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DAMAGE AND ECONOMIC THRESHOLD ESTIMATION OF TORTOISE BEETLE, BEET MOTH AND EUROPEAN CORN BORER FOR SUGAR BEET PLANTS USING ARTIFICIAL INFESTATION

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ABSTRACT: ***This investigation was carried out at Sakha Agricultural Research Station during three sugar beet growing seasons; 2003/2004 through 2005/2006. The experiments were conducted in the field and screen house for estimating the damage caused by Cassida vittata, Scrobipalpa ocellatella and Ostrinia nubilalis. Kawemira variety was sown in three plantations; mid-September, mid-October and mid-November. Each plantation area was divided into two halves; one half was completely protected against insects using curacron (750 ml/fed) twice; at 100 and 150 days after sowing. The second half was left for natural insect infestation. Data revealed that the application of curacron reduced C. vittata infestation by 85.08, 86.89 and 86.80% for the first, second and third plantation, respectively. The corresponding reduction values of S. ocellatella were 55.57, 55.57 and 84.62%. In case of O. nubilalis, the reduction levels of infestation were 75.00 and 60.00% in mid-October and mid-November plantations, respectively, as the insect was absent in mid-September plantation. In another test in the screen house ,Sugar beet plants were individually caged and artificially infested with first instar larvae of insect species twice (100 and 150 day plants) to determine the economic threshold levels. The economic threshold level of C. vittata was attained as 30 larvae/plant for plants of both 100 and 150 days. The economic threshold level of S. ocellatella was estimated as 10 larvae/plant in sugar beet plants aging 100 days, while the older plants (150-day) did not exhibit any economic threshold level at either rate of artificial infestation. This indicates that the older sugar beet plants were not affected by S. ocellatella infestation as for O. nubilalis, the economic threshold levels were obtained as 8 and 10 larvae/plant for sugar beet plants of 100 and 150 days old, respectively.***

Key Words*: sugar beet*, *Sakha*, *Economic*, *plantations.*

INTRODUCTION

Sugar beet, *Beta vulgaris* L. has become an essential source of sugar in Egypt, as the policy of Egypt's government tends to reduce the areas cultivated with sugar-cane to save water. Thus, the areas of sugar beet crop is progressively increase, reaching to 184,000 feddans in 2005/2006 season;

more than one half of this area is located at Kafr El-Sheikh governorate (Anonymous, 2006).

Sugar beet plants are liable to be infested with several insect pests (Guirguis, 1985, Cristofora *et al.*, 1995, Shalaby, 2001 and Bazazo, 2005). It was usually indicated that the tortoise beetle, *Cassida vittata* Vill., and beet moth, *Scrobipalpa ocellatella* Boysd are major pests of this crop (Abo Saied Ahmed, 1987, Bassyouny and Bleih, 1996 and Talha, 2001). Recently, the European corn borer, *Ostrinia nubilalis* Hubner has been surveyed as an insect pest of sugar beet (Bassyouny *et al.*, 2001 and Shalaby, 2001 and 2005).

To reduce insecticide applications, integrated insect pest management programs should be applied.

Development of insect management strategy requires establishment of economic injury levels and economic threshold levels which relate yield losses and insect control expenses to insect infestation levels (Luckman and Metcalf, 1975). In such concern, several authors investigated the economic levels of some insect pests attacking sugar-beet plant. Mesbah (2000) estimated the economic injury levels of *Pegomyia mixta* as 26-29% for the third generation of insect infestation, and as 43-53% for the fourth generation. Dunning and Winder (1972) indicated into the importance of time of insect infestation on sugar beet yield, and found that sugar beet plants are more adversely affected by mid-season than early-and late-season insect defoliation. The control threshold was 170-180 *Laphygma exigua* larvae/100 sugar beet plants (Zhou and Xu, 1993).

The current research, conducted in 2003/04, 2004/05 and 2005/06 sugar beet seasons, aimed at determining the economic threshold and injury levels of *C. vittata, S. ocellatella* and *O. nubilalis* during two stages of sugar beet plants; 100 and 150 days after sowing.

MATERIALS AND METHODS

1. Estimation of damage to sugar beet plants due to major insects:

An experiment was carried out at the experimental farm of Sakha Agricultural Station during 2003/04 sugar beet growing season. An area of about 1/4 feddan was assigned to the experiment. The area was divided into 24 equal plots. At sowing, eight plots were assigned for each of the three plantations, mid-September, mid-October and mid-November. In each plantation that contains eight plots, sugar beet plants in four plots were left exposed to natural insect infestation, while the other four plots were chemically protected from sugar beet insects. However, the current investigation considered tortoise beetle, *Cassida vittata*, beet moth, *Scrobipalpa ocellatella* and European corn borer, *Ostrinia nubilalis*. The insect infestation in the plots were protected using curacron (Selecron 72% E.C.) at a rate of 750 ml/fed. The insecticide was applied in the plots twice; 100 and 150 days after sugar beet sowing. At harvest, 20 sugar beet plants

per plot were inspected to count the occurring insects; larvae and adults of *C. vittata*, larvae of each of *S. ocellatella* and *O. nubilalis*. Weights of foliage and root were recorded and sucrose % was assessed in the laboratory using sucarometer system.

2. Economic threshold of major sugar beet insects:

This study was carried out for three successive sugar beet seasons; 2003/04, 2004/05 and 2005/06. In each season, Kawemira cultivar was sown on mid-November in the screen house at Sakha Agricultural Station. The sugar beet plants were thinned and adjusted as 70 x 70 cm between hills and rows. Individual sugar beet plants were caged when aged 100 and 150 days, using 50 x 60 x 100 cm cages.

2.1. Cassida vittata

In 2003/04 season, first instar larvae of *C. vittata* were used for artificial infestation of individual caged sugar beet plants when they aged 100 days. Rates of artificial infestation were 0, 15, 30, 45 and 55 larvae for each caged plant. The same procedure was repeated with another set of caged sugar beet plants 150 days after sowing.

2.2. Scrobipalpa ocellatella

In 2004/05 season, two sets of individually caged sugar beet plants were artificially infested with 1st instar larvae of *S. ocellatella*. The first set was infested 100 days after sowing, while the second one was 150 days after sowing, both at rates of 0, 2, 4, 6, 8 and 10 larvae/cage.

2.3. Ostrinia nubilalis

In 2005/06, first instar larvae of *O. nubilalis* were used to conduct an experiment as exact as that of *S. ocellatella.*

2.4. Yield estimation:

The plants, artificially infested with the considered insects, were kept caged till harvest. Then sugar beet foliage and roots were weighed, and root sugar content was estimated using sucarometer. Weights of individual plants were adjusted to yield/feddan by multiplying by 25,000 (as the average number of sugar beet plants per feddan).

2.5. Net return calculations:

Reductions in foliage and root weights due to insects were calculated and reduction in sugar percentage was estimated. The reductions were adjusted to one feddan, and cost of chemical control as 1.5 liters of Selecron (750 ml/ application) was considered. In addition, 10 workers (5 workers/application sprayed the insecticide. Thus, the total cost is 200 L.E. for insecticide + 200 L.E. for labor.

2.6. Statistical analysis:

Values of foliage and root weights and sugar percentage due to applying different levels of artificial insect infestations were compared using "F"test and Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

1. Estimation of damage to sugar beet plants due to major insects:

Population of the considered insects were always reduced due to two insecticide applications. *Cassida vittata* larvae and pupae were reduced by 85.08, 86.89 and 86.80% in mid-September, mid-October, mid-November plantations, respectively (Table 1). The corresponding values of *Scrobipalpa ocelaltella* were 66.67, 66.67 and 84.62%. In case of *Ostrinia nubilalis*, only two plantations were considered; mid-October and mid-November with insect reductions of 75.00 and 60.00%, respectively.

Table (1): Insect infestation and sugar beet yield components in protected and unprotected plots.

Plantation	Status	Av. of insects/20 plants			Yield components		
		C. vittata L & A	*S. ocellatella* L	*O. nubilalis* L	Foliage weight (kg/20 plants)	Root weight (kg/20 plants)	Root sugar %
Mid-Sept.	Unprotected	95.50	6.00	0.00	4.906	19.625	19.8
	Protected	14.25	2.00	0.00	5.365	20.950	19.8
	Reduction	85.08	66.67	0.00	8.560	6.320	0.00
Mid-Oct.	Unprotected	314.75	13.50	2.00	5.409	21.788	17.9
	Protected	41.25	4.50	0.50	5.690	22.975	18.2
	Reduction	86.89	66.67	75.00	4.940	5.170	1.65
Mid-Nov.	Unprotected	604.00	65.00	7.50	5.113	19.868	16.6
	Protected	79.75	10.00	3.00	5.425	21.250	18.2
	Reduction	86.80	84.62	60.00	5.750	6.500	8.79

L = larvae, A = adult

Reductions in yield components over the three tested insects are presented in Table (1). Foliage weights were reduced by 8.56, 4.94 and 5.75% due to the insects in three sugar beet plantations, respectively. The corresponding reduction values of root weight were 6.32, 5.17 and 6.50%. However, no reduction in root sugar content was recorded in mid-September plantation, slight (1.65%) in the second plantation, but considerable (8.79%) in the third one.

2. Economic threshold of major sugar beet insects:

2.1. Cassida vittata:

Both foliage and root weights decreased as the number of *C. vittata* larvae inoculated to the sugar beet plant increased (Table 2). In addition, root sugar content was reduced by increasing the level of artificial infestation. When the artificial infestation was practiced at 100-day plants, the root yield reduction per feddan was 0.750 tons when a sugar beet plant was infested with 15 *C.*

vittata **larvae. The yield reductions were 2.750, 4.375and 6.375 tons/fed at levels of 30, 45 and 55 larvae per plant. Waste in return due to reductions in root weight and sugar content % averaged 112.50, 412.50, 656.25 and 956.25 L.E. at infestation rates of 15, 30, 45 and 55 larvae/plant. Since the chemical control cost was 400 L.E./fed (200 L.E. for the insecticide + 200 L.E. for labor), the levels of 30 larvae/plant should be considered as the economic threshold of *C. vittata* infestation. At this level of artificial infestation, or more, the chemical control cost was lower than the waste in return.**

Table (2): Effect of artificial infestation with first instar larvae of *Cassida vittata* on sugar beet yield and yield components.

No. of larvae/plant	Foliage weight /plan (g)	Rroot weight/plant (g)	Sucrose %	Root yield (ton/fed)	Root yield reduction/ fed	Waste in * return (LE)	Cost of chemical control (LE)
Infestation at 100-day plants							
0	350.00 b	980 c	20.2 b	24.500	-	-	400
15	315.00 b	950 bc	18.5 b	23.750	0.750	112.50	400
30	197.50 a	870 bc	17.8 b	21.750	2.750	412.50	400
45	190.50 a	805 ab	17.0 ab	20.125	4.375	656.25	400
55	80.41 a	725 a	13.8 a	18.125	6.375	956.25	400
Infestation at 150-day plants							
0	347.50 c	1015.0 ab	20.6 b	25.375	-	-	400
15	317.50 bc	1000.0 ab	19.6 b	25.000	0.375	62.25	400
30	226.25 abc	900.0 ab	18.1 ab	22.500	2.875	431.25	400
45	197.50 ab	872.5 ab	17.3 ab	21.813	3.562	534.30	400
55	182.50 a	797.5 a	15.2 a	19.938	5.437	815.55	400

*** Values are multiplied by 150 as price of one ton is 150 L.E.**

When the artificial infestation was conducted at 150-day old sugar beet plants, the same trend was found (Table 2). All criteria; foliage and root weight and sugar content were reduced by increasing levels of *C. vittata* artificial infestation. Also, at a level of 30 larvae/plant, the cost of chemical control was less than the waste in return. Thus, it could be reported that the level of 30 larvae/sugar beet plant is the economic threshold of *C. vittata* to sugar beet plants aging either 100 or 150 days.

Ebeida (1997) estimated an economic threshold level of *C. vittata* to sugar beet plants lower than that estimated in the current study. He found that this level is 25 adults per sugar beet plants with a range of 22-28 adults, depending on the planted varieties. He proposed that the economic threshold level can differ according to insect pest control cost and crop price.

2.2. Scrobipalpa ocellatella:

Artificial infestation with *S. ocellatella* larvae to 100-day old sugar beet plants significantly reduced the foliage and root weight and sugar content (Table 3). Root yield reduction averaged 0.038, 0.538, 1.563, 2.257 and 3.474 tons/fed. at artificial infestation levels of 2, 4, 6, 8 at 10 larvae/plant.

Considering the chemical control cost as 400 L.E. per feddan, the economic threshold of *S. ocellatella* could be reported as 10 larvae/plant.

Table (3): Effect of artificial infestation with first instar larvae of *S. ocellatella* on sugar beet yield and yield components.

No. of larvae/plant	Av. foliage weight (g)	Av. root weight (g)	Sucrose %	Root yield (ton/fed)	Root yield reduction/ fed	Waste in return (LE)	Cost of chemical control (LE)
Infestation at 100-day plants							
0	227.50 c	626.50 b	17.5 b	15.663	-	-	400
2	227.50 c	625.00 b	17.4 b	15.625	0.038	5.70	400
4	218.00 c	605.00 ab	17.0 ab	15.125	0.538	80.70	400
6	176.25 b	564.00 ab	16.2 ab	14.100	1.563	234.45	400
8	132.25 a	536.25 ab	15.6 ab	13.406	2.257	338.55	400
10	124.25 a	487.50 a	15.3 a	12.189	3.474	521.10	400
Infestation at 150-day plants							
0	262.50 c	665.00 a	17.3 bc	16.625	-	-	400
2	267.50 c	657.50 a	17.6 c	16.438	0.187	28.05	400
4	235.00 bc	647.50 a	16.9 abc	16.188	0.437	65.55	400
6	192.50 ab	607.00 a	16.5 abc	15.175	1.450	217.50	400
8	160.00 a	590.50 a	15.9 ab	14.763	1.862	279.30	400
10	147.50 a	560.00 a	15.5 a	14.000	2.625	393.75	400

At this level, the waste in return exceeded the cost of chemical control. For 150-day old sugar beet plants, the reduction in sugar beet yield and yield components due to *S. ocellatella* artificial infestation were relatively less as compared to plants infested at 100-day old. It was found that the cost of chemical control was usually higher than the waste in return, whatever, the levels of artificial infestation. Thus, it could be concluded that sugar beet plants (150-day old) artificially infested with *S. ocellatella* first instar larvae up to 10 individuals per plant did not result in economic losses. This result could be interpreted as the older sugar beet plants the more tolerant to *S. ocellatella* infestation they become.

In a similar study, Ebeida *et al.* (1998) estimated the economic threshold level of *Spodoptera littoralis* on sugar beet plants as 17.82-40.60 larvae/plant. Since both *S. ocellatella* and *S. littoralis* are defoliating insects, the economic threshold of *S. littoralis* could be taken into consideration when estimating the economic threshold of *S. ocellatella.*

Bassyouny (1998) concluded that sugar beet plants early in the season were capable of compensating for damage, and the yield loss was negligible. He indicated that the mid-season defoliation resulted in great losses in root and sugar yields under 20% defoliation, while the late season defoliation had little effect on both characters.

2.3. Ostrinia nubilalis:

The trend of reductions in yield and yield components due to artificial infestation with *O. nubilalis* larvae (Table 4) was similar to that of *S. ocellatella* (Table 3).

Table (4): Effect of artificial infestation with first instar larvae of *Ostrinia nubilalis* on sugar beet yield and yield components.

No. of larvae/plant	Foliage weight /plant (g)	Root weight /plant (g)	Sucrose %	Root yield (ton/fed)	Root yield reduction/ fed	Waste in return (LE)	Cost of chemical control (LE)
Infestation at 100-day plants							
0	181.75	727.50	20.00	18.188	-	-	400
2	180.75	727.00	20.00	18.175	13	19.50	400
4	176.00	705.00	19.20	17.625	563	84.45	400
6	165.00	630.00	19.00	15.750	2438	365.70	400
8	158.13	602.00	19.30	15.050	3138	470.70	400
10	152.50	600.00	18.00	15.000	3188	478.20	400
Infestation at 150-day plants							
0	250.00	785.50	20.20	19.638	-	-	400
2	249.50	785.00	20.00	19.625	13	19.50	400
4	190.30	745.00	19.90	18.625	1013	151.95	400
6	188.50	700.00	19.70	17.500	2138	320.70	400
8	172.00	686.00	19.30	17.150	2488	373.20	400
10	170.00	680.00	18.20	17.000	2638	402.45	400

Inoculating sugar beet plants with *O. nubilalis* larvae 100 days after sowing resulted in waste in return of 19.50, 84.45, 365.70, 470.70 and 478.20 LE at 2, 4, 6, 8 and 10 larvae/plant, respectively. When the number of larvae/plant reached eight, the cost of chemical control (400 LE) was less than waste in return (470.70 LE). Therefore, the economic threshold level could be reported as 8 larvae/plant. When the artificially infested sugar beet plants aged 150 days, the economic threshold was 10 larvae/plant.

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تقدير الضرر والحد الحرج للإصابة بخنفساء البنجر ، فراشة البنجر ودودة الذرة الأوربية فى نباتات بنجر السكر باستخدام العدوى الصناعية

جمال عبدالجواد شلبى

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الملخص العربى

أجريت تجارب حقلية وفى الصوبة السلكية خلال ثلاثة مواسم متتالية ٢٠٠٣/٢٠٠٤م وحتى ٢٠٠٥/٢٠٠٦م فى محطة بحوث سخا وذلك لتقدير الضرر الذى تحدثه ثلاث حشرات هامة هى خنفساء البنجر السلحفائية و فراشة البنجر ودودة الذرة الأوربية على عروات البنجر الثلاثة (منتصف سبتمبر، منتصف أكتوبر ومنتصف نوفمبر) وقد تركت نصف المساحة فى كل عروة للإصابة الطبيعية وعومل النصف الآخر بالسليكرون (٧٥٠ مل/فدان) عند عمر (١٠٠-١٥٠) يوما وقد بينت النتائج أن:

- **كان تعداد حشرة خنفساء البنجر منخفضا دائما نتيجة استخدام المبيد حيث وصلت نسبة الخفض ٥٨.٠٨ ، ٨٦.٨٩ ، ٨٦.٨٠% فى العروات الثلاث على التوالى ، وكانت القيم المناظرة لفراشة البنجر هي ٦٦.٦٧ ، ٦٦.٦٧ ، ٨٤.٦٢% وفى حالة دودة الذرة الأوربية بلغت نسبة الخفض ٧٥.٠ ، ٦٠.٠% فى زراعات أكتوبر ونوفمبر على التوالى.**

وعندما وضعت النباتات فرديا فى أقفاص داخل الصوبة السلكية لتقدير حد الضرر الاقتصادى باستخدام العدوى بيرقات العمر الأول لكل من الآفات الثلاثة ، ثبت الآتي:

- **انخفضت دائما مكونات المحصول مع زيادة نسب الإصابة ، وأن الحد الحرج للإصابة بخنفساء البنجر هى ٣٠ يرقة للنبات فى كلا العمرين ١٠٠ ، ١٥٠ يوما ، وكان الحد الحرج للإصابة لحشرة فراشة البنجر هو ١٠ يرقات عند عمر ١٠٠ يوم فى حين لم تتأثر النباتات الأكبر عمرا (١٥٠ يوما) بأى مستوى من الإصابة حيث كانت أكثر تحملا للضرر.**
- **وفيما يخص دودة الذرة الأوربية فقد وجد أن ٨ يرقات/نبات ، ١٠ يرقات/للنبات هى الحدود الحرجة للإصابة عند عمرى ١٠٠ ، ١٥٠ يوم على التوالى.**