Control methods against bugs (Hemiptera; Heteroptera) in organic apple and pear production

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Abstract

True bugs (Hemiptera; Heteroptera) are important pests in fruit production in Norway. In organic fruit production they may damage up to 40% of the crop. Several of the Heteropteran species attacking apple and pear are polyphagous, with many other hostplants than pome fruit. In organic production few control methods are available against bugs. In this study we have tried a cultural control method (mowing of groundcover) as well as spray applications of various biological insecticides against bugs. Spray application of azadirachtin (NeemAzal), rape oil and garlic extract (Ecoguard) were tested. Results indicate that the effect of mowing groundcover inside the orchard is variable and small. Applying NeemAzal reduced the number of bugs and damage. Oil and Ecoguard showed little effect in this study, however further testing is needed. Results from the first two years of the study will be discussed in relation to both cultural and direct control methods against bugs.

Keywords: bugs, Heteroptera, cultural control, biopesticides, NeemAzal,

Introduction

True bugs (Hemiptera; Heteroptera) are important pests in apple and pear production in Norway. In organic fruit production up to 40% of the crop may be damaged (Røen et al., 2003). Heteropteran nymphs sting shoot tips, flower buds and fruit resulting in deformation and stony pits in the fruit. The most important bug pests in fruit are *Lygocoris pabulinus*, *Plesiocoris rugicollis*, *Orthotylis marginalis*, *Plagiognathus arbustorum* and *Acanthosoma haemorrhoidale* (Hesjedal, 1989). Most bugs attacking apples and pears are polyphagous, with many other host plants than pome fruit (Coulianos, 1998; Hesjedal, 1985). Some species, as *Psallus ambiguous*, *Plagiognathus arbustorum* and *Orthotylis marginalis*, feed on both plant juice and other insects and mite (Hesjedal, 1989). Several strategies are available against insect pests in organic fruit production. Biological and cultural control methods may suppress pests directly or via the action of their natural enemies (Mills and Daane, 2005). Groundcover and mowing systems in the orchard may increase the number of natural enemies (Horton et al., 2003; Rieux et al., 1999), however it may also increase the number of pests as more host plants are available (Hesjedal and Vangdal, 1986). Several natural and biological toxins are effective in reducing the number and damage of pests (Godfrey et al., 2005). Both azadirachtin and vegetable oil has shown to be effective against several pests (von Elling et al., 2002; Gajmer et al., 2002; Pless et al., 1995). Garlic extract (Ecoguard®) is a relatively new biological pesticide wich may have an effect on bugs.

The objective of this study was to evaluate 1) the effect mowing in the orchard on damage by bugs, and 2) the effect of different biological pesticides on damage by bugs.

Material and Methods

Mowing experiment

The effect of mowing was evaluated by comparing three different treatments with respect to damage by and population size of different bugs. The experiment was done in three pear orchards in Western Norway. The groundcover vegetation was either not mowed (0), mowed twice (2) or

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mowed five times (5) during the season 2004 and 2005. A randomized block design with three replications was used in each orchard, resulting in 9 plots per orchard. Distance between trees varied from 2.5 m x 5.0 m to 4.0 m x 6 m. Each plot covered at least 180 m^2. The arthropod assemblage in the tree canopy was sampled using a beating tray. A limb was rapped sharply three times on each branch. Twenty branches per plot were sampled three to five times during the season. Insects and spiders in the ground cover was evaluated by sweeping (four sweeps in each plot) twice during the season 2005 (method described by Horton et al., 2003). Arthoropods were identified and counted. Damage on pears was recorded at harvest by picking 100 pears from 4 trees in the middle of each plot. Bug damage on fruit was categorized as early (small stony pits made by capsids) and late (flat stony pits made by shield bugs) damage.

Trial with biological insecticides

Rape oil, NeemAzal (azadirachtin) and Ecoguard (garlic extract) were compared for their effect against bugs in an organic apple orchard in South-Eastern Norway. A randomized block design with four treatments and five replicates was used in 2004, and with six treatments and four replicates in 2005. In each plot 3 trees were used, with two boundary trees between each plot. Distance between trees were 1.5 x 4.5 m, tree height was 2.5-3.0 m. Treatments are shown in table 1. Effect of treatment was measured as damage on apples at harvest and populations size of different heteropteran species four to seven days after last spray application. 100 apples from each plot were controlled for damage. Population size was recorded by beating tray samples; the limb was rapped sharply 3 times on each of 3 branches per tree (9 branches per plot). Arthropods were identified and counted.

Table 1. Treatments, dose and application date of biological insecticides in 2004 and 2005.

treatment	dose	Application date 2004	Application date 2005
control	-	-	-
Rape oil	4 l/100 l	Half-inch green (56 BBCH)	-
Rape oil	3 l /100 l	-	Ballon (59/60 BBCH)
NeemAzal	500 ml/100 l	Blossom (67 BBCH)	Blossom (67 BBCH)
NeemAzal x 2	500 ml/100 l	Blossom (67 BBCH) + after blossom (69 BBCH)	Blossom (67 BBCH) + after blossom (69 BBCH)
NeemAzal x 2	300 ml/100 l	-	Blossom (67 BBCH) + after blossom (69 BBCH)
Ecoguard	2 l/100 l	-	After blossom (71 BBCH)

Results

Mowing groundcover vegetation

Results varied between orchards and years (table 2). Generally early damage (by capsids) on pears was low, whereas late damage was rather high. Few differences between treatments were found, and it appears to be no consistent trend in how mowing frequency affect damage. No effect of mowing was found on the number of bugs and beneficial insects and spiders in the canopy (data not presented). In the groundcover vegetation number of beneficial insects in un mowed plots were significantly higher compared to plots mowed five times (data not presented). A difference in the composition of the fauna in the ground cover and the canopy was found. Eight heteropteran species were found in the canopy and nine species in the ground cover, only four species were found in both habitats (*Anthocoris nemorum*, *Plagiognathus arbustorum*, *Blepharidopterus angulatis* and *Acanthosoma haemorrhoidale*). Of these four species two species are zoophagous, one is zoophytophagous and one is phytophagous.

Table 2. Average number of damaged pears with different treatments of ground cover in 2004 and 2005. Treatments are: no mowing (0), mowed twice during the season (2) and mowed five times during the season (5). N = 25

pears pr tree (100 pears per plot). Numbers with different letters are significantly different within field, type of damage and year (one-way Anova and tukey's test, $p < 0.05$).

		2004		2005	
field	treatment	Early damage	Late damage	Early damage	Late damage
1	0	0.67 ± 1.2 a	8.08 ± 4.8 a	2.42 ± 2.5 a	7.9 ± 4.3 a
	2	0.91 ± 1.1 a	5.42 ± 3.2 a	2.17 ± 2.2 a	4.08 ± 2.7 b
	5	0.92 ± 1.8 a	4.91 ± 2.4 a	1.33 ± 1.2 a	3.83 ± 2.2 b
2	0	0.08 ± 0.3 a	5.00 ± 1.9 b	4.67 ± 4.5 a*	14.33 ± 2.1 a*
	2	0.42 ± 0.7 a	8.25 ± 2.8 a	3.33 ± 3.1 a*	10.33 ± 5.8 a*
	5	0.33 ± 0.5 a	7.78 ± 3.3 a	3.00 ± 2.6 a*	11.33 ± 4.0 a*
3	0	1.42 ± 1.1 a	2.75 ± 2.5 a	0.33 ± 0.5 a	3.5 ± 2.3 a
	2	0.67 ± 0.8 ab	2.67 ± 2.1 a	0.67 ± 0.7 a	5.0 ± 1.9 a
	5	0.25 ± 0.5 b	3.67 ± 2.4 a	0.42 ± 0.7 a	4.75 ± 3.1 a

* numbers are the average of 3 plots with 100 pears pr plot.

Effect of biological insecticides

Untreated trees had significantly more damaged apples compared to NeemAzal treated trees in 2004 (fig 1). No difference in damage between untreated and rape oil treated trees were found. In 2005 no significant differences were found (fig 2); this may be due to high variability in control plots.

There was a difference in number of harmful bugs (phytophagous and zoophytophagous) between treatments both in 2004 and 2005 (data not presented), however there were no difference in number of beneficial insects between treatments (data not presented).

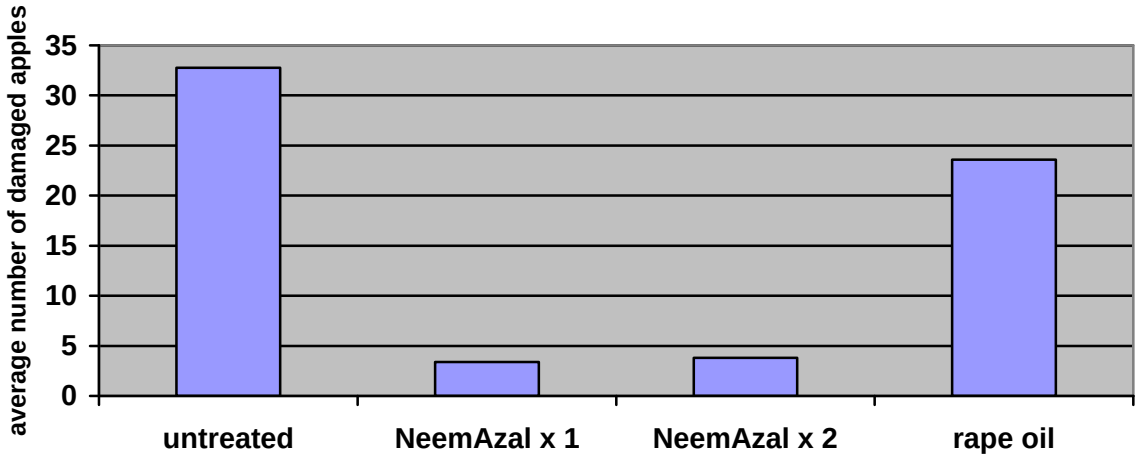

Figure 1. Average number of damaged apples per plot (100 apples) (n = 5) in 2004. Treatments are: untreated [a], NeemAzal (500 ml/100 l) x1[b], NeemAzal (500 ml/100 l) x 2[b] and rape oil (4 l/100 l)[a]. Different letters indicate significant differences between treatments (two-way Anova; treatment: df = 3, F = 18.32, p = 0.0001; block: df = 4, F = 1.64, p = 0.23).

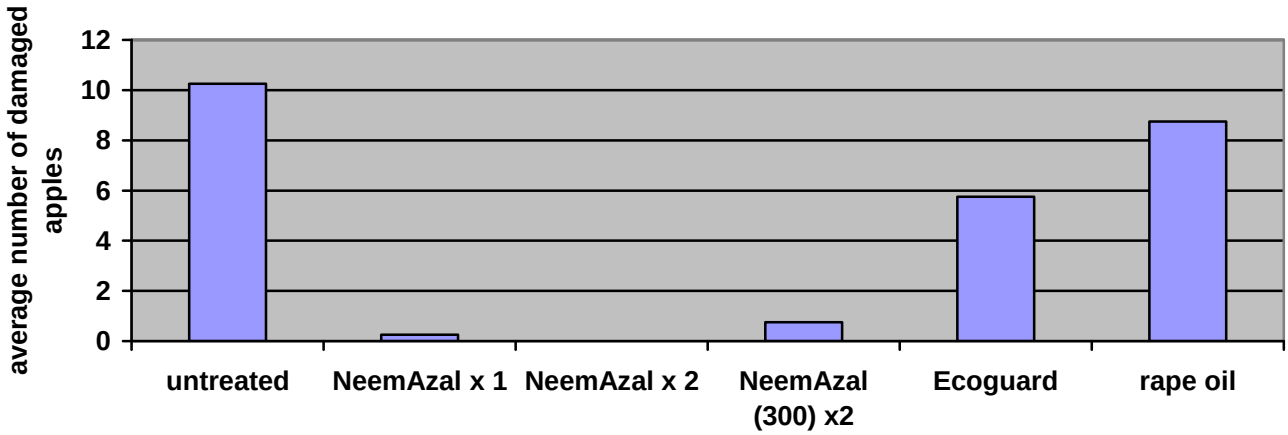

Figure 2. Average number of damaged apples per plot (100 apples) (n = 5). Treatments are: untreated[a], NeemAzal (500 ml/100 l) x1[a], NeemAzal (500 ml/100 l) x 2[a]; NeemAzal (300 ml/100 l) x 2[a], Ecoguard (2 l/100 l)[a] and rape oil (3 l/100 l)[a]. Different letters indicate significant differences between treatments (two-way Anova; treatment: df = 5, F = 1.23, p = 0.35; block: df = 3, F = 0.60, p = 0.62).

Discussion

Our results indicate that mowing groundcover vegetation in pear orchards does not affect fruit damage by true bugs, at least not at a scale that is agronomically interesting. A large variation in damage was found between fields and years. Mowing seemed to decrease the number of beneficial arthropods in the groundcover vegetation. However, sampling by sweepnet in plots mowed five times was difficult due to low vegetation. Direct comparisons of population sizes between ground cover and tree canopy is not possible as different sampling methods were used (sweepnet and beating tray). However, few species of phytophagous bugs were present in both the canopy and the ground cover indicating a low degree of movement between these two habitats. Hesjedal and Vangdal (1986) found that bug damage on pears was smaller in orchards where ground cover was mowed several times during the season. However, they did not compared treatments within the same orchard. In a study on the role of ground cover management on arthropod populations in pear orchards Rieux et la. (1999) found that the arthropod assemblages collected on pear trees from bare ground, natural grass cover and sown ground cover differed. Less beneficial arthropods were found in trees from bare ground. However, there was no replication within the orchard and only one pear orchard was studied.

Rape oil treatment did not affect damage on apples by bugs in this study. Plant oil has earlier proved to be effective against insect eggs by prohibiting/reducing hatching (Pless et al., 1995). It might be that eggs from true bugs are to poorly exposed for oil treatment to work as they are laid in shoots with only a small part being visible. Another explanation is that treatment with oil was to early in relation to hatching of eggs. Treatment with NeemAzal was effective against bug damage on apples. In 2005 both one and two treatments with 500 ml/100 l and two treatments with 300 ml/100 l indicated good effect. Two plots differed in number of bugs and damage in 2005, resulting in lack of significant differences between treatments. In this study Ecoguard had no significant effect against damage. However, trials at different spraying times and concentrations will be carried out.

In conclusion this study indicate that mowing the under cover has little effect on damage by true bugs in pears. Rape oil is probably not effective against bug eggs, however Neem Azal is a promising biological pesticide against true bugs in apples.

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