Pheromones for Insect Control in Orchards and Vineyards
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Can additives to pheromone enhance their efficiency in mating disruption of codling moth?

Julia Kirchert,[1,2] Christine Hapke [1,2] and Erich Dickler [1]

[1]*BBA Dossenheim, Institute for Plant Protection in Fruit Crops, 69221 Dossenheim*
[2]*University of Hohenheim, Institute of Phytomedicine, Entomology, 70593 Stuttgart*

Abstract: In 1998 and 1999, mating disruption efficiency of a new dispenser RAK 3R, containing pheromone plus Citral, a monoterpen, was compared with RAK 3 dispenser, which has been registered in Germany since 1997 for codling moth control. Dispensers were placed in two commercial orchards with different population densities of *Cydia pomonella*. To evaluate mating disruption success, pheromone traps with synthetic lures and pheromone traps with virgin females were used and, every fortnight fruits were checked for codling moth infestation. In Orchard A, both mating disruption methods were successful over a two -year test period. There were no differences between RAK 3R and RAK 3 treated orchards concerning apple damage and catches in the pheromone traps using synthetic lures. In Orchard B, mating disruption failed in 1999. Apple damage exceeded the economic threshold of 2and the trial had to be stopped by mid July. Infestation and catches by the pheromone traps with synthetic lures were much higher in the RAK 3R-plot than in the RAK 3-plot. Pheromone traps with virgin females caught more males in the RAK 3R-plot in both orchards.

Key words: mating disruption, codling moth, *Cydia pomonella*, Citral

Introduction

Codling moth, *Cydia pomonella* L., is the most important pest world-wide in pome fruit production. In the past, it was controlled primarily by the use of pesticides. Due to pesticide resistance (Riedl & Zelger 1994), the mating disruption technique has played an increasingly important role. Furthermore, some pesticides lost their registration in 1999 because of government restrictions (Koch & Schietinger 1999).

However the mating disruption method does not always give reliable control and is more expensive than chemical insecticide applications (Waldner 1997). In this study, a new form of mating disruption was tested. Meiwald (1995) revealed an impact of the monoterpen Citral on pheromone perception of *Lobesia botrana* Den. & Chiff. Therefore, BASF developed a new control method for *C. pomonella* using this compound. Citral, filled in dispensers (RAK 3R) should, together with the pheromone component, improve mating disruption success.

In field experiments, the new RAK 3R-dispensers were compared against RAK 3-dispensers in two commercial orchards.

Material and methods

The two orchards were situated in the Rhine Valley near Heidelberg. Because of the mild climate there were two generations of *C. pomonella*.

Orchard A had a size of 2 ha. Trials were made over the two successive years, 1998 and 1999. Infestation of apples was low in 1998 (< 2%). Orchard B had a size of 4 ha. Apple damage in 1998 varied from low to high values (1-9.9%) in different parts of the field. Trials with the two mating disruption methods were done in 1999 only. Each orchard was divided into a RAK 3R- and RAK 3-plot. In Orchard B, a small area of 88 trees was left as a control plot.

The different dispensers were placed in orchard A in mid May of 1998 and in both orchards in the beginning of May in 1999. The RAK 3R-dispenser contained Citral in one chamber and codlemone in the other. RAK 3 contained only codlemone. 125 RAK 3R-dispensers/ ha and 500 RAK 3-dispensers/ ha were hung, as recommended by BASF, on shady places on the trees. At the border, dispenser density was doubled.

Pheromone traps with synthetic lures and pheromone traps with virgin females were used to evaluate mating disruption success. The latter trap contained a small cage with two calling females positioned in the middle of the sticky insert instead of a rubber septum. The females were changed every 3-5 days. Every fortnight damage controls on apples were done to record codling moth infestation. 3000 apples per plot (1000 apples per cultivar and the border row) were checked at each control date.

Results

Orchard A

In 1998 the infestation rate remained below 1% till the end of August. Shortly before harvest the damage slightly increased and reached values up to 2,3%. There were no obvious differences between the two plots (Fig. 1).

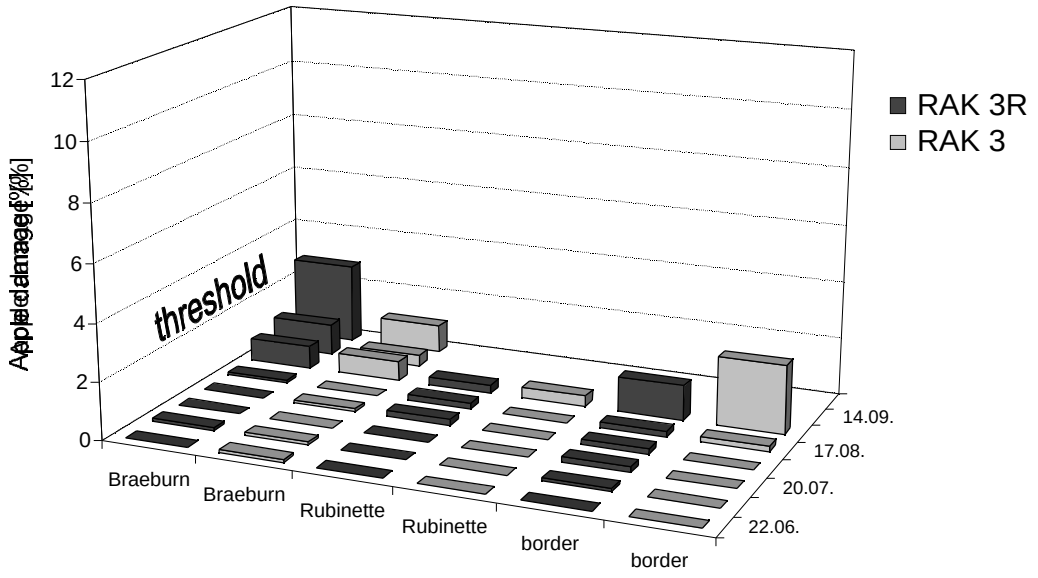

Figure 1. Apple damage Orchard A 1998

Pheromone trap catches were low (0-4 males per week). High trap catches in August might be explained by the change of lures in the beginning of that month (Fig. 2). Both mating disruption methods appeared to work sufficiently in 1998.

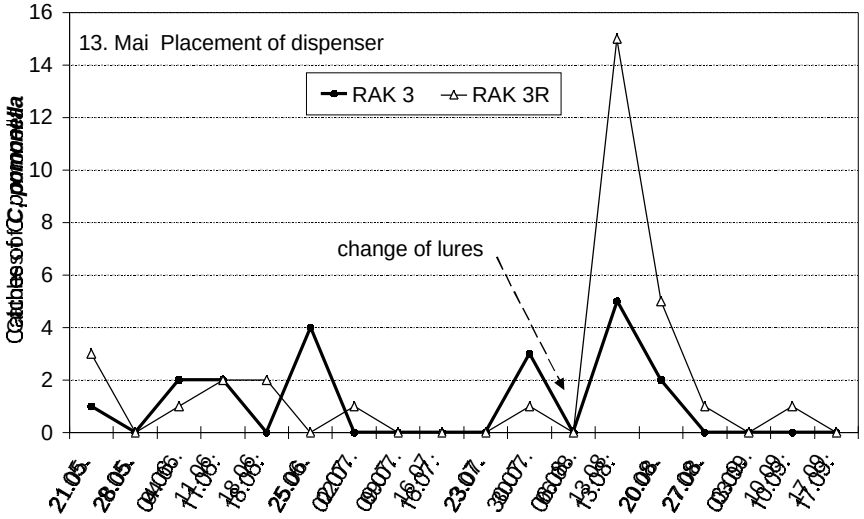

Figure 2. Pheromone trap catches (synthetic lures) Orchard A 1998

In 1999, the situation was almost similar with an infestation rate below the economic threshold. Shortly before harvest the damage increased slightly and reached values up to 3,6%. Infestation rates higher than 2% were found only at the orchard border. There were no obvious differences between the two plots as seen in previous year trial (Fig. 3).

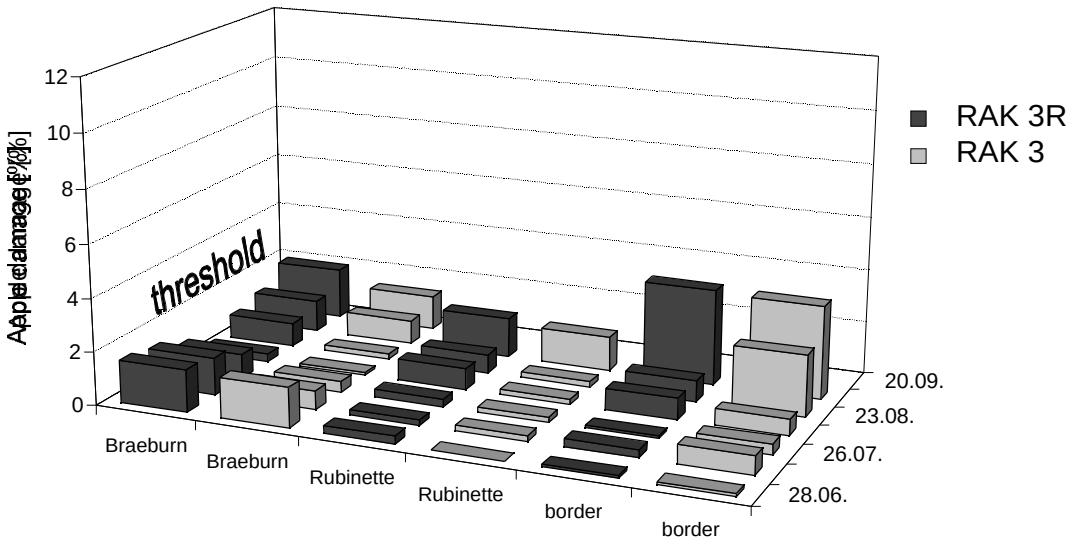

Figure 3. Apple damage Orchard A 1999

Pheromone traps caught 5 males in the RAK 3R- and 7 males in the RAK 3-plot. Compared to 1998, trap catches were lower (Fig. 4).

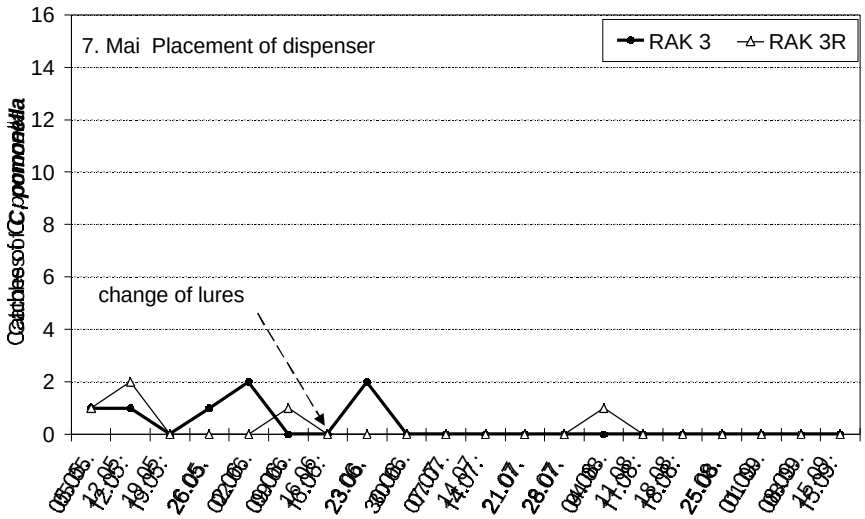

Figure 4. Pheromone trap catches (synthetic lures) Orchard A 1999

In 1999, pheromone traps with virgin females were also used. These traps caught 26 males in the RAK 3R- and 5 males in the RAK 3-plot. However, these results do not correspond with the infestation rate (Fig. 5).

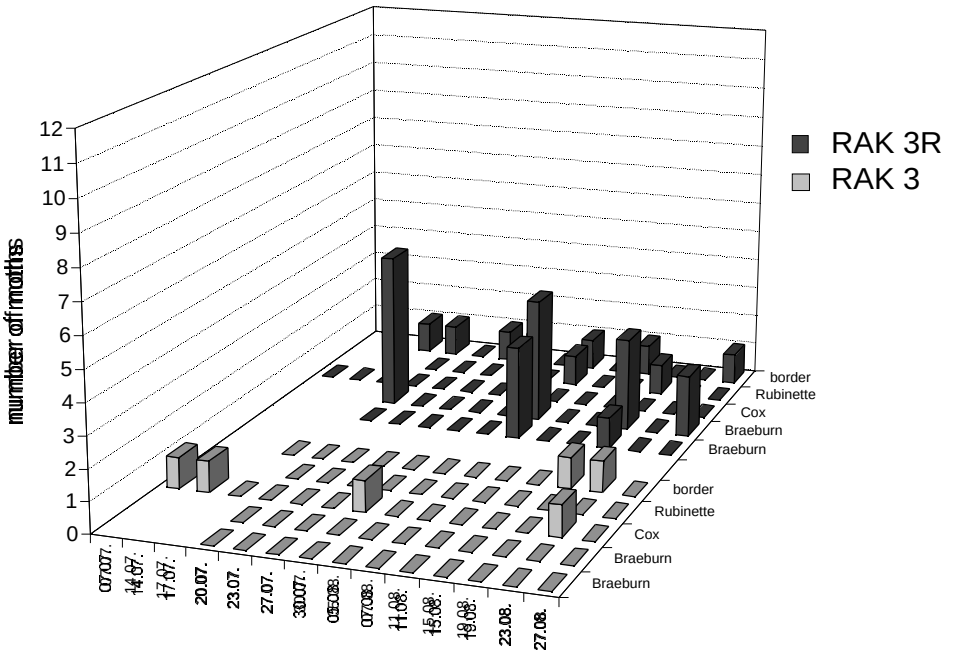

Figure 5. Catches of the pheromone traps with virgin females in Orchard A 1999

Orchard B

At the second damage control date, infestation was already beyond the 2%-threshold. Thus, the experiment was stopped by mid July and the orchard treated with insecticides (Fig. 6).

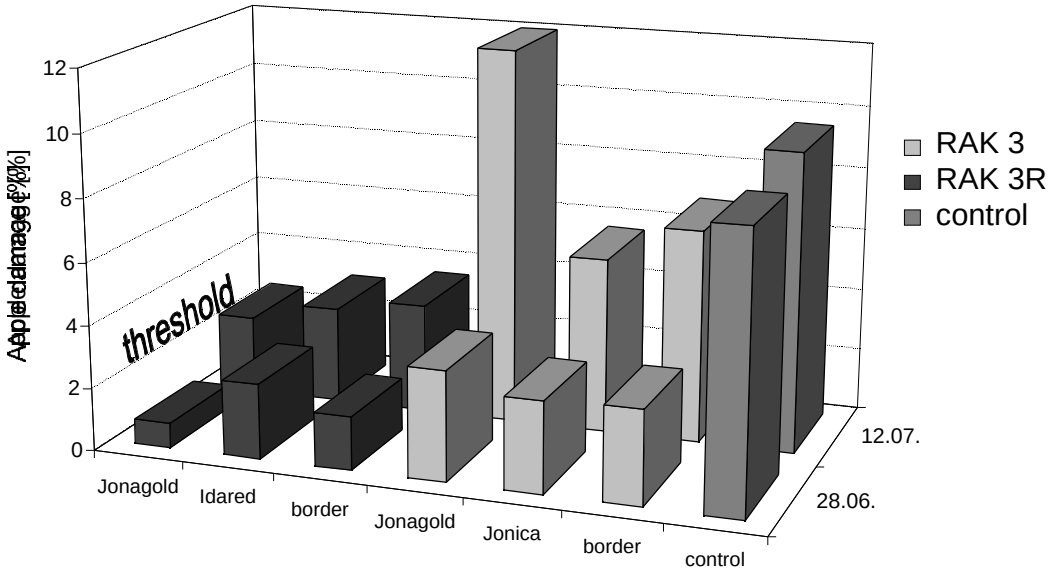

Figure 6. Apple damage Orchard B 1999

Apple damage in the RAK 3R-plot was much higher than in the RAK 3-plot. This situation might be explained by a higher codling moth infestation during the previous year in the RAK 3R-plot than in the RAK 3-plot. Pheromone traps caught 34 males in the RAK 3R-plot, 12 males in the RAK 3-plot and 31 males in the control-plot (Fig. 7).

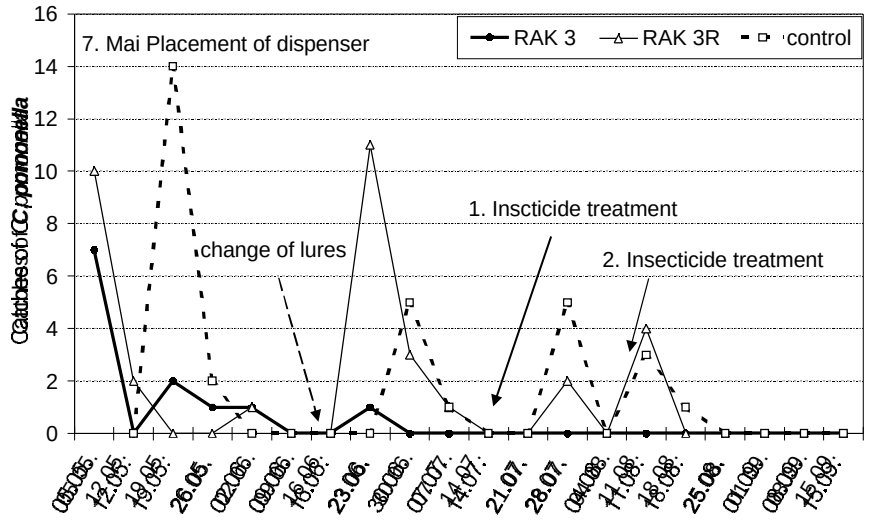

Figure 7. Pheromone trap catches Orchard B 1999

Traps with virgin females caught in total 92 males in the RAK 3R- and 5 males in the RAK 3-plot (Fig. 8).

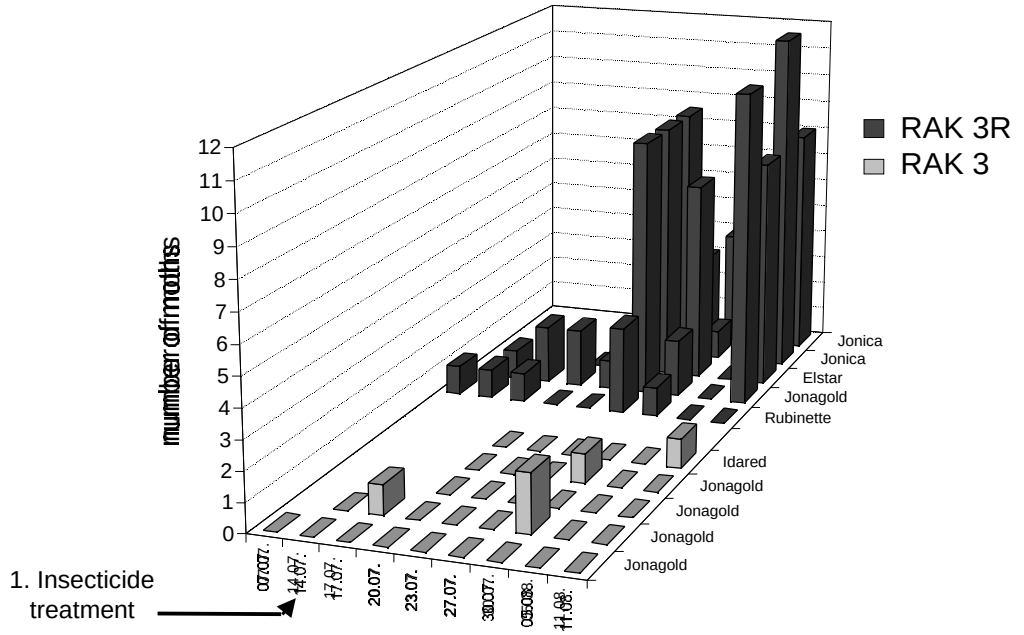

Figure 8. Catches of the traps with virgin females in Orchard B 1999

Mating disruption failed in orchard B. Population densities in 1998 were too high in some parts of the field to control codling moth successfully with this method the following year.

Discussion

Mating disruption with the RAK 3R-dispensers was successful in Orchard A which had low population densities as was mating disruption with RAK 3-dispensers. Only in the border rows infestations were beyond the 2% economic threshold. Damage at the border is often higher than in the centre of a mating disruption plot because wind blowing in from an adjacent untreated field can reduce pheromone concentration in that area (Milli & Koch 1997). Furthermore, migration of gravid females causes higher infestation at the border (Neumann 1997). Pheromone trap catches with synthetic lures showed no difference between the two plots, whereas the traps with virgin females caught slightly more males in the RAK 3R-plot than in the RAK 3-plot.

In Orchard B both mating disruption methods failed. Pre-infestation in 1998 was too high in some parts of the orchard to control codling moth by mating disruption only. It is known that mating disruption does not work sufficient enough at high population densities (Casagrande & Jones 1997). Before starting this trial insecticide sprayings would have been useful to reduce codling moth population (Neumann 1997). Pheromone traps with synthetic lures in the RAK 3R-plot caught more moths than in the RAK 3-plot. The same results showed the pheromone traps with virgin females, even with a greater difference between number of trap catches in both plots. Moreover, these traps caught many more males than

standard pheromone traps in both orchards, so the natural pheromone blend of the females seems to be more attractive than the synthetic one. Contrary to that Barrett (1995) found no difference between traps with calling females and traps loaded with 1 mg pheromone lures.

In trials testing the new mating disruption technique on seven farms near Lake of Constance, carried out by Lange and Trautmann, the infestation rate in all cases did not reach the threshold of 2 %. The standard pheromone plot as a comparison, showed the same results. For further improvements in the new mating disruption method more research has to be done. In particular the mode of action of Citral and the combination of Citral and the pheromone requires detailed investigation. First trials were done by Hapke *et al.* (2000).

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