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ECOLOGICAL STUDIES ON SUNT STEM BORER, *Macrotoma palmata* F. (COLEOPTERA: CERAMBYCIDAE) ATTACKING NAVEL ORANGE TREES IN SHARKIA GOVERNORATE, EGYPT.

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ABSTRACT

The population density of *Macrotoma palmata* F. (Coleoptera: Cerambycidae), attacking Navel orange trees, were monitored at Sharkia governorate during the two successive years 2012 and 2013. The activity seasonal fluctuation in *M. palmata* population on Navel orange trees started from the 2nd half of May to 2nd half of October 2012 or 1st half of November 2013. Summer recorded the maximum flight (0.94-1.00 beetles/tree), followed by autumn (0.19-0.21 beetle/tree) and spring (0.08-0.10 beetle/tree), and stopped during winter. The total number of emerged beetles per year averaged 1.21-1.36 beetles / tree. It had one brood and there were 5.5 - 6 months of beetles' activity, yearly. The effect of weather factors on the borer activity was mostly positively significant with maximum, minimum, and daily mean temperatures, but negatively and insignificantly with day mean relative humidity. Number of emerged beetles was exeedigly doubled during only one year, thus should be highly considered in the integrated citrus pests control.

INTRODUCTION

In Egypt, citrus (*Citrus* spp., Rutaceae) is a strategic fruit crop for local consumption or exportation purposes. Its plantations rank first in fruit area and production. Frequent field observations allover the Governorates of Egypt (Mostafa, 1977) indicated that *Macrotoma palmata* F. is a major coleopteran stem boring insect pest in citrus orchards at both old Delta and valley lands and new reclaimed desert lands. For the target pest, successful integrated pest control depends largely on monitoring studies especially the sesonal fluctuation in the target pest population, the progress of infestation, the seasonal cycle, and the effect of the main weather factors on the target pest. The literature in this respect allover the world is lacking, while in Egypt there were some scattered researches and on other hosts (El-Sebay, 1984; Tadros *et al.* 1993; Batt 1999; Shehata *et al.* 2001 and Tadros *et al.* 2007a&b).

In an attempt to contribute to such a gap in the knowledge, the present comparative ecological studies are aimed. The broad objective of investigation is to add new information to citrus (orange) growers that may help in planning a rather effective “Integrated Control Programs” for the management of tree borers in citrus orchards.

MATERIALS AND METHODS

1. Population density of *M. palmata* beetles in Navel orange trees:

a. Seasonal abundance:

An infested Navel orange orchard of about ten feddans area (approximately more than 25 years old) located at Wady el-mollak district, east Delta, Sharkia Governorate was subjected to monitoring studies of the target boring insect *Macrotoma palmata* F. The seasonal abundance of this pest was carried out during two successive years extending from early January, 2012 until late December, 2013. No chemical treatments were applied in the selected orchard throughout population fluctuation studies. A paint marker using a brush canceled the old exit holes on 100 infested trees with *M. palmata* randomly distributed in the orange orchard. From January 1st, 2013 until December 31, 2013, the new exit holes - indicating emergence of *M. palmata* beetles were counted at half-monthly intervals on the 15th and last day of every month. To avoid repeated counting, new exit holes were immediately canceled with a spray paint marker after counting.

b. Progress of infestation:

Data of the seasonal abundance were accumulated from January 1st, 2012 until December 31, 2013 for each half-monthly interval. The total number of beetles represented the accumulated number for the two years together. To smooth the frequency distribution curve, data were smoothed according to the following mathmatical formula**,** Snedecor and Cochran (1990):

{(2 x Actual number) + Previous number + Following number}/4

The presented figures indicated the periods of the seasonal cycles of beetles activity and inactivity in orange orchards. Progress of infestation also indicated the rate of increase in the borer infestation year after another.

2. Effect of weather factors on the activity of *M. palmata* beetles:

Four main weather factors, the daily maximum temperature (DMxT), day minimum temperature (DMnT), daily mean temperature (DMT) and day mean relative humidity (DMRH) were considered. Necessary weather data were obtained from the Central Laboratory of Climate and Meteorology, ARC, MOA, Giza. Population data of *M. palmata* and the meteorological data, both at half-monthly intervals, were presented. The relationship between the two weather factors and the beetles' population during the activity season was investigated for two successive years extending from January 2012 until December 2013 in the orange orchard.

3. Statistical analysis:

Simple correlation "r" and regression "b" were carried out to determine the direct effect of each weather factors on *M. palmata* activity, population counts in citrus orchard were plotted against the corresponding weather data. The simple correlation "r" and regression "b" coefficients for the relationship between each weather factor and the population of beetles were then worked out, (Snedecor and Cochran, 1990).

RESULTS AND DISCUSSION

1. Population fluctuation of *Macrotoma palmata*:

a. Seasonal abundance:

Tables (1 , 2) and Figure (1) showed that *M. palmata* beetle's emergence in Navel orange orchards was prevailing during the period from the 2nd half of May to 2nd half of October or 1st half of November during 2012 and 2013, respectively.

Macrotoma palmata beetles started to emerge in orange orchards during the 2nd half of May (0.01 beetle / tree) in both 2012 and 2013. Two activity peaks were recorded in 2012 and 2013. Only one peak was observed during 1st half of September 2012 (0.22 beetles / tree) and the other during the 2nd half of August 2013 (0.26 beetles / tree). Emergence of beetles was stopped and recorded during the 2nd half of October 2012 (0.06 beetle / tree), and during, the 1st half of November 2013 (0.01 beetle / tree).

The maximum *M. palmata* beetles' emergence was noticed in summer (0.94 and 1.00 beetles / tree in 2012 and 2013, respectively). Autumn was moderate emergence as it recorded the respective numbers (0.19 and 0.26 beetle / tree). Spring showed the least respective number of beetle activity (0.08 and 0.10 beetle / tree). Beetles activity was completely stopped during winter months. Moreover, the total numbers of beetles emerged during the whole year were 1.21 and 1.36 beetles / tree in 2012 and 2013, respectively. The respective grand means per month were 0.10 and 0.11 beetles / tree.

Smoothed data in Figure (1) emphasized that *M. palmata* had only one brood of beetles' activity in orange orchards prevailed from the 2nd half of May to the 1st half of November in both years of study, 2012 and 2013. The peak of the brood was estimated during the 1st half of September 2012 (0.21 beetle / tree) but during the 2nd half of August 2013 (0.22 beetles / tree).

b. Progress of infestation:

The seasonal cycle of emerged beetles in orange orchards (Tables, 1, 2 and Figure, 1) was 5.5 – 6 months of beetles' activity followed by 6 -6.5 months of beetles' inactivity. Number of emerged beetles was exceedingly doubled during only one year (from 1.21 beetles in 2012 to 2.57 beetles in 2013 / tree / year), thus, imposes need urgent control of the pest year after another.

2. Effect of temperature and relative humidity on beetles activity:

Statistical analysis in Table (3), according to Snedecor and Cochran, (1990), data indicated that the fluctuation in beetles population in orange orchards at Sharkia Governorate was highly significant and positively correlated with the DMxT ("r" from 0. 8061 to 0. 8255) and DMT ("r" from 0. 7994 to 0. 8013), but the DMnT ("r": from 0. 7572 to 0. 7646) in both 2012 and 2013. On the other hand, the effect of DMRH much varied on the fluctuation in the beetles' population showing insignificant and negatively correlation ("r": -0.5228) in 2012 and ("r": -0.4695) in 2013. While the regression data showed that, the DMxT ("b" from 21.463 to 26.294), DMT ("b" from 19.197 to 24.916), and DMnT ("b": from 16.829 to 21.533) in both 2012 and 2013. On the other hand, the effect of DMRH much varied on the

fluctuation in the beetles' population showing insignificant and negatively regression ("b": - 8.417) in 2012 and ("b": - 7.626) in 2013.

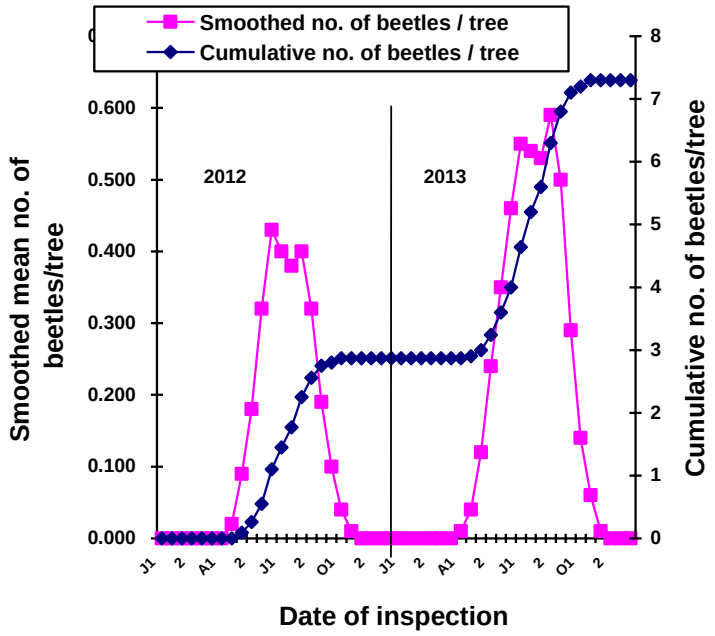
Table (1): Mean number of *M. palmata* beetles in Navel orange orchards at Sharkia Governorate during 2012 seasons

Date of inspection		Mean No. of beetles /tree			Mean max. temp. C	Mean temp. C	Mean min. temp. C	Mean R.H.%
		Actual	Smoothed	cumulative				
Jan.	1-15/1	0.00	0.00	0.00	18.90	15.40	10.60	62
	16-31/1	0.00	0.00	0.00	18.10	14.80	9.40	55
Feb.	1-15/2	0.00	0.00	0.00	19.30	15.60	10.40	64
	16-28/2	0.00	0.00	0.00	19.50	15.80	11.10	48
Mar.	1-15/3	0.00	0.00	0.00	19.90	16.30	11.30	52
	16-31/3	0.00	0.00	0.00	22.00	17.40	10.90	58
Winter		0.00						
Apr.	1-15/4	0.00	0.00	0.00	27.70	23.00	17.20	61
	16-30/4	0.00	0.00	0.00	28.30	21.70	15.40	67
May	1-15/5	0.00	0.00	0.00	27.50	23.70	19.30	70
	16-31/5	0.01	0.01	0.01	28.90	25.30	19.00	69
Jun.	1-15/6	0.02	0.025	0.03	30.30	27.10	21.70	78
	16-30/6	0.05	0.05	0.08	30.70	28.00	23.60	76
Spring		0.08						
Jul.	1-15/7	0.08	0.08	0.16	32.70	28.60	24.30	78
	16-31/7	0.10	0.11	0.26	34.20	29.20	25.70	74
Aug.	1-15/8	0.15	0.15	0.41	32.80	30.10	25.50	77
	16-30/8	0.21	0.195	0.62	33.20	30.10	24.40	78
Sep.	1-15/9	0.22	0.21	0.84	32.40	29.20	22.90	77
	16-31/9	0.18	0.18	1.02	31.40	28.60	21.90	73
Summer		0.94						
Oct.	1-15/10	0.13	0.125	1.15	30.20	27.20	21.70	73
	16-30/10	0.06	0.06	1.21	27.30	24.20	20.00	65
Nov.	1-15/11	0.00	0.015	1.21	27.70	24.00	18.80	74
	16-30/11	0.00	0.00	1.21	25.10	21.70	15.20	72
Dec.	1-15/12	0.00	0.00	1.21	24.10	20.30	14.10	70
	16-31/12	0.00	0.00	1.21	23.30	17.30	9.80	62
Autumn		0.19						
Total/tree/year		1.21		1.21				
Total/tree/month		0.10						

Table (2): Mean number of *M. palmata* beetles in Navel orange orchards at Sharkia Governorate during 2013 seasons

Date of inspection		Mean No. of beetles /tree			Mean max. temp. C	Mean temp. C	Mean min. temp. C	Mean R.H.%
		Actual	Smoothed	cumulative				
Jan.	1-15/1	0.00	0.00	1.21	15.90	12.40	9.60	59
	16-31/1	0.00	0.00	1.21	15.10	12.80	9.40	54
Feb.	1-15/2	0.00	0.00	1.21	16.30	13.60	8.40	63
	16-28/2	0.00	0.00	1.21	16.50	13.80	9.10	49
Mar.	1-15/3	0.00	0.00	1.21	16.90	14.30	9.30	52
	16-31/3	0.00	0.00	1.21	19.00	15.40	8.90	57
Winter		0.00						
Apr.	1-15/4	0.00	0.00	1.21	29.70	21.00	17.20	61
	16-30/4	0.00	0.00	1.21	30.30	19.70	15.40	66
May	1-15/5	0.00	0.00	1.21	29.50	20.70	19.30	71
	16-31/5	0.01	0.01	1.22	30.90	23.30	19.00	69
Jun.	1-15/6	0.03	0.03	1.25	32.30	25.10	21.70	78
	16-30/6	0.06	0.055	1.31	32.70	26.00	23.60	76
Spring		0.10						
Jul.	1-15/7	0.07	0.08	1.38	34.70	26.60	22.30	75
	16-31/7	0.12	0.145	1.50	36.20	27.20	23.70	75
Aug.	1-15/8	0.15	0.17	1.65	33.80	29.10	23.50	77
	16-30/8	0.26	0.22	1.91	35.20	28.10	22.40	78
Sep.	1-15/9	0.21	0.2175	2.12	30.40	27.10	20.90	78
	16-31/9	0.19	0.23	2.31	29.40	24.4	19.90	79
Summer		1.00						
Oct.	1-15/10	0.16	0.15	2.47	25.20	21.20	20.70	74
	16-30/10	0.09	0.09	2.56	25.30	20.20	17.00	66
Nov.	1-15/11	0.01	0.03	2.57	16.70	12.00	9.80	75
	16-30/11	0.00	0.00	2.57	13.10	9.70	7.20	72
Dec.	1-15/12	0.00	0.00	2.57	11.10	8.30	6.10	71
	16-31/12	0.00	0.00	2.57	11.30	7.30	5.80	55
Autumn		0.26						
Total/tree/year				2.57				
Total/tree/month								

Figure (1): Mean numbers of *M. palmata* beetles in Navel orange orchards at Sharkia Governorate during 2012 and 2013



Table(3): Simple correlation "r" and regression "b" coefficients between the mean numbers of *M.palmata* beetles and the tested weather factors effected on insect emergence from Navel orange trees at Sharkia Governorate, during years 2012 and 2013

Statement	Year	
	2012	2013
First emergence	2nd half of May	2nd half of May
Peaks	1st half of September	2nd half of August
Last emergence	2nd half of October	1st half of November
Broods	1st half of May to 1st half of November	2nd half of May to 1st half of November
Simple correlation "r" coefficients		
DMxT	0.8061 **	0.8255 **
DMT	0.7994 **	0.8013 **
DMnT	0.7572 **	0.7646 **
DMRH	- 0.5228	- 0.4695
Simple regression "b" coefficients		
DMxT	21.463	26.294
DMT	19.197	24.916
DMnT	16.829	21.533
DMRH	- 8.417	- 7.626

****: Significant at 0.01 levels (Highly significant)**

***: Significant at 0.05 levels (Significant)**

3. Discussion and conclusion:

Studies on the sesonal fluctuation of *M. palmata* beetle population, progress of infestation, seasonal cycle, and the effect of main weather factors on the target pest are essential in planning successful and effective "Integrated Control Programs" for the management of boring insect pests (El-Sebay, 1984) and (Tadros, *et al*., 1996).

Batt (1999) and Tadros *et al*. (2006) recorded *M. palmata* during their survey on borers attacking deciduous fruit trees.

Literature is lacking concerning such studies on *M. palmata* abroad. However, in Egypt, there were some researches in this respect. The previous results are somewhat in agreement with Tadros *et al.* (1993&2006) and Shehata *et al.* (2001) who monitored the seasonal fluctuation of *M. palmata* population in stone fruit orchards in Egypt, and stated that emergence started almost around June and continued until September or October and the weater factors influenced the development of *M. palmata* specially temperature which has mainly positively effects but relative humidity was of insignificant and of mostly negative effect.

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دراسات بيئية على حفار ساق السنط "*Macrotoma palmata*" الذى يصيب البرتقال في محافظة الشرقية

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يعتبر حفار ساق السنط *M. palmata* (Coleoptera: Cerambycidae) من أكثر حفارات أشجار الفاكهة السائدة ذات الأهمية الاقتصادية والتي تهاجم أشجار الموالح وغيرها من أشجار الفاكهة والأشجار الخشبية . تم تتبع النشاط الموسمي للحفار على أشجار البرتقال في محافظة الشرقية علي مدار عامين متتاليين (2012 ، 2013) . يبدأ النشاط الموسمي للحفار من النصف الثاني من مايو إلى النصف الثاني من أكتوبر (2012) أو النصف الأول من نوفمبر (2013) . سجلت شهور الصيف أعلى مستوى لنشاط للحشرات (0,94 – 1,00 حشرة / شجرة) ، يليها الخريف (0,19 – 0,21 حشرة / شجرة) ، ثم الربيع (0,08 – 0,10 حشرة / شجرة) ، في حين توقف النشاط خلال الشتاء . بلغ إجمالي عدد الحشرات التي خرجت من الشجرة خلال العام (1,21 – 1,36 حشرة / شجرة) . وللحفار ذروة واحدة من النشاط خلال العام . وهناك دورة من نشاط الحشرات لمدة (5,5 - 6 شهور) . وقد تضاعف الحشرات الخارجة خلال عام واحد (من 1,21 إلى 2,57 حشرة) . تلاحظ أن تأثير العوامل الجوية علي نشاط هذا الحفار كان موجب ومعنوي في معظم الأحوال مع درجات الحرارة الصغري والمتوسطة والعظمي ، ولكنها سالبة وغير معنوية مع متوسط الرطوبة النسبية . في جميع الأحوال تضاعفت الإصابة بالحفار خلال عام واحد مما يستوجب المكافحة المستمرة .

قام بتحكيم البحث

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