Organic control of oilseed rape pests through natural pesticides and mixed cultivation with turnip rape

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Abstract

*A mixed cropping system of rapeseed and 10 % turnip rape as trap crop was compared with oilseed rape in pure stand to demonstrate the reduction of infestation by insect pests. Furthermore the application of bio-pesticides like pyrethrum/rape oil (Spruzit® Neu), spinosad (SpinTor), diatomeen earth (SiO_2) /sunflower-oil and rock powder/water was tested. Oilseed rape showed a higher infestation by stem weevils (*Ceutorhynchus *spp.) in the mixed cropping system compared to rapeseed in pure stand. The reduction of the pollen beetle (*Meligethes aeneus*) on the rapeseed buds resulted from higher attractiveness of turnip rape as a consequence of advanced growth. The faster development of turnip rape seems to be the important key of successful pollen beetle regulation. The application of pyrethrum and spinosad against* Ceutorhynchus *spp. had no effect, spinosad was the only agent that caused a reduction of the pollen beetle.*

Introduction

In organic oilseed rape cultivation, insect pests frequently cause substantial yield losses because effective organic strategies to control them are lacking. Consequently, the amount of organic oilseed rape planted in Germany is relatively small (only 2300 ha in 2008) and insufficient to meet the increasing demand for this crop. At the end of 2008, a three-year research project funded by the Federal Organic Farming Programme was launched to address this problem. The tests are being conducted at an EU-certified organic farming site (Control No. D-ST-043-48291) operated by the Julius Kühn Institute in Dahnsdorf, Germany. It has sandy loess (sL) soil, a soil quality index of 48, and a mean annual precipitation of 587 mm. The aim is to determine the pest-reducing potential of mixed cultivation of oilseed rape with turnip rape (t. rape) compared to cultivation of oilseed rape alone and to assess the efficacy of different natural pesticides. Stem weevils (*Ceutorhynchus* spp.) and pollen beetles (*Meligethes aeneus*) are the main target organisms studied.

Materials and methods

Studies were conducted at two test fields in 2009 and 2010. Monocultures of oilseed rape (OR -varieties Oase in 2009 and Robust in 2010) and mixed cultures of OR (varieties Oase in 2009 and Robust in 2010) with 10% turnip rape (TR - Largo 00-quality) were laid out for four replications (sowing rate: 70 seeds/m²). Each replication was divided into four subplots of 34×25 m (monocultures) and 26×25 m (mixed

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cultures), respectively (Table 1). The date of treatment was determined based on the pesticide application thresholds recommended for integrated pest management, i.e., the time of peak occurrence (yellow traps). The efficacy of stem weevil (SW) control was determined by measuring infestation densities on 20 OR and TR plants randomly selected from the middle of each plot. The main stem was cut open and the larvae were counted and taxonomically identified under a microscope. The efficacy of pollen beetle (PB) control was determined by counting the number of beetles on 50 OR and TR plants (10 TR plants in 2009) randomly selected from the middle of each plot. Counts were conducted from the beginning of the flight period to the beginning of flowering. The plants were harvested with a plot combine on 21 July 2009 and on 30 July 2010.

Table 1: Efficacy of biopesticide treatment on stem weevil (SW; Ceutorhynchus spp.) and pollen beetle (PB; Meligethes aeneus) infestation. Active ingredient (a.i.): pyrethrum 4.59 g/l, spinosad 480 g/l (BBCH = standardised description of plant development stages)

2009	BBCH	2010	BBCH	target pest
(1) untreated control	-	(1) untreated control	-	-
(2) 8 l ha^{-1} pyrethrum	50–51	(2) 0.2 l ha^{-1} spinosad	19–20	SW
(3) 8 l ha^{-1} pyrethrum 0.2 l ha^{-1} spinosad	50–51 57	(3) 0.2 l ha^{-1} spinosad 0.2 l ha^{-1} spinosad	19–20 53–59	SW PB
(4) 8 l ha^{-1} pyrethrum 12 kg ha^{-1} diatomeen earth & 12 l ha^{-1} sunflower-oil	50–51 57	(4) 0.2 l ha^{-1} spinosad 12 kg ha^{-1} rock powder	19–20 53–59	SW PB

Results

In 2009, stem weevil infestation rates in turnip rape were up to 5 times higher than those in oilseed rape (Oase) in mixed cultures (Figure 1). Nonetheless, this did not result in the anticipated diversion of pests from oilseed rape. In fact, stem weevil infestation in oilseed rape in mixed cultures was worse than in monocultures. Significant differences were not detected due to the high degree of scatter. In 2010, infestation rates for TR and OR ("Robust") in mixed cultures were approximately equal and, as in 2009, the rate of stem weevil infestation in oilseed rape was higher in mixed cultures than in monocultures. The difference was statistically significant in 3 out of 4 variants. The biopesticide used in 2009 (pyrethrum) did not achieve a significant reduction of infestation and, in some cases, more stem weevils were found in the plots where it was used. The same applies to the product used in 2010 (spinosad). In mixed cultures in 2009, infestation levels with pollen beetles in turnip rape were higher than those in oilseed rape, particularly in the early bud stage. Although this effect decreased with increasing development, it remained significant in most cases. Preferential infestation of TR did not result in a decrease in OR infestation in mixed cultures compared to monocultures. No phenological advance in TR versus the OR variety "Oase" " was observed.

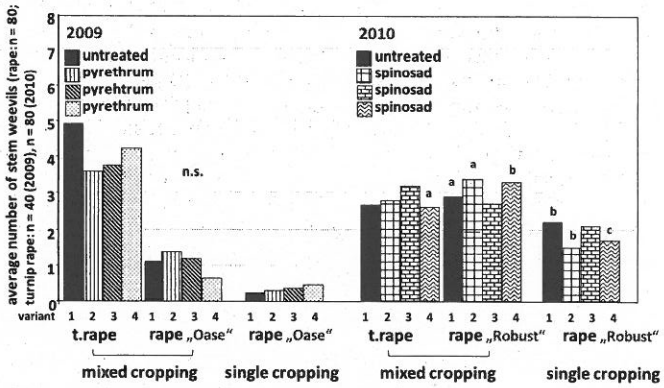

Figure 1: Effects of the four treatment variants on stem weevil infestation.

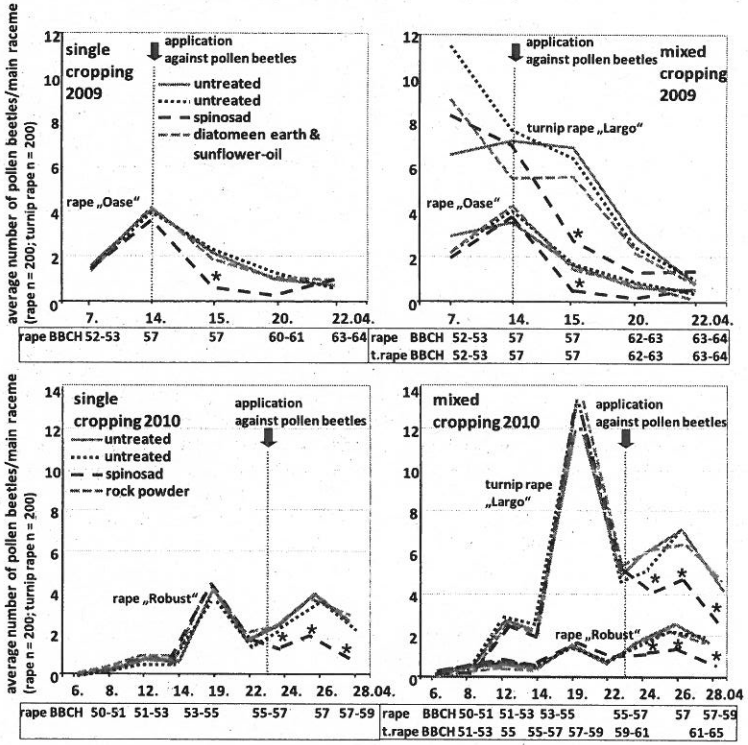

Figure 2: Pollen beetle (*Meligethes aeneus*) infestation over time as a function of treatment variant; * = significant for α = 5 % Wilcoxon test.

In 2010, pollen beetles displayed a significant preference for TR over OR ("Robust") in mixed cultures. At times, the difference was greater than a factor of ten. Consequently, PB infestation levels on oilseed rape in mixed cultures were significantly lower than those in monocultures. Moreover, a distinct phenological advance of turnip rape was clearly detectable in 2010. Regarding the biocontrol agents used in 2009, spinosad resulted in a distinct—in some cases significant—reduction of PB infestation, and diatomeen earth plus sunflower oil (SO) exhibited a tendency towards PB reduction. Efficacy for up to 6 days after treatment (Abbott's formula) was ≤ 78% for spinosad and +21 % to -33 % for diatomeen earth + SO. In 2010, spinosad again achieved a distinct and significant reduction of PB infestation, whereas rock powder did not. Efficacy for up to 6 days after treatment was ≤ 68 % for spinosad and +8 % to -19 % for rock powder.

Discussion

Stem weevil infestation in oilseed rape was higher in mixed cultures than in monocultures in both years studied, which is in line with the findings of other studies (Strauch 2009, Büchs & Katzur 2004). The preferential infestation of turnip rape by pollen beetles only has an infestation-reducing effect on oilseed rape when the phenology of turnip rape is advanced by several days relative to that of oilseed rape, as was observed in the two-year comparison. Neither pyrethrum nor spinosad was effective in reducing stem weevil infestation. Only spinosad achieved successful pollen beetle control with an efficacy distinctly higher than 70%, which is comparable to that of the corresponding conventional pesticides. The other products tested—rock powder and deatomeen earth + sunflower oil—had no infestation-reducing effect. No repellent effect was detected based on analysis of the extent of damage (number of blind stalks in podless stalks). This may be because the concentration (12 kg ha^{-1}) was too low. Doses of 25 kg/ha produced distinct effects in Switzerland (Breitenmoser, 2008).

Conclusions

Based on these preliminary results, mixed cultivation of oilseed rape with turnip rape cannot be recommended as a method of oilseed rape pest control. Even if this had an infestation-reducing effect on pollen beetles, it would be negated by increased stem weevil infestation which would be problematic because, currently, there is no selective treatment for the control of stem weevils. The pollen beetle treatments studied either resulted in no yield benefits or in yield benefits that were too small to compensate for the costs of treatment. Our recommendation for agricultural practice is continue to use an early-flowering oilseed rape variety and to ensure optimal crop management (weed control and fertilization) in order to fully exploit the enormous compensation potential of oilseed rape crops.

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Should the publication of corrigenda become necessary, these will be posted at the conference homepage http://www.isofar.org/kowc2011

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