIMATING THE DAMAGE CAUSED BY THE CORN STEM BORER, *SESAMIA CRETICA* LED. (LEPIDOPTERA: NOCTUIDAE) TO SOME MAIZE VARIETIES

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ABSTRACT

A field study was conducted at the College of Agricultural Engineering at the University of Baghdad to assess the susceptibility of maize varieties (Baghdad, Fajr and Maha) to the corn stem borer, *Sesamia cretica*. The results showed that the varieties differed in their susceptibility to the corn borer, with a significant difference between the Baghdad variety, which was the most susceptible variety, and the other varieties. The highest infestation rate was 30.49% on the Baghdad variety, and the lowest infestation rate was 9.84% on the Maha variety. The highest percentage of dead heart was 17.63% on the Baghdad variety, and the lowest percentage was 12.57% on the Maha variety. The results showed that the Baghdad variety had the highest percentage of loss in plant height 16.86% , number of larvae 2.90 larvae/plant, number of tunnels 5.86 tunnel/plant, tunnel length 15.79 cm/tunnel, and percentage of excavated area 11.01%. The lowest percentages were for the Maha variety, which were 10.5%, 1.57 larvae/plant, 3.81 tunnel/plant, 9.24 cm/tunnel, and 6.51%, respectively.

Keywords: Corn stem borer, excavated area, Maize varieties, Damage assessment

تقدير اضرار الاصابة بحشرة حفار ساق الذرة *Sesamia cretica Led* (Lepidoptera: Noctuidae) لبعض اصناف الذرة الصفراء

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الخلاصة

نفذت دراسة حقلية في كلية علوم الهندسة الزراعية/ جامعة بغداد لتقييم حساسية أصناف نبات الذرة الصفراء (بغداد و الفجر والمها) للإصابة بحشرة حفار ساق الذرة *Sesamia cretica*. بينت النتائج بان الاصناف كانت متفاوتة بحساسيتها للإصابة بحشرة حفار ساق الذرة مع وجود فرق معنوي بين الصنف بغداد الذي كان اكثر الاصناف حساسية للاصابة وباقي الاصناف اذ بلغت اعلى نسبة الإصابة 30.49 % على صنف بغداد وكانت اقل نسبة الإصابة على صنف المها اذ بلغت 9.84 %. لقد بلغت اعلى نسبة لموت القمة النامية 17.63 % على صنف بغداد واقل نسبة على صنف المها 12.57 %. وبينت النتائج ان الصنف بغداد اعطى اعلى نسبة للفقد في ارتفاع النبات 16.86 % ،اعداد اليرقات 2.90 يرقة ،اعداد الانفاق 5.86 نفق ،معدل اطوال الانفاق 15.79سم ،النسبة المئوية للمنطقة المحفورة11.01 %. اما اقلها فكان للصنف المها اذ بلغ (10.5 % ،1.57 يرقة ،3.81 نفق ، 9.24 سم ، 6.51 %) على التوالي .

الكلمات المفتاحية : حفار ساق الذرة ، *المنطقة المحفورة ، اصناف الذرة الصفراء ،تقدير الاضرار*

[*] **The article is taken from the master's thesis of the first researcher.**

INTRODUCTION

Maize (*Zea mays* L.) is a globally important strategic cereal crop, ranking third after wheat and rice in terms of global cultivated area and production. Its grains are an important food source for humans and animals, and its importance has increased rapidly due to the world's population growth and the expansion of livestock projects **(Ghnai, 2013).** There are many factors that affect the growth and yield of maize, including the number of plants per unit area. Plant density significantly affects leaf area, plant growth rate, number of ears, number of grains, and grain weight **(Khalaf &Hassan, 2022a; Khalaf &Hassan 2022b).** Maize is attacked by many insects, including the shoot fly *Atherigona soccata* Rondani, the cotton leafworm *Spodoptera littoralis*, the corn stem borer *Sesamia cretica*, and the corn leaf aphid *Rhopalosiphum maidis* **(Al-Karboli *et al.*, 1999; Al-Karboli &Al-Nakhli, 2006; Kumar *et al.*, 2018).** Many methods have been used to control these insects, both in the laboratory and in the field. **Al-Hassnawi &Al-Karboli (2009)** found that delaying the planting date of sorghum to the end of July instead of the recommended date in mid-July significantly reduced the incidence of corn borer and the dead heart on seedlings. Plant extracts have also been used to control *S. littoralis*, The ethanolic extract of black pepper *Piper nigrum* and *Withania somnifera* plant have shown high efficacy in controlling of *S. littoralis* **(Al-Khazraji *et al.*, 2016; Al-Jourany &Al-Khazraji, 2022).** Corn stem borer *Sesamia cretica* is one of the main pests that attack maize and sorghum, sugarcane, and other plants, causing significant economic damage. The loss rate on maize crop can reach more than 80% in case of early infestation due to the drilling of larvae in the stem, the feeding on the leaves, and the damage of the head **(Al-Azzawi *et al.*, 1990; Al-Karboli *et al.*, 1997).**

Maize crop have the ability to protect them from stem borer feeding by using different structural defense mechanisms. The plant's structural properties affect the natural feeding and establishment of the corn borer on maize **(Malvar *et al.*, 2008; Rodriguez *et al.*, 2021).** These structural properties represent the first line of defense against insects and play an important role in the resistance of the host plant to insects. Although there are many factors that affect these properties, such as the use of plant growth regulators or amino acids and different mineral elements, these properties remain a characteristic of a single plant variety **(War *et al.*, 2012; Alak *et al.*, 2013).** Many researchers have pointed out the importance and role of the structural properties of maize in the resistance to corn borer larvae. Some of the important structural properties that can be an indicator of plant resistance to insect infestation or feeding are the density of hairs, the diameter of the stalk, the hardness of the stalk bark, and the length of the meristematic region **(Santiago *et al.*, 2005; Rasool *et al.*, 2017; Guo *et al.*, 2022)**. Due to the importance of growing cereal crops in Iraq, including maize, the aim of this study was to investigate the sensitivity of some maize varieties to corn stem borer *S. cretica* infestation.

MATERIALS AND METHODS

Preparation of the field for autumn cultivation

A piece of land with an area of 750 m^2 was selected from the field of the College of Agricultural Sciences and Engineering at the University of Baghdad during the autumn season of 2022. All agricultural operations were carried out according to the recommendations for crop cultivation **(Al-Baldawi *et al.*, 2014).** The Baghdad, Fajr and Maha varieties were planted in plots and in rows at a distance of 75 cm between the rows and 20 cm between the plants

using a randomized complete block design (RCBD). The field was divided into equal plots of 5 × 5 m with a total of 6 blocks, each block containing 3 plots. The distance between one block was 1m. Three blocks were used at a rate of 3 replicates / variety to calculate the percentage of infestation and dead heart of the plants. The other three blocks were left to estimate the damage caused by the corn stem borer on the maize at a rate of 3 plots (replicates)/variety of the used maize varieties.

Evaluating the susceptibility of maize varieties to stem borer infestation *S. cretica*

The susceptibility of varieties to *S. cretica* infestation was evaluated based on the following criteria:

1. **Percentage of infestation**: The percentage of infestation was calculated directly after the appearance of the infestation on the plants in the field and weekly readings were continued until the harvest stage by counting the number of infested plants in each plot (replicate) and the total number of plants inside the plot at a rate of three replicates/variety according to the following equation:

$$\text{Percentage of infestation} = \frac{\text{Number of infested plants}}{\text{Total number of plans per plot}} x\ 100$$

2. **Estimation of the percentage of dead heart**: The percentage of dead heart was estimated after three weeks of the infestation appearance by counting all the plants in each replicate and counting the plants infested with dead heart. Dead heart can be easily distinguished by removing the apex of infested plants **(Al-Karboli &Al-Nakhli, 2006).**

3. **Estimation of the damage caused by corn stem borer on maize in the field:**

The damage caused by corn stem borer on plants was estimated after three weeks of the appearance of the infestation, based on the method of **Al-Jubori &Al-Karboli (2012).** Five infested and five non-infested (control) plants were randomly selected from below the crown area from each replicate/variety, and the data on the infestation were recorded weekly until the harvest stage as follows:

- **Loss in plant height:**

The height of the infested plant from the crown area to the flag leaf was measured and compared with the height of the healthy plant. The amount of loss in plant height for each of the studied varieties was calculated. The experiment was conducted at a rate of three replicates/variety.

- **Number of larvae:**

The number of larvae inside the infested stems was counted. The experiment was conducted at a rate of 3 replicates/variety.

- **Number of tunnels:**

The leaves surrounding the stem were removed and the stem was longitudinally sliced using a sharp tool gently to avoid damaging the larvae inside the stem in order to count the number of tunnels in the infested plants, which represent the feeding sites of the larvae. The experiment was conducted at a rate of three replicates/variety.

- **Tunnel lengths:**

The length of the tunnel was measured in cm and the total length of the tunnels was calculated. The experiment was conducted at a rate of three replicates/variety.

- **Percentage of the total excavated area / stalk of maize plant:**

After counting the number of tunnels inside the stems of the infested plants, the lengths of each excavated area were measured in cm and the lengths of the tunnels were added. The total length of the tunnels inside the stem was then calculated. The percentage of the excavated area was then calculated by applying the following equation:

$$\% \text{ of excavated area / plant } = \frac{\text{Total length of tunnels in the plant}}{\text{Plant length (cm)}} \; x\; 100$$

RESULTS AND DISCUSSION

Percentage of infestation by corn stem borer *S. cretica* during the autumn season

The results of Table (1) show that the infestation by *S. cretica* started to appear on August 28, 2022, at 8.63%, 18.13%, and 5.23% for the Baghdad, Fajar, and Maha varieties, respectively. The statistical analysis results indicated that there were significant differences between the different varieties in the percentage of infestation. The percentage of infestation started to increase during the stages of plant growth. The highest percentage of infestation was at the end of the season on the Baghdad variety, at 48.30%, followed by Fajar at 27.53%, and Maha at 16.10%. The results also showed that the highest rate of infestation was on the Baghdad variety, at 30.49%, making it the most sensitive variety to *S. cretica*. The Fajar variety had a rate of 22.29%, while the Maha variety had a rate of 9.84%, making it the most resistant variety. The difference in the percentage of infestation between the different varieties may be due to the differences in the physical and chemical factors that characterize each variety of maize. This is in agreement with what **Harba *et al.* (2017)** found that the percentage of infestation by *S. cretica* increases on maize as the plants grow and reach the maturity and harvest stages, The percentage of infestation was 2.17% on the American variety P2 and 13.97% on the Syrian variety P4 three weeks after germination. It increased to 9.07% and 27.07% for both varieties, respectively, when the floral inflorescences appeared. It reached 15.1% and 43% for both varieties, respectively, at harvest.

Table (1): Percentage of infestation of maize varieties with *S. cretica*.

Date	Percentage of infection %			
	Varieties			
	Baghdad	Fajr	Maha	Mean
28/8/2022	8.63	18.13	5.23	10.67
4/9/2022	15.40	19.80	6.10	13.77
11/9/2022	19.67	20.70	6.87	15.74
18/9/2022	26.67	20.70	7.57	18.31
25/9/2022	30.73	20.80	7.97	19.83
02/10/2022	37.73	21.80	9.07	22.87
09/10/2022	41.30	24.67	14.40	26.79
16/10/2022	45.93	26.50	15.23	29.22
23/10/2022	48.30	27.53	16.10	30.64
Mean	30.49	22.29	9.84	
4.467 = Interaction LSD		1.489 = Variety LSD		2.579 = Date LSD (0.05)

Percentage of dead heart in maize varieties

Figure (1) shows that the highest percentage of dead heart in maize due to the infestation by corn stem borer was 17.63% for the Baghdad variety, while it was 12.57% for the Fajr variety and 3.60% for the Maha variety. The statistical analysis results showed that there were significant differences in the percentage of infestation between the different varieties. The difference in the percentage of infestation with dead heart between the different varieties may be due to the difference in the genetic traits of the varieties, which play a role in the resistance of maize varieties to the infestation by corn borer. In a similar study, **Al-Jubori &Al-Karboli (2012)** indicated a difference in the percentage of dead heart in sorghum varieties, with the highest percentage of dead heart being 7.19% for the Lilo variety and the lowest percentage being 2.01% for the Babel variety, The researchers indicated that the decrease in yield is due to the infestation of plants by stem borer and the dead heart, which leads to the death of plants and a decrease in the number of plants in the unit area.

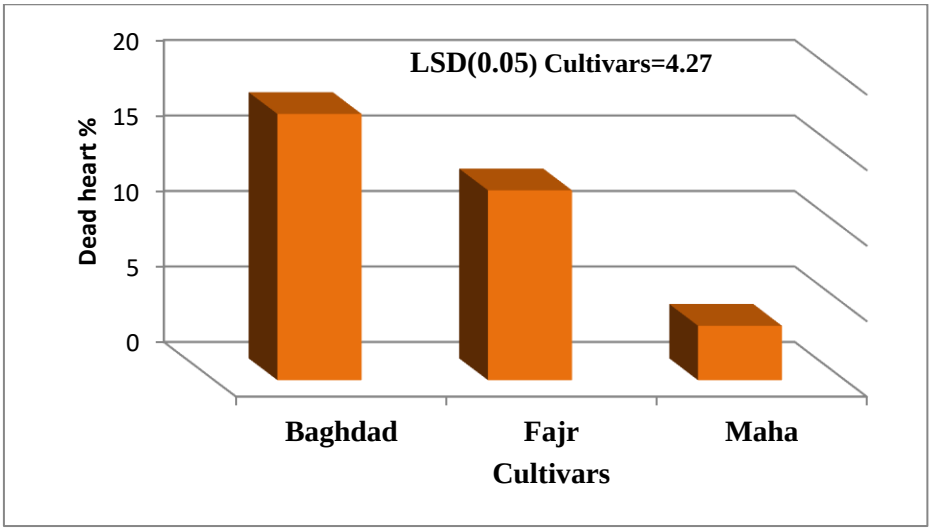

Figure (1): Percentage of dead heart in maize varieties.

Percentage loss in height of maize varieties

The results showed that the lowest percentage of loss in the height of maize plants was on September 11, 2022, at 4.70%, 2.97%, and 2.80% for the Baghdad, Fajr, and Maha varieties, respectively (Table 2). The percentage of loss in plant height began to increase gradually, and the highest percentage loss in plant height was on October 23, 2022, at 25%, 19.67%, and 15.37% for the Baghdad, Fajr, and Maha varieties, respectively. The results of the statistical analysis indicated that there were no significant differences between the Fajr and Maha varieties during the first three weeks, while significant differences were found between the Baghdad and Fajr, and Baghdad and Maha varieties. The results showed that the highest rate of loss in plant height was on the Baghdad variety, which reached 16.86%, while the loss rate in plant height on the Fajr variety was 12.29% and 10.05% on the Maha variety, with significant differences between the rates of the Baghdad and Fajr varieties. Ahmed and **Ahmed &Ahmed (2015)** reported that there were high significant differences in the rate of loss in the height of maize plants due to the feeding of corn stem borer larvae on different corn varieties,

as the percentage of loss reached 29.5% for the Cadz variety, 12.2% for the Buhooth 106 variety, and 6.8% for the Mas variety.

Table (2): Percentage loss in height of maize plants.

Date	Percentage loss in height %			
	Varieties			
	Baghdad	Fajr	Maha	Mean
11/9/2022	4.70	2.97	2.80	3.49
18/9/2022	11.33	7.93	7.40	8.89
25/9/2022	15.00	9.67	9.53	11.40
02/10/2022	18.00	13.03	10.37	13.80
09/10/2022	20.67	15.33	11.63	15.88
16/10/2022	23.33	17.40	13.23	17.99
23/10/2022	25.00	19.67	15.37	20.01
Mean	16.86	12.29	10.05	
2.345 = Interaction LSD 0.886 = Variety LSD 1.354 = Date LSD (0.05)				

Number of *S. cretica* larvae on the maize varieties

The results indicate that the number of corn stem borer larvae on the maize varieties Baghdad, Fajr, and Maha on September 11, 2022, was 2.66, 1.66, and 1.66 larvae/plant, respectively (Table 3). The results of the statistical analysis showed that there were significant differences in the number of larvae between the Baghdad variety and the other varieties, and no significant differences between the Fajr and Maha varieties. The results also showed that the highest number of larvae was on October 9, 2022, with 3.66 larvae/plant on the Baghdad variety, while the highest number of larvae on the Fajr variety was 2.00 larvae/plant. The results also showed that the highest average number of corn stem borer larvae was on the Baghdad variety, with 2.90 larvae/plant, followed by the Fajr variety with 1.71 larvae/plant, and the Maha variety with 1.57 larvae/plant. There were significant differences between the Baghdad variety and the other varieties. **Al-Hasnawi &Al-Karboli (2011)** reported that there are significant differences in the number of larvae/ plant between infested corn varieties, The increase in the number of larvae leads to an increase in the damage and loss that the plants are exposed to, and that affects the growth and thus reduces the yield of the varieties.

Table (3): Average number of corn stem borer larvae on maize varieties**.**

Date	number of corn stem borer larvae plant^{-1}			
	Varieties			
	Baghdad	Fajr	Maha	Mean
11/9/2022	2.66	1.66	1.66	2.00
18/9/2022	2.33	1.66	1.66	1.88
25/9/2022	3.66	1.66	1.33	2.22
02/10/2022	2.00	1.66	1.33	1.66
09/10/2022	3.66	2.00	1.66	2.44
16/10/2022	3.33	1.66	1.66	2.22
23/10/2022	2.66	1.66	1.66	2.00
Mean	2.90	1.71	1.57	
1.269 = Interaction LSD 0.479 = Variety LSD 0.733 = Date LSD (0.05)				

The number of corn stems borer tunnels on maize varieties

The results indicate that the average number of tunnels in the stem of maize plants (Table 4), which indicates the activity of the larvae in feeding, was 2.67, 2.00, and 1.67 tunnels/plant for the Baghdad, Fajr, and Maha varieties, respectively, on September 11, 2022. The results also showed that the highest average number of tunnels on the Fajr and Maha varieties was 5.33 tunnels/ plant for both varieties, respectively, on September 18, 2022, and the highest average number of tunnels on the Baghdad variety was on October 16, 2022, which was 7.00 tunnels/plant. The overall average number of tunnels was 5.86 tunnels/plant on the Baghdad variety, followed by the Fajr variety and the Maha variety, with averages of 4.10 and 3.81 tunnels/plant, respectively. **Harba *et al.* (2013)** reported that there were significant differences in the number of tunnels of corn borer feeding in the stem of maize varieties.

Table (4): Average number of corn stems borer tunnels on maize.

Date	number of corn stem borer tunnels/plant			
	Varieties			
	Baghdad	Fajr	Maha	Mean
11/9/2022	2.67	2.00	1.67	2.11
18/9/2022	5.00	5.33	5.33	5.22
25/9/2022	6.67	4.33	4.00	5.00
02/10/2022	6.67	4.00	4.33	5.00
09/10/2022	6.67	4.00	3.33	4.67
16/10/2022	7.00	5.00	4.67	5.56
23/10/2022	6.33	4.00	3.33	4.56
Mean	5.86	4.10	3.81	
1.598 = Interaction LSD 0.604 = Variety LSD 0.922 = Date LSD (0.05)				

The average length of tunnels on maize varieties

The results indicate that the average length of tunnels on maize stem was 5.70, 4.30, and 2.53 cm/tunnel for the Baghdad, Fajr, and Maha varieties, respectively on September 11, 2022 (Table 5). The results of the statistical analysis showed that there were significant differences in the length of tunnels between the Baghdad and Maha varieties. The results also showed that the highest value of tunnel length was 20.87 cm/tunnel on the Baghdad variety on October 2, 2022, while it was 17.80 and 14.30 cm/tunnel on the Fajr and Maha varieties, respectively. The overall average length of tunnels was 15.79 cm/ tunnel for the Baghdad variety, 12.90 cm/tunnel for the Fajr variety, and 9.24 cm/tunnel for the Maha variety. The decrease in the average length of tunnels in November may be due to the increased stiffness of plant tissue as the plant ages, which hinders the movement of larvae. The difference in the number and length of tunnels on maize varieties studied may be due to the differences in the chemical composition of the different varieties, which is one of the plant's defense mechanisms in terms of its effect on the *S. cretica* behavior or interfering with the metabolism. **Munyiri *et al.* (2013)** reported that the length of tunnels and the number of holes in the stem are considered to be important indicators for estimating the sensitivity of varieties to stem borers.

Table (5): Average length of tunnels on maize stem.

Date	Average length of tunnels (cm)			
	Varieties			
	Baghdad	Fajr	Maha	Mean
11/9/2022	5.70	4.30	2.53	4.18
18/9/2022	12.70	10.23	5.63	9.52
25/9/2022	19.87	16.43	12.03	16.11
02/10/2022	20.87	17.80	14.30	17.66
09/10/2022	19.77	16.77	12.93	16.49
16/10/2022	16.57	12.67	9.17	12.80
23/10/2022	15.07	12.13	8.10	11.77
Mean	15.79	12.90	9.24	
6.072 = Interaction LSD 2.295 = Variety LSD 3.506 = Date LSD (0.05)				

Percentages of excavated area in maize stem varieties

The results indicate that the percentage of the excavated area in the stem on September 11, 2022, was 6.73, 4.27, and 3.23% for the Baghdad, Fajr, and Maha varieties, respectively (Table 6). The results of the statistical analysis showed that there were significant differences in the percentage of the excavated area between the Baghdad variety and the other varieties. The results also showed that the highest percentage of the excavated area was 17.20, 13.27, and 11.20% for the three varieties, respectively, on October 23, 2022. The results also showed that the highest average percentage of the length of the excavated area was on the Baghdad variety which was 11.01% followed by the Fajr variety and the Maha variety with percentages of 7.56 and 6.51%, respectively. **Al-Jubori & Al-Karboli (2012)** indicated that there were significant differences in the percentage of the excavated area in the stems of infested plants.

Table (6): Percentage of excavated area in maize stem.

Date	Percentage of excavated area			
	Varieties			
	Baghdad	Fajr	Maha	Mean
11/9/2022	6.73	4.27	3.23	4.74
18/9/2022	10.93	7.00	5.27	7.73
25/9/2022	11.63	9.00	7.17	9.27
02/10/2022	8.30	4.77	4.10	5.72
09/10/2022	8.90	4.10	5.83	6.28
16/10/2022	13.40	10.50	8.77	10.89
23/10/2022	17.20	13.27	11.20	13.89
Mean	11.01	7.56	6.51	
5.319 = Interaction LSD 2.010 = Variety LSD 3.071 = Date LSD (0.05)				

CONCLUSION

The results of this study showed that the severity of damage caused by the corn stem borer *S. cretica* can vary depending on the variety of maize. The Baghdad variety of maize was the most susceptible to the *S. cretica*. The Baghdad variety had the highest infestion rate, percentage of dead heart, percentage of loss in plant height, number of larvae, number of tunnels, tunnel length, and percentage of excavated area. The Maha variety was the least susceptible variety, with the lowest values for all of the above parameters.

Farmers should choose maize varieties that are resistant to the corn stem borer to reduce the risk of crop loss, and these results suggest that the Baghdad variety should be avoided in areas where the corn stem borer is a problem. The Maha variety is a better choice for farmers in these areas. These findings highlight the importance of selecting and breeding maize varieties that are more resistant to the corn stem borer to mitigate the economic and agricultural impact of this pest.

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