

## Environmental factors associated with fluctuation in the population density of the sugar-cane scales, *Pulvinaria tenuivalvata* (newstead) (hemipteran: coccidae)

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### ABSTRACT

This study aims to monitor the effect of temperature and relative humidity on the population fluctuation of *P. tenuivalvata*. Ecological studies on population dynamic of *P. tenuivalvata* (Newstead) (hemipteran: coccidae) on sugarcane fields were studied in Aswan Governorate two successive seasons 2015-2016. Data showed that this pest was active during summer, autumn and winter from May to January). The insect had 3 generations per year. The first generation was observed during May, June and early of July. The second took place during July, August and 2<sup>nd</sup> half of September. This generation can be regarded as the most economically important generation. The third generation lasted 3 months i.e. extended from November to the 2<sup>nd</sup> week of January. The relationship between insect populations expressed as interval numbers of insects and prevailing weather factors in the two tested years revealed that significant and strong relation between interval of insects and corresponding of maximum and minimum temperature. The correlation coefficient values of the three considered weather factors are (-0.6281, -0.5931 and +0.8612) in 2015 and (+0.6109, +0.5428 and +0.612) 2016 respectively. The effect of one degree of these factors (Unit effect) as indicated by the regression coefficient was about (+2.95, +3.22 and +3.92) and (-3.68, +2.11 and +3.31) from three factors during 2015 compared to insects in 2016, respectively. The explained variances E.V were calculated (as about 64.35 and 71.2 in 2015 and 2016, respectively). In conclusion, the effect of partial regression as indicated by unit effect was negative for maximum temperature.

**Keywords:** Aswan Governorate; Newstead; Hemiptera coccida

### INTRODUCTION

Sugarcane is the major source of sugar production in Egypt. Sugar demands increase year after year due to the increase of habitant population. The yield of sugarcane is markedly influenced by numerous factors among which are agricultural practices among which are agricultural practices, fertilization and infestation by different pests.

One of the most interesting factors affecting sugar production (quantity and quality) are insect pests and fungal disease. Sugarcane is damaged by 35 insect species of hard and soft scale insect (Marreg *et al.*, 1992)

The soft scale, *Pulvinaria tenuivalvata* (Newstead) was first recorded in sugarcane plantation at Attfieh (Giza Governorate) throughout the season 1995 (Ali *et al.*, 1997); the infestation rate was 36.8% in 1995/96 season. This rate progressively increased to reach, the maximum 71.4 % in the next season (1996-1997). Further examination of sugarcane fields in Upper Egypt revealed the wide distribution of the pest in Giza, El-Minia, Sohag, Quena, Luxor, and Aswan were sugarcane in intensity cultivated. The most interest fact in the drastic increase of insect infestation in Quena, Luxor and Aswan where infestation rate multiplied 2,6 and 4.0 times, respectively (Shalaby 2002). These results reflect the severity, dangerous and bad situation of this pest on sugarcane in Upper Egypt.

Sugarcane produced about 73% of the total amount of sugar production (Anonymous 2004). It is only crop cultivated in Egypt for sugar production however, new plants in currently under construction for sugar beet at the northern part of the Nile Delta. Molasses, alcohol, vinegar and some other materials are by-products of the sugar industry. Sugarcane in Egypt is subjected to infestation with a good number of insect pests of which the sugarcane borers are the most important.

In general, sugarcane cultivated in large continuous areas and remain in the field for the whole year. This fore, a wide range of insect species cause the most significant losses. Some of these insects are major pests of regular occurrence and cover serious damage, others are minor species. Among of these insect pests are soft scale insects (Maarg *et al.*, 1992).

During the last few years, it has been recorded the soft scale insect *P. tenuivalvata* (Newstead) as noticed firstly at Giza Governorate in 1995/1996 season and supported widely and quickly to cover 18 thousand Feddan in all sugarcane plantation in 2000/2001 season (Besheit *et al.*, 2002). Sucking leaf juice can cause damage due to the loss of vigor; spots on the foliage due to toxin in the scale saliva (Valand *et al.*, 1989).

The present study was designed to monitor the effect of temperature and relative humidity on the population fluctuation of *P. tenuivalvata*.

## MATERIAL AND METHODS

### Insect incidence in sugarcane fields

The percentage of Infestation = No. of infested leaves / Total no. of sampled leaves x100.

The population density of *P. tenuivalvata* was estimated in sugarcane fields at Awadlah District, Aswan Governorate throughout two successive seasons 2015 and 2016 to carry out this estimate, a sugarcane field of about one Feddan was chosen at Awadlah. Sugarcane plants received regular agricultural practices and no chemical treatments were applied. Sampling of 300 leaves were collected at random from four plots, 42m<sup>2</sup> each representing the cane field communed from 15<sup>th</sup> of May to 15<sup>th</sup> of January. In laboratory, upper and lower surfaces of each leaf were examined.

### The effect of weather factor

The number of insect is influenced, in general, by many factors including population density, behavior of insects and weather factors. The seasonal fluctuation in the population density of P.T. in relation to three main weather factors namely the day maximum temperature °C (X<sub>1</sub>), the night minimum temperature °C (X<sub>2</sub>) and the daily mean relative humidity % (X<sub>3</sub>) were obtained from the Agro-Meteorological station at Aswan Governorate between the change of number of insects and reading of three considered factors were calculated.

The simple correlation coefficient (r) and regression coefficient (b), formula was adopted to find out the simultaneous effect of these factors, together, on the seasonal changes of insect.

End of the above mentioned factors on the one hand (X) and the interval numbers of insects on the other (y). Partial regression method used in this analysis (termed the C-multiplies, (Fisher1950) was helpful in obtaining basic information about the amount of variability in the activity of insect, which could be attributed to these three factors, together, which was calculated as percentages of variance explained, (E V.%).

## RESULTS AND DISCUSSION

Data tabulated in Tables (1, 2) showed that the infestation numbers during the two successive seasons (2015&2016).

The mean infestation varied in the two successive seasons with a markedly high population level in the 2015. In that year the numbers increased steadily from the first half of May onward to reach a total of 73 during May 112,209,322, to reach of maximum 445 during September (Table 1). After September the

numbers decreased gradually during October, November and December, respectively. Data in Table (2) indicate that the population in the infestation in 2016 showed the same trend though on a much smaller scale.

These results may be that *P. tenuivalvata* pass winter as over wintering. Monthly fluctuation and population density of *P. tenuivalvata* in sugarcane fields demonstrated the occurrence of the highest density of adults throughout September–October (Table 1, 2). In two successive seasons.

These numbers were especially decreased to reach the minimum during November. Temperature and relative humidity through September and October ranged 23-25 °C and 61-65 %RH. These results infer that weather of mild temperature and high humidity was the most favorable conditions for *P. tenuivalvata* development and build-up of its population. So, it could be concluded that these were three generations for *P. tenuivalvata* per year. The first occurred in April –May, the second in September, while the third one appeared during November, (Shalaby 2002).

Sugarcane crop is damaged by about 35 species of hard and soft scale insects belonging to the families Acleridae, Asterolecaniidae, Coccidae and Diaspididae in different caulis (Rao and Sankaran, 1969). In Egypt, Maareg *et al.* (1992) recorded *Pulvinaria elongate* on the leaves of sugarcane in Alexandria, while *Pulvinaria tenuivalvato* the first record on sugarcane foliage in plantation in upper Egypt (Ali *et al.*,1997). The complete and integration of the climatic in cadence effect is calculated as percentages of explained variance (E.V.%) The partial regression values gives the average rate of population changes due to a unit change in any of the three factors under test.

Table (3) showed that simple correlation Coefficient between number of insects and prevailing weather factors were significantly negative for maximum, minimum temperature in (2015 and 2016) seasons and positive significant for relative humidity percentages. The effect of Partial regression as indicated by unit effect was negative for maximum temperature positive effect for minimum temperature and relative humidity. The unit effect of every factors was (-2.95, 3.22 and 3.92) & (-3.68, 2.11 and 3.21) in 2015 and 2016 respectively Explained variance for two seasons were (64.35% and 71.2%), respectively.

## CONCLUSION

It could be concluded that the effect of partial regression as indicated by unit effect was negative for maximum temperature and had a

positive effect for minimum temperature, and relative humidity on *Pulvinaria tenuivalvata* at Aswan Governorate.

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**Table 1.** Mean number of *P. tenuivalvata* in relation to weather factors Maximum, minimum temperature and relative humidity in sugarcane fields in Awadallah District, Aswan Governorate during 2015.

Sampling date	Insects.	Weather factors				
		<sup>1</sup> Max.temp, °C	<sup>2</sup> Min temp, °C	Me. Temp., °C	<sup>3</sup> RH, %	
May	15/5/2015	31	33.82	15.95	24.88	64.93
	30	42	36.41	17.07	26.74	65.52
June	15	49	40.02	21.4	30.71	63.82
	30	63	39.02	20.6	29.81	62.56
July	15	97	41.06	23.22	32.14	62.3
	30	112	42.91	24.23	33.57	59.14
August	15	135	41.32	26.25	33.78	62.95
	30	187	42	25.27	33.63	62.45
Septe.	15	215	42.56	26	34.28	59.83
	30	230	41.67	25.9	33.78	61.31
Octob.	15	198	41.62	24.4	33.01	62
	30	161	39.19	22.77	30.98	64.55
Nov.	15	138	31.46	16.66	24.06	72.98
	30	112	28.68	14.7	21.69	72.17
Dec.	15	72	23.56	8.44	16	74.7
	30	45	20.58	7.5	14.04	74.4
Jan	15/1/2016	22	23.1	6.77	14.93	75.33
Total		1909	608.98	327.13	468.05	1120.94
Me.		112.29	35.82	19.24	27.53	65.93

Averages for the week before the mean number of infestation

Averages for the week before the mean number of infestation

Averages for the two week before the mean number of infestation

**Table 2.** Mean number of *P. tenuivalvata* in relation to weather factors Maximum, minimum temperature and relative humidity in sugarcane fields in Awadallah District, Aswan Governorate during 2016.

Sampling date	Insect.	Weather factors				
		Max. temp, °C	Min temp., °C	Me. Temp., °C	RH, %	
May	15/5/2016	21	37.68	19.88	28.78	59.91
	30	34	41.09	22.85	31.97	57.18
June	15	43	41.01	23.07	32.04	57.49
	30	56	40.08	21.81	30.94	62.89
July	15	67	40.64	22.85	31.74	63.01
	30	82	43.47	25.71	34.59	62.51
August	15	103	45.12	29.89	37.50	58.23
	30	128	43.99	27.99	35.99	59.57
Sept..	15	148	42.26	25.32	33.79	63.08
	30	161	41.83	26.48	34.15	61.61
Oct..	15	178	38.83	23.51	31.17	65.84
	30	153	35.97	22.65	29.31	71.93
Nov.	15	121	28.56	13.74	21.15	76.48
	30	78	28.25	14.16	21.20	78.55
Dec.	15	44	22.22	7.75	14.98	79.95
	30	20	21.69	6.17	13.93	81.03
Jan.	15/1/2017	8	22.1	7.1	14.6	79.9
Total		1445	614.79	340.93	477.86	1139.16
Me.		85	36.16	20.05	28.10	67.00

1: Averages for the week before the mean number of infestation.

2: Averages for the week before the mean number of infestation.

3: Averages for the two week before the mean number of infestation.

**Table 3.** Simple correlation (r), and partial regression values of environmental parameters on the population density of soft scale insect *P. tenuivalvata* season (2015-2016).

Year	Environmental factors	R	B	f	E.V. %
2015	Max. temp., °C	-0.6281	-2.95		
	Min. temp., °C	-0.5931	3.22	8.78	64.35
	R.H. , %	0.8612	3.92		
2016	Max. temp., °C	-0.6109	-3.68		
	Min. temp., °C	-0.5428	2.11	11.21	71.2
	R.H. , %	0.612	3.21		

r: Simple correlation co-efficient; b: regression coefficient; *p*: Probability level; E.V: Explained Variance.

## ارتباط العوامل البيئية بالتغير في كثافة تعداد حشرة قصب السكر القشرية الرخوة (*Pulvinaria tenuivalvata* (Newstead))

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### الملخص العربي

استلزم الاهتمام بمحصول قصب السكر نتيجة ازدياد الطلب على السكر وذلك لمواجهة الزيادة في تعداد السكان ومن الافات الهامة التي سجلت على هذا المحصول حشرة قصب السكر القشرية الرخوة وتهدف هذه الدراسة الى معرفة تأثير الحرارة والرطوبة على النشاط البيولوجي لهذه الافة. وقد اشتملت الدراسة على تقييم الانتشار الموسمي وكثافة الاعداد للحشرة القشرية الرخوة وقد اثبتت النتائج ان الكثافة العددية للحشرة تزداد خلال سبتمبر واکتوبر بزيادة الرطوبة واعتدال درجة الحرارة كما ان للحشرة ثلاثة اجيال الاول في ابريل ومايو والثاني في سبتمبر اما الثالث فيكون في نوفمبر. وتمت دراسة بعض العوامل البيئية على الكثافة العددية وتضمنت تأثير درجة الحرارة العظمى والصغرى والرطوبة النسبية والتي كانت على التذبذب العددي لهذه الافة خلال عامي الدراسة ٢٠١٥، ٢٠١٦. وقد اوضحت الدراسة ان معامل الارتباط بين درجة الحرارة العظمى والصغرى والرطوبة النسبية خلال عامي الدراسة سالبا ومعنويا بالنسبة لدرجة الحرارة العظمى والصغرى موجبا ومعنويا بالنسبة للرطوبة النسبية. كما قدر تأثير الوحدة في معامل الانحدار سالبا بالنسبة لدرجة الحرارة العظمى موجبا في كل من درجة الحرارة الصغرى والرطوبة النسبية خلال سنتي الدراسة اما عن التأثير المشترك للعوامل البيئية الثلاثة مجمعة فقد وصل الي (٦٤,٣% و٧١,٢%) خلال عامي الدراسة ٢٠١٥ و٢٠١٦ على الترتيب. ونستنتج من هذا وجود علاقة انحدار عكسي مع درجات الحرارة العظمى.