INFLUENCEOF TEMPERATURE ONSEASONALABUNDANCE OF *Ectomyelois ceratoniae Zeller*,1839 (LEPIDOPTERA, PYRALIDAE) IN TOLGA PALM GROVE

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RESUME

Le but de ce travail est l'étude de l'impact de la température sur l'abondance saisonnière des populations de la pyrale des dattes *Ectomyelois ceratoniae Zeller dans* la palmeraie de Tolga (Biskra) durant l'année 2010. Le suivi de la fluctuation du vol des adultes de la pyrale à l'aide des pièges à phéromones nous a permis de constater la présence de deux générations successives et non chevauchantes durant l'année. Nos résultats montrent aussi que les relevés des températures minimales sont significativement et positivement corrélées aux relevés des individus piégés en hiver et en automne, alors qu'elle a un effet négative et significatif faible en été (R2=0,428 ; P< 0,015)et une action non significative au printemps (R2= 0,274 ;P< 0,066). Tandis que les températures maximale et moyenne ont un effet positivement significatif pendant la période hivernale et automnale, mais elles ont une influence significative et négative en été et au printemps. En outre, l'action combinée des températures maximale et minimale a révélé un effet significatif sur le vol des adultes de la pyrale des dattes durant toute l'année.

MOTS CLES: *Ectomyelois ceratoniae*, palmier dattier, l'abondance saisonnière, piège à phéromone, température.

ABSTRACT

The purpose of this paper is the study of temperature impact on the population of carob moth seasonal abundance (*Ectomyelois ceratoniae Zeller*)in a palm of Tolga (Biskra) during 2010. The monitoring of the adult flight moth fluctuation using pheromone traps allowed us to see the presence of two successive and non-overlapping generations during the year. Our results also show that the records of minimum temperatures are significantly and positively correlated to the records of individuals trapped in Winter and Autumn while it has a weak negative and significant effect in Summer (R2 = 0.428, P <0.015) and no significant action in Spring (R2 = 0.274, P <0.066). Furthermore, the maximum and average temperature have a significant positive effect during winter and autumn period, but they have a significant and negative influence in summer and spring. In addition, the combined action of maximum and minimum temperatures revealed a significant effect on the adult flight of the carob moth throughout the year.

KEYWORDS: *Ectomyelois ceratoniae*, date palm, seasonal abundance, pheromone trap, temperature.

INFLUENCE DE LA TEMPERATURE SUR L'ABONDANCE SAISONNIERE D'*Ectomyelois ceratoniae ZELLER*, 1839 (LEPIDOPTERA, PYRALIDAE) DANS LA PALMERAIE DE TOLGA

ملخص

الغرض من هذه الدراسة هو تأثير درجة الحرارة على الوفرة الموسمية لسوسة التمر *Ectomyelois ceratoniae* في بساتين النخيل بطولقةبسكرةخلالعام2010. رصد تذبذب طيران فراشة التمور باستخدام المصائد الفرمونية سمح لنا أن نلاحظ وجود جلين متعاقبين خلال السنة .تظهر النتائج أيضا أن لدينا درجات الحرارة الصغرى مترابطة بشكل إيجابي مع عدد الأفراد المسجلة في فصل الشتاء و الخريف، لكنه يكون بتأثير سلبي في الصيف ($R2 = 0.428$، $P < 0.015$) وبدون تأثير ملموس في الربيع ($R2 = 0.274$، $P < 0.066$). فيحين أن الحد الأقصى ومتوسط درجة الحرارة له تأثير إيجابي وبشكل كبير خلال فترة الشتاء والخريف ، ولكن لديهم تأثير سلبي في الصيف و الربيع. وبالإضافة إلى ذلك، كشف الأثر المشترك لدرجات الحرارة القصوى والدنيا أن لها تأثير كبير على طيران سوسة التمور على مدار السنة.

الكلمات المفتاحية

– نخيل التمر- المصائد الفرمونية- درجة الحرارة- الوفرة الموسمية .*Ectomyelois ceratoniae*

1 INTRODUCTION

The Algerian date palm, ranked 5th overall by exports, suffers from several constraints mainly phytosanitary (Allam, 2008), which reduce the amount of production and affects the quality of crops by the attack of some pests whose most important is the carob moth (*Ectomyelois ceratoniae* Zeller). The latter can cause considerable damage that can reach 20 to 30% of the date production in the Mediterranean (Abdelmoutaleb, 2008). Cultivation techniques associated with the struggle of the chemical interventions employed to date have not enabled the effective protection of production.

The study of the responsible mechanisms for the regulation of living organism populations is essential for a better understanding of the biological communities structure and their evolutionary forces in nature (Alyokhin et al., 2011). In addition, staff knowledge of changes in the effect of physical environmental factors is a fundamental in the interpretation of pest abundance variation mechanisms in nature (Obame Minko, 2009).

The climate is the main factor responsible of the distribution, the development and the proliferation of arthropods. While the temperature is the main weather factor which acts directly on the fluctuation and evolution of insects. The studies done on the temperature influence of carob moth ecophases fluctuation and development in Algerian south-east were limited to the works of Wertheimer (1958) and Le Berre (1978) on date palm and those of Doumandji, (1981) in the Algiers littoral on carob tree. The ambiguity that surrounds the exact role of temperature on insect biology, prompted us to study the importance of this factor on the seasonal abundance of carob moth in palm grove of Tolga.

2 MATERIALS AND METHODS

Our study site is located in the region 40 km from Tolga chief wilaya of Biskra (Figure 1). Biskra region is located in the Saharan bioclimatic stage mild winter, with a dry season which runs throughout the year (Mehaoua, 2006). It is characterized by high temperatures up to an annual average of 21.5 °C and average annual rainfall of 135.1 mm (Mehaoua, 2006).The operation is consisted bydate palm aged more than 30 years primarily composed by the most widespread and economically profitable varieties in the region: Deglet Nour, Ghars and Mech Degla.

The evolution following of carob moth population was performed using pheromone traps which are placed in four directions and in the center of the palm spaced from one another by a distance of 50 m (Al-Jamali, 2006).They are clinging to palm trees to a height of 1.5 m above the ground (Al-Jamali, 2006).Playing catch traps weekly. The change of pheromone as indicated by the manufacturer (4 weeks in winter and two weeks in summer) (Zouioueche, 2011).In parallel of pheromone traps we have placed, in a weather shelter of a man height, an electronic thermometer to record the maximum and minimum temperatures of our study site (4 readings per day: 02 h30, 8:30, 14:30, and 20:30). Prior to statistical analysis, the size of the carob moth caught have been transformed by the relationship $Y' = \sqrt{(Y\ 3/8)}$ in order to stabilize the variance and normalize the data (Borcard, 1998 Dagnelie, 2011).The data have been transformed by a statistical analysis of linear regression using the software XLSTAT.

Figure 1: Study station location

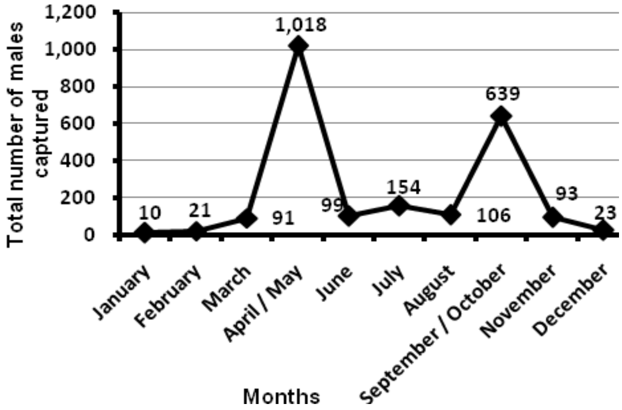

Figure 2 : Population fluctuations of Ectomyelois ceratoniae during the year

3 RESULTS

The results of weekly reports pheromone traps during 2010 show the presence of two high flight periods: the first beginning in March until June with a maximum abundance in April and May (1018 males), the second one runs from August to November with a major flight during the months of September and October (639 individuals). From the month of December until the end of February the number of males captured is very small, with 10 males during January and 23 males during December (Figure 2).

- **WINTER SEASON**

During the winter period, the number of adults captured during each week is significantly lower (Figure 3) the maximum and minimum number was respectively 28 adults on the 4th March and 0 male on the 7th January. During this season, the minimum temperature varies between 5.37 and 13, 97 ° C, while the highest recorded is 13.17 to 22.57 ° C, with average fixed between 8.97 and 18.27°C.

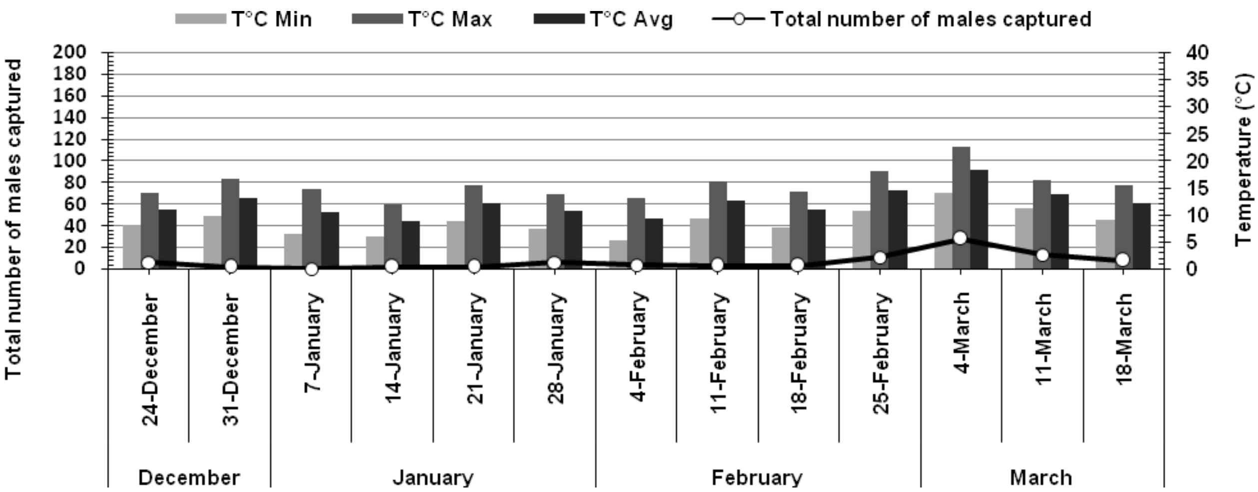

Figure 3: Temperature and Ectomyelois ceratoniae population fluctuations during winter

The results (Table 1) show that the average minimum temperatures, maximum and average, and their combined action, showed a significant and positive effect on carob moth fluctuation respectively with r^2= 0.630, 0.547, 0.606, 0.630 and P <0.001, 0.004, 0.002, 0.007.

Table 1: Linear regression between carob moth population and minimum, maximum and average temperatures during the winter season

T°C	Regression Equation	Coefficient of determination (r^2)	P
X_1 (Minimum)	**Y** = -1.185+0.409*X_1	0.630	0.001
X_2 (Maximum)	**Y** = -2.859+0.338*X_2	0.547	0.004
X_3 (Average)	**Y** = -2.268+0.384*X_3	0.606	0.002
X_1-X_2	**Y** = -1.193+0.409*X_1+1.292-3*X_2	0.630	0.007

- **SPRING SEASON**

The *Ectomyelois ceratoniae* population increased during the first three weeks for reaching peak abundance between April 15 and April 29, with a maximum 184 adults with an average temperature situated between 18.88 and 21.33 ° C. Then, the population decreases sharply in May to reach 21 individuals in the third week of June with temperatures increasing (minimum: 26.54 ° C, maximum: 32.74 ° C and average: 29.64 ° C) (Figure 4).

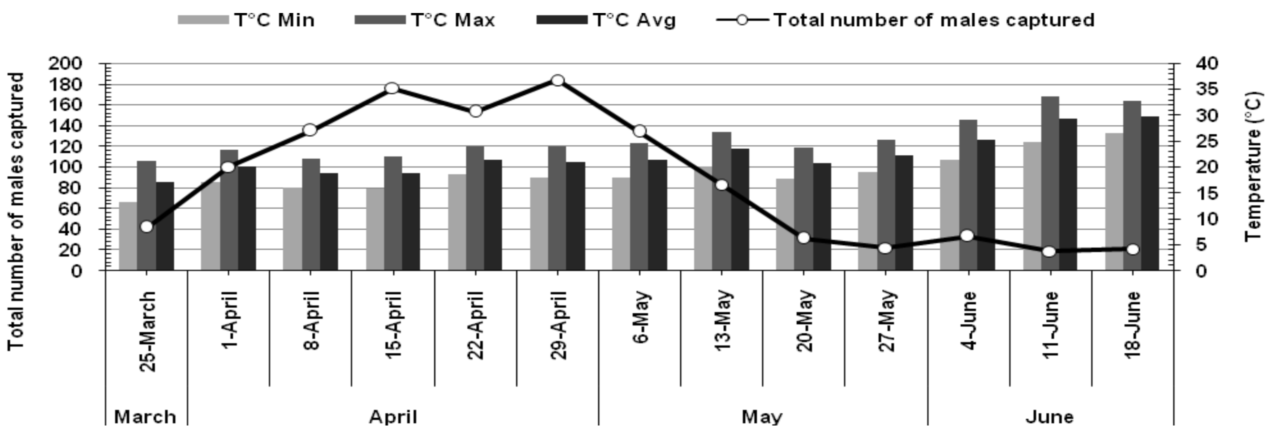

Figure 4: Temperature and Ectomyelois ceratoniae population fluctuations during spring

Statistical analysis of the results (Table 2) shows that the average minimum temperature does not have a significant effect on carob moth flight (r^2= 0.274, P <0.066). Whereas, the average maximum and average temperatures present a low significant and negative effect respectively with r^2 = 0.380, P <0.025 and r^2 = 0.332, P <0.039. While the dual impact of the minimum and maximum temperature is significant and negative (r^2 = 0.479, P <0.038) on *Ectomyelois ceratoniae* abundance in spring.

Table 2: Linear regression between carob moth population and minimum, maximum and average temperatures during spring season

T°C	Regression Equation	Coefficient of determination (r^2)	P
X_1 (Minimum)	**Y** = 18.409-0.511*X_1	0.274	0.066
X_2 (Maximum)	**Y** =22.653-0.546*X_2	0.380	0.025
X_3 (Average)	**Y** =20.708-0.539*X_3	0.332	0.039
X_1-X_2	**Y** =27.278+1.302*X_1-1.695*X_2	0.479	0.038

- **SUMMER SEASON**

The results (Figure 5) show that the maximum peak of the moth population was recorded during the second week of September, with a total of 69 individuals at a maximum temperature of 31.74 °C. The maximum temperature increase (34.54 to 38.06 ° C) results in an overall decrease of flying butterflies *Ectomyelois ceratoniae* from the end of June until the end of August.

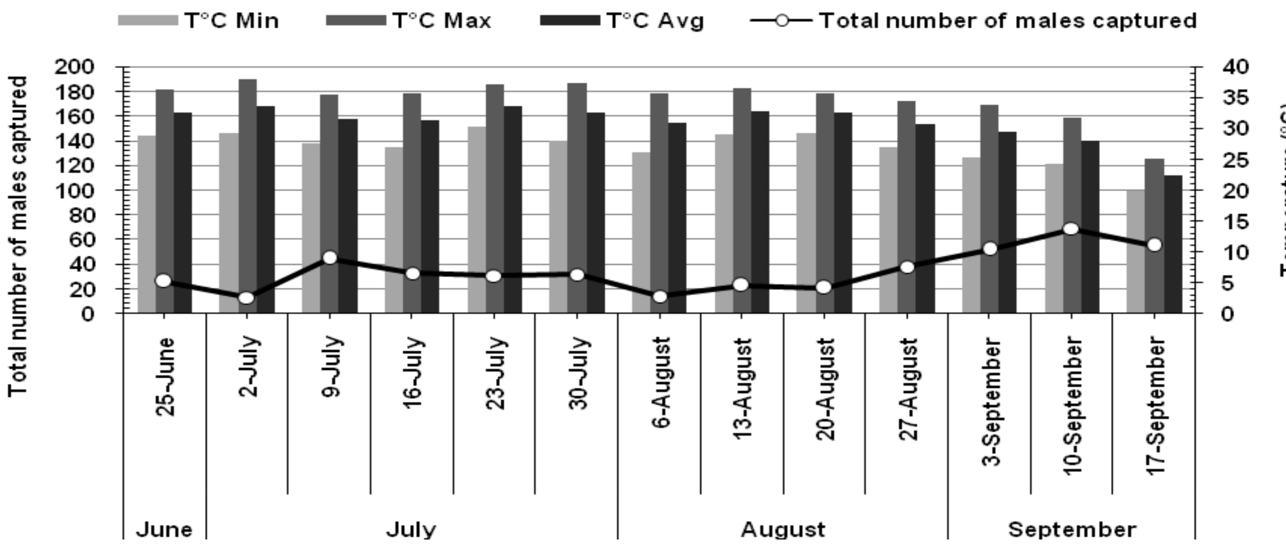

Figure 5: Temperature and Ectomyelois ceratoniae population fluctuations during summer

From Table 3, we note that during the summer, the minimum temperature has a significant influence but low on carob moth population abundance (r^2 = 0.428, P <0.015). While the average maximum temperatures and medium as well as the simultaneous impact of minimum and maximum average temperatures show a significant and negative effect respectively with r^2 = 0.455,P<0.011 and r^2 = 0.457, P <0.011.

Table 3: Linear regression between carob moth population and minimum, maximum and average temperatures during the summer season

T°C	Regression Equation	Coefficient of determination (r^2)	P
X_1 (Minimum)	**Y** = 14.775-0.332*X_1	0.428	0.015
X_2 (Maximum)	**Y** = 15.641-0.283*X_2	0.455	0.011
X_3 (Average)	**Y** = 15.512-0.314*X_3	0.455	0.011
X_1-X_2	**Y** = 15.631-8.162-02*X_1-0.219*X_2	0.457	0.047

- **AUTUMNAL SEASON**

The adult moth flight began during the last week of September where the maximum and mean minimum temperature, approaching respectively 19.99, 25.02 and 22.51 ° C, this flight coincides with the maturity of the first fruits of date and then increase during the mid-October when the number of males captured peaked (183 individuals) with an average temperature of 21.30 °C. With the lowering of average temperatures in the months of November and December, the population *Ectomyelois ceratoniae* has begun to decline until December 17 (minimum temperature and 7.09 average: 10.08 ° C), with a minimum flight during the first three weeks of December (Figure 6).

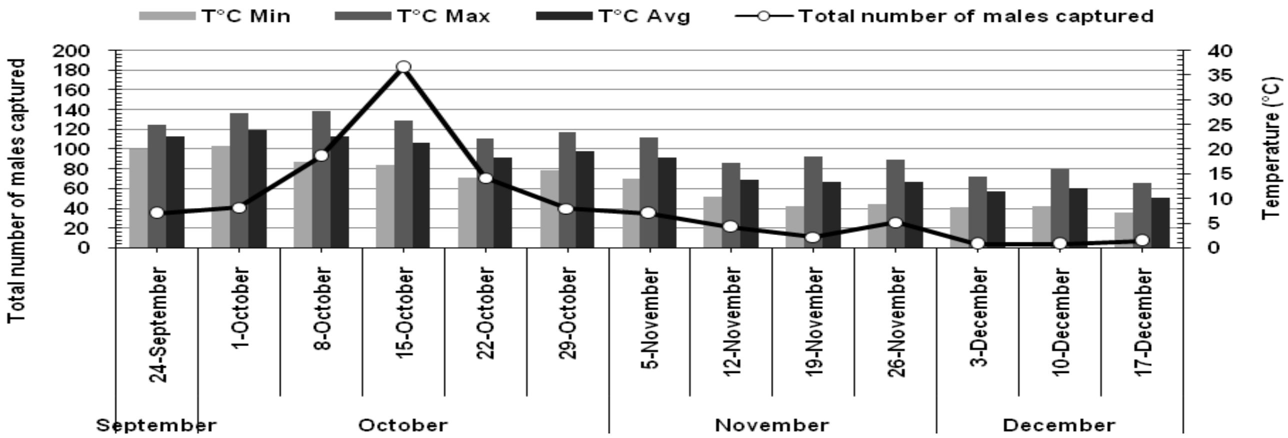

Figure 6: Temperature and Ectomyelois ceratoniae population fluctuations during autumn

Our results (Table 4) show that carob moth population is weakly correlated with average and minimum temperature (R^2 = 0.461 and P <0.011).While it is positive and significant for medium temperatures, maximum and average with R^2 = 0.622 respectively, 0.556 and P <0.001, 0.003, but maximum and minimum temperatures combination has a greater effect on the abundance of *E. ceratoniae* during the autumn period with R^2 = 0.664 and P <0.004.

Table 4: Linear regression between carob moth population and minimum, maximum and average temperatures during the autumnal season

T°C	Regression Equation	Coefficient of determination (r^2)	P
X_1 (Minimum)	**Y** = -0.180+0.463*X_1	0.461	0.011
X_2 (Maximum)	**Y** = -4.897+0.517*X_2	0.622	0.001
X_3 (Average)	**Y** = -2.689+0.505*X_3	0.556	0.003
X_1-X_2	**Y** = -7.385-0.424*X_1+0.903*X_2	0.664	0.004

4 DISCUSSION

The carob moth adults have a permanent flight throughout the year with two important frequencies corresponding to two generations: the first one is spring generation and the second is autumnal one. The present results are different in comparison to those obtained by Wertheimer (1958), who noted the presence of three major successive generations during the year in southern Algeria. While Doumandji (1981)found that the *E. ceratoniae* can reach in good conditions four generation in Algerian littoral.

From December to February the adults number caught is very small, it may be due to low temperatures during winter. During this period, the larvae remains active but their development is very slow and the flights of butterflies seem to take place in the months of April-May (Doumandji, 1981).For Dhouibi (1982) the onset of the first adults is early and the responsible factor for this difference is the temperature. Le Berre (1978) reported that the first generation emergence of adults is when the average temperature exceeds 15 °C. Wertheimer (1958) also reported that the onset of adult occurs at an average temperature of 15 ° C between the last days of March and April 15 but the daily number of butterflies emerged is very low. So it seems that the low winter temperatures in the region of Biskra limit the emergence and development of *E. ceratoniae*. There is a strong correlation between the low temperatures and the decrease size of the moth date.

In the spring, temperatures are optimal for the development of the carob moth. Extreme temperatures during this season have no effect on the population of E. *ceratoniae*. Doumandji (1981) has situated the optimum heat level for the emergence of the adult moth is 24 ° C or above. Indeed, the temperature has a significant impact on the emergence of adults (Lambret, 2010).The carob moth probably prefers relatively high temperatures. The development cycle takes 54 days at a temperature of 27 ± 1 ° C under controlled conditions (Naidji and Kebici, 2009).While Cox (1976) situated that the development cycle of the carob moth is48 days at 20 °C, 30 days at 25 °C and 23 days at 30 °C.

During the summer, high temperatures seem to have a negative impact on the abundance of the *E. ceratoniae* population, resulting in a significant decrease in the number of individual captured. These results can partly be compared with those of Le Berre (1975), who showed that the carob moth does not survive above 35 ° C. In our palm grove, the maximum temperature recorded, in summer, exceeds 38°C which explains the very low number of captured adult.

The average temperatures during the month of October seems optimal for population growth of *E. ceratoniae*. While low temperatures during November and December seem to play an important role in the reducing moth size in Autumn. Wertheimer (1958) indicated that the largest number of tracks from the third flight surprised by the slow autumnal refresh their biological activities and remain in the fruits without tempted to go out, there is now no other flights to the following spring. He also mentioned that though a few individuals complete their transformation into a butterfly in storage sheds and have the opportunity to return to palm grove.

Temperature appears to be the main factor responsible of *E. ceratoniae*. Fluctuations. So carob moth is developed only between certain thermal limits called actual development temperatures, which vary with the stage of development. It generally results in a decrease or increase in the duration of development, both embryonic and larval and therefore that of the complete life cycle (Obame Minko, 2009).

5 CONCLUSION

The study of carob moth adult flight fluctuations allowed us to identify two non-overlapping generations during the year. On the other hand, the seasonal abundance of the carob moth is strongly influenced by the temperature and their fluctuation effect. In addition, extreme temperatures have a negative effect on the flight of *E. ceratoniae*.

Determining the effect of temperature on the *E. ceratoniae* population was essential; it won't only provide the opportun time or the pullulation of this pest, but also in the formulation of an effective control strategy at precised times of the year against this redoubtable pest.

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