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## Mass trapping technique in reducing *Ectomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae) damages in date palm groves in Tunisia

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### Abstract

The carob moth, *Ectomyelois ceratoniae* (Zeller), (Lepidoptera: Pyralidae), is a cosmopolitan species widely distributed in different habitats worldwide. This pest is a well known by its severe attacks in fields and in storage. In Tunisia, it is considered as a serious problem to, pomegranate and date palm crops causing important yield losses. In this context, a control program by mass trapping technique was evaluated in 2016 in the southwestern of Tunisia in a grove where pomegranate trees are intercropped with date palms. Therefore, delta and water traps were tested, both with two densities (10 and 12 traps/ha) on pomegranate and date palm trees separately. Results showed that 12 delta traps/ha has significantly reduced pomegranate fruits damages by 77.43%. However, none of tested traps was efficient in limiting date fruits losses where infestation rate varies between 18.5 and 23.5% on control and treated plot by 10 water traps/ha, respectively.

**Keywords:** *Ectomyelois ceratoniae*, oases, water trap, delta trap, pomegranate trees, date palms

### Introduction

The carob moth is a cosmopolitan species <sup>[1]</sup>. It is present in several countries of the Mediterranean basin such as Spain, Italy, France, Morocco and Algeria <sup>[2, 3, 4, 5]</sup>. In Tunisia, this pest is reported from the north to the south <sup>[6]</sup> on different host plants such as orange <sup>[7]</sup>, carob <sup>[8]</sup> fig <sup>[9]</sup>, pomegranate <sup>[10, 11]</sup> and palm date <sup>[12, 13]</sup>. This insect, causes considerable losses on agronomic and economic crops, in particular the date palm tree (*Phoenix dactylifera*) and pomegranate tree (*Punica granatum*) <sup>[14]</sup>. Due to their endophytic behavior, the first instar larvae feed on the calyx of pomegranates and then they enter inside fruits to complete their development <sup>[15]</sup>. Therefore, pomegranates are damaged, and are prone to invasion by fungal agents. On dates, the first instar larvae are always located on the perianth. Inside fruits, the larvae are often present near the stone. Attacked fruits fall easily from bunches <sup>[16]</sup>.

Many chemical treatments were conducted in order to control carob moth and reduce fruits damage in open fields. However, the intensive use of chemical pesticides have failed to obtain low fruit infestation, due to endophytic behavior of *E. ceratoniae*. Besides, chemicals are considered as a serious threat on human health and environment <sup>[17]</sup>. Therefore, new alternatives have been adopted at the orchard level and successfully reduced fruits infestation. These tactics include, cultural control, Trichogramma releases, mating disruption and mass trapping <sup>[18]</sup>.

Since the discovery of the female synthetic pheromone of *E. ceratoniae*, mass trapping baited with the sex pheromone of the target pest seems to be sufficient to maintain the damage rate in low level. This method is frequently applied in many parts of the world for example: Iran <sup>[19]</sup>, Turkey <sup>[20]</sup> Algeria <sup>[21]</sup> etc...

Mass trapping is a global method that is used against: lepidopterans such as *Tuta absoluta* <sup>[22]</sup> *Cydia pomonella* <sup>[23]</sup>, *E. ceratoniae* <sup>[10]</sup>, flies such as *Ceratitis capitata* <sup>[24]</sup> and *Silba adipata* <sup>[25]</sup> and coleopterans such as *Rhynchophorus ferrugineus* <sup>[26]</sup>, *Oryctes Agamemnon* <sup>[27]</sup>.

The aim of this study was to estimate the efficacy of two types of traps, each tested with two doses separately on pomegranate and date palm trees in biological date palm grove located in governorate of Tozeur, south-west of Tunisia.

## Materials and Methods

### Experimental site

Experiments were carried out during 2016, in a date palm grove in the region of Degache (Governorate of Tozeur) with an area of 4.5 ha. This orchard was planted with 120 date palm trees per hectare (Deglet Nour variety) with a density of  $8 \times 8$  m and intercropped with pomegranate trees (30 trees/ha; Tounsi variety) randomly displayed.

Study orchard was divided into 9 plots with the same area with 0.5ha each (control plot and 8 treated plots). Each plot was separated from others by windbreaks.

### Mass trapping

This experiment was conducted on an area of 4 ha (8 treated plots). Both water and Delta traps were tested separately each type with two densities 10 and 12 traps per hectare.

Mass trapping was carried out from 06 May to 04 October on pomegranate trees then tested from 02 September to 28 October on date palm trees. Delta traps (ISCA) are often used to monitor and control Lepidopteran pests. Traps consist in triangular plastic trap (w: 10 cm, l: 19.5 cm, h: 10 cm) with a triangular cross-section  $3 \times 3 \times 3$  cm at each end. Sticky cards are placed in the internal side with the pheromone capsule in order to attract and retain males of target pest.

Traps were combined with the sex pheromone of *E. ceratoniae* female ((Z,E)-7,9,11,-dodecatrien-1-ol formate).

Water traps are plastic containers (21 cm deep;  $15 \times 8.5$  cm size), containing 1.5 L of water and combined with the sex pheromone of *E. ceratoniae* which is suspended above the container. All tested traps were hanged to the trunk trees at a height of 1.5 m.

Traps were weekly checked, the pheromone capsules and sticky cardboards were changed with fresh ones every 3 to 4 weeks.

### Estimation of field infestation

In order to evaluate the efficacy of each trap type and each tested dose, five pomegranate trees from each plot including the control were randomly selected. The chosen trees were examined weekly for the occurrence of carob moth damage. For dates, from each tested plot 200 dates/ 5 date palm trees (randomly chosen) were sampled during harvest (on 28

October 2016) and examined in laboratory under binocular microscope (Leica® model MS5).

The effectiveness of each treatment was evaluated by the Abbott (1925) formula [28].

The percentages of infestation and efficacies of each tested trap were evaluated either:

- The percentage of infestation =  $(N_A / N_B) * 100$
- For pomegranates:  $N_A$  is the number of infested pomegranate fruits per tree and  $N_B$  is the total number of pomegranate fruits per tree
- Concerning dates:  $N_A$  is the number of infested fruits and  $N_B$  is the total number of fruits.

### Statistical analysis

Data on the effectiveness of mass trapping were analyzed using the software IBM SPSS (Statistics 20). General linear model procedures were used to perform the analysis of variance. Wherever significant difference occurred, Tukey's multiple comparison test was applied for mean separation.

## Results

### Male catches on pomegranate trees

After a winter diapause period, *E. ceratoniae* adults started their activity again in May 2016 in all tested plots. Indeed, the first male catches was recorded on 20 May with an average of 0.6 and 9.6 males per 10 and 12 delta traps, respectively. At the same date, for water traps, male captures were significantly lower ( $p < 0.05$ ) than those of delta traps with 1.2 and 1.16 males per 10 and 12 traps per hectare, respectively and extended until October 4<sup>th</sup>. This appearance coincided with pomegranate fruiting. The temporal evolution of the number of males trapped is shown in Figure 1. At 10 traps/ha, the capture of *E. ceratoniae* males was similar between the two tested traps ( $p = 0.875$ ). In fact, during the 2016 season, a total of 26.6 and 20.4 males/trap were counted for the water and delta traps, respectively.

During this experiment, mass trapping conducted at 12 traps/ha revealed a maximum number of males on 18 August with 54.1 males/ delta trap compared with 4.3 males/ water trap. It seems that the capture potential is highly important for delta traps compared with water trap at the density of 12 traps/ha ( $p < 0.05$ ) during 2016 season.

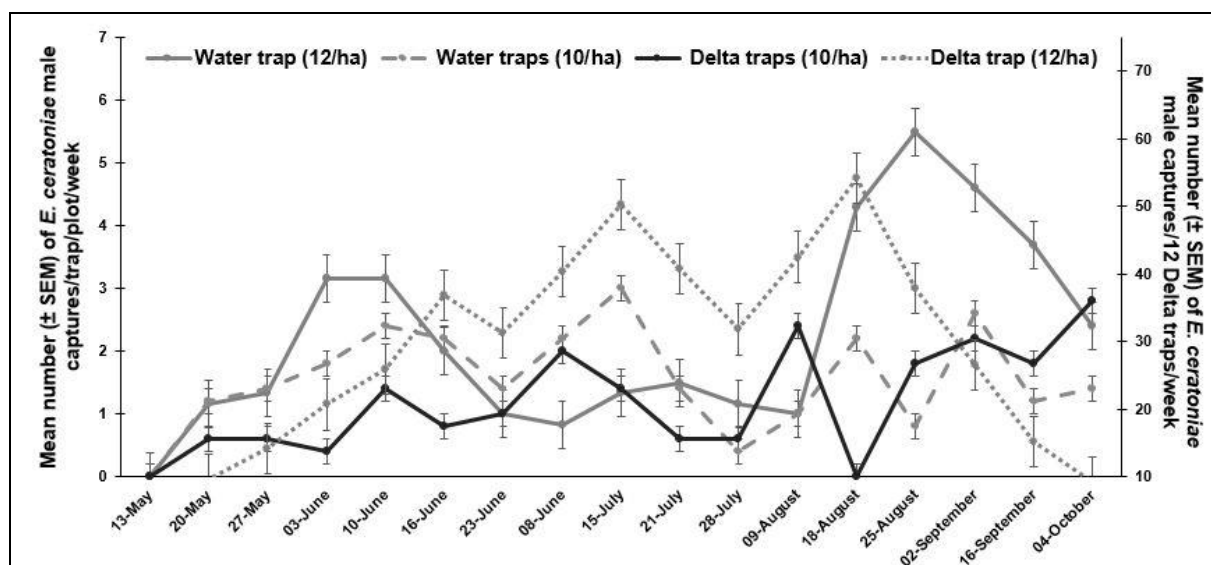


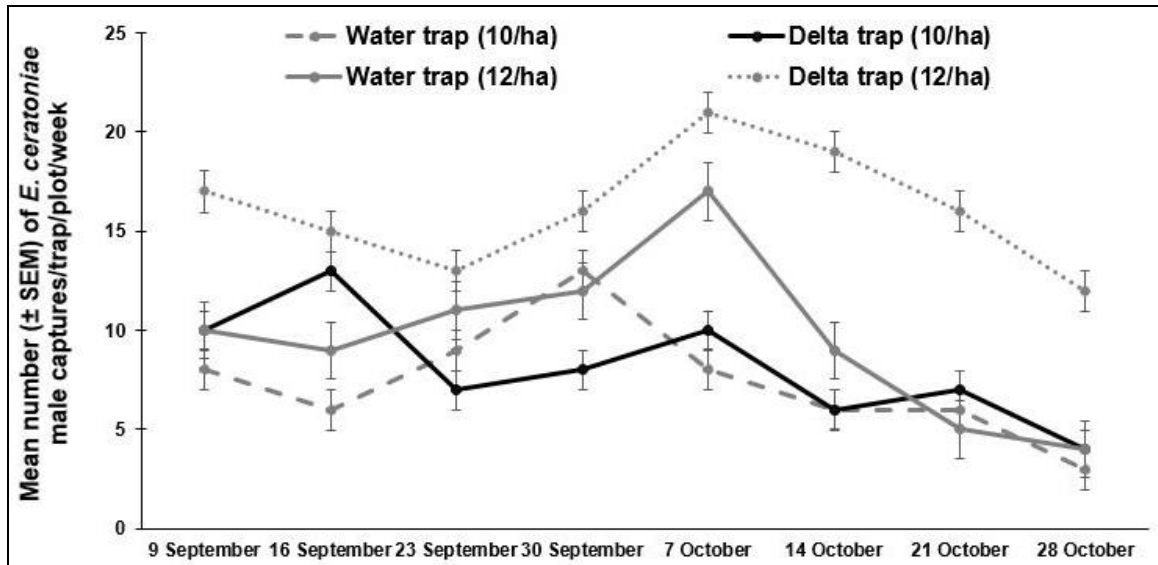
Fig 1: Weekly captures of *E. ceratoniae* males per 10 and 12 water and delta traps/ha on pomegranate trees during 2016

**Male catches on date palm trees**

From the beginning of September until the end of October (28), water and delta traps were set on date palm trees in four plots. Statistical analyses did not show any significant difference between the two trap types and the two tested densities ( $p = 0.998$ ). In fact, the maximum number of trapped adults varies between 13 males per 10 water and delta traps both, respectively registered on September 30<sup>th</sup> and 16<sup>th</sup> September and 19 males /12 delta traps per hectare counted

on October 14<sup>th</sup>. The maximum of trapped *E. ceratoniae* males trapped through 12 water traps/ ha was registered on 07<sup>th</sup> October with 17 adults/trap (Fig. 2).

In addition, the two months study revealed no significant difference between the two trap types at 10 traps/ha ( $p = 0.543$ ). Besides, for 12 traps/ha the potential of capturing adults on date palm trees, for the two tested traps is similar ( $p = 0.476$ ).

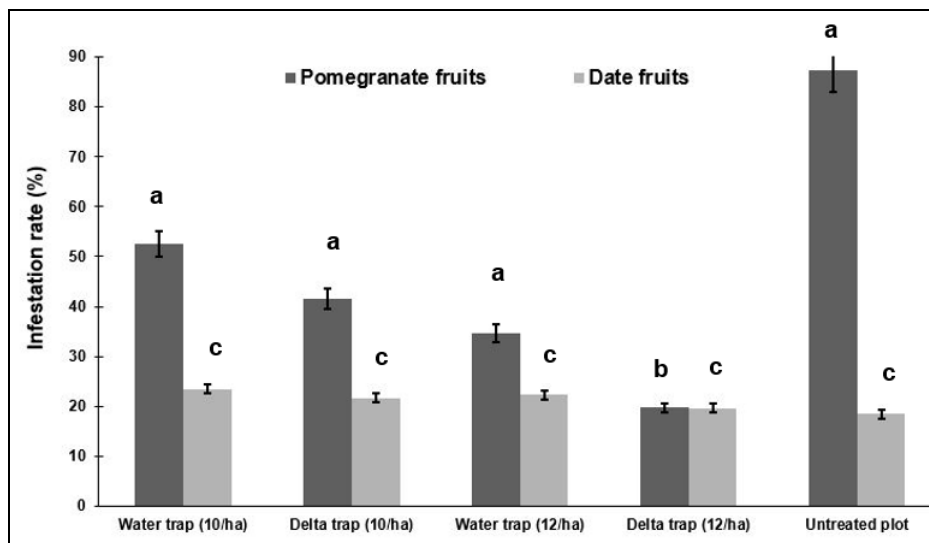


**Fig 2:** Weekly captures of *E. ceratoniae* males per 10 and 12 water and delta traps/ha on date palm trees during 2016

**Fruit infestation**

In order to determine the adequate trap type and the density to control *E. ceratoniae* in Tunisian date palm groves, experiments were conducted in the governorate of Tozeur in 2016. Satisfactory results were observed for the delta traps at the density of 12 traps/ha on pomegranates where the infestation rates were respectively 19.7% in the treated plot and 87.3% in the untreated plot. Thus, a reduction in fruit damage induced by mass trapping with the density of 12 delta traps per hectare was 77.43% (Fig. 3). On the other hand, the density of 10 delta traps/ha was not effective enough to

reduce the infestation of pomegranate fruits in the treated plot with an average infestation evaluated at 41.5%. This density has only protect the half of harvested pomegranate fruits (about 52.46%). For water traps, 10 and 12 traps/ha were not sufficient to reduce the infestation level of pomegranate fruits; indeed, infestation varied between 52.5 and 34.7% for densities of 10 and 12 traps/ha, respectively. On date palms, neither water traps nor delta traps succeeded to limit the infestation of dates. Therefore, we need to adopt other tactics of controlling the carob moth.



**Fig 3:** Infestation rate caused by the carob moth according to different tested densities, water and delta traps and the host plant in Tunisian date palm grove during 2016 {Different letters above the bars indicate significant differences ( $p \leq 0.05$ ; Tukey's test) at the same host plant }

## Discussion

Adults of the carob moth *E. ceratoniae* were present in all studied plots from May to October 2016. Male catches recorded on May correspond to the emerged overwintering chrysalids. Then, the number of trapped males gradually increased until reaching its maximum in October coinciding with the maturity of the pomegranate and date fruits. A study of Ben Chaabane and Mahjoubi (2018) <sup>[13]</sup> confirms that a maximum captures of *E. ceratoniae* was registered in October coinciding with pomegranate fruits ripening in Hezoua oases during 2018.

This study showed that mass trapping technique using delta traps has significantly caught more adults than water traps, besides the dose of 12 traps/ha seems to be an efficient trial to minimize *E. ceratoniae* population in date palm groves. Previous studies in many countries, confirmed that this alternative had a great potential in reducing *E. ceratoniae* population by capturing a maximum number of males in open fields. In Turkey, Mamay and Dag (2016) <sup>[29]</sup> tested the efficacy of 20 traps combined with the sex pheromone of *E. ceratoniae* per hectare on pomegranate orchards. In Iran, Mehrjardy *et al.* (2016) <sup>[30]</sup> showed that mass trapping caught about 841 and 722 of carob moth males on pomegranate and fig fields, respectively.

Beside, in Algeria, the control of the carob moth using biotechnical management method seems to be promising in reducing pomegranate and date fruits losses <sup>[31]</sup>.

In Tunisia, delta traps are frequently used against the carob moth in orange orchards with a density of 10 traps/ha <sup>[7, 10]</sup>, in pomegranate orchards Dhoubi *et al.* (2016) <sup>[10]</sup> proved that 10 traps/ha could be recommended to control *E. ceratoniae* population. In oases, a density of 6 traps/ha on pomegranate trees and 15 traps/ha on date palm trees both combined with *Trichogramma* releases can significantly protect pomegranate and date fruits <sup>[13]</sup>.

On the other hand, water traps did not reduce *E. ceratoniae* population; this could be explained by the evaporation phenomenon during the hot season. In fact, a previous study showed that 14 water traps/ha caught a low number of the carob moth adults in Tunisian oases <sup>[14]</sup>. Generally, for more efficiency of water traps, it's recommended to use a large number of traps exceeding 30 traps/ha <sup>[32]</sup>.

In this work, the mean infestation rate of pomegranate fruits during harvest has reduced from 87.3% in control plot to 19.7% in treated plot by a density of 12 delta traps/ha. However, none of 10 delta traps/ha or water traps with the tow tested densities (10 and 12 traps/ha) had significantly reduce damages in tested plots. Zougari *et al.* (2020) <sup>[14]</sup> suggested that, 14 delta traps/ha can significantly reduce pomegranate damages caused by the carob moth which do not exceed 17.6%. Therefore, in this case it is suggested for farmers to apply 12 traps/ha for low cost.

Many studies were conducted on the effectiveness of delta traps against many pests citing: *Cydia pomonella* <sup>[23]</sup>, *T. absoluta* <sup>[33, 34]</sup>, *Lobesia botrana* <sup>[35]</sup>. This eco-friendly agent has captured a large number of target pests without disturbing the ecosystem in groves. Besides, studies confirms that this trial has no negative effect on non-target organisms.

## Conclusion

Mass trapping by delta traps baited with the sex pheromone of carob moth female could be a promising control approach to reduce *E. ceratoniae* population, then reduce pomegranate fruit damages. However, no efficiency of mass trapping was

observed in limiting date fruit losses. Therefore, it is recommended to combine mass trapping method with other ecofriendly methods in an Integrated Pest Management program, such as *Trichogramma* releases, moustico nets, biological insecticides, essential oil fumigation in order to protect the oasis ecosystem.

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## Disclosure statement

The authors report no conflict of interest.

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