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FUMIGANT TOXICITY OF *EUCALYPTUS TRANSCONTINENTALIS* ESSENTIAL OIL AGAINST EGGS AND ADULTS OF THE CAROB MOTH *ECTOMYELOIS CERATONIAE*

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ABSTRACT

The Carob moth, *Ectomyelois ceratoniae* is a polyphagous species which infests a large number of crop products. It is known as a pest of dates, figs, carob, almonds and citrus in Mediterranean countries. In Tunisia, it is the most important and destructive insect pest of dates causing important damages both in field and in storage. Pest control in storage is largely based on synthetic fumigants as methyl bromide and Phosphine. Nevertheless, due to their toxicity to human and their harmful effects on the environment, methyl bromide can no longer be used. Therefore, there is an urgent need to develop safer and efficient alternatives. Recently, research showed that essential oils and their constituents may have potential as alternative compounds to currently used fumigants. The present study aims to determine the fumigant toxicity of essential oil extracted from *Eucalyptus transcontinentalis* against eggs and adults of *E. ceratoniae*.

Results showed that at the concentration 142 µL L^{-1} air, 100% of adults mortality was obtained after 2 h of exposure. The LC_{50} and LC_{95} values were respectively 12.94 and 27.4 µL L^{-1} air. Hatching rate was 0% at the concentration 142.86 µL L^{-1} air against 98.33% for the control. These results indicated that both adults and eggs of *E. ceratoniae* were susceptible to vapours of *E. transcontinentalis* essential oil.

Results suggested that *E. transcontinentalis* essential oil could be used as an alternative to synthetic fumigant in postharvest treatment program against the carob moth.

Key words: Insecticidal activity, Carob moth, Eucalyptus, Essential oil, Fumigation, Eggs.

INTRODUCTION

The Carob moth, *Ectomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae), is a polyphagous species which infests a large number of crop products (Dhouibi, 1989). In Tunisia, it is the most important and destructive insect pest of dates causing important damage both in field and in storage (Jarraya, 2003).

Methyl bromide and phosphine are the most commonly products used for postharvest treatment of dates in Tunisia and worldwide (Zare et al., 2002). No doubt that these synthetic insecticides play an important role in reducing losses in dates due to the carob moth. However, these fumigants have serious drawbacks such as development of genetic resistance

in the treated pests, toxic residue problems and toxicity to consumers. Moreover, due to its harmful effects on the environment, methyl bromide can no longer be used. Methyl bromide is highly reactive to ozone and is classified as a potent stratospheric ozone depletor (Cox, 2004).

Recently, research showed that essential oils and their constituents may have potential as alternative compounds to currently used fumigants (Batish et al., 2008). Essential oils are volatile and can act like fumigants, offering the prospect for use in stored product protection (Papachristos and Stamooulos, 2002).

The objective of this study was to determine the fumigant toxicity of *Eucalyptus transcontinentalis* Maiden essential oil against eggs and adults of *E. ceratoniae*.

MATERIALS AND METHODS

Insect

E. ceratoniae adults and eggs were obtained from a rearing colony established at the Laboratory of Biotechnology Applied to Agriculture, National Agricultural Research Institute of Tunisia (INRAT). The moth was reared on an artificial diet based on wheat bran (Mediouni and Dhouibi, 2007).

Essential oil extraction

Leaves *of E. transcontinentalis* were collected in May 2010 from Sidi Ismail arboretum (northern Tunisia). Essential oil was extracted by water steam distillation using a Clevenger apparatus. The distilled oils were stored in the refrigerator at 4ºC.

2.3. Chemical analysis

GC/MS analyses were performed using an Agilent-Technologies 6890 N Network GC system equipped with a flame ionization detector and HP-5MS capillary column (30 m × 0.25 mm, film thickness 0.25 µm; Agilent-Technologies, Little Falls, CA, USA). The injector and detector temperatures were set at 220 and 290°C, respectively. The column temperature was programmed from 80 to 220°C at a rate of 4°C/min, with the lower and upper temperatures being held for 3 and 10 min, respectively.

2.4. Fumigant bioassays

The fumigant toxicity bioassays against eggs and adults of *E. ceratoniae* were conducted as described by Papachristos and Stamooulos (2002) with some modifications.

For adult assays, plastic jars of 350 mL volume were used as exposure chambers. A small piece of woven dental cotton was attached to the undersurface of the cap to serve as an oil diffuser on which different doses of pure essential oil were applied. The tested doses were 14.29, 20, 28.57, 57.14 and 142.86 µL L^{-1} air. Twenty (20) new emerged unsexed adults were put in each plastic jar. Exposure times were 6, 12, 24, 36, 48, 96 and 120 h and each treatment was replicated three times. Corrected mortality was calculated using Abbott's formula (1925).

For egg hatching bioassay, the same methodology was used, but in this case, 20 fertile eggs (2 days old) were placed in each plastic jar. Untreated eggs were used as control. The same concentrations were tested. Each concentration was replicated three times. Hatched and non hatched eggs were counted. Exposure periods were 24, 48, 72, 96, 120, 144, 168, 192, 216 and 240 h. The hatching rate was calculated as follows:

$$\frac{\text{Number of hatched larvae} * 100}{\text{Total number of eggs}}$$

RESULTS

Chemical composition

A total of 99.06% from the constituents of *E. transcontinentalis* essential oil were identified. Mainly components were 1,8-cineole (82.82%) and α-pinene (7.96%).

Toxicity on eggs

Fig. 1 illustrates the evolution of hatching rate of *E. ceratoniae* eggs at different doses of *E. transcontinentalis* essential oil after 10 days of exposure. At the concentration of 142.86 µL L^{-1} air, hatching rate was 0% against 98.33% for the control. Thus, *E. cereratoniae* eggs are very susceptible to *E. transcontinentalis* essential oil.

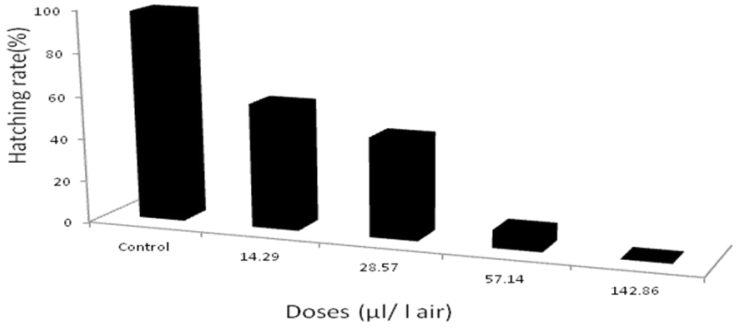

Fig. 1- Hatching rate of *E. ceratoniae* eggs exposed to different dosages of *E. transcontinentalis* essential oil after 10 days of exposure.

Effect on adult mortality

Results of the insecticidal activity of essential oil from *E. transcontinentalis* against carob moth adults were shown in Fig. 2.

At the highest concentration (142 µL L^{-1} air), 100% mortality was obtained after 2 h of exposure.

Probit analysis showed that the LC_{50} and LC_{95} were respectively 12.94 and 27.4 µL L^{-1} air after 24h of exposure.

CONCLUSION

Based on this study, we can conclude that the essential oil of *E. transcontinentalis* was rich in 1,8-cineole (82.82%). Insecticidal activity results suggested that this oil could be used for the development of new natural "bio-fumigant" for control of the carob moth in storage.

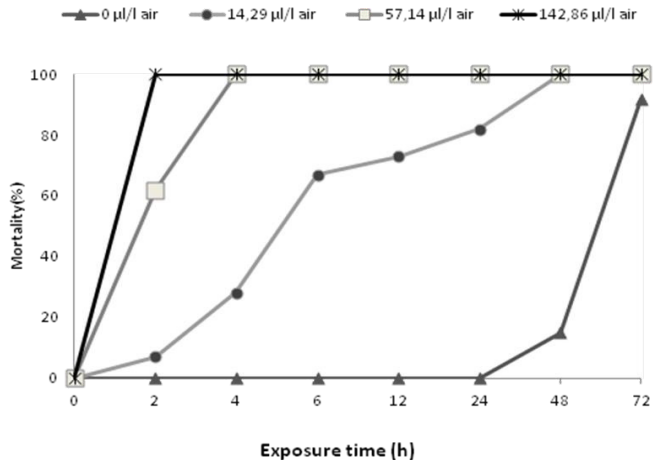

Fig. 2- Percentage mortality of *E. ceratoniae* adults exposed to various concentrations and periods to *E. transcontinentalis* essential oil.

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