PREDICTION OF *SYNANTHEDON MYOPAEFORMIS* BORKH. MOTHS ACTIVITY BASED ON PHEROMONE TRAPPING AND DEGREE-DAY ACCUMULATIONS OF TEMPERATURE IN APPLE ORCHARDS IN EGYPT

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Abstract

In Egypt, the clearwing moth *S. myopaeformis* (Lepidoptera: Aegeriidae) is a serious pest on apple trees. The relationship between weather factors (of temperature and relative humidity) and the population fluctuation was quantitatively calculated during six successive years (from 1997 to 2002 separately, and 1997-2002 together) in apple orchards at Qalubia governorate. Trials were conducted to determine the correlations between the main weather factors and moths activity as well as using the day-degree method for predicting the peak emergence period of adult moths, i.e. to asses prediction formula through which population fluctuation could be expected. R-square values of each single weather factor indicated that daily maximum (X1) and minimum temperature (X2) significantly affected *S. myopaeformis* population fluctuation, showing 0.461-0.958 for (X1) and 0.607-0.904 for (X2) and were included in selection of suitable statistical models used. Statistical combined models {(X1X2), (X1X1²), (X2X2²), (X1X2²), (X1²X2), (X1²X2²) and (X1X2X1²X2²)} were used in assessing the prediction formula. The effective weather factor was the daily maximum temperature (X1) rather than minimum temperature (X2). Prediction calculations were based on the linear regression formula described by Bishop (1969) {Y' = a + b1X1 + b2X2 bjXj}. Results indicated that the degrees of correlation between the predicted and observed data varied between very close correlation in 2000, close correlation in 2001 and 2002, moderate correlation in 1997/2002 together and very poor correlation in 1999. Other factors such as the nutrition of trees, horticultural practices that may accelerate or delay the tree activity played an important role in predicting the population activity. According to graphs and statistical analysis (χ^2 test) which magnified the differences between the observed and predicted population it could not relay on temperature and relative humidity only to predict the population activity of *S. myopaeformis* in the following seasons.

INTRODUCTION

In Egypt, apples are economically important crops, occupying an area of about 65 000 feddans. Apple trees severely attacked with the clearwing moth *S. myopaeformis* (Lepidoptera: Aegeriidae). Larvae bore tunnels under the bark of tree stem and branches, girdle the wood, and reduce the production, cause weakness, and finally death of trees. As larvae and pupae live inside the tree wood, so they are not directly exposed to the weather factors, and not affected with all of them. The success of the integrated control programs to check their ravages depends largely on the predicting the seasonal activity of the target pest to determine the proper timing of application of each control treatments.

Prediction of population activity of *S. myopaeformis* based on prediction formula is the first trial in Egypt. Studies on the effect of temperature and relative humidity on the seasonal abundance of *S. myopaeformis* were presented by Awadallah *et al.* (1978), Tadros and Kinaway (1992), and Tadros (1994) in Egypt. Mussey and Potter (1997) in USA suggested a phonology calendar that facilitates prediction of activity and timing of control actions of Sesiids.

The aim of the present investigation is to predict the population activity of *S. myopaeformis* in apple orchards during 1997 to 2002:

MATERIALS AND METHODS

Pheromone traps were used in monitoring experiments of *S. myopaeformis* moth population along six activity seasons from 1997 until 2002 in heavily infested apple orchards (more than 5 feddans) at Tokh district, Qalubia governorate.

Locally made bottle traps (described by Tadros *et al.*, in press) were suspended on trees at 2 meters above the ground at the rate of 1 trap per 5 trees. Each trap was baited with a polyethylene dispenser impregnated with 1 mg active ingredient (a. i.) of a blend of *S. myopaeformis* sex pheromone containing the following isomers: (Z, Z) 3, 13 – octadecadienyl acetate (84.29%), (Z, E) 3, 13 – octadecadienyl acetate (2.83%), (E, Z) 3, 13 – octadecadienyl acetate (9.69%) and (E, E) 3, 13 – octadecadienyl acetate (0.61%). Dispensers renewed at 6-week intervals, and the trapped males were counted and removed at half monthly intervals.

Screening statistical analysis were quantitatively calculated to determine the direct effect (simple correlation coefficient "r") of 6 main weather factors, namely: daily maximum (DMxT), minimum (DMnT) and mean (DMT) temperature and daily maximum (DMxRH), minimum (DMnRH), and mean (DMRH) relative humidity on the rate of *S. myopaeformis* moth population.

As the DMxT (X1), DMnT (X2), DMxRH (H1), and DMnRH (H2) showed stronger (significant) effect, the squared partial regression coefficients (R-square) for the relationship between each tested weather factor and the population fluctuation of *S. myopaeformis* were also calculated during the 6 years.

DMxT (X1) and DMnT (X2) showed dominating effect on *S. myopaeformis* population fluctuation. Therefore, R-square of each factor {DMxT (X1) and DMnT (X2)} singly as well as in different statistical models of combinations {(X1X2), ($X1X1^2$),

$(X2X2^2)$, $(X1X2^2)$, $(X1^2X2)$, $(X1^2X2^2)$ and $(X1X2X1^2X2^2)\}$ for each single year from 1997 to 2002 and, at the same time, for the 6 years together were assessed.

The ideal model (highest R-square with respect to the statistical model containing the lowest number of items) was chosen to calculate the predicted population values (Y`). Thereafter, the predicted values for each year were plotted against the corresponding actual (observed) population values that obtained from pheromone trap catches for the same year.

The effective weather factor(s) on the rate of population during 1997-2002 were used to set prediction of its expected population in the same year(s). Stepwise regression analyses for 1997–2002 revealed the effective weather factor(s) that significantly influenced particular insect activity within that particular year.

Prediction calculations were based on the following linear regression formula described by Bishop, (1969):

$Y' = a + b1X1 + b2X2......bjXj$

where:

Y': predicted population of a particular insect.

a: constant (calculated for every mathematical relationship between a certain weather factor and a particular insect population during a specific activity period).

b: slope for the independent variable X.

X: independent variable (weather factor).

To verify the validity and reliability of predicated (calculated) population for a certain year, the actual (observed) and predicted population of that year was plotted against each other and the statistical difference between them was calculated by χ^2 test. Insignificant χ^2 values confirmed the reality of predictions and significant χ^2 values assured the incorrectness of these prediction.

RESULTS AND DISSCUION

Screening results of the squared partial regression coefficients (R-square) of the 4 weather factors as single effect (Tables, 1) indicated that DMxT (X1) and DMnT (X2) were only the most significant factors affecting the rate of moth's emergence.

Table (1) clarified that R-square of the other different statistical models which were the most affecting significant combined factors of DMxT (X1) and DMnT (X2), $\{(X1X2)$, $(X1X1^2)$, $(X2X2^2)$, $(X1X2^2)$, $(X1^2X2)$, $(X1^2X2^2)$ and $(X1X2X1^2X2^2)\}$ on *S. myopaeformis* population fluctuation, were assessed for each single year from 1997 to 2002 and at the same time for the 6 years (1997-2002) together.

The ideal model was indicated by the highest R-square value with respect to the statistical model containing the lowest number of items of the effective weather factor(s) on *S. myopaeformis* population fluctuation.

The ideal model during the period from 1997 to 2002, was chosen to calculate the predicted population values (Y`), to be used to set predictions of its expected population in the same year(s). Prediction calculations were based on the linear regression formula described by Bishop (1969).

The assessed predicted values for each year were then plotted against the corresponding actual (observed) population values obtained from pheromone trap catches for the same year(s).

R-square of the 11 statistical different models were shown in Table (1). The effect of 4 tested single weather factors, DMxT (X1), DMnT (X2), DMxRH (H1) and DMnRH (H2) as well as 7 of combined factors of X1 and X2 {$X1X2$, $X1X1^2$, $X2X2^2$, $X1X2^2$, $X1^2X2$, $X1^2X2^2$ and $X1X2X1^2X2^2$} on *S. myopaeformis* population in each separate 6 years from 1997 to 2002 alone and the mean of the 6 years together were precisely assessed.

Data in Table (1) indicated that R-square values of each single DMxT (X1), DMnT (X2), DMxRH (H1), and DMnRH (H2) separately were significantly varied in their effect on *S. myopaeformis* population fluctuation. R-square values of temperature were 0.461-0.958 for (X1) and 0.607-0.904 for (X2) while those of relative humidity were 0.002-0.936 for (H1) and 0.078-0.968 for (H2).

Accordingly, the R-square values of the two single factors of relative humidity (H1 and H2) which were negligible excluded from the results and were not included in selection of suitable statistical models used. These results agreed with *S. myopaeformis* living behavior and the phenomenon that immature stages hide inside, surrounded by tree-wet tissues, and consequently hardly affected by the outside relative humidity.

Table 1. Squared partial regression coefficients (R-square) of maximum, minimum temperature and relative humidity, at different statistical models, on the population fluctuation of *S. myopaeformis* male moths in apple orchards at Qalubia governorate during 1997-2002.

Year	*R-square values of statistical models*										
	Single factors				*Combined factors*						
	X1	X2	H1	H2	X1X2	$X1X1^2$	$X2X2^2$	$X1X2^2$	$X1^2X2$	$X1^2X2^2$	*$X1X2X1^2X2^2$*
1997	0.921	0.895	0.003	0.099	0.921	0.922	0.895	0.922	0.918	0.918	*0.931*
1998	0.900	0.864	0.002	0.588	0.901	0.903	0.866	0.900	0.891	0.889	*0.907*
1999	0.461	0.607	0.566	0.462	0.643	0.673	0.630	0.645	0.617	0.619	*0.751*
2000	0.923	0.904	0.030	0.078	0.924	0.925	0.923	0.923	0.912	0.908	*0.936*
2001	0.858	0.824	0.002	0.466	0.858	0.907	0.926	0.867	0.832	0.838	*0.946*
2002	0.882	0.782	0.005	0.115	0.887	0.892	0.859	0.890	0.865	0.873	*0.893*
1997 -02	0.958	0.884	0.936	0.968	0.977	0.964	0.904	0.973	0.961	0.971	0.981

X1: daily mean maximum temperature
X2: daily mean minimum temperature
H1: daily mean maximum relative humidity
H2: daily mean minimum relative humidity

On the other hand, it was noticed that in case of combined factors, the statistical combined model $X1X2X1^2X2^2$ gave the highest values of R-square (0.751, 0.893, 0.907, 0.931, 0.936, 0.946, and 0.981 for 1999, 2002, 1998, 1997, 2000, 2001 and 1997-2002 years, respectively) and used in assessment of Bishop Formula in the present study. However, the statistical models of DMnT ($X1X1^2$ and X1) were more or less perfect models that they: 1) had less items (1 or 2) than the combined model which had 4 items and, 2) their values more or less same as the values of the combined model where R-square values were 0.922, 0.903, 0.673, 0.925, 0.907, 0.892 and 0.964 for $X1X1^2$ model and 0.921, 0.900, 0.461, 0.923, 858, 0.882 and 0.958 for X1 model during 1997, 1998, 1999, 2000, 2001, 2002 and 1997-2002 years, respectively.

Data in Table (1) clearly indicated that the statistical models contained X1 had a bigger value of R-square. A vice versa results were noticed that each statistical model, which had not contained X1, had a smaller value of R-square. It was obvious that X1 and its multiplication $X1X1^2$ which represent DMxT was the effective weather factor.

These results almost coincided with the *S. myopaeformis* mode of life that all immature stages which live near the surface just beneath the bark of the apple tree affected by maximum temperature rather than other weather factors (Tadros and Kinawy, 1992).

Although the statistical combined model $X1X2X1^2X2^2$ which had the largest R-square values and used in assessing the prediction formula (to gave good fitness between predicted and observed values either in assessment or in Figures), yet it must recognize that the effective whether factor was DMxT (X1) rather than DMnT (X2) and its combinations.

Table (1) clarified that, R-square in the combined 1997-2002, for DMxT was the strongest thermal factor affecting *S. myopaeformis* activity. This factor expressed higher significant positive effect {R-square for (X1): 0.958, R-square for ($X1X1^2$): 0.964, and R-square for ($X1X2X1^2X2^2$): 0.981}.

More or less equal high values of R-square were obtained in the combined 2001, 2000, 1997 and 1998 where the respective R-square for ($X1X2X1^2X2^2$) were 0.946, 0.936, 0.931 and 0.907.

Lower values of R-square were obtained in 1999, 2002, and 1997-2002 where R-square for ($X1X2X1^2X2^2$) were 0.751, 0.893, and 0.981, respectively.

The half-monthly predicted (expected) values which assessed according to the selected statistical model and according to Bishop prediction formula and actual (observed) numbers of *S. myopaeformis* moths in apple orchards were plotted in each year from 1997 to 2002 as well as the mean of the 6 years (1997-2002) (Figures 1, 2, 3, and 4).

Tables (2, and 3) and the illustrated Figures (1, 2, 3, and 4) clarified the actual and smoothed observed half-monthly population of *S. myopaeformis* together with the predicted population (plotted with smoothed values) and the Chi square test (χ^2) of significance in apple orchards at Qalubia governorate during 1997, 1998, 1999, 2000, 2001, 2002 and 1997-2002 according to DMnT and DMxT.

Generally, results indicated that the smoothed observed population in the combined 1997-2002 and single years of 2002, 2000, and 1997 was almost the same as the predicted population with very small differences during all the activity season of *S. myopaeformis* moths.

Results presented in Tables (2, and 3) and illustrated in Figures (1, 2, 3 and 4) clearly indicated that there were some degrees of correlation between the predicted and observed data in some years of study. These degrees varied between very close relation in only one year (2000), close correlation in some years (2001 and 2002), moderate correlation in the combined study of 1997 ./ 2002 together and very poor correlation in 1999 separate year.

Table 2. χ^2 test for observed and predicted population of *S. myopaeformis* moths in apple orchards at Qalubia governorate during 1997, 1998, 1999, 2000, 2001, and 2002 separately. (Prediction formula: $Y' = a+b1X1+b2X2+b3X1^2+b4X2^2$) Where: a=21.63535, b1=-2.98075, b2=2.52232, b3=0.04880, b4=-0.05748

Date of sampling			Effective factors		Observed population		Predicted population (Y`)	χ^2
Year	Month	Half	Max. temp. (X1)	Min. temp. (X2)	Actual	Smoothed		
1997	Feb.	2nd	18.2	5.7	2	5.87	12.82	3.77
	Mar.	1st	19.6	6.8	14	11.45	28.46	10.17
		2nd	19.7	7.7	16	27.75	20.91	2.24
	Apr.	1st	21.9	9.1	65	64.25	48.47	5.13
		2nd	24.9	11.0	111	99.75	84.43	2.78
	May	1st	29.4	13.8	112	126.00	126.92	0.01
		2nd	31.9	16.2	169	148.25	148.93	0.00
	June	1st	33.6	18.9	143	151.00	176.88	3.79
		2nd	34.0	19.9	149	161.50	190.05	4.29
	July	1st	34.0	20.5	205	184.75	197.88	0.87
		2nd	33.2	19.8	180	181.75	187.09	0.15
	Aug.	1st	32.5	19.3	162	185.25	179.04	0.22
		2nd	32.3	18.6	237	211.75	170.31	10.08
	Sep.	1st	31.7	18.3	211	214.25	164.64	14.95
		2nd	31.2	17.7	198	185.75	156.86	5.32
	Oct.	1st	29.8	17.3	136	142.50	145.54	0.06
		2nd	28.5	15.9	100	101.25	125.90	4.83
	Nov.	1st	26.6	14.3	69	75.75	100.54	6.11
		2nd	24.3	11.9	65	55.25	71.86	3.84
	Dec.	1st	21.7	9.7	22	32.00	39.87	1.55
		2nd	19.2	7.9	19	20.00	7.73	19.49
	Total							99.65
1998	Feb.	2nd	21.2	7.9	3	7.33	7.94	0.05
	Mar.	1st	21.4	7.9	16	12.75	9.30	1.28
		2nd	24.4	9.5	16	20.25	33.51	5.25
	Apr.	1st	26.5	11.5	33	45.00	53.59	1.38
		2nd	30.7	14.7	98	87.75	89.27	0.03
	May	1st	31.3	16.4	122	128.50	92.63	13.89
		2nd	33.5	18.1	172	132.25	107.94	5.48
	June	1st	33.9	19.1	63	92.50	108.63	2.39

		2nd	34.9	20.1	72	73.25	114.04	14.59
	July	1st	34.9	20.4	86	88.25	111.57	4.87
		2nd	35.3	20.5	109	111.75	115.16	0.10
	Aug.	1st	34.8	20.3	143	128.50	111.90	2.46
		2nd	36.1	21.4	119	125.25	118.05	0.44
	Sep.	1st	36.0	21.6	120	128.75	116.36	1.32
		2nd	36.5	21.4	156	129.75	122.94	0.38
	Oct.	1st	33.1	19.2	87	102.50	100.30	0.05
		2nd	30.6	17.5	80	81.50	83.49	0.05
	Nov.	1st	27.4	16.0	79	73.50	61.46	2.36
		2nd	25.6	14.5	56	50.75	50.64	0.00
	Dec.	1st	22.9	12.5	12	21.75	33.27	3.99
		2nd	21.3	10.6	7	8.67	20.47	6.80
	Total							67.15
1999	Feb.	2nd	20.8	8.6	10	12.3	22.97	4.92
	Mar.	1st	22.3	9.7	17	20.8	66.73	31.69
		2nd	24.5	10.8	39	42.3	162.57	89.05
	Apr.	1st	26.7	12.1	74	68.3	208.20	94.07
		2nd	28.6	13.3	86	84.3	231.46	93.62
	May	1st	30.2	15.2	91	93.0	210.18	65.33
		2nd	32.3	17.5	104	98.0	208.73	58.74
	June	1st	33.0	19.4	93	92.8	233.53	84.87
		2nd	34.1	20.9	81	85.0	274.15	130.51
	July	1st	34.1	21.5	85	88.0	301.85	151.50
		2nd	34.7	22.0	101	104.8	316.19	141.39
	Aug.	1st	34.8	21.8	132	121.0	307.19	112.85
		2nd	36.2	22.3	119	121.5	299.55	105.83
	Sep.	1st	36.3	21.9	116	128.3	266.94	72.05
		2nd	36.6	21.2	162	135.0	222.28	34.27
	Oct.	1st	33.6	19.2	100	108.3	224.45	60.16
		2nd	31.1	17.4	71	77.5	199.06	74.24
	Nov.	1st	28.6	15.5	68	60.0	155.06	58.27
		2nd	26.4	13.2	33	38.8	134.15	67.84
	Dec.	1st	24.8	11.8	21	20.8	114.75	77.00
		2nd	22.5	10.1	8	12.3	45.26	23.95
	Total							1632.18
2000	Feb.	2nd	0.00	0.00	0.00	0.00	0.00	0.00
	Mar.	1st	3.61	3.61	3.61	3.61	3.61	3.61
		2nd	0.53	0.53	0.53	0.53	0.53	0.53
	Apr.	1st	0.01	0.01	0.01	0.01	0.01	0.01
		2nd	1.26	1.26	1.26	1.26	1.26	1.26
	May	1st	2.25	2.25	2.25	2.25	2.25	2.25
		2nd	0.20	0.20	0.20	0.20	0.20	0.20
	June	1st	1.48	1.48	1.48	1.48	1.48	1.48
		2nd	3.11	3.11	3.11	3.11	3.11	3.11
	July	1st	2.44	2.44	2.44	2.44	2.44	2.44
		2nd	1.79	1.79	1.79	1.79	1.79	1.79
	Aug.	1st	0.13	0.13	0.13	0.13	0.13	0.13
		2nd	0.01	0.01	0.01	0.01	0.01	0.01
	Sep.	1st	1.94	1.94	1.94	1.94	1.94	1.94
		2nd	1.93	1.93	1.93	1.93	1.93	1.93
	Oct.	1st	3.11	3.11	3.11	3.11	3.11	3.11
		2nd	2.31	2.31	2.31	2.31	2.31	2.31
	Nov.	1st	0.80	0.80	0.80	0.80	0.80	0.80
		2nd	0.05	0.05	0.05	0.05	0.05	0.05
	Dec.	1st	6.43	6.43	6.43	6.43	6.43	6.43
		2nd	17.07	17.07	17.07	17.07	17.07	17.07
	Total							50.46

2001	Feb.	2nd	21.9	9.7	9	12.33	4.53	13.45
	Mar.	1st	22.7	10.4	19	23.50	21.08	0.28
		2nd	24.9	11.7	47	54.50	53.03	0.04
	Apr.	1st	28.3	14.2	105	90.75	92.87	0.05
		2nd	31.2	16.0	106	110.75	108.14	0.06
	May	1st	32.1	16.9	126	125.25	113.34	1.25
		2nd	34.2	18.6	143	128.00	118.02	0.84
	June	1st	35.4	20.0	100	110.50	121.49	0.99
		2nd	36.3	21.4	99	104.50	126.26	3.75
	July	1st	36.1	21.5	120	114.00	130.19	2.01
		2nd	36.8	22.9	117	119.00	135.64	2.04
	Aug.	1st	36.9	23.3	122	122.75	137.22	1.53
		2nd	37.8	24.5	130	136.00	135.84	0.00
	Sep.	1st	37.1	23.4	162	153.50	136.19	2.20
		2nd	37.6	23.0	160	156.50	125.42	7.70
	Oct.	1st	35.7	21.5	144	147.50	134.95	1.17
		2nd	32.8	19.0	142	134.50	134.24	0.00
	Nov.	1st	29.0	15.9	110	115.50	114.65	0.01
		2nd	24.8	13.1	100	85.75	72.34	2.49
	Dec.	1st	22.5	12.1	33	42.25	46.03	0.31
		2nd	20.1	11.0	3	13.00	10.33	0.69
	Total							40.87
2002	Feb.	2nd	20.4	9.9	8	8.00	4.80	2.13
	Mar.	1st	22.1	10.9	15	18.75	20.08	0.09
		2nd	24.2	11.3	37	40.50	37.27	0.28
	Apr.	1st	26.2	12.6	73	66.75	53.22	3.44
		2nd	29.1	14.2	84	82.75	74.73	0.86
	May	1st	31.0	15.9	90	92.50	87.99	0.23
		2nd	34.0	18.0	106	99.50	106.38	0.44
	June	1st	35.0	19.8	96	92.50	110.82	3.03
		2nd	34.8	22.0	72	81.00	107.06	6.35
	July	1st	34.8	23.7	84	84.75	103.64	3.44
		2nd	35.4	24.3	99	102.75	106.06	0.10
	Aug.	1st	36.7	24.0	129	119.00	114.46	0.18
		2nd	37.0	23.5	119	121.00	117.11	0.13
	Sep.	1st	37.2	23.4	117	128.25	118.29	0.84
		2nd	34.4	21.3	160	137.00	105.39	9.48
	Oct.	1st	31.3	19.3	111	116.50	88.31	9.00
		2nd	28.8	16.8	84	90.25	72.50	4.34
	Nov.	1st	28.5	15.9	82	71.00	70.85	0.00
		2nd	27.5	14.4	36	44.50	63.64	5.76
	Dec.	1st	25.5	13.6	24	23.00	48.39	13.32
		2nd	22.8	12.1	8	13.33	26.55	6.58
	Total							70.02

As a matter of fact, predication studies were conducted for such several years (six separate years, from 1997 to 2002, in addition to the seventh study for date of 1997 to 2002 together) in order to assure the results of almost close relation between observed and predicted numbers of emerged moth population or not.

The aim of carrying out the study for several years was also to exclude the effect of the other factors rather than the temperature and relative humidity, which may affect the population activity and reduce the strong correlation between the observed and predicted population.

These other factors, as the nutrition status of trees, the horticultural practices which may accelerate or delay the tree activity, ...etc. gave the interpretation that there were poor correlation in most of years of study and played an important role in predicting the population activity of *S. myopaeformis*.

Accordingly, graphs and statistical analysis (χ^2 test) magnified the differences between the observed and predicted population and clearly indicated that it could not relay on temperature and relative humidity to predict the population activity in the following seasons.

These results were somewhat in agreement with Awadallah *et al.* (1978), Tadros and Kinaway (1992), and Tadros (1994) who monitored the population of *S. myopaeformis* on apple trees in Egypt by counting pupal skins and/or male capture in traps baited with synthetic pheromone. Both techniques showed that adult emergence was significantly affected by the combined action of temperature and relative humidity rather than the effect of each factor separately.

Mussey and Potter (1997) in USA, found that phonological sequences of plant flowering and Sesiidae activity were highly consistent between years. Plant phonology was generally a better predictor of insect activity than was calendar date. Comparison of the temporal deviation between plant-insect correlations suggested that some phonological predictors were consistent across geographic regions, whereas others were not. A phonology calendar was developed that facilitates prediction of pest activity and timing of control actions by horticultural professionals and lay persons.

Table 3. χ^2 test for observed and predicted population of *S. myopaeformis* moths in apple orchards at Qalubia governorate during 1997-02. (Prediction formula: $Y` = a + b1X1 + b2X2 + b3X1^2 + b4X2^2$) Where: a=21.63535, b1=-2.98075, b2=2.52232, b3=0.04880, b4=-0.05748

Date of sampling		Effective factors		Observed population		Predicted population (Y`)	χ^2
Month	Half	Max. temp. (X1)	Min. temp. (X2)	Actual	Smoothed		
Feb.	2nd	20.3	8.4	8	11.23	15.63	1.24
Mar.	1st	21.4	9.1	17	18.24	31.03	5.28
	2nd	23.6	10.3	30	34.86	62.17	12.00
Apr.	1st	26.2	12.1	62	60.80	87.86	8.33
	2nd	29.1	14.0	89	84.72	120.16	10.46
May	1st	31.0	15.8	99	102.44	133.60	7.27
	2nd	33.3	17.8	123	108.67	150.92	11.83
June	1st	34.5	19.5	89	97.66	155.69	21.63
	2nd	35.0	20.8	89	93.10	156.72	25.83
July	1st	35.0	21.4	106	102.24	153.87	17.33
	2nd	35.2	21.9	109	111.21	155.34	12.54
Aug.	1st	35.2	21.8	122	120.56	155.97	8.04
	2nd	36.0	22.3	130	129.63	164.79	7.50
Sep.	1st	35.8	21.8	136	135.99	162.69	4.38
	2nd	35.5	21.0	141	131.68	161.75	5.59
Oct.	1st	32.8	19.3	108	112.51	133.83	3.40
	2nd	30.5	17.4	92	92.38	110.94	3.11
Nov.	1st	28.2	15.6	76	76.61	85.78	0.98
	2nd	26.0	13.5	61	56.04	65.85	1.46
Dec.	1st	23.9	12.1	25	30.52	40.08	2.28
	2nd	21.6	10.5	10	15.32	11.09	1.61
Total							172.08

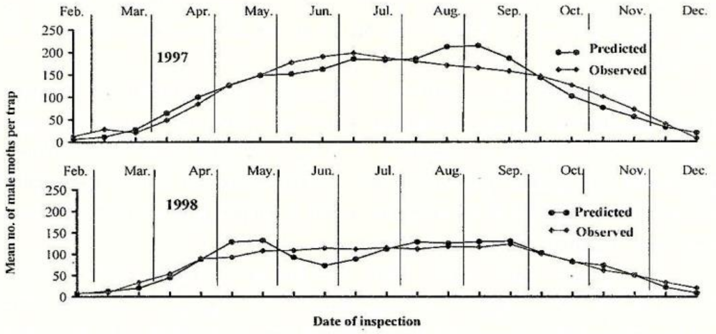

Figure 1: Observed and predicted populations of *S. myopaeformis* moths by the number of males per trap on apple orchards at Qalubia governorate in 1997 and 1998.

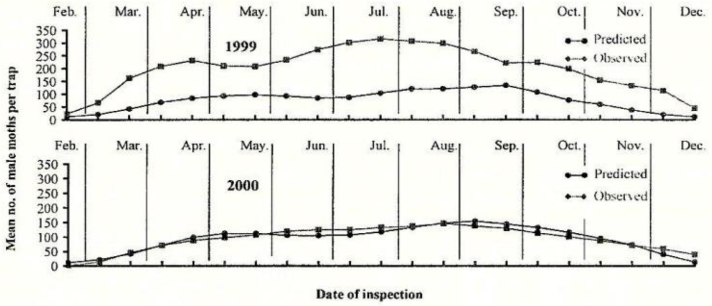

Figure 2: Observed and predicted populations of *S. myopaeformis* moths by the number of males per trap on apple orchards at Qalubia governorate in 1999 and 2000.

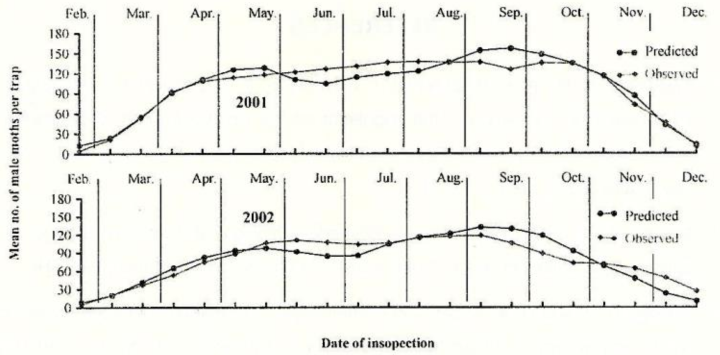

Figure 3: Observed and predicted populations of S. myopaeformis moths by the number of males per trap on apple orchards at Qalubia governorate in 2001 and 2002.

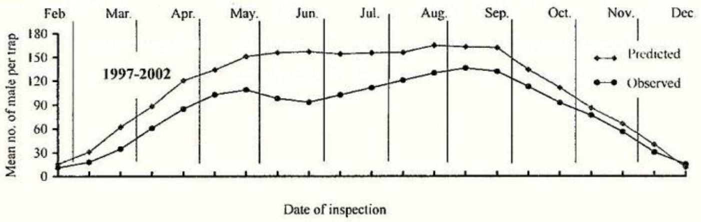

Figure 4: Observed and predicted populations of *S. myopaeformis* moths by the number of males per trap on apple orchards at Qalubia governorate in 1997-2002.

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التنبؤ بالتعداد المستقبلي لفراشات حفار ساق الحلويات رائق الأجنحة *Synanthedon myopaeformis* على أساس تعداد المصايد والتراكم الحراري اليومي في حدائق التفاح في مصر

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يعتبر حفار ساق الحلويات رائق الأجنحة من الآفات شديدة الخطورة علي أشجار التفاح في مصر. أجريت تجارب دراسة وحساب العلاقة بين مجموعة من العوامل الجوية (من درجات الحرارة والرطوبة النسبية) وبين التذبذب الكمي في تعداد الفراشات خلال ٦ سنوات متتالية (من ١٩٩٧ حتى ٢٠٠٢ منفصلة ومرتبطة معا) في حدائق التفاح في محافظة القليوبية. أجريت التجارب لتحديد العلاقات بين أهم العوامل الجوية ونشاط الفراشات مع استخدام طريقة التراكم الحراري اليومي في قمة خروج الفراشات (حساب معادلة للتنبؤ يمكن من خلالها توقع التذبذب في التعداد). دل حساب قيم مربعات الارتباط الجزئي لكل من العوامل الجوية الستة والتوليفات المختلطة منها على أن المتوسط اليومي لدرجات الحرارة العظمى (X1) والصغرى (X2) هما أكثر العوامل معنوية في تأثيرها على معدل التذبذب في تعداد فراشات الحفار (٠,٤٦١-٠,٩٥٨ للحرارة العظمى، و ٠,٦٠٧-٠,٩٠٤ للصغرى) لذا تم استخدامهما في اختيار نماذج الإحصاء المناسبة. كما تم استخدام نماذج التوليفات المختلطة إحصائيا {($X1X2$) و ($X1X1^2$) و ($X2X2^2$) و ($X1X2^2$) و ($X1^2X2$) و ($X1^2X2^2$) و ($X1X2X1^2X2^2$)} في حساب معادلة التنبؤ. أجري حساب التنبؤ بناء علي معادلة الانحدار الخطي {$Y' = a + b1X1 + b2X2 \quad bjXj$} حسب بيشوب (١٩٦٩). دلت النتائج علي أن المتوسط اليومي لدرجات الحرارة العظمي هي العامل المؤثر فعليا على نشاط فراشات حفار ساق الحلويات رائق الأجنحة أكثر من المتوسط اليومي لدرجات الحرارة الصغرى كما بينت النتائج أن الارتباط بين التعداد المحسوب (المتوقع) والتعداد الفعلي الحقيقي (المشاهد) كان كبيرا ووصل إلى حد التطابق خلال عام ٢٠٠٠ وقل هذا التطابق في عامي ٢٠٠١ و ٢٠٠٢ وكان التطابق ضعيفا في متوسط الأعوام مجمعة ١٩٩٧-٢٠٠٢ ولم يلاحظ التطابق في عام ١٩٩٩. قد تؤثر العوامل الأخرى مثل مستوي التغذية في الأشجار والعمليات البستانية في تقدم أو تأخر نشاط الأشجار، وبالتالي تلعب دورا هاما في التأثير علي نشاط الحفار. وتؤكد الرسوم البيانية واختبار مربع كاى (الذي يعظم الاختلافات بين تعداد الحشرة المشاهد والمتوقع) هذه الاستنتاجات، وبناء علي ذلك لا يمكن الاعتماد فقط علي درجات الحرارة والرطوبة النسبية فقط في التنبؤ بتعداد ونشاط فراشات الحفار في المواسم التالية.