Anthonomus rubi (Strawberry blossom weevil): Covering as a control possibility in the late strawberry cultivar *Malwina* in the first year

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Abstract

Anthonomus rubi *is one of the key pests in organic strawberry production. The adult female is able to reduce the yield of strawberries up to 60% by cutting of the flower stalks after laying the eggs in the unopened flower buds. These damaged buds ceased to develop and either fall to the ground or remain dangling from the partially severed stalk.*

While strawberry cultivars with a higher number of flower buds tend to compensate these losses, cultivars with a smaller number of flower buds, like Malwina*, don't. So that the strawberry blossom weevil can cause severe yield losses and an economical disaster for the grower. One control possibility in the first year to reduce the amount of damaged flower buds is covering the plants with fleece or net. But as several one year field trials in 2010 and 2011 showed, a careful control management is necessary to reduce the damages and increase the yield amount of first class fruits significantly at the same time. Therefore one important key is the timing of covering the plants before the weevil enters the field. The other key is to provide a less stressful climate for the strawberry plants and developing fruits under covering conditions. Otherwise the yield of the first class fruits could be significantly negatively affected. Additionally the amount of the second class fruits could significantly increase as also the amount of the decomposed fruits.*

Keywords: *Anthonomus rubi*, strawberry, covering

Introduction

In organic strawberry cultivation *Anthonomus rubi* is one of the key pests by reducing the yield harvest up to 60% (Svensson, 2002). The adult weevil is brown-black, 3-3,5mm long (Höhn & Stäubli, 2010) and usually flies into the one year strawberry fields from nearby forest areas (Kovanci et *al*., 2005) when constant temperatures of 13°C-18°C are reached (Höhn & Stäubli, 2010). The major host plant of the weevil is the strawberry (*Fragaria*) but it also feeds on other *Rosacea* genera like raspberry and blackberry (Berglund et *al*., 2007).The damages are caused by the weevil by cutting the flower stalks after laying one egg into the unopened flower bud. After cutting the flower stalks, the buds either fall down to the ground or remain on the stalk and stay unopened. The whole development from egg to the adult weevil occurs in the unopened flower bud which is used for protection against predators, drying out through direct sunlight (Blümel, 1989) and as a food source (Höhn & Stäubli, 2010). To protect the strawberry fields in the first year from weevil damages regulation strategies with the covering types net and fleece has been observed.

Material and Methods

For the trial season in 2011 one strawberry field in Remshalden-Rohrbronn (wider area of Stuttgart, Germany) near by a forest area with strawberries in their first year after planting has been chosen for field trials.

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Malwina was chosen as strawberry cultivar because as former field trials over the last three years showed, Malwina starts to bloom when the female weevil is already present and seeking for strawberry buds. Furthermore Malwina it is one of the latest cultivars, highly tolerant against *Verticillium*-Wilt (*Verticillium dahliae*), Powdery mildew (*Erysiphe necator*) and Leather rot (*Phytophtora cactorum*) and therefore highly valuable for organic growers (Hinzmann, 2011). The net and fleece trials where built as a completely randomised block design with four replications over two single rows and 48 plants per variable, which were labelled with numbered tags. White net (Rantai Type S48, 0,8mm*0,8mm) in combination with flexible steel rods and white fleece (23g) where chosen for covering. For the fleece method three different cover dates where chosen in dependence on the weevil occurrence in areas which were a) more than two fields far away (F_{far}), b) nearby the trial area (F_{near}) and c) already present in the trial area ($F_{present}$). In F_{far} the plants were covered at the 12nd April, in F_{near} at the 21st April and in $F_{present}$ at the 29th April while the control stayed uncovered. At the 13th Mai the fleece was removed. For the net trial two variables of fixing the net edges to the ground where chosen. One variable was to fix the edges completely by digging the edges into the ground (N_{opt}) while the other was to fix the edges just randomly to the ground with soil (N_{easy}) while the control stayed uncovered. The strawberry plants of both variables were covered at the 21st April and uncovered at the 13th May. To evaluate the damages of the strawberry blossom weevil the ratings criteria “Destroyed flower buds” and “Yield” were performed (Table 1).

Table 1: Fleece & Net: Rating criteria “Destroyed flower buds [%]” and “Yield [g/48 plants]”, 2011.

Rating criteria	Counted data of amount of
Destroyed flower buds [%]	- destroyed flower buds, unopened flower buds, opened blossoms, early developed fruits
Yield [g/48 plants]	- first class fruits, second class fruits, unsalable fruits (fall)

In fleece the data rating in regards to the “Destroyed flower buds” were performed at the 9thJune and in net at the 14th June. In regards to the “Yield” the rating in fleece and net started on the same day the destroyed flower buds were counted and were performed at six further dates (Table 2).

Table 2: Fleece & Net: Dates of yield rating, 2011.

	Fleece	Net		Fleece	Net		Fleece	Net
1.	9th June	14th June	3.	17th June	21st June	5.	23rd June	27th June
2.	14th June	17th June	4.	21st June	23rd June	6.	27th June	30th June

Statistic analysis of data was made with R 2.13.1, The R Project for Statistical Computing.

Results

Fleece (F): The variable F_{far} showed significant less destroyed flower buds (7,9%) than the Control (30,9%), F_{near} (14,7%) and $F_{present}$ (20,6%). Furthermore the variables F_{near} and $F_{present}$ showed significant less destroyed flower buds than the Control (Figure 1, left). In regards to the yield of the first class fruits (class I) F_{near} showed significant more fruits (10.095g) than F_{far} (7.728g) and the Control (7.704g). The yield of the second class fruits (class II) showed in F_{far} significant more picked fruits (2.394g) than in the Control (925g) and $F_{present}$ (1.608g). Furthermore F_{near} showed significant more second class fruits than the Control. The unsalable fruits (fall) showed yield amounts between 506 in the Control and 960g in F_{far} but no significant differences (Figure 1, right).

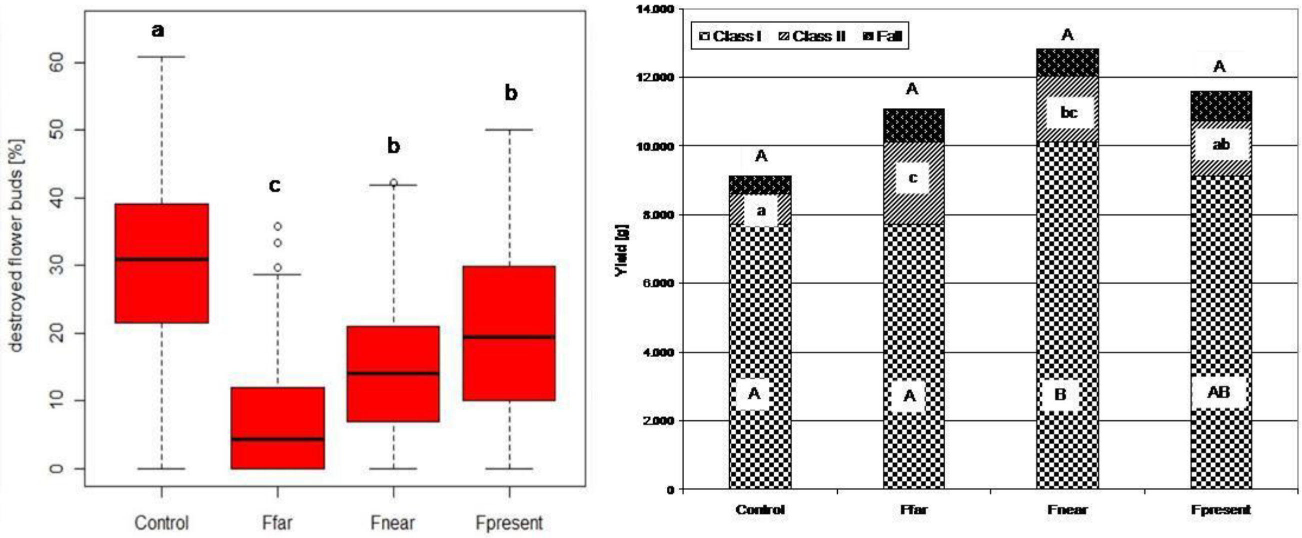

Figure 1: Fleece-Covering (2011) for F_{far} (12.4), F_{near} (21.4), $F_{present}$ (29.4) in the cultivar Malwina (n=48 plants/variable). Left: Destroyed flower buds [%] (pairwise CI, Harrell-Davis-Test, α=0,05). Right: Yield of first class fruits, class I (ANOVA, Tukey-Test, α=0,05), second class fruits, class II (ANOVA, Tukey-Test, α=0,05) and unsalable fruits, fall (pairwise CI, Hodges-Lehmann, α=0,05). Values with different letters differ significantly.

Net (N): N_{opt} showed significant less destroyed flower buds (21%) than the Control (32%) (Figure 2, left). The yield of the first class fruits (class I) showed yield amounts between 6.381g in N_{opt} and 8.056g in N_{easy} and no significant differences between the variables. The yield of the second class fruits (class II) showed in N_{opt} a significant higher yield amount (3.153g) than in the Control (2.292g). The yield of the unsalable fruits showed yield amounts between 800g in N_{easy} and 1.102g in the Control and no significant differences (Figure 2, right).

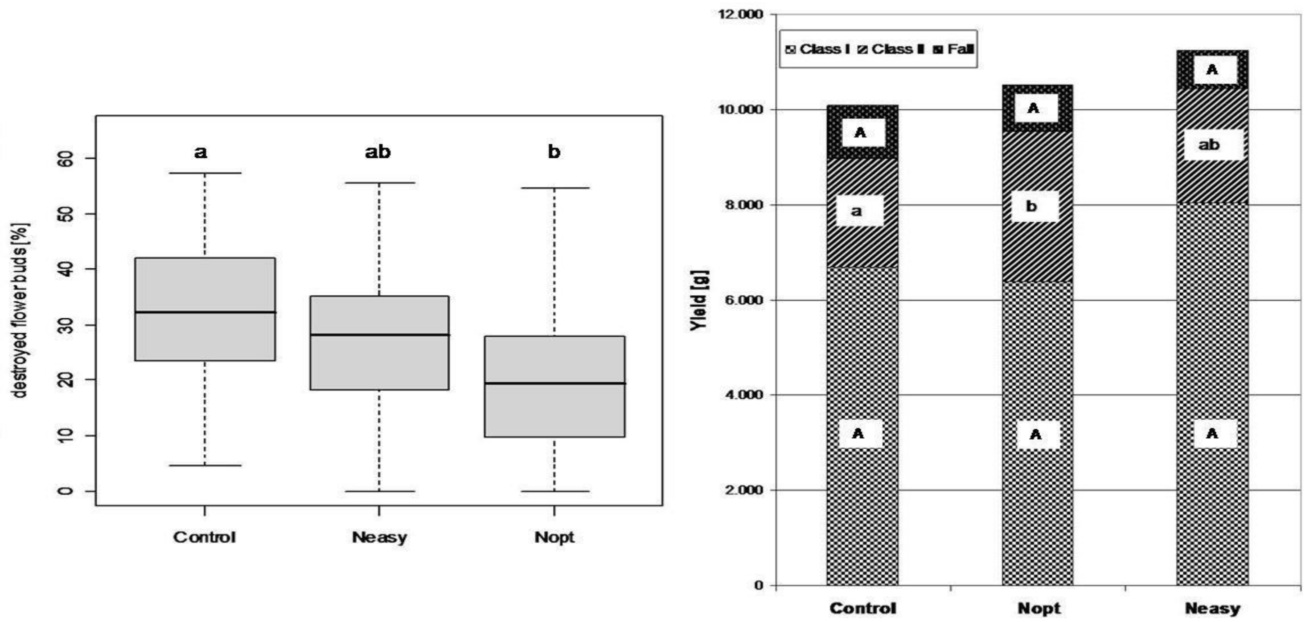

Figure 2: Net-Covering (2011) for N_{easy} and N_{opt} (21.4.2011) in the cultivar Malwina with n=48 plants/variable. Left: Destroyed flower buds [%] (ANOVA, Tukey-Test, α=0,05). Right: Yield of first class fruits, class I (ANOVA, Tukey-Test, α=0,05), second class fruits, class II (ANOVA, Tukey-Test, α=0,05) and unsalable fruits, fall (pairwise CI, Hodges-Lehmann, α=0,05). Values with different letters differ significantly.

Discussion

At the present time it is quite difficult to control the strawberry blossom weevil in organic farming. For plants in the first year covering is a possibility but the covering date itself is highly important to reduce the destroyed buds significantly in comparison to the control. The early covering date (F_{far}) in **Fleece** showed the significant lowest percentages of destroyed flowers buds compared to the control and the variables with coverings dates of nine (F_{near}) and seventeen days ($F_{present}$) later than F_{far}. But F_{far}, the supposed most effective variable, did not reflect it in the yield of the first class fruits, because F_{far} showed almost the same yield amount of first class fruits than the control. Furthermore F_{near} and $F_{present}$ showed also significant less destroyed flower buds than the control and in contrast F_{near} showed a significantly higher yield amount of first class fruits than the control and F_{far}. However F_{far} showed a significantly higher yield amount of the second class fruits than the control and $F_{present}$. Meanwhile F_{near} also showed significantly more second class fruits than the control. Even so the variables in **Net** where different compared to fleece they showed also that perfect covering as in N_{opt}, caused significantly less destroyed flower buds compared to the Control. But it showed also, that this effect did not reflect in the yield of first class fruits either. Therefore N_{opt} showed also a significantly higher yield of second class fruits compared to the control. Due to the fact that covering causes higher temperatures and a microclimate with higher humidity (Wilcox & Seem, 1994) the plants and fruits had to grow and develop mainly under stressful conditions. So that even if the blossom weevil attack can be significantly reduced by covering the climate stress still influences negatively the yield of the more valuable first class fruits. Svensson (2002) and Berglund et *al.* (2007) showed for different cultivars the same effects and furthermore that the amount of decomposed fruits could also increase. The results for the cultivar Malwina showed furthermore that a) less effective methods like N_{easy} and b) methods were the period of time for covering was shorter, like F_{near} and $F_{present}$, can cause significantly higher yield amounts for first class fruits. More research has to be done with other types of covering to reduce the climate stress in combination with a monitoring method to optimize the period of covering.

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