

Biocontrol of the Carob Moth *Ectomyelois ceratoniae* (Lepidoptera, Pyralidae) in Two Oases in the South of TUNISIA using Mating Disruption with SPLAT EC O

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Abstract – The carob moth, *Ectomyelois ceratoniae* (Lepidoptera, Pyralidae) is a serious pest in Tunisia. It attacks many horticultural shrubs mainly dates (*Phoenix dactylifera*) and pomegranate (*Punica granatum*) causing enormous economic losses. This study aims to improve an efficient control to this pest on pomegranate in two oases in the south of Tunisia using mating disruption with SPLAT EC O. Field trials were conducted in two oases of two governorates Kebili and Tozeur. In field, mating disruption using SPLAT EC O (500g/ha), seemed promising. Results showed that mating disruption with SPLAT EC O was an efficient way in reducing the rate of infestation by *E. ceratoniae*.

Keywords – Dates, *Ectomyelois Ceratoniae*, Mating Disruption, Pomegranate, Splat EC O.

I. INTRODUCTION

Carob moth (*Ectomyelois Ceratoniae*) is a polyphage pest causing qualitative and quantitative reduction of dates and pomegranate fruit [1]. This pest eats internal tissues of fruits and makes entrance of fungi and bacteria easier which causes the fruit decaying. (Fig1)



Fig. 1. Damages of *Ectomyelois ceratoniae* on pomegranate fruit



Fig. 2. Carob moth larva on dates

In order to prevent yield damage and monitor the pest population, a lot of measures have been conducted on field. [2], [4], [5], [6], [7] [8], [9], [11], [12], [13].

But the results weren't enough adequate due to the entophytic behavior of the insect [3],[10]. In fact the larvae feed and develop inside the fruit. There is thus an urgent need for a sensitive mean of monitoring the endemic population of *Ectomyelois ceratoniae*. As the excessive use of chemicals on crops has been a controversial issue, mating disruption has become an alternative controlling method of the pest population.

Mating Disruption

Mating disruption is the fact of saturating the orchard with the female moth sex pheromone to delay or prevent mating. [13]

When introducing many sources of the sex pheromone in the orchard, the probability of the male finding the female is reduced. Therefore mating is either delayed with a negative effect on fertility or prevented. If *Ectomyelois ceratoniae* females don't mate, they can't lay fertile eggs and if their mating is delayed, they will lay fewer fertilized eggs.

Consequently, the new pest generation is reduced, and fewer eggs are hatched so fewer larvae are present to cause crop damage.

This study reveals the results obtained when we used SPLAT EC-O as a disruptant substance in order to control the carob moth in two oases in the south of Tunisia.

II. MATERIALS AND METHODS

1-Splat EC O

The treatment used in this essay is SPLAT EC-O. The natural pheromone sex of the carob moth is highly volatile substance in the field [3]. We used SPLAT EC O due to its consistence and remnance during the study. SPLAT EC O is Z, E 7, 9, 11 dodecatrienyl, mimic format of Z, E, 9, 11,13 tetra decatrienal which was identified as the major component of the carob moth sex pheromone[12]

This mimic pheromone formulation is used to control moth population through mating disruption; This product doesn't kill the carob moth like "Attract and Kill" technique. It controls the populations by disrupting their mating with the volatiles of the mimic sex pheromone. The timing of the product application is important to optimally target the mating season.

2-Experimental Fields

We applied several dollops in two oases situated in two different governorates in the south of Tunisia.

• **Application Techniques**

With a caulking gun Fig 3, we apply SPLAT EC-O as many point sources (dollops) on trunk trees in the field to disrupt adult moth mating (Fig 4).



Fig. 3. Application of SPLAT EC O on pomegranate tree with caulking gun



Fig. 4. A dollop of SPLAT EC O applied on pomegranate trunk

First oasis: oasis of Bazma (governorate of Kebili)

Series of treatments were conducted in an Oasis (5ha) in the region of Bazma (governorate of Kebili) where pomegranate trees and palms were planted. This oasis was divided into six plots (B1, B2, B3, B4, B5 et B6) as it is represented in the site plan (Fig.5) and characteristics are detailed in Table 1.

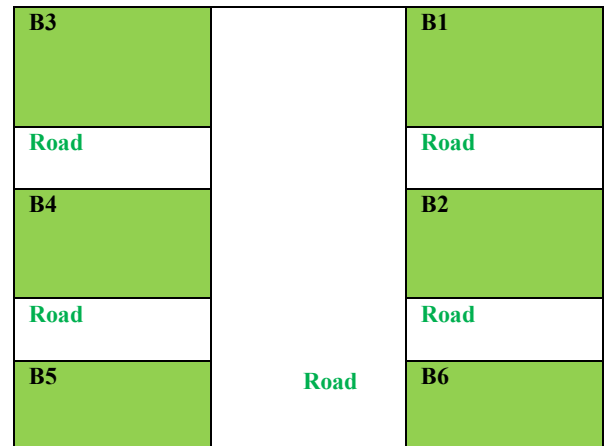


Fig. 5. Site plan of the oasis of Bazma (governorate of Kebili)

We provided the treatments with SPLAT EC O (500g/ha) three times in the following dates.

1st series of treatments: 30/06/2016

2nd series of treatments: 10/08/2016

3rd series of treatments: 20/09/2016

Table1. Characteristics of the oasis of Bazma treated with SPLAT EC O (500g/ha)

Plot	Surface area (ha)	Planting density
B1	1	Date palms : 135 (8*8m) - pomegranate trees : 63
B2	0.5	- date palms : 70(8*8m) - pomegranate trees : 27pieds
B3	1	- date palms : 130 (8*8m) - pomegranate trees : 40
B4	0.5	- date palms : 72(8*8m) - pomegranate trees : 27
B5	0.5	- date palms :71 (8*8m) - pomegranate tree : 14
B6	1.5	- date palms :200 (8*8m) - pomegranate tree : 58

In order to detect and do the monitoring of the pest we put two pheromone traps/ ha (Fig 6).



Fig. 6. Pheromone trap installed on pomegranate tree.

Second oasis: Mrah Lahwar (governorate of Tozeur)

Series of treatments were conducted in the oasis Mrah Lahwar (5ha) (governorate of Tozeur) where pomegranate trees and palm dates were planted. This oasis was divided into six plots (A1, A2, A3, A4, A5 et A6) as it is represented in the site plan (Fig 7) and characteristics are detailed in Table 2.

We provided the treatments with SPLAT EC O (500g/ha) three times in the following dates
1st series of treatments: 31/06/2016
2nd series of treatments: 11/08/2016
3rd series of treatments: 21/09/2016

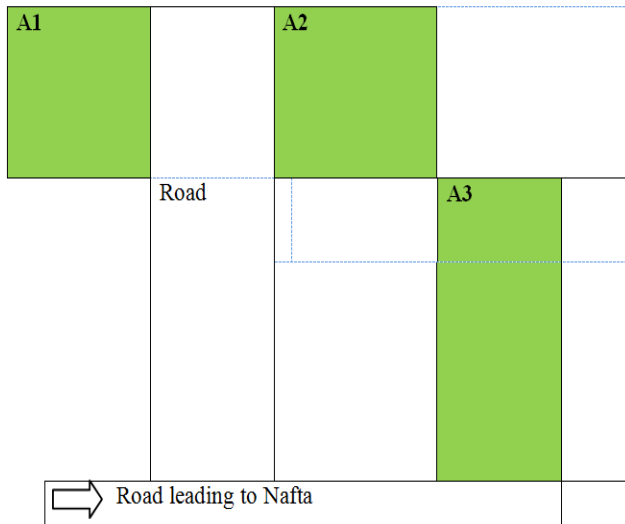


Fig. 7. Site plan of the oasis of Mrah Lahwar (Tozeur)

Table 2. Characteristics of the oasis of Mrah Lahwar (Tozeur)

Plot	Surface area (ha)	Planting density
A1	2	Date palms : 200 (10*10m) - pomegranate trees : 58 trees
A2	2	Date palms : 200 (10*10m) pomegranate trees : 52 trees
A3	1	Date palms : 100 (10*10m) pomegranate trees : 37 trees

2 - The Control of SPLAT EC O Efficiency

In order to control the efficiency of the treatment, we reared 30 pomegranates from oasis where we applied the product and 30 pomegranates from control plot. For the dates, we reared 100 treated dates and 100 dates from control plot. The samples were reared each week then taken to the laboratory.

The gathered samples were taken to the laboratory where we counted individuals from different instars. We installed two pheromone traps /ha in order to survey adults' number and its evolution. During the period of our study we registered the climatic data in the experimented fields: in Kebili the temperature varied from 27, 5°C to 43, 22°C and relative humidity varied from 27% to 44 % (Fig 8). The governorate of Tozeur is known for its higher temperature. It varied between 32°C and 45°C during the period of treatment. The relative humidity varied from 45% to 55% (Fig 9).

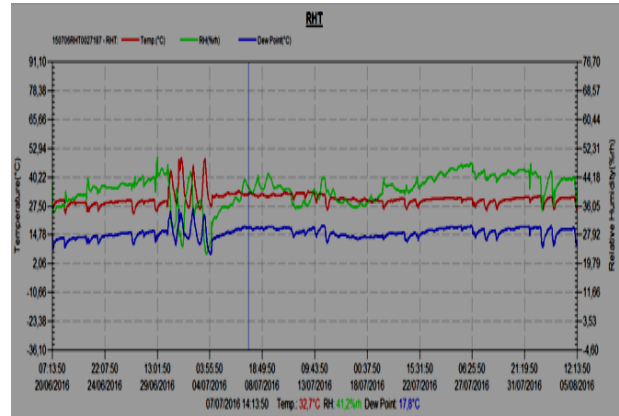


Fig. 8. Climatic data recorded in Bazma (governorate of Kebili) during the period of the study



Fig. 9. Climatic data recorded in the oasis Mrah Lahwar (governorate of Tozeur) during the period of the study

III. RESULTS AND DISCUSSIONS

A. Results of Mating Disruption Conducted in the Oasis of Bazma (governorate of Kebili)

The samplings done each week were taken to the laboratory. We counted infested fruits. We determined the evolution of infestation rate on pomegranate (Fig.10) as well as on dates (Fig.11).

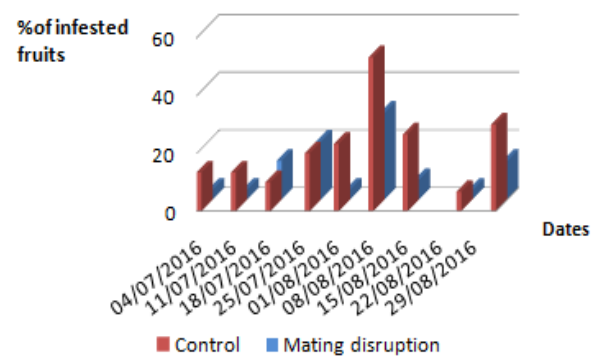


Fig. 10. Infestation rate on pomegranate fruits in the oasis of Bazma (governorate of Kebili)

From July until September, we evaluated the effect of mating disruption with SPLAT EC O on the evolution of infestation rate on pomegranate (Fig.10) by examining samples of fruits.

After one week of the treatment by SPLAT EC O (500g/ha), the infestation level by *E. ceratoniae* decreased to reach 10% compared to 50% in the control plot at the same period.

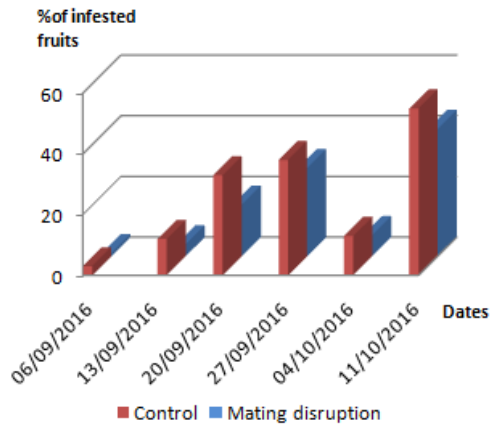


Fig. 11. Infestation rate on dates in the oasis of Bazma (governorate of Kebili)

The infestation rate of dates increased in September and October which corresponds to the third generation. Besides, the increase of the percentage of infested fruits (Fig.11) is explained by the attractiveness of some uncovered bunches of dates to adult pest from other orchards. The pest is attracted to uncovered bunch to penetrate the fruit. After one week of the treatment by SPLAT EC O (500g/ha), the infestation level by *E. ceratoniae* decreased 60% to 10% in the control plot (Fig.12).

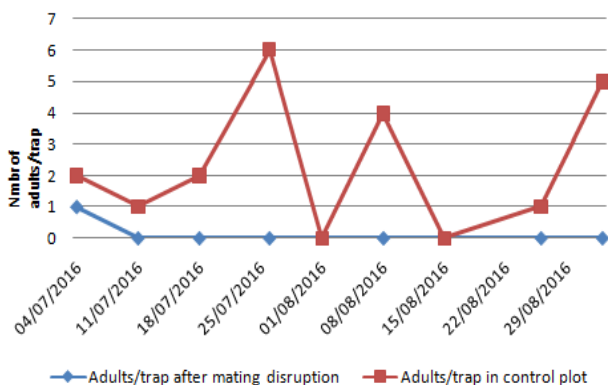


Fig. 12. Evolution of the number of adults on pomegranate trees captured with pheromone traps installed in the experimental oasis in Kebili

In July, in control plot, the numbers of captured adults in pheromone trap increased (6 adults/trap). It corresponds to the second generation of carob moth. Then the number decreased to 4 adults/trap. By August, the number of adult increased, it coincided with the emergence of second generation of the pest. After mating disruption, the number of adults/trap decreased. There was no individual in the pheromone trap during the study. (Fig.12)

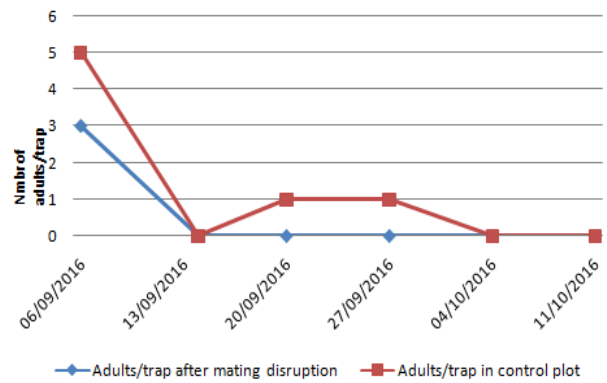


Fig. 13. Evolution of the number of adults on palm dates captured with pheromone traps installed in the experimental plot in Kebili

The males captured in the pheromone traps (Fig.13) indicate that mating disruption with SPLAT EC O was efficient in lowering the rate of infestation of *E. ceratoniae*. After mating disruption, we noticed the absence of adults in traps

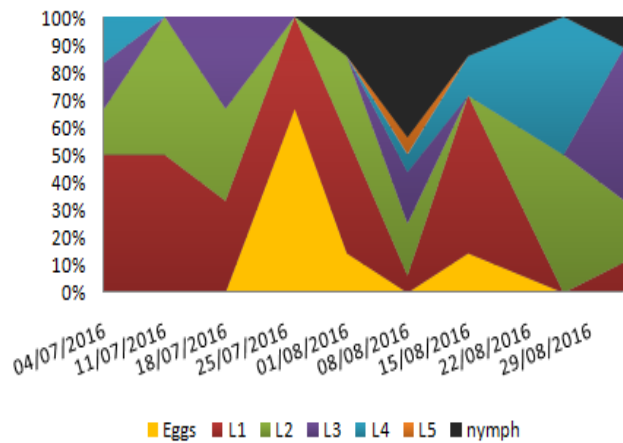


Fig. 14. Population structure on pomegranate tree in control plot in Kebili

Referring to results shown in (Fig.13) we notice that the infestation rate by *E.Ceratoniae* on pomegranate fruit as well as on dates decreased considerably. In fact after only one week from the application of SPLAT EC O, moth populations decreased in the treated oasis comparing to the control one.

The population structure on pomegranate tree (Fig.14) shows the decrease of fertile eggs by the end of treatment. This confirms the previous results.

The statistical results revealed that there is a coherent relation between the pest population structure and the period of applying the treatment.

The peak of eggs number in August on pomegranate was due to the appearance of second generation. Besides the penetration of other adults from other oasis, because of the uncovered bunches, increases the infestation rate. The mimic pheromone is not efficient anymore. These results confirm that mating disruption with SPLAT EC O is an efficient mean to control *E.ceratoniae*.

B-Results of Mating Disruption Conducted in the Oasis of Mrah Lahwar (governorate of Tozeur)

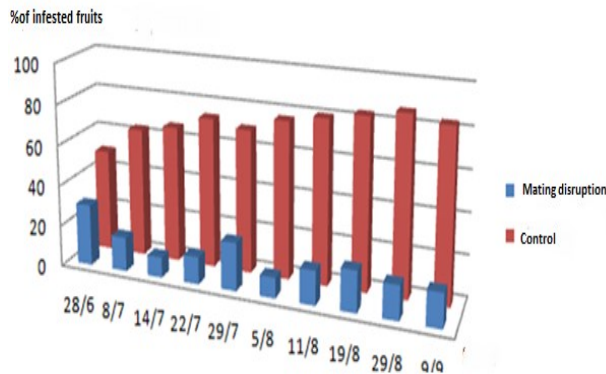


Fig. 15. Infestation rate of pomegranate fruits in the oasis of Mrah Lahwar (governorate of Tozeur).

After mating disruption, the infestation rate decreased considerably on pomegranate trees from 80% to 15% (Fig. 15) and from 40% to 10% on dates (Fig. 16).

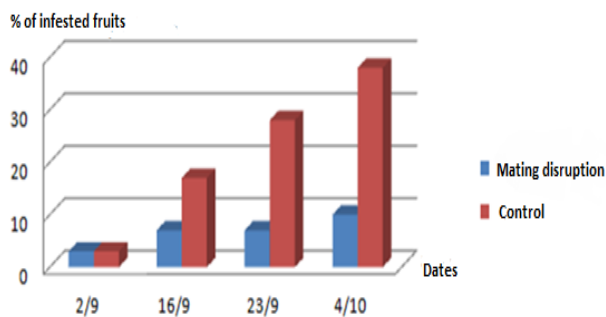


Fig. 16. Infestation rate of dates in the oasis of Mrah Lahwar (governorate of Tozeur)

From September to October, the infestation rate is more accentuated compared to previous months. This is explained by the penetration of other pest individuals into experimental plots because some date palms weren't covered. After mating disruption, the infestation rate decreased considerably to reach 8% on October as it is represented in Fig. 16.

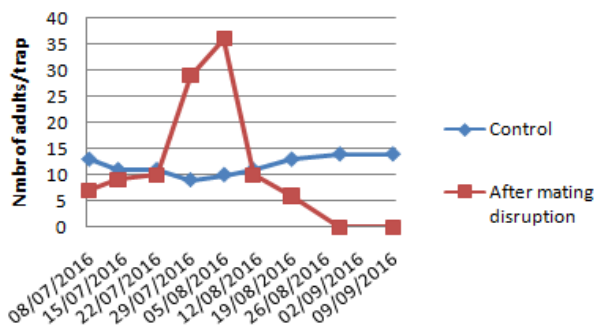


Fig. 17. Evolution of the number of adults on pomegranate trees captured with pheromone traps installed in the experimental oasis of Mrah Lahwar (governorate of Tozeur)

The evolution of number of adults in Tozeur is more accentuated compared to Kebili. This difference is due to

the higher temperature and lack of moisture in this region. These are favorite factors to the pest development. In fact the dates are dry. The whole between calice and the fruit facilitate the penetration of the moth. Once the pest is in the fruit, it will damage the fruit and achieve its development.

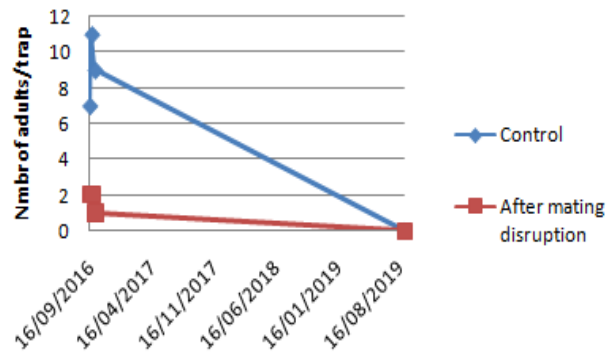


Fig. 18. Evolution of the number of adults on date palms captured with pheromone traps installed in the experimental oasis of Mrah Lahwar (governorate of Tozeur)

The number of adults per trap decreased considerably. The number lowered from 12 adults/ trap in control plot to 2 adults/ trap after mating disruption during the same period (Fig 18).

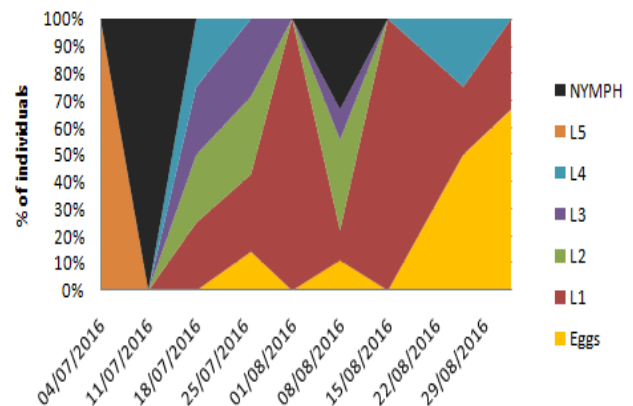


Fig. 19. Population structure of *E.ceratoniae* on pomegranate trees in Mrah Lahwar (governorate of Tozeur)

During the period of our study, we notice the lack of fertile eggs. However by the 15th of august we registered an increase in eggs level because we didn't apply another dose from SPLAT EC O. The high rate of larva of the fifth instar and the nymph (Fig.19) explain that SPLAT EC O affects the adults' activity .

IV. CONCLUSION

In the two experimental oases in governorate of Kebili and governorate of Tozeur, a significant reduction in the infestation level of *Ectomyelois ceratoniae* by SPLAT EC O (500g/ha) was noticed. Our results reveal that the use of mating disruption with SPLAT EC O is a promising mean

to control *Ectomyelois ceratoniae* population. However, the efficiency of the treatment seemed more remarkable in cleaned plot of the oasis (Fig 20 and Fig 21). So we recommend removing crops debris from orchards just after the harvest and before using the product.

Besides we recommend fortifying orchard borders with additional dose of the product. This will optimally control moth entry points. Adding another dose by the end of the third generation (in autumn) would enhance the treatment performance.

Monitoring the target pest with pheromone-traps is a crucial step before using the treatment. In fact placing monitoring traps in the area before applying mating disruption gives us an idea about the infestation level and the pest situation in the orchard.



Fig. 20. A Clean oasis where crop debris were removed



Fig. 21. Bunches of healthy dates (not infested with *Ectomyelois ceratoniae*) after mating disruption

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