

Ecological Studies on the Apple Clearwing Moth *Synanthedon myopaeformis* Borkh. (Lepidoptera: Sesiidae) in Apple Orchards at Menoufia Governorate, Egypt.

Batt, M. A.¹ and A. M. Abd El-Raheem²

¹ Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt.

² Economic Entomology & Agricultural Zoology Dept., Faculty of Agriculture, Menoufia University, Menoufia, Egypt.



ABSTRACT

The seasonal abundance and population density of emerged moths of *Synanthedon myopaeformis* Borkh. (Lepidoptera : Sesiidae) from infested apple trees at Berket El Saba district, Menoufia governorate during 2015 and 2016 years exhibited that the emerged moths continued all year round where, nine emergence peaks were recorded throughout year months. The highest number of emerged moths was observed during the summer months (40.96% and 41.26% at 2015 and 2016 seasons, respectively) and the highest monthly percentage of emerged moths was recorded in August. The highest number of emerged moths were recorded at the basic stem region 0-50cm above the ground surface, while the least number of emerged moths was found at the height 150-200cm and there was significant positive correlation between minimum & maximum temperatures and number of emerged moths, while the correlation was negative between RH% and number of emerged moths. The obtained results indicated that the minimum & maximum temperatures and RH% were responsible for 71.67% and 73.71% of changes population during the successive periods at 2015 and 2016, respectively.

Keywords: *Synanthedon myopaeformis*, Lepidoptera, Sesiidae, population fluctuation, weather factors, Apple trees.

INTRODUCTION

Apple clearwing moth, *Synanthedon myopaeformis* Borkh. (Lepidoptera: Sesiidae) is one of the most harmful Lepidopterous borer in apple orchards. Larvae of this pest bore their destructive tunnels inside the stem and branches of apple trees (Fig.1), resulting in crop losses, deterioration and finally death of the whole tree.

Various studies on this insect were carried out in many regions of the world. In Egypt, *S. myopaeformis* was recorded more than 100 years ago (Seitz, 1913), many researchers worked out several studies on this insect (Abd El-Kader and Zaklama, 1971; Tadros, 1977; Awadallah *et al.*, 1978 (a& b); Tadros 1992, 1993, 1994, Tadros and Kinawy, 1992; Girgis *et al.*, 1995; Shehata, 1995; Abdel-Azim, 1997; Shehata *et al.*, 1999 and Tadros *et al.*, 2003.



Fig. 1. *Synanthedon myopaeformis* moths, pupal skins and damage on apple trees

Temperature and relative humidity are major important factors for the different activities of different insect species. The various climatic and weather factors always are operating and affecting any insect population present, these factors may be favourable or unfavourable for the various activities of insects.

At present time, meteorological changeable conditions show intensity and increase of the temperature degrees and relative humidity, which indeed demand new ecological studies from the other conducted previously.

This work was conducted to study the effect of temperature & RH% on emergence periods, seasonal abundance and population fluctuations of *Synanthedon myopaeformis* moth, as well as, the relation between weather factors and infestation height on population density & peaks of moths in apple orchards.

MATERIALS AND METHODS

An apple orchard was selected at Abo-Mashour village, Berket El- Saba district, Menoufia governorate, Egypt to conduct the experiments. This orchard was about two feddans cultivated since 18 years with apple trees, *Malus domestica* Variety, Balady. Most apple trees of this orchard were naturally infested with *Synanthedon myopaeformis* Borkh. borer.

During last week of December 2014, 50 infested trees of same size were chosen and marked by colored paint. The old empty pupal skins (exuviae) which were protrusive from emergence holes of moths were removed. The stems of selected trees (above surface ground) were divided to four heights (each of 50 cm). These divisions were marked by colored paint. The number of new pupal skins protuberant (number of emerged moths) were weekly counted and removed at

different heights along two years 2015 and 2016. Temperature degrees (maximum & minimum) and relative humidity were listed by a meteorology device at the study region.

The statistical analysis of obtained data on the variations in population of emerged moths under effect weather factors and different heights of emergence sites on stem of apple trees as well as the values of correlation and variance were estimated according to SAS program (2001).

RESULTS AND DISCUSSION

According to weekly emergence of *S. myopaeformis* moths (Fig. 2), the population density showed nine emergence peaks of each 2015 and 2016. The nine peaks during 2015 were recorded at 3rd week of January, 4th week of February, 1st and 4th week of April, 4th week of May, 3rd week of June, 1st week of August, 1st week of September and 3rd week of October; while during 2016 the nine emergence peaks observed during the 4th week of January, 1st and 4th week of April, 2nd week of May, 1st week of June, 1st week of July, 1st week of August, 1st week of October and 1st week of December.

The obtained results confirmed by those conducted in Egypt by Willcocks (1924) who stated that the moths in breeding cages always emerged during April and May. Similar results were recorded by Abd-El-Kader and Zaklama (1971), they recorded that the adult emergence occurred from mid-April to mid-August with a peak during July, at Alexandria in 1964. Tadros (1977) found that *S. Myopaeformis* moths started to appear from the 4th week of February until 4th week or 2nd week of December 1974 and 1975, respectively, at Maamoura district, Alexandria governorate, furthermore, the population fluctuation appeared three peaks of emergence, while, he found that the moths appeared continuously through the whole two consecutive years (1975 and 1976), the number of emerged moths detected four and five peaks of population at Fedemeen, Fayoum governorate. The obtained results by Girgis *et al.*, (1995) revealed that *S. myopaeformis* started to appear at the 2nd week of February in both 1993 and 1994 on apple trees while it appeared on the plum trees at the 3rd week of February and the 2nd week of March in the two years successively. Abdel-Azim (1997) listed that mean number of *S. myopaeformis* moths monitored by pheromone trapping and pupal skin count techniques in apple orchards in valley and reclaimed lands of Giza and Behera governorates showed that four peaks at Giza and three peaks at Behera during the emergence period (1st week of February until 4th week of December 1993 & 1994).

In Italy, Manzoni (1928) mentioned that the larvae of this insect pupate in May and the adult emerge shortly afterwards. Also, in Spain, Cabezuelo Perez and Hernandez Esteruelas (1973) reported similar results. They stated that the adults emerged between May 13th and July 26th. The peak recorded in the 2nd half of June. In France, adults were attracted to bait early in May, while the last adults were taken in Mid-August, Chrestain and Lavy (1966). Masee (1936) in England, reported the emergence of moths in late June or in July.

In Russia, Gromovaya and Simirnova (1964) mentioned that adults were presented from the end of May to 10th - 15th of August with a maximum flight in the middle of June. Similar results were recorded by Baryakin (1967) in Soviet Union.

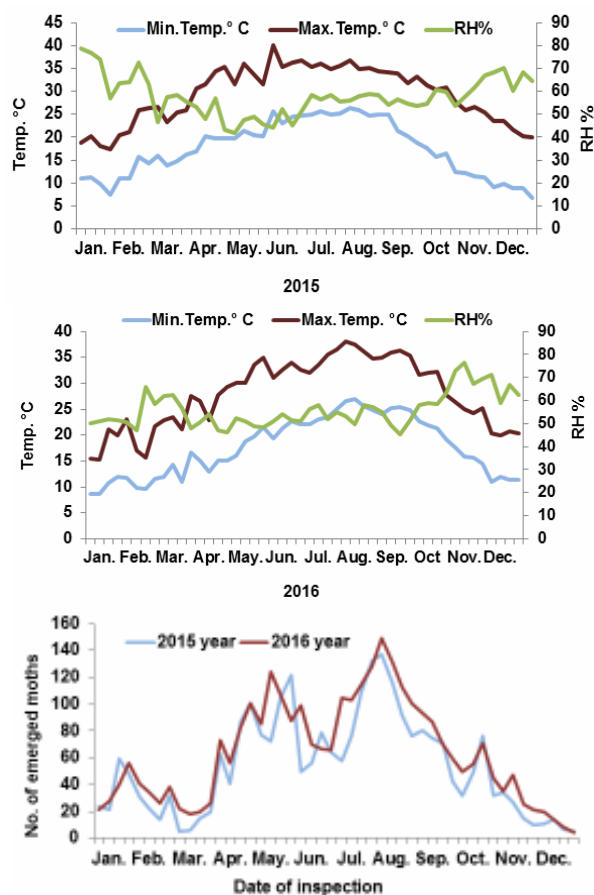


Fig. 2. Population fluctuation of *S. myopaeformis* moths with corresponding changes in temperature and relative humidity during 2015 and 2016 years

Seasonal abundance:

Data on emerged *S. myopaeformis* moths from infested apple trees in examined orchard, at Abo Mashour village, Berket El-Saba district, Menoufia governorate (Tables 1,2) recorded that the emergence of the tested insect was continued all over the months of 2015 and 2016 years.

The population and percentages of emerged moths during different seasons and months of 2015 and 2016 were illustrated in Tables 1 and 2. The obtained results indicated that highest population recorded during the summer season, where emergence percentages were 40.96% and 41.26% from annual emergence, followed by 35.49% and 33.55% for spring season, 12.06% and 13.01% for autumn season, while the least percentages were 11.49% and 12.18% recorded during winter season for 2015 and 2016, respectively, Fig (3). Three statistical groups for seasonal population were found during 2015 and 2016 (L.S.D = 133.65 and 111.47, respectively (Table 1&2). The monthly population showed that the highest monthly percentages recorded

during August 2015 and 2016 (16.12% and 16.27% percentages observed during December of both 2015 and 2016 (1.43% and 1.52% emergence, respectively).

Table 1. The population and percentages of *S. myopaeformis* moths emerged from different heights of apple trees during 2015 season at Berket El-Saba, district, Menoufia governorate.

| Season | Months | Numbers of emerged moths at heights above ground surface (cm). | | | | Total | Emergence percentage |
|--------------|--------|--|--------|---------|---------|--------|----------------------|
| | | 0-50 | 50-100 | 100-150 | 150-200 | | |
| Winter | Jan. | 80 | 26 | 46 | 0 | 152 | 5.88 |
| | Feb. | 47 | 20 | 32 | 0 | 99 | 3.83 |
| | Mar. | 14 | 14 | 18 | 0 | 46 | 1.78 |
| | Total | 141 | 60 | 96 | 0 | 297 c | 11.49 |
| Spring | Apr. | 95 | 53 | 95 | 49 | 292 | 11.29 |
| | May | 143 | 90 | 100 | 44 | 377 | 14.57 |
| | Jan. | 163 | 43 | 30 | 13 | 249 | 9.63 |
| | Total | 401 | 186 | 225 | 106 | 918 b | 35.49 |
| Summer | Jul. | 188 | 75 | 69 | 43 | 375 | 14.49 |
| | Aug. | 184 | 131 | 68 | 34 | 417 | 16.12 |
| | Sep. | 122 | 73 | 50 | 23 | 268 | 10.35 |
| | Total | 494 | 279 | 187 | 100 | 1060 a | 40.96 |
| Autumn | Oct. | 85 | 50 | 34 | 20 | 189 | 7.31 |
| | Nov. | 39 | 17 | 19 | 11 | 86 | 3.32 |
| | Dec. | 14 | 10 | 8 | 5 | 37 | 1.43 |
| | Total | 138 | 77 | 61 | 36 | 312 c | 12.06 |
| Grand total | | 1174 | 602 | 569 | 242 | 2587 | 100 % |
| Average | | 97.83a | 50.17b | 47.41 b | 20.17 c | - | - |
| Occurrence % | | 45.38 | 23.27 | 21.99 | 9.36 | 100% | - |

For heights F:9.29 L.S.D = 21.47 For seasons F:95.2 L.S.D = 133.65

Table 2. The population and percentages of *S. myopaeformis* moths emerged from different heights of apple trees during 2016 season at Berket El-Saba, district, Menoufia governorate.

| Season | Months | Numbers of emerged moths at heights above ground surface (cm). | | | | Total | Emergence percentage |
|--------------|--------|--|--------|---------|---------|--------|----------------------|
| | | 0-50 | 50-100 | 100-150 | 150-200 | | |
| Winter | Jan. | 65 | 43 | 37 | 0 | 145 | 4.77 |
| | Feb. | 67 | 41 | 31 | 0 | 139 | 4.58 |
| | Mar. | 37 | 25 | 19 | 5 | 86 | 2.83 |
| | Total | 169 | 109 | 87 | 5 | 370 c | 12.18 |
| Spring | Apr. | 99 | 68 | 97 | 49 | 313 | 10.31 |
| | May | 146 | 90 | 116 | 52 | 404 | 13.30 |
| | Jan. | 156 | 63 | 44 | 39 | 302 | 9.94 |
| | Total | 401 | 221 | 257 | 140 | 1019 b | 33.55 |
| Summer | Jul. | 216 | 106 | 80 | 48 | 450 | 14.82 |
| | Aug. | 218 | 143 | 91 | 42 | 494 | 16.27 |
| | Sep. | 150 | 79 | 56 | 24 | 309 | 10.17 |
| | Total | 584 | 328 | 227 | 114 | 1253 a | 41.26 |
| Autumn | Oct. | 103 | 59 | 42 | 17 | 221 | 7.28 |
| | Nov. | 67 | 29 | 22 | 10 | 128 | 4.21 |
| | Dec. | 19 | 14 | 9 | 4 | 46 | 1.52 |
| | Total | 189 | 102 | 73 | 31 | 395 c | 13.01 |
| Grand total | | 1343 | 760 | 644 | 290 | 3037 | 100 % |
| Average | | 111.92a | 63.34b | 53.67 b | 24.17 c | - | - |
| Occurrence % | | 44.22 | 25.02 | 21.21% | 9.55 | 100 % | - |

For heights F:12.69 L.S.D = 20.49 For seasons F: 169.55 L.S.D = 111.47

Means followed by the same letter are not significant at the 5% level.

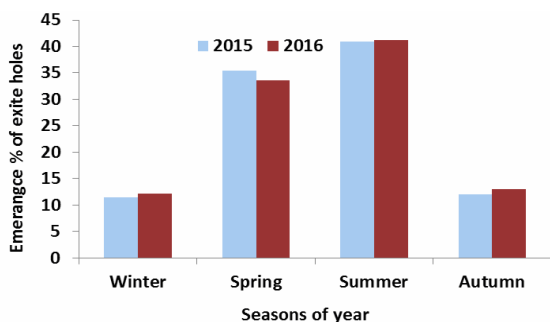


Fig. 3. Emergence percentage of *S. myopaeformis* moths from infested apple trees during different seasons of 2015 and 2016.

The relation between the infestation site and number of emerged moths:

Field observation showed that the infestation of apple trees by *S. myopaeformis* was varied with different heights above ground surface of infestation places Fig (4).

Obtained results illustrated in Fig (4) show the emergence of moths from different heights of apple trees during 2015 and 2016. The highest number of emerged moths was recorded at the stem basic region above the ground surface (0-50 cm) which appeared 45.38% and 44.22% emergence from total population at 2015 and 2016, respectively; then decreased to 23.77%

and 25.02% emergence at region (50-100 cm), 21.99 and 21.21% emergence at region (100-150 cm), while the lower percentages were 9.36% and 9.55% emergence at region of 150-200 cm height.

Statistical analysis of emerged moth numbers at various heights of apple trees clearly appeared highly significant differences between the population of emerged moths ($F = 9.29$ & 12.69). Three statistical groups were observed during each 2015 and 2016 (L.S.D. = 21.47 & 20.49), as follows:

Group a: at 0-50 cm height.

Group b: at 50 -100 cm height and 100-150 cm height.

Group c: at 150 -200 cm height.

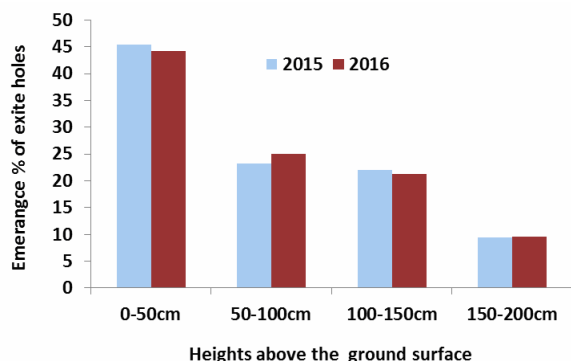


Fig. 4. Emergence percentage of *S. myopaeformis* moths from infested apple trees at different heights above the ground surface during 2015 and 2016.

Effect of some weather factors (Max. Temp., Min. Temp, and RH%) on population fluctuation of *S. myopaeformis* moths.

Obtained data in Table (3) show the relation between population of emerged moths and weather factors during 2015 and 2016.

Statistical analysis of the obtained data cleared that there were significant positive correlation between each Minimum and Maximum temperatures and numbers of emerged moths during 2015 ($r = 0.712$ and 0.784 , respectively), while the correlation was negative between number of moths and RH% ($r = - 0.525$). The same trend was noticed in 2016 where the obtained r values were 0.855 for minimum temperatures, 0.826 for maximum temperatures and $- 0.518$ for RH%.

The corresponding values of simple regression recorded 4.608 , 4.309 , -2.575 (in 2015) and 5.363 , 5.0398 , -2.282 (in 2016) for Minimum & Maximum temperatures and RH%, respectively, Table (3).

With respect to the analysis of variance (Table 3), the tested weather factors were responsible for 71.67% and 73.71% (explained variance) of population changes during the successive periods of occurrence (2015 and 2016), respectively.

The obtained results also indicated that unexplained variance (28.33 in 2015 and 26.29 in 2016) may refer to effect of some other factors, such as the nutritional requirements of larvae, chemical composition of tree wood, the age of trees, moisture content of the wood, state of the trees and physiological conditions.

Table 3. Simple correlation (r), simple regression (b) and explained variance (E.V.) of the three weather factors (Min. temp., Max. temp and RH %) with the number of emerged moths of *S. myopaeformis* during 2015 and 2016 years.

| Year | Weather factor | Simple correlation and regression values | | E.V% |
|------|----------------|--|---------|-------|
| | | r | b | |
| 2015 | Min. temp. | 0.71244 | 4.60849 | 71.67 |
| | Max. temp. | 0.78420 | 4.30944 | |
| | RH% | - 0.5254 | -2.5754 | |
| 2016 | Min. temp. | 0.85540 | 5.36349 | 73.71 |
| | Max. temp. | 0.82607 | 5.03982 | |
| | RH% | - 0.51822 | -2.2823 | |

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دراسات إيكولوجية على حفار ساق الحلويات رائق الاجنحة *Synanthedon myopaeformis* Borkh (Lepidoptera: Sesiidae) في بساتين التفاح بمحافظة المنوفية - مصر

محمد عبد الغنى بط¹ و أحمد محمد عبد الرحيم²
¹ معهد بحوث وقاية النباتات- مركز البحوث الزراعية- الدقى - الجيزة- مصر
² قسم الحشرات الإقتصادية والحيوان الزراعى - كلية الزراعة - جامعة المنوفية - المنوفية - مصر

تمت دراسة التذبذب الموسمي وكثافة تعداد خروج فراشات حفار ساق الحلويات رائق الاجنحة *Synanthedon myopaeformis* Borkh. من أشجار التفاح المصابة في احدى البساتين التابعة لمركز بركة السبع بمحافظة المنوفية خلال أعوام 2015، 2016. وأظهرت الدراسة أن خروج فراشات حفار ساق الحلويات رائق الاجنحة يكون مستمر طول العام ، وقد سجلت 9 قمم خروج في كل عام ، وقد لوحظ أن أعلى خروج للفراشات كان خلال شهور الصيف والتي قدرت ب 40,96% ، 41,26% من الخروج السنوي خلال 2015، 2016 على التوالي ، وقد سجلت أعلى نسبة خروج للفراشات خلال شهر أغسطس. تشير النتائج أيضا أن أعلى عدد لخروج الفراشات سجلت من منطقة الساق القاعدية (صفر -50سم من فوق سطح التربة) ، بينما سجلت منطقة الساق (150-200سم من فوق سطح التربة) أقل عدد لخروج الفراشات. هذا وقد وجد ارتباط معنوي موجب بين كل من الحرارة الصغرى والحرارة العظمى وتعداد الفراشات الخارجة ، في حين كان الإرتباط معنوي سالب بين الرطوبة النسبية وتعداد الفراشات. وتشير النتائج أن عوامل الطقس الثلاثة كانت مسؤولة عن 71,67% ، 73,71% من تغيرات تعداد الحشرة تحت الدراسة خلال عامي 2015، 2016.