

## Resistance of *Bt* Corn hybrid (MON 810 event: Ajeeb YG)<sup>®</sup> to the Corn Borers, *Sesamia cretica* Led., *Chilo agamemnon* Bles. and *Ostrinia nubilalis* Hbn. in Egypt.

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### ABSTRACT

Field experiments were carried out to study the effect of the encoding *Bt* gene in corn plants (Ajeeb YG<sup>®</sup> as a genetically modified hybrid) and conventional non *Bt* hybrid (Ajeeb)<sup>®</sup>, on the incidence of three corn borers, namely, the pink corn borer, *Sesamia cretica* Led., the purple-lined corn borer, *Chilo agamemnon* Bles. and the European corn borer, *Ostrinia nubilalis* Hbn., during the two successive seasons of 2007 and 2008. In the growing season of 2007, the study was conducted at five field sites located in four Egyptian governorates: (a) 10-Bezour-Noubaria (Behira), El-Shrouk-Noubaria (Behira), (b) Salhia (Esmailia), (c) Bassyoun (Gharbia) and (d) Bdahel (Beni Swief). While, in the growing season of 2008, three planted locations of three governorates were studied: 10-Bezour-Noubaria (Behira), Bassyoun (Gharbia) and Bdahel (Beni Swief). The infestation rates of the three assigned corn borers were determined under field conditions along with three growing stages (8-leaf, flowering and pre-harvest stages) of the tested plants. The insect infestation was expressed in number of living larvae and/or pupae/plant as well as number of holes/plant.

In both studied seasons, the data indicated that there were significant differences between the infestation of the three corn borers in *Bt* and the non *Bt* maize hybrids during the whole season in all locations. The *Bt*-plants of Ajeeb YG<sup>®</sup> hybrid showed a complete avoidance of the three corn borers infestation (0.00 larvae or pupae/plant) throughout the three growing stages of the tested corn plants in all locations and both seasons. Also, there were not any holes observed in the *Bt* hybrid in all sites throughout the both seasons.

On the other hand, the non *Bt* corn plants were more susceptible to the infestation of the three corn borers. The 8 leaf stage was more susceptible to *Sesamia cretica*. The highest infestation records were 1.35 and 1.60 living larvae or pupae/plant at Bdahel (Beni Swief) and Bassyoun (Gharbia) in seasons 2007 and 2008, successively. The heavily infestation of *C. agamemnon* occurred at the flowering stage at 10-Bezour-Noubaria (Behira) registering 1.28 and 0.93 living larvae or pupae/plant, in respect. The infestation level of *O. nubilalis* increased gradually with the progress of plant growing from flowering to Pre-harvest stage and elevated up to 4.25 living larvae or pupae/plant at Salhia (Esmailia) in 2007. While, the infestation of *O. nubilalis* in the conventional hybrids was the incisive compared with *S. cretica* and *C. agamemnon*. The infestation rate of *O. nubilalis* in 2007 recorded 7.95 and 2.17 living larvae or pupae/plant at Salhia (Esmailia) and Bassyoun (Gharbia) in 2008, sequentially. In addition, combining the infestation of the three corn

borers together showed that the highest infested governorates were Esmailia in 2007 and Gharbia in 2008 giving 9.64 and 6.11 living larvae or pupae/plant, respectively.

## INTRODUCTION

Corn is one of the important cereal crops in the world (138.37 million hectares), with the largest area of 28.72 million hectare (mha) being in the USA. In Egypt, next to wheat, maize is mainly used for animal feed, as well as human nutrition. Such importance has kept the maize acreage without reduction compared to the other cultivated crops. The annual cultivated area with maize covers about two million feddans (Mesbah *et al.*, 2002).

Corn plants are usually attacked by several common injurious insect-pests, i.e., the pink stem borer, *Sesamia cretica* Led., the purple-lined borer, *Chilo agamemnon* (Bles.), and the European corn borer *Ostrinia nubilalis* (Hb.), which are considered as the major factors affecting the productivity of growing maize plants, and causing great damage and yield losses. Nine percent of the world's maize crop is lost annually due to insect pests representing a cost of 5.7 billion dollars, while an additional 550 million dollars is spent on insecticides (James, 2003).

Transgenic corn expressing the *Bt*-gene Cry1Ab was developed in the USA for protection against the devastating European corn borer, *Ostrinia nubilalis* (Lepidoptera: Pyralidae) and has been approved for commercial cultivation in 1996 (James 1997). Among the genetically modified commercially grown crops, *Bt* corn occupied the second place (9.8mha) after herbicide tolerant soybean (33.3mha) and is cultivated in the USA, Canada, Argentina, South Africa, Spain and Germany (James 2002).

Several genes encoding *Bt* insecticidal proteins, called Cry genes, have been isolated and characterized from many different *Bt* strains (Höfte and Whitely, 1989). The *Bt* insecticidal proteins available in commercial *Bt* formulations are those encoded by the Cry1, Cry2, Cry3 and Cry4 gens. In general sense, Cry 1-encoded proteins are toxic to lepidopterans (Gill *et al.*, 1992) and the most common in *Bt* strains, with at least 12 different identified proteins (Fischhoff, 1996). The Cry1Ab, Cry1Ac and Cry9c genes in transgenic corn provide effective and selective control of most major lepidopteran corn pests (Jansens *et al.*, 1997).

*Bt* transgenic plants will likely reduce the amount of broad-spectrum synthetic insecticides used for insect control (ILSI, 1999). Such a reduction will result in higher densities of natural enemies, providing enhanced impact of biological control (Alstad and,

Abdow1995), minimizing the outbreaks of spider mites, reducing farmers' input costs and improving their returns.

The aim of this research work was to study the effect of the encoding *Bt* gene in corn plants hybrid (MON 810: Ajeeb YG) against the infestation of three corn borers, namely, the pink corn borer *Sesmia cretica*, the purple-lined corn borer *Chilo agamenon* and the European corn borer *Ostrinia nubilalis*, during the growing seasons of 2007 and 2008.

## **MATERIALS AND METHODS**

### **1. Experimental design:**

In the growing season of 2007; the study was carried out in five field sites located in the four Egyptian governorates, 10-Bezour-Noubaria (Behira), El-Shrouk-Noubaria (Behira), Salhia (Esmailia), Bassyoun (Gharbia) and Bdahel (Beni Swief). While, in the growing season of 2008, three planted locations were studied: 10-Bezour-Noubaria (Behira), Bassyoun (Gharbia) and Bdahel (Beni Swief) representing three governorates.

The Ajeeb YG<sup>®</sup> hybrid (Mon 810 event) that represents the *Bt* corn was compared with its conventional non *Bt* hybrid (Ajeeb)<sup>®</sup>. The planting dates ranged between the first of June and mid of June as recommended in Egypt. Each location occupied one feddan was divided in two portions for the *Bt* and non *Bt* hybrids. The non *Bt* hybrid was implemented in 20% of the total cultivated maize area according to the industry guidelines. To date, the most robust, scientifically based recommendation for a refuge is to plant at least 20% of the total maize (in an area) to non-*Bt* maize.

Both *Bt* and conventional hybrids were cultivated under the same production system of same timing, maturity group, water supply, and general conditions. The conventional hybrid was planted as strips surrounding the *Bt* hybrid. The plants were sown with 2-3 kernels/hill and 17 hills/row; about 10 kg seeds/feddan were used for each tested hybrid. The seeds were supplied by Fine Seeds International Co. (Giza, Egypt).

### **2. Sampling technique and pest inspection:**

The trial followed the randomized complete block design (RCBD) with four plots (replicates) for each hybrid. Samples of 10 plants from the central rows in each plot were collected randomly. The *Bt* and non *Bt* plants were inspected at the three growing stages of 8-leaf, flowering and pre-harvest. The plant samples were cut longitudinally and inspected in the field. The rates of insect-pest infestation in terms of mean number of living larvae and/or pupae/plant were recorded. Also, the numbers of holes in each plant samples were recorded.

### 3. Data analysis:

Statistical analysis was fulfilled to check the significance of differences among treatments (Goulden, 1952). The least significant differences (L. S. D.) were determined according to the computerized programme of Duncan (1955).

## RESULTS AND DISCUSSION

### 1- Efficacy of the *Bt*-corn hybrid on the incidence of the three corn borers species in certain Egyptian governorates:

#### 1.1. During the growing season of 2007:

The field trials were carried out in five field sites located in four Egyptian governorates, Behira (10-Bezour-Noubaria), Behira (El-Shrouk-Noubaria), Esmailia ( Salhia ), Gharbia (Bassyoun) and Beni Swief (Bdahel).

##### 1.1.1. The pink stem borer, *Sesamia cretica* Led.

In 2007 season, the mean numbers of larvae and/or pupae/plant for *Sesamia cretica*, were recorded throughout the three growing stages of the both tested hybrids of (Ajeeb YG)<sup>®</sup> and (Ajeeb)<sup>®</sup>.

Generally, data shown in Table (1) indicated that there were significant differences between the infestation of *S. cretica* in *Bt* and the non *Bt* maize hybrids during the whole season in all locations. The *Bt*-plants of Ajeeb YG<sup>®</sup> hybrid gave a complete avoidance of *Sesamia cretica* infestation (0.00 larvae or pupae/plant) throughout the three growing stages of the tested corn plants (8-leaf, flowering and pre-harvest stages) in all locations. Plants expressing the insecticidal crystal protein (ICP) from *Bacillus thuringiensis* Berliner are protected from attack by various Lepidopteran pests (Herman et al., 2002)

The infestation of the pink borer *Sesamia cretica* throughout the 8 leaf stage in the non *Bt* hybrid was higher than the other two stages in all locations, except in El-Shrouk-Noubaria(Behira).

At the flowering stage, the mean number of living larvae and/or pupae/plant was 0.10, 1.05, 0.33, 0.15 and 1.15 in 10-Bezour-Noubaria (Behira), El-Shrouk-Noubaria (Behira), Salhia (Esmailia), Bassyoun (Gharbia) and Bdahel (Beni Swief), respectively. The relative high infestation of *S. cretica* at this stage of the non *Bt* hybrid was noticed at Beni Swif governorate (the only inspected location in the Upper Egypt). This might be due to the cultivation of sugar cane, which represents the main host plant for the insect.

During the pre-harvest stage, the data showed that the mean number of larvae and/or pupae/plant in the non *Bt* hybrid was declined to 0.05, 0.68,

0.00, 0.00, 0.075 larvae/plant in 10-Bezour-Noubaria (Behira), El-Shrouk-Noubaria (Behira), Salhia (Esmailia), Bassyoun (Gharbia) and Bdahel (Beni Swief), in respect.

**1.1.2. The purple-lined corn borer, *Chilo agamemnon* Bles.**

The presented data in Table (1) referred to 0.00 living larvae or pupae/plant of *C. agamemnon* in the *Bt* hybrid throughout the whole season at the three inspected plant growing stages in all locations. It was obvious that the infestation by this insect at the 8 leaf stage wasn't observed in all locations cultivated by both hybrids, except Bassyoun (Gharbia) that showed 0.18 living larvae or pupae/plant in the non *Bt* hybrid.

However, the infestation of *C. agamemnon* at the flowering stage was significantly increased in the non *Bt* hybrid in all locations, except Salhia (Esmailia) and Bassyoun (Gharbia) where the infestation was 0.00%.

The infestation was 1.28, 0.35 and 0.20 living larvae or pupae/plant for the field sites of 10-Bezour-Noubaria (Behira), Bdahel (Beni Swief) and El-Shrouk-Noubaria (Behira), respectively. The high infestation in Behira governorate could be due to the huge acreage of rice in this governorate; and in Beni-Swief might be due to the large cultivation of sugar cane on a large scale in Upper Egypt.

In relation to the pre-harvest stage, a relatively decreased infestation was observed. The corresponding mean values were 0.48, 0.25 and 0.05 larvae or pupae/plant for 10-Bezour, Bdahel and El-Shrouk, in respectively. No infestation evidence of *C. agamemnon* was recorded in this stage for Ajeeb® hybrid in Salhia and Bassyoun .

**1.1.3. The European corn borer, *Ostrinia nubilalis* Hbn.**

The European corn borer *Ostrinia nubilalis* Hbn is considered as the major pest of maize plants and is the focus of most integrated pest management programmers in USA (Ferro and Howell, 1985). Its larvae can cause lodging by boring into the corn stalk, but it is not usually economically feasible to control them in the ear stage (Kathy and Flander, 1999). In conclusion, rationally, *O. nubilalis* borers are difficult to manage because there is few cultural control options can't be controlled in the ear stage and spraying contact insecticides is effective only against small larvae before they bore into stalk. So, *Bt* corn hybrids of MON810 event could be considered as a good solution to manage all of corn borers which place at the forefront of the integrated corn management in Egypt for this insect. Currently available *Bt* hybrids are very effective against European corn borer (Rice and Pilcher, 1997)

In respect of the infestation by *O. nubilalis*, Table (1) highly revealed 100% efficacy of Mon 810 to prevent the infestation in Ajeeb YG® plants. The infestation of *O. nubilalis* in the conventional hybrids was the highest

compared with *S. cretica* and *C. agamemnon*. In the flowering stage, (early infestation) infestation rates were 3.7, 1.95 and 0.45 living larvae or pupae/plant in Salhia, Bassyoun and Bdahel, respectively. However, the infestation rate was detected in all locations throughout the pre-harvest stage. The mean No. of living larvae or pupae/plant were 4.25, 2.78, 1.13, 0.60 and 0.58 in Salhia, Bassyoun, El-Shrouk, Bdahel and 10-Bezour, respectively.

#### 1.1.4. Summing up the infestation levels of each corn borer all over the whole season:

In both tested hybrids of *Bt* corn (Ajeeb YG)<sup>®</sup> and the conventional non *Bt* (Ajeeb)<sup>®</sup>, combining the three inspection periods (8-leaf, flowering and pre-harvest stages) for each corn borer and/or for the three corn borers together was presented in Table (3). Our result was paralleled by the data of Massoud (2005) who found the infestations of *S. cretica*, *C. agamemnon* and *O. nubilalis* were negligible or completely prevented in *Bt* plants (XL214, MSA852 and CRN3505) throughout the whole season for all sowing dates. The range of infestation reduction was 90.48-100% for *Bt* hybrids. It was clear that the data revealed that the *Bt* corn plants showed a complete resistance to the infestation by the three corn borers throughout the whole season (0.00 larvae or pupae/plant) in all locations. Vice versa, the non *Bt* corn plants were more susceptible to the infestation of the three corn borers for the three inspected stages. The calculated total mean number of *S. cretica* all over the whole season were 2.54, 2.18, 1.95, 1.69 and 0.72 in Bdahel, El-Shrouk, Bassyoun, Salhia and 10-Bezour, respectively. Moreover, Salhia (Esmailia) and Bassyoun (Gharbia) registered the highest infestation 7.95 and 4.73 larvae or pupae/plant, respectively, of *O. nubilalis*. In respect to the infestation by *C. agamemnon*, 10-Bezour-Noubaria (Behira) showed the highest infestation (1.75 larvae or pupae/plant), while Salhia (Esmailia) was free from this insect pest.

The high infestation expressed in the mean number of the three corn borers together in the non *Bt* hybrid was 9.64 in the Salhia, followed by 6.86, 4.24, 3.56 and 3.09 larvae or pupae/plant in Bassyoun, Bdahel, El-Shrouk-Noubaria and 10-Bezour-Noubaria, respectively.

In general, the above mentioned data demonstrated that the non *Bt* corn was highly susceptible to the infestation with the three corn borers in all the studied governorates especially Esmailia, Gharbia and Beni-Swief.

#### 1.1.5. The mean number of holes at the pre-harvest stage:

The mean number of holes/plant was recorded only at the pre-harvest stage in both hybrids. Generally, there were significant differences between *Bt* and the non *Bt* maize hybrids. Whereas, there isn't any holes observed in the *Bt* hybrid in all field sites. *Bt*-corn hybrids (MON 810)

reduce insect damage in corn plants and the Cry1Ab protein levels are sufficient to provide effective protection from the feeding damage of the corn borers throughout the growing season (Massoud, 2005).

In addition, the means number of holes/plant during the pre-harvest stage in the non *Bt* corn (Ajeeb)<sup>®</sup> was 5.95 at Salhia , followed in a descending order by 4.92 at Bassyoun , 4.30 at El-Shrouk-Noubaria , 3.82 at Bdahel and 3.60 at 10-Bezour-Noubaria .

#### 1.2. During the growing season of 2008.

The field trials were carried out in the three Egyptian governorates, Behira (10-Bezour-Noubaria), Gharbia (Bassyoun) and Beni Swief (Bdahel).

##### 1.2.1. The pink stem borer, *Sesamia cretica* Led.

Data from Table (2) showed that there were significant differences between the infestation of *S. cretica* in *Bt* and the non *Bt* maize hybrids in all locations and along the three inspected plant growing stages. The *Bt* corn plants clarified a complete resistance to the infestation of *S. cretica* throughout the 8 leaf stage (0.00 larvae or pupae/plant) in all locations. Fitch *et al.* (1996) found 80-100% mortality of lesser cornstalk borer in transgenic sugarcane plants.

On the other hand, the high mean rates of *S. cretica* infestation were observed at the 8 leaf stage of the tested non *Bt* hybrid (Ajeeb)<sup>®</sup> recording 0.60, 1.60 and 1.50 larvae or pupae/plant in 10-Bezour-Noubaria , Bassyoun and Bdahel , respectively. El-Sherif (1965) reported that corn seedlings were attacked by the larvae of *S. cretica* beginning when they were about 15 days old or about 30 cm high.

Slight infestation rate was observed in the flowering and/or the pre-harvest stages. The mean number of larvae or pupae/plant in the non *Bt* corn (Ajeeb)<sup>®</sup> in Behira, Gharbia and Beni Swief governorates were 0.20, 0.10 and 0.00, respectively. In the pre-harvest stage the infestation was only detected in 10-Bezour-Noubaria (Behira) giving 0.13 larvae or pupae/plant.

##### 1.2.2. The purple-lined corn borer, *Chilo agamemnon* Bles.

According to the results listed in Table (2), as expected, the no infestation of *C. agamemnon* at the 8 leaf stage was observed in the *Bt* and non *Bt* hybrids among the three locations (0.0 larvae/plant). There weren't any remarkable infestation symptoms in the *Bt* plants.

The infestation of *C. agamemnon* has been started during the flowering stage, the means number of larvae/plant in the non *Bt* corn (Ajeeb)<sup>®</sup> at Behira, Gharbia and Beni- Swief were 0.93, 0.30 and 0.40, respectively. But, the infestation of *C. agamemnon* during the pre-harvest stage was 1.94 in Gharbia followed by 0.20 in Beni Swief. Regarding *C. agamemnon*, Hosny and El-Saadany (1970) concluded that the female

moths began laying eggs on corn plants that had reached 100-120 cm height or about 40-45 days of age. Mote (1986) stated that the highest percentage of stem tunneling by *Chilo* occurred in Indian sorghum sown on June the 1<sup>st</sup>, while the lowest was observed in the crop sown on August the 15<sup>th</sup>.

#### 1.2.3. The European corn borer, *Ostrinia nubilalis* Hbn.

The obtained data in Table (2) indicate that, the infestation rate of *O. nubilalis* in non *Bt* corn (Ajeeb)<sup>®</sup> was relatively higher in the pre-harvest stage than in the flowering one at all locations. The mean number of living larvae or pupae/plant in flowering stage was 0.13, 0.70 and 0.30 in 10-Bezour-Noubaria (Behira), Bassyoun (Gharbia) and Bdahel (Beni Swief), respectively.

The infestation level increased gradually in the non *Bt* (Ajeeb)<sup>®</sup> with the progress of plant growing from flowering to Pre-harvest stage. Whereas, the mean number of living larvae or pupae/plant were 1.00, 1.47 and 0.70 in Behira, Gharbia and Beni Swief governorates, respectively. Late season populations of *O. nubilalis* prefer to oviposit on corn that is at or near the pollen-shedding stage, so late-planted corn can be very attractive relative to adjacent older stands for this reason (Witkowski and Wright, 1997).

#### 1.2.4. Summing up the infestation levels of each corn borer all over the whole season:

There were significant differences of the total of each corn borer all over the whole season and the total records of the three corn borers together between Ajeeb YG<sup>®</sup> and Ajeeb<sup>®</sup> (table, 3). Whereas, no any remarkable infestation symptoms has occurred in *Bt* plants showing 0.00 infestation rate for the two locations ,10-Bezour-Noubaria (Behira) and Bassyoun (Gharbia), while the only larvae of *C.agamemnon* was observed through flowering stage at Bdahel (Beni Swief) .

It was obvious also that the intensive infestation of *S. cretica*, *C. agamemnon* and *O. nubilalis* was detected in Bassyoun (Gharbia) giving 1.70, 2.24 and 2.17, respectively.

The total of the mean number of larvae or pupae/plant in the three inspected periods at 10-Bezour-Noubaria (Behira), Bassyoun (Gharbia) and Bdahel (Beni Swief) was 2.99, 6.11 and 3.10, respectively.

#### 1.2.5. The mean number of holes at the pre-harvest stage.

Data in Table (3) include the mean number of holes/plant during the pre-harvest stage in both hybrids, season 2008. The *Bt* plants of Ajeeb YG<sup>®</sup> were free from any holes in 10-Bezour-Noubaria (Behira) and Bassyoun (Gharbia) while there was insignificant 0.03 holes/plant in Bdahel (Beni Swief). On the other side, the non *Bt* corn (Ajeeb)<sup>®</sup> showed 13.87 at Bassyoun (Gharbia), 3.40 at 10-Bezour-Noubaria (Behira) and 0.80 at Bdahel (Beni Swief).



Table (1). Efficacy of Bt-corn plants (MON 810 event: Ajeeb YG)<sup>®</sup> on the infestation of corn borers at three different growing stages, during the growing season of 2007.

Location	Hybrid	*Mean No. of <i>S. cretica</i> larvae or pupae/plant			*Mean No. of <i>C. agamemnon</i> larvae or pupae/plant			*Mean No. of <i>O. nubilalis</i> larvae or pupae/plant		
		Inspection period			Inspection period			Inspection period		
		8 leaf stage	Flowering stage	Pre-harvest	8 leaf stage	Flowering stage	Pre-harvest stage	8 leaf stage	Flowering stage	Pre-harvest stage
10- Bezour-Noubaria (Behira)	Ajeeb <sup>®</sup>	0.58 <sup>b</sup>	0.10 <sup>a</sup>	0.05 <sup>a</sup>	0.00	1.28 <sup>b</sup>	0.48 <sup>b</sup>	0.00	0.05 <sup>a</sup>	0.58 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>
El-Shrouk-Noubaria (Behira)	Ajeeb <sup>®</sup>	0.45 <sup>b</sup>	1.05 <sup>b</sup>	0.68 <sup>b</sup>	0.00	0.20 <sup>b</sup>	0.05 <sup>a</sup>	0.00	0.00	1.13 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00	0.00 <sup>a</sup>
Salhia (Esmalia)	Ajeeb <sup>®</sup>	1.38 <sup>b</sup>	0.33 <sup>b</sup>	0.00	0.00	0.00	0.00	0.00	3.70 <sup>b</sup>	4.25 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00	0.00	0.00	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Baasyoun (Gharbia)	Ajeeb <sup>®</sup>	1.80 <sup>b</sup>	0.15 <sup>b</sup>	0.00	0.16 <sup>b</sup>	0.00	0.00	0.00	1.95 <sup>b</sup>	2.78 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00	0.00	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Bdahel (Beni Swief)	Ajeeb <sup>®</sup>	1.33 <sup>b</sup>	1.15 <sup>b</sup>	0.075 <sup>b</sup>	0.00	0.35 <sup>b</sup>	0.25 <sup>b</sup>	0.05	0.45 <sup>b</sup>	0.60 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>

\* Means followed by the same letter (s) in each column are not significant at P=0.05

**Table (2). Efficacy of Bt-corn plants (MON 810 event: Ajeeb YG)<sup>®</sup> on the Infestation of corn borers at three different growing stages, during the growing season of 2008.**

Location	Hybrid	*Mean No. of <i>S. cretica</i> larvae or pupae/plant			*Mean No. of <i>C. esgammnon</i> larvae or pupae/plant			*Mean No. of <i>O. nubilalis</i> larvae or pupae/plant		
		Inspection period			Inspection period			Inspection period		
		8 leaf stage	Flowering stage	Pre-harvest stage	8 leaf stage	Flowering stage	Pre-harvest stage	8 leaf stage	Flowering stage	Pre-harvest stage
10-Bezour-Noubaria (Behira)	Ajeeb <sup>®</sup>	0.60 <sup>b</sup>	0.20 <sup>b</sup>	0.13 <sup>b</sup>	0.00	0.93 <sup>b</sup>	0.00	0.00	0.13 <sup>b</sup>	1.00 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Baasyoun (Gharbia)	Ajeeb <sup>®</sup>	1.80 <sup>c</sup>	0.10 <sup>b</sup>	0.00	0.00	0.30 <sup>b</sup>	1.94 <sup>b</sup>	0.00	0.70 <sup>b</sup>	1.47 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Bdahel (Beni Swief)	Ajeeb <sup>®</sup>	1.50 <sup>b</sup>	0.00 <sup>a</sup>	0.00	0.00	0.40 <sup>b</sup>	0.20 <sup>b</sup>	0.00	0.30 <sup>b</sup>	0.70 <sup>b</sup>
	Ajeeb YG <sup>®</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00	0.025 <sup>a</sup>	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.025 <sup>a</sup>

\* Means followed by the same letter (s) in each column are not significant at P=0.05

Table (3). Efficacy of Bt-corn plants (MON 810 event: Ajeeb YG<sup>R</sup>) on the holes and the total of corn borer all over the whole season 2007 and 2008.

Location	Hybrid	*Mean No. of the three corn borers throughout the inspection periods (larvae or pupae/plant)				*Mean No. of holes/ plant
		<i>S. cretica</i>	<i>C. agamemnon</i>	<i>O. nubilalis</i>	Total	
Season 2007						
10- Bezour-Noubaria (Behira)	Ajeeb	0.72 <sup>b</sup>	1.75 <sup>b</sup>	0.62 <sup>b</sup>	3.09 <sup>b</sup>	3.60 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
El-Shrouk-Noubaria (Behira)	Ajeeb	2.18 <sup>b</sup>	0.25 <sup>b</sup>	1.13 <sup>b</sup>	3.56 <sup>b</sup>	4.30 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Salhia ( Esmailia)	Ajeeb	1.69 <sup>b</sup>	0.00	7.95 <sup>b</sup>	9.64 <sup>b</sup>	5.95 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Bassyoum (Gharbia)	Ajeeb	1.95 <sup>b</sup>	0.18 <sup>b</sup>	4.73 <sup>b</sup>	6.86 <sup>b</sup>	4.92 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Bdahel (Beni Swief)	Ajeeb	2.54 <sup>b</sup>	0.60 <sup>b</sup>	1.10 <sup>b</sup>	4.24 <sup>b</sup>	3.82 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Season 2008						
10- Bezour-Noubaria (Behira)	Ajeeb	0.93 <sup>b</sup>	0.93 <sup>b</sup>	1.13 <sup>b</sup>	2.99 <sup>b</sup>	3.40 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Bassyoum (Gharbia)	Ajeeb	1.70 <sup>b</sup>	2.24 <sup>b</sup>	2.17 <sup>b</sup>	6.11 <sup>b</sup>	13.87 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>	0.00 <sup>a</sup>
Bdahel (Beni Swief)	Ajeeb	1.50 <sup>b</sup>	0.60 <sup>b</sup>	1.00 <sup>b</sup>	3.10 <sup>b</sup>	0.80 <sup>b</sup>
	Ajeeb YG	0.00 <sup>a</sup>	0.025 <sup>a</sup>	0.00 <sup>a</sup>	0.025 <sup>a</sup>	0.025 <sup>a</sup>

\* Means followed by the same letter (s) in each column are not significant at P=0.05

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## الملخص العربي

مقاومة الذرة *Bt*® (MON 810 event: Ajeeb YG) لثاقبات الذرة :

نودة القصب الكبيرة و نودة القصب الصغيرة و نودة الذرة الأوروبية

بمصر.

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أجريت دراسة حقلية لدراسة تأثير إدخال جين ال *Bt* في هجين الذرة عجيب واى جى

لمقاومة الثاقبات

الثلاثة: نودة القصب الكبيرة و نودة القصب الصغيرة و نودة الذرة الأوروبية مقارنة بهجين الذرة المحلى (عجيب)® بدون جين *Bt* خلال موسم 2007 فى خمس مناطق تمثل اربع محافظات وهى القرية العشرة بزور- النوبارية والشروق-النوبارية(محافظة البحيرة)، بسيون (محافظة الغربية)، الصالحية (محافظة الاسماعلية) وبداهل (محافظة بنى سويف). و فى موسم 2008 تمت الدراسة فى ثلاثة محافظات هى قرية العشرة بنوز (محافظة البحيرة)، بسيون (محافظة الغربية) و بداهل (محافظة بنى سويف).

ظهرت النتائج انه يوجد اختلافات معنوية بين هجين الذرة المحلى (عجيب)® وهجين الذرة

*Bt*(عجيب YG)® المعدل وراثيا من حيث اصابتهام بثاقبات الذرة الثلاثة خلال موسمي 2007 و 2008

حيث لم تشاهد اى اصابة بثاقبات الذرة الثلاثة فى هجين الذرة عجيب واى جى المعدل وراثيا( سواء كانت يرقات او عذارى او تقوب ) فى كل المواقع خلال موسمي 2007 و 2008 فى حين ازدادت الاصابة فى هجين الذرة المحلى (عجيب)® فى كل المواقع.