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Emergence dates of *Eurytoma amygdali* Enderlein adults in the south-east of France and control strategy

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Abstract. *Eurytoma amygdali* Enderlein was discovered in France in 1981 and is now present in the South-east area of France, but it is absent in Pyrénées-Orientales and Corsica. In this study, the adult emergence dates in 2005, 2006 and 2007 have been observed in three different places. Some chemical control tests in insectarium have shown that "Karate® Zeon" insecticide, with the Pyrethroid Lambda cyhalothrine as active ingredient, has a high effectiveness and a persistence of more 23 days. These tests were confirmed in field orchards. With one single chemical spray applied at the beginning of the adult emergence, only 1 to 4% of fruits were infested, when more than 60% of fruits were infested in the control almond orchard without insecticide. With these results, the Karate® Zeon has been legally authorized in France to be used against *Eurytoma amygdali.*

Keywords. *Eurytoma amygdali* – Almond – *Prunus dulcis* – Chemical control.

Dates d'émergence des adultes d'*Eurytoma amygdali *Enderlein dans le sud-est de la France et stratégie de contrôle

Résumé. Eurytoma amygdali *Enderlein est apparu en France dans les années 1980 et est présent maintenant dans le Sud-est de la France, mais est absent en Pyrénées-Orientales et Corse. Dans l'étude effectuée, les dates d'émergence des adultes en 2005, 2006 et 2007 ont été observées dans trois lieux différents. Des tests en insectarium de lutte adulticide ont montré que le produit "Karate® Zeon" ayant comme matière active la pyréthrinoïde Lambda-cyhalothrine, a une bonne efficacité et une rémanence supérieure à 23 jours. Ces tests ont été aussi réalisés en verger au champ. Avec un seul traitement de Karate® Zeon, appliqué dès les premiers jours d'émergence des adultes, seulement 1 à 4 % de fruits étaient infestés, alors que plus de 60 % des fruits étaient infestés dans le verger témoin non traité. A partir de ces résultats, le produit Karate® Zeon a été autorisé légalement en France sur amandier contre* Eurytoma amygdali*.*

***Mots-clés*.** Eurytoma amygdali – *Amandier* – Prunus dulcis – *Lutte chimique.*

I – Introduction

The almond seed wasp, *Eurytoma amygdali* was detected in France for the first time in 1981 (Arambourg *et al.*, 1983) in the Var and Bouches-du Rhone departments. The progression towards adjacent departments was regular and *Eurytoma amygdali* is found now after Montpellier, but is not yet in the Roussillon area near Spain, neither in Corsica (Fig. 1).

It is a new pest in France, and almond growers do not yet know how to manage this insect. Up to 80% of the crop of some orchards can be destroyed. The biology of this insect has been well described by different authors (Mentjelos, 1970; Plaut, 1971, 1972, 1973; Talhouk, 1977; Duval, 2006) but there is no known phenological data of Eurytoma in the French climatic conditions. From 2005 to 2007, we have observed the adult emergence dates in three different places with the perspective of applying a reasoned chemical control. We tested a new insecticide in alternative to the Zolone which was the authorized product in France in 2005 against *Eurytoma amygdali*. This

insecticide did not give the expected results and resulted in multiple insecticide sprayings by growers at inappropriate times.

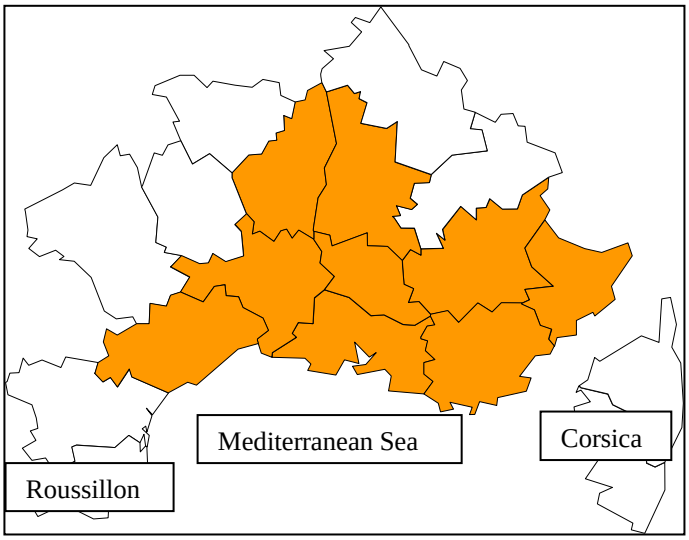

Fig. 1. Distribution of *Eurytoma amygdali* in France.

II – Material and methods

1. Emergence from cages

The studies were conducted during the years 2005, 2006 and 2007. We put in wooden cages (Fig. 2) infested fruits from the previous year that had been picked the first week of March, from almond trees of three different almond orchards: Montfavet-Avignon (Vaucluse), St Didier (Vaucluse), Valensole (Alpes de Haute-Provence). The varieties in these orchards are Ferragnès, Lauranne and Ferraduel. The wooden cages were placed in an insectarium room opened to exterior. A hole was made in the cage in order adults are attracted by the light of the hole connected to a transparent plastic bottle. The emerged male and female adults in the bottle were counted every day and were removed.

2. Chemical control experiments

Insectarium tests: Two contact insecticides were experimented: the Zolone (Phosalone), the authorized insecticide and the Karate® Zeon that contains as active ingredient, a synthesized Pyrethroids lambda-cyhalothrine. A treatment of the two insecticides was applied with a hand-sprayer on two almond trees of the INRA almond orchard in Montfavet on April 22nd, 2006. Every day after this treatment, some almond leaves of these trees were picked up and placed in a new plastic box with *Eurytoma* adults newly emerged the same day from the wooden cages. 24h after the introduction of the Eurytoma adults and the treated almond leaves in the box, the mortality rate was recorded.

Field tests: Bottles with glass tube (Fig. 3) with infested almond fruits were placed in the orchards for detecting the first adult emergences in the field. One or two days after the the first emerged

male, Karate ® Zeon treatments were applied in the orchard. In a part of every orchard, a second treatment with the same insecticide was applied two weeks after the first treatment. At the harvest, the number of infested fruits was counted.

Fig. 2. Wooden cages with bottle.

Fig. 3. Bottle with glass tube.

III – Results and discussion

1. Emergence dates

In Montfavet, the first emergence began on April 13th in 2005, April 18th in 2006, April 2nd in 2007 (Table 1). The flowering date was also the earlier in this place because it is the warmer place. In Valensole, the first emergence was more one week later like the flowering date. The length of the emergence in every site was comprised beetwen 21 and 27 days excepting for one case, St Didier in 2006 with 12 days.

Table 1. Emergence dates in 2005, 2006 and 2007 in 3 localities

Years and localities	First flowering date	Emergence date		Emergence length (days)
		Beginning	End	
2005				
Montfavet (84)	16-March	13-April	09-May	26
Saint Didier (84)	19-March	18-April	12-May	24
Valensole (04)	30-March	22-April	18-May	26
2006				
Montfavet (84)	17-March	18-April	09-May	21
Saint Didier (84)	18-March	23-April	05-May	12
Valensole (04)	01-April	26-April	20-May	24
2007				
Montfavet (84)	27-February	02-April	29-April	27

Figure 4 shows the typical distribution of the adult emergence observed in Saint Didier in 2005. The male emergence preceded the female emergence of 2 to 4 days and the ratio male:female was about one male for two females and was similar to the observed ratio in the other countries.

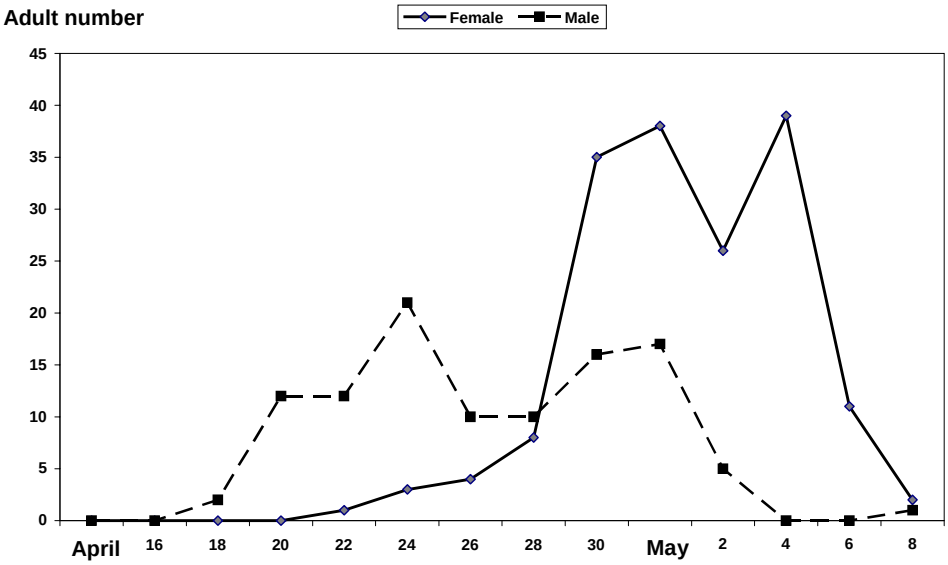

Fig. 4. Male and female adult emergence date, Saint Didier 2005.

2. Chemical control tests in insectarium

Table 2 shows that the two insecticides have a good action against *Eurytoma*. The mortality rate was 100% the first day after the treatment. The contact of the insect on the treated leaves is sufficient to eliminate it. However, the Zolone was fully efficient only four days after the treatment and the Karate® Zeon was efficient still after more 23 days. We stopped the test because we did not have new emerged *Eurytoma* adults anymore. These results showed that a single treatment with the Karate® Zeon could cover the total emergence period of *Eurytoma* female which was observed between 20 and 26 days in the three years. It was necessary to check this hypothesis with chemical control experiments in the field.

Table 2. Retentiveness of the Karate® Zeon and the Zolone (chemical treatment applied on April 22nd)

Observation date	Days after chemical spray	*Eurytoma* death rate after 24 h contact with treated leaves	
		Karate® Zeon	Zolone
22-April	J	100%	100%
23-April	J+1	100%	100%
24-April	J+2	100%	100%
25-April	J+3	100%	100%
27-April	J+5	100%	85%
29-April	J+7	100%	90%
30-April	J+8	100%	30%
04-May	J+12	80%	
08-May	J+16	100%	
12-May	J+20	100%	
15-May	J+23	100%	

3. Chemical control experiments in fields

The results of the experiments in fields are presented in Table 3. The two strategies, one single treatment applied just at the beginning of the emergence and the second strategy with a second treatment applied two weeks after the first, had a very good effectiveness with a low rate of infestation. The chemical control with a single treatment is cheaper and more advisable, but the optimal time for spraying at the first emergence has to be right.

Table 3. Percentage of infested fruits at harvest in almond orchards treated with one and two sprays of karate® Zeon

	St Didier	Valensole	Valensole
	2006	2006	2007
Karate® Zeon, two sprays	2%	1%	0.2%
Karate® Zeon, one spray	2.30%	2%	
Control: bordering orchard	64%	82%	

IV – Conclusions

Our data show that a protection of the almond orchards against *Eurytoma amygdali* with a single treatment of the contact insecticide Karate® Zeon is possible. However almond growers have to be trained to detect the first adult emergence with field cages or field bottles, in order to apply the treatment at the optimal time at the first adult emergence.

The use of sex pheromone traps would be easier to detect the first male flights (Katsoyannos *et al.*, 1992; Mazomenos *et al.*, 2004). In 2005, the two compounds, cited as sex pheromone by Krokos *et al.* (2001) were tested in our three experimental almond orchards with delta traps. No male were trapped, on the contrary of results of Mazomenos. We thought our compounds were not purified enough, but we have to go on these studies on sex pheromone traps.

To hope decreasing the populations of *Eurytoma amygdali* in the areas of almond growing, it is also important to remove the abandoned orchards and the infested wild almond trees. In France, it is a challenge to prevent the invasion of Eurytoma in the Corsica and Roussillon areas.

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