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The Economic Thresholds and Injury Levels for the English Grain Aphid, *Sitobion avenae* (F.) (Hemiptera- Aphididae) on Wheat Crop

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ABSTRACT

A yield loss 28.66, 47.35, 61.77 and 79.86% caused due to introduce 1, 3, 5 and 7 individuals/ spike of aphid species *Sitobion avenea* Fabricius (Hemiptera- Aphididae) as abundant wheat insect pests to fifteen tillers under cages. A market price of 2017 the wheat crop (420 E.L/Aradab) and costs of control measures 90 E.L/feddan was standard, during flowering and heading stage. The calculated economic injury level (EIL) and economic threshold (ETL) in average were 7.03 and 2.26 aphid/ spike/ feddan, respectively. Calculated gain threshold was 0.21 Ardab/feddan.

Keywords: *Sitobion avenea*; Feddan; Ardab = 150 K.G

INTRODUCTION

Insect pests caused a great yield loss of wheat productions, where, cereal aphid only, caused yield reduction estimated by up to 23% (Tantawi, 1985). Thus, protection and expansion the productions of wheat, will be highly appreciated. Control wheat insects species insecticidal has many risks, like destruct of the balance between aphid and their natural enemies Smith *et al.*, (1985) and El- Heneidy *et al.*, 1991) and accelerated development of insecticide resistance in aphid species Shotkoski *et al.*, (1990). So, integrate pest management (IPM) program, where, utilizes all available tools and techniques to avoid the insecticide hazards to the wheat crop and environment, was highly needed. Economic injury levels and economic thresholds are important components of a cost effective integrated pest management program and are useful for decision- making in the application of pesticides Larsson (1991).

Study response of the yield due to *S. avenae* infestations and their economic injury level and economic threshold were the aim of this paper.

MATERIALS AND METHODS

According to the methods of Ghanim and El-Adl (1983) and El-Serafi (1996), under of fifty metal cages with dimensions (1/2m wide × 1.5m high), covered with a muslin textile to avoid any invasion by other animals species rather than tested pest. Fifteen uninfected tillers to every ones cage before heading stage were used in the experimental, sown in the second half of December to synchronize with aphid species *S. avenae* peaks in April, using the commercial variety, Gemmiza11. *Sitobion avenae* collected awhile appears on wheat fields and carried to mass-rearing under laboratory conditions, Plant Protection Research Institute, Sakha Agriculture Research Station, and artificial re-infested tillers under cages, beginning Heading stage by 0, 1, 3, 5 and 7 individuals/ tiller to every cage, respectively and repeated into three replicates. Cage plants unhand with normal agriculture practices and no insecticides were used until harvest. Every ones cage carried to laboratory awhile harvest, determined some yield components: whole, were removed spikes and counted per cage, counted the grains per ears and the weight of 1000 individual grains was considered. Aphox® 50% a water dispersible granule (w/w) pirimicarb, was estimated using the recommended aphicide, at the rate of 31.2 g /100 L. water. Calculation included the costs of control measures, 2017 market price of the crop and average 20 ardab/feddan. One feddan of wheat requires 400 litter water solution + 150 g of Aphox. Costs = 60 L.E. + application expenses about 30 L.E. A total of costs were 90 L.E/feddan was considered in calculations.

To evaluate the damage of the artificial populations of *S. avenae*, injury level and economic threshold on wheat crop as follow:

Economic Injury Level (EIL) Calculation:

Economic Injury Level (EIL) the following parameters were estimated: rate of yield reduction, number of aphids, cost of aphid control procedures and market price of the crop. The generalized form of the EIL described by Pedigo *et al.* (1986) is:

$$EIL=C/VD/K$$

Where:
***C* is the management cost per production unit (E.L/ Fed.),**
***V* is market value per unit of production (E.L/ Ardab),**
***K* is the proportional reduction in injury with control and**
***D*′ is (D+I) into a single variable, D′ = percent yield loss per pest,**
or, the damage per unit injury (Ardab reduction/Fed./injury).

Economic Threshold Level (ETL) Calculation:

The formula used in estimating the economic threshold was cited after Wetzel (1995):

$$ETL= cc/cp \times 100$$

Where:
cc= Cost of implementing control measure.
cp= Cost of the increasing rate of yield.

Yield loss: calculate according to the formula of Wetzel *et al.* (1980).

$$yr = (yc – yt /yc) \times 100$$

Where:
yr = Loss in the yield due to pests.
yc = The yield in control (in the absence of the insects).
yt = the yield in the presence of insects.

Gain threshold: (the amount of yield loss that constitutes minimum economic damage), and calculated according to Stone and Pedigo (1979) formula:

Gain threshold = cost of pest control / market price of wheat Ardab.
Gain threshold (Ardab/Fed.) = 90 /420 = 0.21 Ardab/Fed.

RESULTS AND DISCUSSION

The reduction of kernels yield, similes to the control summarized in Table (1), where, the high values of yield reflects the less damage of the re-infested certain aphid numbers. There was a negatively correlated between the yield (quantity and quality), where the high values of yield were 29.93 kernels per

spike and 29.3g weight of thousand kernels in control treatment, while, those values were decrease by every one aphid introduced to tested plot of a trial, whereby, introduced was 1. 3, 5 and 7 individuals/ tiller (spike) of aphid *S. avenea*. The values of kernels per spike were 16.72, 14.95, 12 and 8.87, respectively. The yield weight were 20.9, 15.4, 11.2 and 5.9 g/1000 kernels, respectively, where, introduce one individuals per tiller, caused the lowest reduce of yield 28.66% equal to 5.73 ardab/feddan. While, introduced seven individuals per spike caused of the high reduction of yield 79.86% equal to 15.97 ardab/feddan.

The obtained results were agree with some authors i.e. Kolbe and linke (1974) in Germany, who determined the yield loss caused by 20-30 individuals, of cereal aphid species *S. avenae*, *R. padi* and *M. dirhodum* on winter wheat by 10% reduction, reached to 30% reduction, with increases of cereal aphids population to 150 individual per spike. They added that, cereal aphids control during flowering and spike stages increased the yield quantity. In Egypt, Ghanim and El-Adl (1983), determined the wheat yield loss caused by *M avenae* was 40% and reported that the damaging role of *M avenae* above the others of two species *Rhopalosiphum padi* Linneus, *Schizaphis graminum* Rondani. In Finland, Kurppa (1989) determined the yield loss caused by outbreak of aphid specie *R.padi* (20- 60 individual per tiller), synchronized with seedling emergence was 153 kg/ha. Infestation was decreased yield by a mean of 30 kg/ha per day, and decreased to 41 kg/ha per day when delayed. El-Heneidy *et al.* (2003) reported that, the stress of amassed cereal aphids *R. padi* and *S. graminum* caused of yield reduce to every specie and the two species together (21.2-75%, 21.3-80.8% and 22.2-84.2%), respectively.

Table 1. Economic injury level, economic threshold level and wheat yield loss caused by the English grain aphid *Sitobion avenea*.

No. of aphid/ tiller	No. of kernels/spike	Weight of 1000 kernels	% Yield loss	Yield loss (ardab)/feddan	Injury level (ardab)/Aphid	EIL	ETL
0	29.93	29.3	-	-	-	-	
1	16.72a	20.9a	28.66d	5.73d	0.114	6.56	3.80
3	14.95a	15.4b	47.35c	11.19c	0.053	8.54	2.26
5	12.00ab	11.2c	61.77b	12.35b	0.049	7.08	1.73
7	8.87b	5.9d	79.86a	15.97a	0.045	5.96	1.34

There are no significant differences between the means with the same litters in the same column, according to Duncan Multiple Range Test at level of probability 0.05.

The economic injury level is the lowest population density that will causes economic damage. Where, the economic damage is defined as the amount of injury that will justify the cost of pest control measures (Hoyt and Burts, 1974, Stern *et al.*, 1959). The higher EIL reflects the more tolerance of wheat plants to the certain population of aphid specie, where the EIL calculated were 6.56, 8.54, 7.08 and 5.96 with average 7.03 aphid/ tiller/ feddan, when introduced (1, 3, 5 and 7aphid/ tiller), respectively.

Economic threshold was defined as the density at which control measures should be determined (e.g., biological control, cultural control, pesticide, etc.) to prevent an increasing pest population form reaching the economic injury level, (Stern, 1973). The Calculated ETL was 3.8, 2.26, 1.73 and 1.34 with average 2.26 aphid/ tiller/ feddan, when introduced (1, 3, 5 and 7aphid/ tiller), respectively, to enable the control decision makes avoided the insect population to prevent their population form reaching to economic injury level EL-Heneidy *et al.* (2003).

Calculated gain threshold (the amount of yield loss that constitutes minimum economic damage), where equals 90 /420 = 0.21 Ardab/feddan, this value approximately, equal the reduction (0.23 ardab) of seven individuals, thus, seven individuals per spike was economic injury level of aphid species *S. avenea* on wheat plants during flowering and heading stage.

The obtained results agree with those obtained by Robert *et al.* (1985) in the USA, where, determined the ETLs of *S. graminum* on winter wheat were less than 10 individuals per plant. Larsson (1991) in Sweden, evaluated the ETLs of *S. avenae* and *R. padi* on winter wheat and barely, where, noticed the yield response to treatment significantly with more than 10 aphids/tiller. In Germany, Wetzel (1995) found the injury level of *R. padi* and *M. dirhodum* were 10-15 individuals per spike on winter wheat.

While 3.5 individuals per ear was the ETL of aphid specie *M. avanae*. In addition, Li- Jiping et al. (1995) in China, noticed that the ETL for cereal aphids on wheat was 10 aphids/ plant at heading stage. El-Serafi (1996) in Germany, who determined EIL and ETL of *S. avenae* on wheat crop were 6.66 and 5 insect/ ear. El-Heneidy *et al.* (2003), in Egypt, determined the EIL values to cereal aphids *R. padi* and *S. graminum* and the two species together (6.47, 5.9 and 6.13 aphid/ tiller), respectively. While, it's ETL were (5.10, 4.41 and 4.39 aphid/tiller), respectively.

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الحدود الإقتصاديه الحرجه ومستوى الضرر الإقتصادى لحشرة المن *Sitobion avenae* (رتبة متشابهة الأجنحه -عائلة المن) على محصول القمح

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تم دراسة تأثير أربع كثافات عدديه مختلفة لحشرة *Sitobion avenae* (١، ٣، ٥ و ٧) أفراد/ نبات على عدد خمسون نبات (تلر) مغطاه بقماش من الموسلين لضمان عدم حدوث تأثير على المحصول غير التعداد الذى تم إدخاله، مقارناً بالكنترول التى لم يتم الإدخال اليها. تسببت تلك الكثافات التى تم إدخالها إلى خفض فى وزن الحبوب الناتجه بنسبة (٢٨.٦٦، ٤٧.٣٥ ، ٦١.٧٧ و٧٩.٦٦ %) بالترتيب، أى بما يعادل (٠.١١٤ ، ٠.٠٥٣ , ٠.٠٤٩ ، ٠.٠٤٥) أردب/ الفدان/ فرد المن على الترتيب . بإعتبار أن متوسط إنتاجية الفدان ٢٠ أردب. وكان الحد الحرج للإصابه (EIL) المحسوب كما يلى ٦.٥٦ ، ٨.٥٤ , ٧.٠٨ و٥.٩٦ فرد/نبات /فدان بالترتيب، بمتوسط ٧.٠٣ فرد/نبات /فدان، وكان الحد الإقتصادى للإصابه المحسوب ٣.٨ , ٢.٢٦ ، ١.٧٣ ، ١.٥٥ فرد/نبات /فدان بالترتيب، بمتوسط ٢.٢٦ فرد/نبات /فدان. وكذلك عند حساب حد المنفعة الإقتصاديه التى تعتبر نقطة بدايه وقوع الضرر الإقتصادى Gain threshold نجد قيمته تساوى ٠.٢١ أردب أي يساوى تقريبا لتلك٠.٢٣ أردب المتسببه عن العدد المدخل ٧ فرد/ السنبله.