MANAGEMENT OF *ANTHONOMUS RUBI* AND *BYTURUS TOMENTOSUS* IN ORGANIC RASPBERRY USING SEMIOCHEMICAL TRAPS

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ABSTRACT

In the absence of effective control measures, the strawberry blossom weevil (*Anthonomus rubi*) (SBW) and the raspberry beetle (*Byturus tomentosus*) (RB) cause large (10 - >80%) losses in yield and quality in organically grown raspberry. Attractive lures were combined into a single multitrap for economic management of these pests simultaneously. This is one of the first approaches to pest management of non-lepidopteran insect pests of horticultural crops using semiochemicals in the EU, and probably the first to target multiple species from different insect orders. The aim is to develop optimized lures and cost effective trap designs for mass trapping and to determine the optimum density and spatial and temporal patterns of deployment of the optimized traps for controlling these pests by mass trapping. The combination between an aggregation pheromone attracting *Anthonomus rubi* and raspberry flower volatile attracting *Byturus tomentosus* seems to be the best combination.

Keywords: raspberry, *Anthonomus rubi, Byturus tomentosus*, semiochemical trap.

RÉSUMÉ

L'anthonome des framboises (*Anthonomus rubi*) et le ver des framboises (*Byturus tomentosus*) causent de grosses pertes dans les cultures biologiques de framboises (10 - >80%) car il n'y a pas de méthodes satisfaisantes de contrôle pour ces deux ravageurs. Une nouvelle approche est testée pour contrôler simultanément ces deux ravageurs avec un piège commun. Le but est de développer des attractifs , de créer le design du piège, de trouver la composition optimale des attractifs, ainsi que la densité et la période optimale de piégage. Des essais de combinaisons de leurres entre une agrégation de phéromones et des volatiles de fleurs de fraisiers ou de framboisiers ont montré qu'une combinaison semblait plus efficace pour capturer ces deux insectes. Il s'agit de la combinaison entre une agrégation de phéromones attirant *Anthonomus rubi* et des volatiles de fleurs de framboisiers attirant *Byturus tomentosus*.

Mots-clés : framboises, *Anthonomus rubi, Byturus tomentosus*, piège sémio chimique.

INTRODUCTION

The strawberry blossom weevil called SBW (*Anthonomus rubi* Herbst) and the raspberry beetle called RB (*Byturus tomentosus* DeGeer) are two important pests in raspberries in northern and central Europe. They cause yield and quality damages up to 80 %. Damages are caused by *A. rubi* cutting the flower peduncle cut and by larval development in fruits for *B. tomentosus*. Presently, there are only chemical treatments to control the strawberry blossom weevil and a semiochemical trap has been developed to control the raspberry beetle (Birch et al, 2009; Baroffio *et al*, 2012). Alternative methods of control are required by growers, organic or not, and by consumers.

« Softpest Multitrap » is a EU FP7 Core Organic 2 project (2012-14) with the aim to develop in strawberry a common trap against *Lygus rugulipennis* and *Anthonomus rubi* and in raspberry a common trap against *Byturus tomentosus* and *Anthonomus rubi*. Experiments were done in six countries to find and to test a common semiochemical trap for both pests in each crop (Wibe *et al*, 2012).

The attractant for *A. rubi* is composed of the male aggregation pheromone and a plant volatile. The attractant for *B. tomentosus* is a raspberry flower volatile. Lure combination trials were performed in Switzerland and in Norway in raspberry to find the best combination. The Swiss results made in 2013 and 2014 are presented.

MATERIALS AND METHODS

The trials were conducted in 2013 and 2014 in Switzerland. The plots were located in Wallis, in the mountains (Table I)

Table I : Plot and crop description
(description des parcelles)

Year	Location	Altitude	Variety	Surface m^2	Plantation year	Mulching	Plantation density/m^2
2013	Nendaz, Valais	1000 m	Glen Ample, open field	1500	2006	Mypex	3
2014	Salins, Valais	750 m	Glen Ample, open field	3000	2004	No Mypex	3

The traps were green bucket traps with white cross-vanes and a bee excluder grid (Figure 1). Each trap had different lure combinations (Table II). Trapping was carried out from April to October 2013 and 2014. Captures were checked every week and lures changed every 4 – 8 weeks. The traps were filled with water containing Triton X-100 (10 ml Triton in 10 l water). All the traps were placed on the ground.

The attractant for *A. rubi* is composed of the male aggregation pheromone and a plant volatile (Aggregation pheromone is composed of 100 µl normal 1 :4 :1 blend of grandlure 1 : grandlure 2 : lavandulol and the plant volatile (PV2) is composed of 200 mg of strawberry flower volatile) (Innocenzi *et al*, 2001; Cross *et al*, 2006 a; Wibe *et al,* 2014). The attractant for *B. tomentosus* (RV) is composed of 2 g of raspberry flower volatile (Woodford *et al*, 2003; Birch *et al*, 2009).

Five replicates of each combination were randomly placed in the plots. The traps were placed with a distance of 10 m between them (Figure 2). The catches were counted and determined, and also sexed for *A. rubi*, every week. The *A. rubi* damages were counted, 20 inflorescences (cut buds) were controlled for each trap. Statistics were executed with the R software.

Figure 1 : Green bucket trap with white cross vanes
(modèle de piège avec des faces blanches)

Table II : Lure combination
(attractifs testés en combinaison)

2013	2014	Combination	Insect control	Year
1	2	Aggregation pheromone (Agg ph) + PV2 low (standard)	*A. rubi*	2013 2014
0	3	PV2low	*A. rubi*	2014
2	1	Raspberry volatile (RV)	*B. tomentosus*	2013 2014
3	5	RV + Agg ph + PV2 low	*A. rubi* *B. tomentosus*	2013 2014
4		RV + PV2	*A. rubi* *B. tomentosus*	2013
5	4	RV + Agg ph	*A. rubi* *B. tomentosus*	2013 2014
0	6	Aggregation pheromone (Agg ph) + PV2 high	*A. rubi* *B. tomentosus*	2014

Figure 2 : Pattern of the lure combination experiment in 2014
(Disposition des différentes combinaisons en 2014)

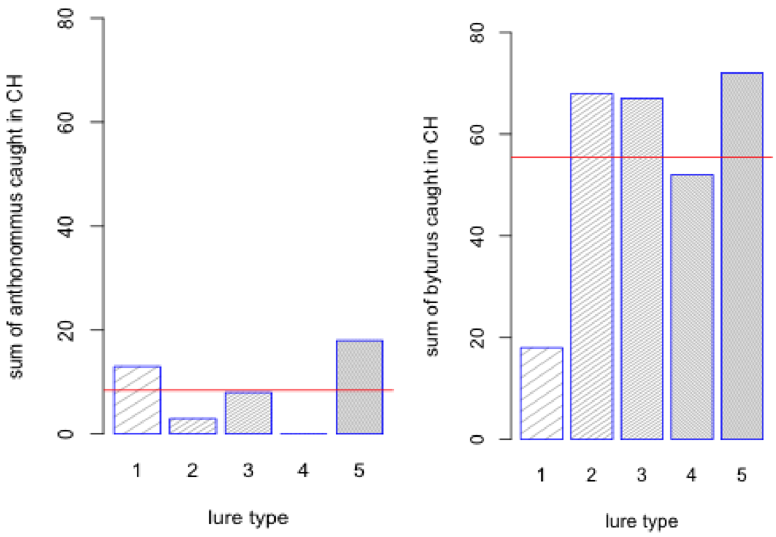
RESULTS

RESULTS 2013

Anthonomus rubi and *Byturus tomentosus*

In Switzerland the combination 5 (5 : raspberry volatile + aggregation pheromone) attracted more *A. rubi* than others lures. The lure 5 was significantly different from lures 2 and 4.This combination seemed to be more attractive for *B. tomentosus* but there was no significant difference between all the combinations.

Figure 3 : Lure comparison for *Anthonomus rubi* and *Byturus tomentosus* in 2013 (comparaison des attractifs sur les captures d'anthonome et de ver des framboises en 2013)



Number of *A. rubi* (left) and *B. tomentosus* (right) caught according to the lure combination in Switzerland in 2013

1 : standard A. rubi, 2 : raspberry volatile, 3 : raspberry volatile + standard *A. rubi*, 4 : raspberry volatile + PV2, 5 : raspberry volatile + aggregation pheromone

RESULTS 2014

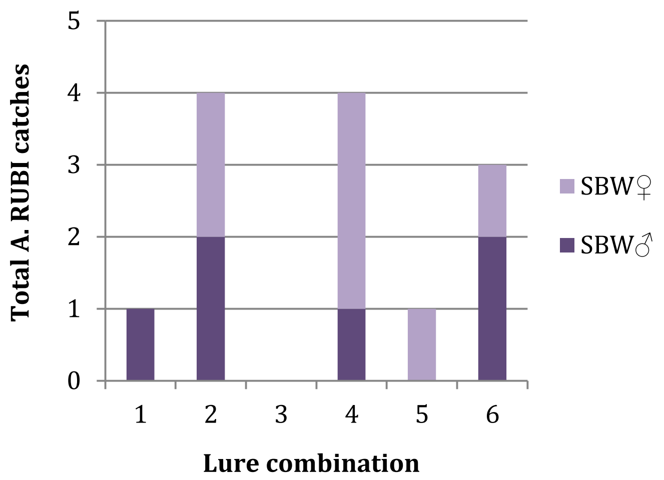
Based on the 2013 results, the combination 4 in 2013 (Raspberry volatile + PV2) which gave an insufficient result was removed from the 2014 trial. A new combination with low and high concentration of PV2 was tested in 2014 (5 low and 6 high) .

Anthonomus rubi

In 2014, the strawberry blossom weevil population level was very low. There were 6 males and 7 females caught, with no difference between the catches (Kruskal-Wallis, p-value = 0.78). Lures did not select more *A. rubi* males or females.

A. rubi catches are weak, there is maximum 4 insects caught by a lure combination (figure 4). Lure combination did not influence the number of catches for *A. rubi* (Kruskal-Wallis, p-value = 0.22). Combination 1 (1: Raspberry volatile) is the only which does not contain a *A. rubi* lure.

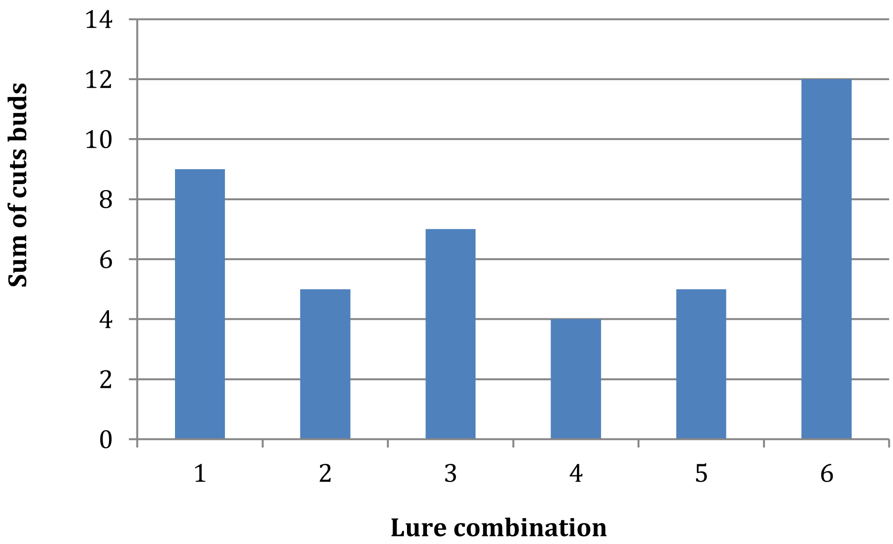
Figure 4 : Lure comparison for *Anthonomus rubi* males and females in 2014
(comparaison des attractifs sur les captures d'anthonome mâles et femelles en 2014)



1: Raspberry volatile, 2 : Standard *A. rubi*, 3 : PV2 low, 4 : Agg pheromone + Raspberry volatile, 5 : Standard *A. rubi* + Raspberry volatile, 6 : Agg pheromone + PV2 high + Raspberry volatile

The *A. rubi* damages (figure 5) were not influenced by the lure combination (Kruskal, p-value = 0.84). The combination 1 did not contain an *A. rubi* lure so it might have more damages than other combinations. But the more damages were reported for the combination 6 which was the only one with PV2 high. The minimal damages were for the combination between aggregation pheromone and raspberry volatile (it was the best combination in 2013).

Figure 5 : Damage assessment (cut buds) in 2014
(estimation des dégâts en nbre de boutons coupés en 2014)

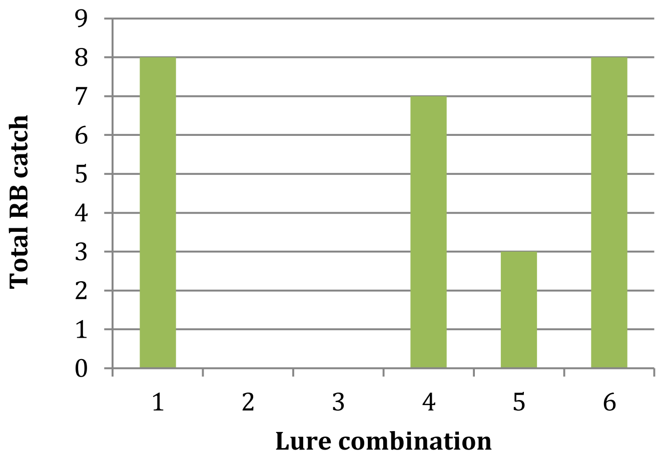


1: Raspberry volatile, 2 : Standard *A. rubi*, 3 : PV2 low, 4 : Agg pheromone + Raspberry volatile, 5 : Standard *A. rubi* + Raspberry volatile, 6 : Agg pheromone + PV2 high + Raspberry volatile

*Byturus tomentosus (*RB)

RB catches were influenced by the lure combination (Kruskal-Wallis, p-value = 0.0082) but when we compare each combination from one other, there was no significant difference (Pairwise, p-value minimum = 0.054). Combination 2 and 3 did not contain a RB lure so it is normal that there was no catches (figure 6). Other combination seemed to have a similar efficiency.

Figure 6 : Lure comparison for *Byturus tomentosus* in 2014
(comparaison des attractifs sur les captures de *Byturus tomentosus* en 2014)

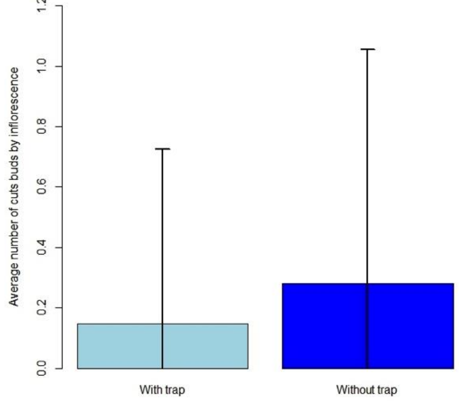


1: Raspberry volatile, 2 : Standard *A. rubi*, 3 : PV2 low, 4 : Agg pheromone + Raspberry volatile, 5 : Standard *A. rubi* + Raspberry volatile, 6 : Agg pheromone + PV2 high + Raspberry volatile

DISCUSSION

The Swiss results are similar to the Norwegian ones though the latter had a higher population. The results show the possibility to catch both pests in the same trap. The best combination for the maximum of catches are numbers 4 (Agg pheromone + Raspberry volatile) and 6 (Agg pheromone + PV2 high). The best combination to reduce the damage is number 4 (Agg pheromone + Raspberry volatile). When the plot with traps is compared to the control plot without any traps, there is a significant reduction of the damages in the plot with traps compared to the plot without traps (Figure 7).

Figure 7 : Damage assessment in 2014
(estimation des dégâts en 2014)



CONCLUSION

The common trap had to be put on the ground (results from a previous trial made in 2012 in the same project). Traps have to be put every 10 m on the plot. The best lure combination is, according to our results, a combination between aggregation pheromone of *A. rubi* and raspberry volatile which attracts *B. tomentosus*. The trap design must be optimized : there is an attraction from the lure but not enough catches in the trap compared to the visual observation. This innovative 3 year project gives a new direction for a biological control with semiochemical traps. There is still some research to be done to find the right trap model and the optimal trap concentration.

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