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AN APPLIED EQUATION TO EVALUAT THE YIELD LOSSES OF SOME ECONOMIC CROPS CAUSED BY THE ADULT STAGE OF *SCHISTOCERCA GREGARIA* (Forskal).

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ABSTRACT: To evaluate the yield losses caused by the adult stage of the desert locust , *Schistocerca gregaria*, four economic crops were cultivated in small plots. These crops were: *Vicia faba, Zea mays, Triticum sativum, Gossypium barbadense.* A simulation between defoliation and adults release into these plots was conducted at the same periods of growing stage of these crops. The densities of the released immature adults were 100 and 200 adult/m², which represent a medium and large density swarms, respectively (Cressman, 2001). The obtained results revealed that, defoliation of 25% and 50% of the leaves of all the tested crops after one or two months of planting slightly decreased their yields. The highest percentages of yield losses in this case were obtained after defoliation before flowering stage of these crops. When the previous numbers of immature adults were released into another plots, the yield losses exhibited the same trend of reduction after defoliation, but the reduction in the yields was more pronounced after adult releasing one and two months of planting as well as before flowering stage of

these crops. The proportion of one insect in the yield losses of each crop in one day was calculated in kg. to indicate the yield losses due to one unit of any swarm (the adults). It is concluded that, one adult in a medium density swarm (100 adult/m²) caused yield loss more than the other insect in a large density swarms (200 adult/m²). It could be attributed to a sever competition for the food in the large swarm.

Thus, on the basis of these results an applied equation was generated to estimate crop losses depends upon the amounts of yield losses per one adult in one day, specially the assessment of crop losses caused by the desert locust, *S. gregaria* is not available over the last years.

INTRODUCTION

Bullen (1970) stated that, the worldwide crop losses caused by locusts are relatively small (0.2%) compared with the overall losses due to insect pests (14%). Despite this fact, locusts can nevertheless cause considerable economic problems on countries and regional levels. The assessment of crop loss due to grasshoppers species are occasionally encountered. The reliability of such estimates is usually imparity by indirect methods (Fishpool and Popov, 1981). Actual data about the damage caused by the desert locust, *Schistocerca gregaria* are not available over the last years (Herok, 1993).

Krall (1995) indicated that, instead of simply waiting for *S. gregaria* outbreaks to occur, attempts are being made to take preventive action against this pest to prevent its damage. Sinha (1998) recorded the amount of damage due to *S. gregaria* in some places of India in 1989. The mean amount of damage caused by this pest was greatest on Bajra (*Pennisetum typoideum*) 20%; followed by 13.3% on Phog (*Colligonum polygonoides*); 8% on Kanti (*Tribulus alatus*) and 7% on Bhurat (*Cenchrus biflorus*). Sinha and Diwakar (2002) found that locust infestation resulted in 79% damage to Sorghum and Bajra, (*P. typoideum*). The actual data about the damage caused by *S. gregaria* are not available over the last years, there are many reasons for this, the most important one is that, this pest is considered as an occasional pest, making any

continuous scientific research work impossible. So, the present study is an attempt through semi-natural conditions to develop an applied equation to estimate the actual crop losses by the adult stage of *S. gregaria*.

MATERIALS AND METHODS

1. Experimental insects:

A wild strain of *Schistocerca gregaria* was collected from its previously occurred infestation during the successive two seasons (1999-2000) in which the yield losses of four economic crops were estimated. These crops were, *Vicia faba, Zea mays, Triticum sativum* and *Gossypium barbadense*. The collected wild samples of this pest were reared and maintained under crowded conditions in the laboratory, following the technique described by (Hunter-Jones, 1961).

2.Assessment of crop losses:

To evaluate the crop losses for the previously selected four economic crops, small plots 400m² were cultivated with each of them during two successive seasons (1999-2000), and 100 & 200 adult, *S. gregaria* which represent medium density swarm (100 adult/m²) and large density swarm (200 adult/m²) (Cressman, 2001) (100 and 200) were released into one square meter cage in these plots. Three cages (replicates) were installed for each density and released period of each crop. The effects of this release on the yield losses of these crops were simulated by the defoliation of their leaves. The adults release and leaves defoliation were carried out during four periods of the growing stage of each crop. These periods were, after planting with one and two months, before flowering stage and after flowering stage (Thomas *et al*, 1974). After harvesting every treatment was threshed, separately and the percentages of their yield losses were calculated relatively to the yield of the control plots. These percentages of yield losses were converted to amounts of losses in kg. by one insect per day.

RESULTS AND DISCUSSION

Since, the objective of the present study was to generate a simple and applied equation for evaluating the actual yield losses due to the infestations of the desert locust , *Schistocerca gregaria*,

defoliation of four economic crops was carried out in the same periods of their growing stage in which 100 and 200 adults were released. These treatments were carried out after one and two months of planting, before flowering stage and after flowering stage of these crops *V. faba, Z. mays, T. sativum* and *G. barbadense*. Defoliation was conducted to simulate the yield losses of these crops with the yield losses after releasing of the previously indicated numbers of *S. gregaria* adults into the cultivated plots with these crops.

1. Effects of defoliation on the yield of some crops :

Defoliation with different percentages (25% and 50%) of the leaves of *V. faba, Z. mays, T. sativum* and *G. barbadense* were carried out after one and two months of planting, before flowering stage and after flowering stage.

Table (1) shows that, defoliation of the leaves of *V. faba* increased the yield losses of this crop with different percentages within the two seasons (1999–2000). The highest percentages of these losses were after defoliation with 25% and 50% before flowering stage of this crop. The averages of yield losses were, 21.6, 28.5, 60.9, 65.7, 2.1 and 28.9 percent after defoliation with 25% and 50% after one and two months of planting, before flowering stage and after flowering stage, respectively compared to 0.0% yield losses in the control plots. In the case of *Z. mays*, the yield losses were high after defoliation before flowering stage. The averages of the yield losses percentages of the two seasons were, 3.8, 10.1, 31.1, 36.7, 50.7, 65.9, 18.7 and 33.3 for defoliation with 25% and 50% after one and two months of planting, before flowering stage and after flowering stage, respectively, compared to 0.0% of yield losses in the control plots. The same trend of yield losses in the yields of *T. sativum* and *G. barbadense* was obtained. The highest percentages of yield losses was occurred, when defoliation was conducted before flowering stage of both crops (Table – 1).

2. Effects of adult, *S. gregaria* on the yield of some crops :

Defoliation effects on the yield of the tested economic crops revealed that, the artificial injury to the leaves of these crops resulted in significant reduction in their

Table (1) : Averages of Yield Losses (%) due to Defoliation on, *Vicia faba, Zea mays, Triticum sativum* and *Gossypium barbadense*:

Defoliation	Treatment	Yield Losses (%) of *V. faba*			Yield Losses (%) of *Z. mays*			Yield Losses (%) of *T. sativum*			Yield Losses (%) of *G. barbadense*		
		1999	2000	Mean	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
	Control	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
One month	25 %	23.50	19.70	21.60	4.70	2.90	3.80	2.05	00.61	1.33	18.33	18.41	18.37
after planting	50 %	33.17	23.87	28.52	10.05	10.21	10.13	18.99	19.40	19.20	19.72	19.63	19.68
Two months	25 %				31.72	30.42	31.07	50.30	49.53	49.92	26.79	25.61	26.20
after planting	50 %				37.10	36.19	36.65	54.93	56.61	55.77	33.39	32.62	33.01
Before	25 %	60.53	61.40	60.97	50.84	50.47	50.66	59.24	59.77	59.51	41.02	41.40	41.21
flowering	50 %	66.33	65.13	65.73	68.01	63.92	65.97	65.13	67.10	66.12	59.16	60.65	59.91
After flowering	25 %	3.58	0.59	2.09	20.68	16.77	18.73	26.41	28.09	27.25	5.39	5.98	5.69
	50 %	32.02	25.80	28.91	34.41	32.23	33.32	28.52	30.75	29.64	12.37	10.84	11.61

yield. So, the effects of *S. gregaria* adult stage on the yield of the same crops were studied by releasing 100 and 200 adult/m² of their plots during the same periods of growing.

Table (2) indicated that, the percentages of the yield losses of *V. faba* after releasing 100 and 200 adult/m² for 4 days before its flowering stage were significantly increased than the other periods of release and the control plots. The averages of the yield losses of the two seasons (1999–2000) were, 36.5, 44.8, 64.2, 70.6, 28.5 and 36.4 percent when 100 and 200 adult/m² were released after one and two months of planting, before flowering stage and after flowering stage. The percentages of yield losses in the yield of *Z. mays* were also increased by releasing of 100 and 200 adults/m² into the cultivated plots with this crops before its flowering stage. The averages of the yield losses in the yield of this crops during the two seasons were, 18.9, 32.5, 12.6, 29.9, 57.6, 70.6, 8.3 and 15.2 percent when 100 and 200 adult/m² were released in these plots, respectively.

Also, the yield losses of *T. sativum* were increased by the same treatments, the highest percentages were after insects releasing before flowering stage. The means of the yield losses of this crop during the two experimental seasons (1999–2000) were, 32.9, 61.3, 24.5, 34.1, 61.7, 69.2, 9.8 and 12.7 after releasing 100 and 200 adult/m² after one and two months of planting, before flowering stage and after flowering stage, respectively. In the case of releasing the same numbers of *S. gregaria* adults into the cultivated plots with *G. barbadense*, the percentages of yield losses were increased specially when this release was conducted before flowering stage. The averages of the yield losses of this crop after treatment with 100 and 200 adult/m² after one and two months of planting, before flowering stage and after flowering stage were, 16.9, 27.7, 12.4, 17.8, 36.8, 48.7 and 3.3 percent, respectively. It is concluded that, defoliation and *S. gregaria* adults release into the cultivated plots with *V. faba, Z. mays, T. sativum* and *G. barbadense* almost have had the same effects on the yields of these crops. The highest reduction in the yields of these crops was occurred when defoliation on adults released were conducted before flowering stage of these crops.

Table (2) : Averages of Yield Losses (%) due to *S. gregaria* release on, *Vicia faba*, *Zea mays*, *Triticum sativum and Gossypium barbadense*:

Infestation	*Locust Density	Yield Losses (%) of *V. faba*			Yield Losses (%) of *Z. mays*			Yield Losses (%) of *T. sativum*			Yield Losses (%) of *G. barbadense*		
		1999	2000	Mean	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
	Control	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
One month after planting	100/m²	38.04	35.02	36.53	19.82	17.89	18.86	33.87	32.08	32.98	16.84	16.92	16.88
	200/m²	46.42	43.12	44.77	31.75	33.30	32.53	60.13	62.46	61.30	27.26	28.04	27.65
Two months after planting	100/m²				13.36	11.73	12.55	25.78	23.17	24.48	12.65	12.06	12.36
	200/m²				31.70	28.03	29.87	34.13	34.05	34.09	17.67	17.94	17.81
Before flowering	100/m²	65.33	63.05	64.19	55.62	59.50	57.56	60.57	62.79	61.68	36.65	36.92	36.79
	200/m²	71.85	69.29	70.57	69.84	71.36	70.60	69.14	69.33	69.24	49.21	48.13	48.67
After flowering	100/m²	30.23	26.77	28.50	11.82	4.77	8.30	9.05	10.60	9.83	1.77 +	1.22 +	1.50 +
	200/m²	37.25	35.54	36.40	16.18	14.29	15.24	10.83	14.62	12.73	4.00	2.62	3.31

* 100 adult/m², represent a medium density swarm, while 200 adult/m², represent a large density swarm (Cressman, 2001).

Therefore, to generate an applied equation to estimate the yield losses due to the infestations of the adult stage of *S. gregaria*, it deemed necessary to calculate the actual numbers of the yield losses per one adult for one day in kg. during this period.

Table (3) revealed the proportion of one adult in the yield losses in kg. per one day from *V. faba, Z. mays, T. sativum* and *G. barbadense* after releasing 100 and 200 adult/m² into three plots. The amounts of yield losses (Y) per adults in one day from all these crops were increased when the release of 100 and 200 adult/m² were conducted before their flowering stage.

The averages of the amounts of yield losses (Y) in kg. during the two seasons were used in the developed equation of the present study. The following amounts of yield losses (Y) for one adult per day were calculated after releasing before flowering stage of each indicated crop:

A. Yield losses (Y) for infestations up to 100 adult/m² :

1) *V. faba* = 8.8 kg./insect/day
2) *Z. mays* = 26.0 kg./insect/day
3) *T. sativum* = 17.0 kg./insect/day
4) *G. barbadense* = 4.0 kg./insect/day

B. Yield losses (Y) for infestations up to 200 adult/m² :

1). *V. faba* = 4.8 kg./insect/day
2) *Z. mays* = 15.9 kg./insect/day
3) *T. sativum* = 9.6 kg./insect/day
4) *G. barbadense* = 2.7 kg./insect/day

On the bases of these constant numbers induced during the most effective periods on the yield of the indicated 4 crops, the locust control officers can use the following equation to estimate the amounts of yield losses in ton if the infestation occurred before flowering stage :

$$\text{Yield loss/day (Ton)} = \frac{(Y) \times \text{No. adult/m}^2 \times \text{area (Fed.)}}{1000}$$

If the desert locust infestations were occurred during any period of growing stage as indicated in table (3) the corresponding average of yield losses (Y) could be used.

Generally, the data presented in this study are considered as the

Table (3) : Indicate the proportion of one insect in yield losses per kg. per one day from *V. faba, Z. mays, T. sativum* and *G. barbadense* :

Infestation	*Locust Density	*Vicia faba*			*Zea mays*			*Triticum sativum*			*Gossypium barbadense*		
		Crop Loss (kg.) / Insect / day			Crop Loss (kg.) / Insect / day			Crop Loss (kg.) / Insect / day			Crop Loss (kg.) / Insect / day		
		98/1999	99/2000	Mean	1999	2000	Mean	98/1999	99/2000	Mean	1999	2000	Mean
One month after planting	100/m²	5.3	4.7	5.0	9.0	8.0	8.5	9.5	8.9	9.2	1.8	1.8	1.8
	200/m²	3.2	2.9	3.1	7.2	7.5	7.3	8.3	8.7	8.5	1.5	1.5	1.5
Two months after planting	100/m²				6.1	5.3	5.7	7.3	6.5	6.9	1.4	1.3	1.4
	200/m²				7.2	6.2	6.7	4.8	4.7	4.8	1.0	1.0	1.0
Before flowering	100/m²	9.1	8.5	8.8	25.2	26.7	26.0	16.7	17.1	17.0	3.9	4.0	4.0
	200/m²	5.0	4.7	4.8	15.8	16.0	15.9	9.5	9.7	9.6	2.7	2.6	2.7
After flowering	100/m²	4.2	3.6	3.9	5.4	2.1	3.8	2.8	3.0	2.9			
	200/m²	2.6	2.4	2.5	3.7	3.2	3.4	1.6	2.0	1.8	0.2	0.2	0.2

*100 adult/m², represent a medium density swarm, while 200 adult/m², represent a large density swarm (Cressman, 2001).

first experimental trial concerned with the damage caused by the desert locust, *Schistocerca gregaria*. These data indicated that, the most effective release period was before flowering stage of the crops. So, the preventive control measures have to be concentrated against the desert locust before this stage. By this equation locust control officers can calculate the expected losses or the actual losses caused by this pest and convert them to amount of money according to their actual price, relatively to the control costs. Thus, the utility of the control strategies will be cleared and the control decision will be on scientific bases. In this case it will be depends on the elements of the desert locust economic threshold. It is well established that, an actual estimation method for the damage caused by *S. gregaria* was not available over the last years, there are many reasons for this, the most important one is that, this pest is considered as an occasional pest, making any continuous scientific research work impossible. Moreover, desert locust control officers have so much to do during plagues, so economic data does not seem appropriate and yield losses evaluation is extremely difficult for the migration of locust swarms for long distances (Krall, 1995).

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معادلة تطبيقية لتقدير الخسائر فى إنتاجية بعض المحاصيل الاقتصادية الناجمة عن الحشرة الكاملة للجراد الصحراوى " شيستوسيركا جريجاريا"

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لتقييم الخسائر فى إنتاجية المحصول الناجمة عن إصابات الجراد الصحراوى ، تم زراعة أربعة محاصيل اقتصادية فى قطع تجريبية ، وهى محاصيل الفول البلدى والذرة والقمح والقطن ، وقد تم المحاكاة بين نزع أوراق نباتات هذه المحاصيل وبين إطلاق الحشرات الكاملة الغير ناضجة جنسياً على النباتات فى القطع التجريبية فى نفس مراحل نمو هذه المحاصيل (بعد شهر ، بعد شهرين من الزراعة ، قبل التزهير وبعده) حيث كانت كثافات الحشرات الكاملة الغير ناضجة جنسياً التى أطلقت على المحاصيل هى ١٠٠ ، ٢٠٠ حشرة كاملة/متر مربع على هذه القطع التجريبية بينما كان نزع أوراق نباتات تلك المحاصيل بنسبة

٢٥% ، ٥٠% بعد شهر أو بعد شهرين من الزراعة قد أدى إلى نقص خفيف فـــى إنتاجيـــة محاصيلها أما النسب الأعلى من فقد إنتاجية المحاصيل كانت فى مرحلة ما قبل التزهير.

وعندما أطلقت الحشرات الكاملة الغير ناضجة جنسياً على قطع تجريبية أخرى أدت إلى نفس النتائج المتحصل عليها فى تجارب نزع الأوراق ، وكانت النتائج أكثر تأثيراً أيضـــاً فى فترة ما قبل التزهير.

هذا وقد تم حساب ما تسببه الحشرة الواحدة (كوحدة) من فقد فى كـــل محصـــول بالكيلو جرام فى اليوم الواحد للدلالة على الفقد فى المحصول نتيجة لهجوم أى ســـرب مـــن الجراد (الحشرة الكاملة) حيث تعتبر الـــ ١٠٠ حشرة/متر مربع عبارة عن ســـرب متوســـط وتسبب خسارة فى المحصول أكثر من الـــ ٢٠٠ حشرة/ متر مربع والتى تعتبر سرب كبـــير وذلك نظراً لتنافسها على الغذاء فى حالة السرب الكبير.

كانت هذه النتائج التطبيقية هى الأساس لوضع معادلة لحساب أو تقدير الفقد فـــى المحصـــول بصفة عامة معتمدة على كميات الفقد فى المحصول بالنسبة لكل حشرة فى اليوم الواحد.