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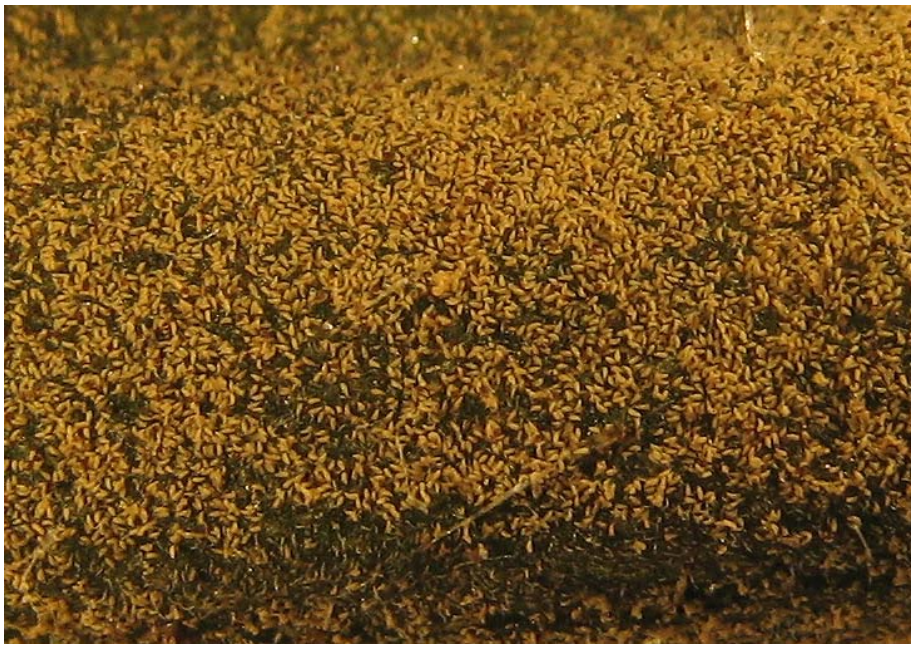
'THE EFFECT OF CARBON KICK BOOSTER ON SOME PHYTOPHAGOUS MITE SPECIES'

Final Report of experiments



Gall mites (Eriophyidae) on tomato (Photo: T. Tuovinen)

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THE EFFECT OF CARBON KICK BOOSTER ON SOME PHYTOPHAGOUS MITE SPECIES

Summary

The effect of Carbon Kick Booster (CKB) on the raspberry leaf and gall mite (*Phyllocoptes gracilis*) and the apple rust mite (*Phyllocoptes schlechtendali*) was studied in laboratory. A field test for observation of possible injury effect of sprayings was arranged on raspberry and a field experiment on apple.

In the laboratory, 2.0% CBK solution sprayed on the underneath side of the leaves caused 60-90% higher mortality of the raspberry leaf and bud mite than mere water in 3-6 days. When the silicon-based adjuvant Silwet Gold (0.05%) was added in the spraying solution the effect was over 90%.

In the field experiment on raspberry, 5.0% ja 10.0% CKB caused brown lesions in the leaves of young shoots. The maximum damaged area was ca. 20% of the leaf area. Later in the season the sprayings of CBK was observed to increase the length of the shoots compared to untreated plants.

CKB 2.0% caused 95-100% higher mortality compared to water control in 3-6 days. Silwet Gold adjuvant added in the solution did not improve mortality.

In the field experiment, the effect of 2.0% CKB and 0.05% Silwet Gold (0.05%) solution on apple rust mite was non-uniform depending on the apple cultivar. In three cultivars CBK+Silwet Gold caused over 90% higher mortality compared to the untreated trees whereas in two cultivars no significant effect was noticed. Besides, the spraying had a significant effect on red spider mite (*Panonychus ulmi*).

As a conclusion, CBK had a significant control effect on the studied free-living gall mite species. In the laboratory, a single treatment had a clear killing effect on mites. In open field, weather factors like low temperature and rain can have an effect on the final control result. The conceivable effect on other pest insects and mites supports the proposal for further field tests in open field.

INTRODUCTION

Carbon Kick Booster (later CKB) includes according to the manufacturer's specification triacontanol $C_{30}H_{62}O$, turnip rape seed oil 90% and emulsifiers 10%. CKB has been used as an accelerator of ethanol based C-fertilizers, as 0.5-2.0% water solutions. CKB has been noticed to have some plant protection effects, e.g. on powdery mildew and spider mites when sprayed in greenhouses. CKB has been recently approved as a plant protection preparation for powdery mildew and two-spotted spider mite in greenhouses and home gardens (Evira, 18.10.2007). A report on the effect of CKB on two-spotted spider mites and several natural enemies used as biological control agents in greenhouses has been published (Simula, 2005). The effect of CKB on gall mites (Acari: Eriophyidae) has not been studied earlier.

This report concerns the experiments arranged in 2007 at MTT Agrifood Research Finland on the possible effect of CKB and a mixture of CKB and a silicon based surfactant Silwet Gold (later SG) on raspberry the leaf and bud mite (*Phyllocoptes gracilis*) and the apple rust mite (*Aculus schlechtendali*). At the same time observations of the effect of the sprayings on the fruit tree red spider mite (*Panonychus ulmi*) were done. The experiments were performed in the laboratory, except two field tests, one on the injury effect of CKB+SG and the other on apple.

EXPERIMENTAL PROTOCOLS

Raspberry

1. Experiment

Aim:
The aim of the 1st experiment was to find out the possible effect of CKB on the raspberry leaf and bud mite.

Trial place and time:
MTT, Plant Protection Laboratory, Jokioinen.
The first test A: treatments 10.7.2007 and inspections 11.7., 13.7., and 16.7.
The second test B: treatments 23.7.2007 and inspections 24.7., 26.7., and 30.7.

Treatments, two test series:
1. Carbon Kick Booster, 2.0%
2. Carbon Kick Booster 2.0% + Silwet Gold 0.05%
3. Silwet Gold surfactant 0.05%
4. Untreated (water treatment)

Materials and methods:
Raspberry leaf and bud mites:
Test materials included leaflets of raspberry, one leaflet per replicate, 4 replicates/treatment. Leaves were inspected under a binocular before treatments and only leaves with tens of mites were accepted for tests. Leaflets were placed upside down in a laboratory spraying equipment (Potter Tower), using the equivalent of 30 ml/m^2 leaf area (1st test) and 60 ml/m^2 (2nd test). Converted to one ha of sprayed area the amounts correspond to sprayings of 300 and 600 l/ha. After the sprayings the leaflets were left to dry for 1-2 hours and then placed in Petri dishes on moist towel papers. Petri dishes were kept in normal room temperature and daylight (L/D ca 18/6).

Inspections:
The first inspection was done one day after the treatment. Leaflets were inspected under a binocular and the numbers of moving and immobile mites were separated and counted. As the gall mites have a short immobile nymph stage the inspections were repeated after 3 and 6 or 7 days to ensure which mites were still living. One treatment (SG) was rejected in the last inspection because of drying of the leaflets. Statistical analyses were done using ANOVA and Tukey's test (P=0.05).

Results:
In the laboratory test A the numbers of moving mites were significantly lower in the first inspection (1 day) in treatments 2) CKB+SG and 3) SG than in untreated control or treatment 1) CKB. After three days, all three treatments were significantly different from untreated control and the effects compared to control were 1) CKB 58%, 2) CKB+SG 83% ja 3) SG 69%. There were no significant differences between the numbers of mobile mites in the treated leaflets (Fig. 1). In the last inspection, the treatments 1) CBK ja 2) CKB+SG were significantly different from untreated but not from each other.

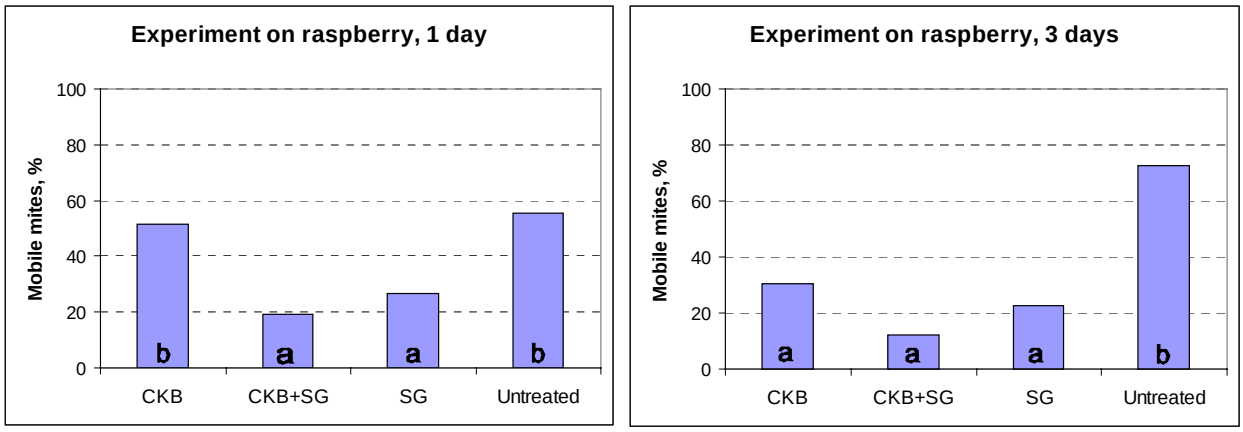

Figure 1. Laboratory test A. Effect of CKB 2.0%, CKB 2.0% + SG 0.05% and SG 0.05% treatments on the proportion of mobile gall mites (%) on raspberry leaves 1 ja 3 days after the treatments. Different letters in columns show significant differences between treatments (P=0.05).

In the laboratory test B a double dose with the same concentration as in test A was used. The effect was better and faster than in test A. Three days after treatments the number of mobile mites in all treated leaves was less than 5% of those in the untreated control (Fig. 2).

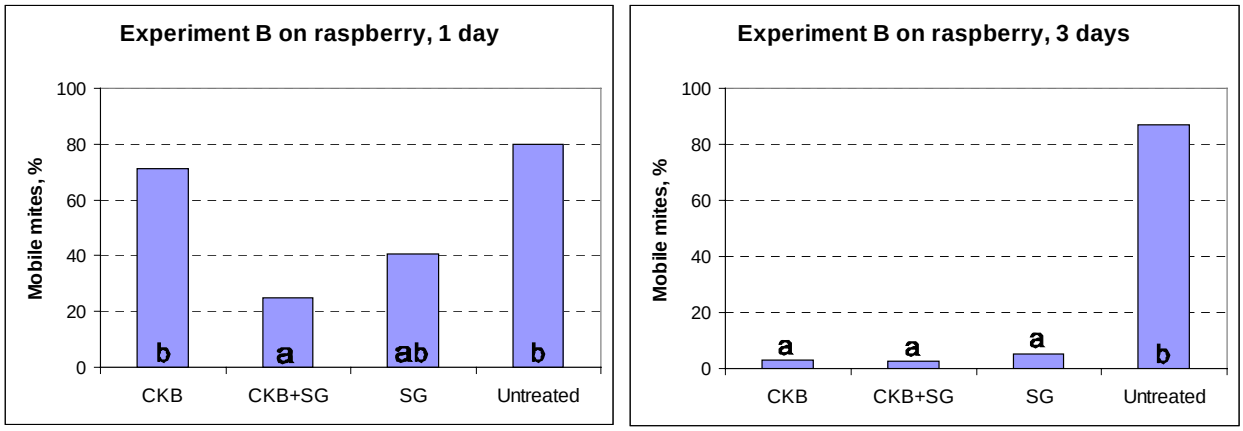

Figure 2. Laboratory test B. Effect of CKB 2.0%, CKB 2.0% + SG 0.05% and SG 0.05% **double dose** treatments on the proportion of mobile gall mites (%) on raspberry leaves 1 ja 3 days after the treatments. Different letters in columns show significant differences between treatments (P=0.05).

These results confirmed that all treatments, CKB, CKB+SG and SG had significant effect on the number of mobile raspberry leaf and bud mite in the laboratory. One treatment led to 58-97% mortality in three days (interpreted as the proportion of immobile mites). Addition of the surfactant SG did not increase the final effect of CKB but accelerated it significantly. The mere SG treatment was not as effective as CKB or the mixture CKB+SG. The duplication of the doses increased the efficacy of all treatments to over 90%. In practical conditions it is important to spray using volumes which guarantee that all leaves will be wet on both sides. Field tests are recommended to confirm these results also in practice.

2. Experiment

Aim:
To find out if high doses of CKB cause injuries or malfunctions on raspberry.

Trial place and time:
MTT, Plant Protection, Jokioinen.
Treatments were made 6.6.2007, inspections 13.6. 20.6. and 17.7.

Treatments:
1. Carbon Kick Booster, 10.0% + Silwet Gold 0.05%
2. Carbon Kick Booster 5.0%
3. Untreated

Materials and methods:
The treatments were made in randomized plots consisting of 4 m of a raspberry row. Sprayings were performed so that all leaves were wetted on both sides. At the treatment the raspberry shoots were 5-30 cm high. Weather conditions during the treatment: sunny weather, +26 ^{o}C, RH 27%, calm.

Visual inspections for injuries in leaves were made one and two weeks after treatments. The lengths of the shoots were measured six weeks after the treatments.

Results:
In visual inspections brown patches were noticed in part of the treated leaves one and two weeks after treatments. The maximum injury in single leaves was estimated ca. 20% of the leaf area and in total leaf area the injuries were estimated 1-2%. (cf. Figs. 1-2).

The number of shoots per plot varied 17-34 (over 30 cm long shoots). The length of the shoots was not affected by treatments when all shoots, including those developed after the treatments, were analysed. When the analyses were made separately for the 10 longest shoots of each plot, the shoots were significantly longer, 12% in CKB 5% and 19.7% in CKB10% + SG 0.1% treatments than in the untreated control plots (Kruskal-Wallis, P=0.05).

The results showed that the injuries caused by high volume high concentration CKB (and SG) did not cause severe injuries in raspberry shoots. On the contrary, the treatments accelerated the growth of the shoots ca. 10-20%.

Figure 3. Raspberry leaves one week (left) and two weeks (right) after the treatments by CKB 10% + SG 0.1%.

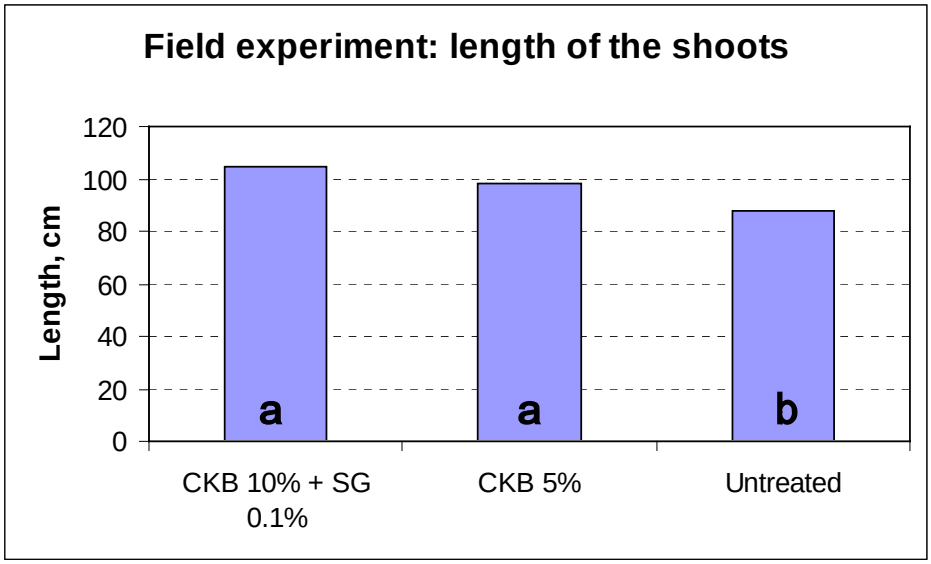

Figure 4. The effect of CKB 10% + SG 0.1% and CKB 5% treatments on the length of the shoots of raspberry.

Apple

1. Experiment

Aim:
To find out the effect of Carbon Kick Booster on the apple rust mite.

Trial places and times:
MTT, Plant Protection Laboratory, Jokioinen.
Laboratory test A: treatments 6.8.2007 and inspections 7.8., 10.8., and 13.8.
Laboratory test B: treatments 9.8.2007 and inspections 10.8., 13.8., and 15.8.
MTT, Horticultural Research, Piikkiö
Field experiment: treatments 3.8.2007 and inspections 2.8. (pre-treatment) and 20.8.

Treatments:
Laboratory test A
1. Carbon Kick Booster, 2.0%
2. Carbon Kick Booster 2.0% + Silwet Gold 0.05%
3. Silwet Gold surfactant 0.05%
4. Untreated (water treatment)

Laboratory test B
1. Carbon Kick Booster, 1.0%
2. Carbon Kick Booster 1.0% + Silwet Gold0.025%
3. Silwet Gold surfactant 0.025%
4. Untreated (water treatment)

Field test:
1. Carbon Kick Booster 2.0% + Silwet Gold 0.05%
2. Untreated

Materials and methods:
Test materials included pieces of apple leaves, 4 replicates were included. Leaves were inspected under a binocular before treatments and only leaves with tens of mites were accepted for tests. Leaves were placed upside down in a laboratory spraying equipment (Potter Tower), and sprayed using the equivalent of 60 ml/m^2 leaf area. Converted to one ha of sprayed area the amount of spraying liquid corresponds to spraying of 600 l/ha. After the sprayings the leaves were left to dry for 1-2 hours and then placed in Petri dishes on moist hand towel papers. Petri dishes were kept in +26^{o}C temperature, 60% RH and continuous light.

In the field experiment groups of 5-10 trees including six cultivars were sprayed using a knapsack mist sprayer. Weather conditions during the spraying at 7-8 am: +17 ^{o}C, cloudy, RH 88%, calm.

Inspections:
In the laboratory tests the first inspection was done one day after the treatment. Leaves were inspected under a binocular and the numbers of moving and immobile mites (all mites present on leaves) were separated and counted. The gall mites were assessed as mobile (and alive) if they moved their legs. As the gall mites have a short immobile nymph stage the inspections were repeated after 3-4 and 6-7 days to ensure which mites were still living.

In the field test pre treatment inspection was done one day before treatment from 50 leaves/cultivar. Ten leaves were inspected using binocular and counting the mites on the area of 1.5*1.5 cm (window method), the rest of the sample was washed and sieved and all mites were collected for inspection.

Statistical analyses of the laboratory tests were done using ANOVA and Tukey's tets (P=0.05). In the field test the treatments were compared by cultivars using log-transformed (log x+1) by t-test (P=0.05).

Results:

Apple rust mite

In the laboratory test A the number of moving mites was significantly lower in the first inspection (1 day) in treatments 1) CKB and 2) CKB+SG than in 3) SG or in untreated control. After three days, treatments 1) CKB and 2) CKB+SG were significantly different from 3) SG and untreated control. After a week there were moving mites only in the untreated control (proportion of moving mites only 11%). Treatment by the surfactant SG alone did not have any effect at all.

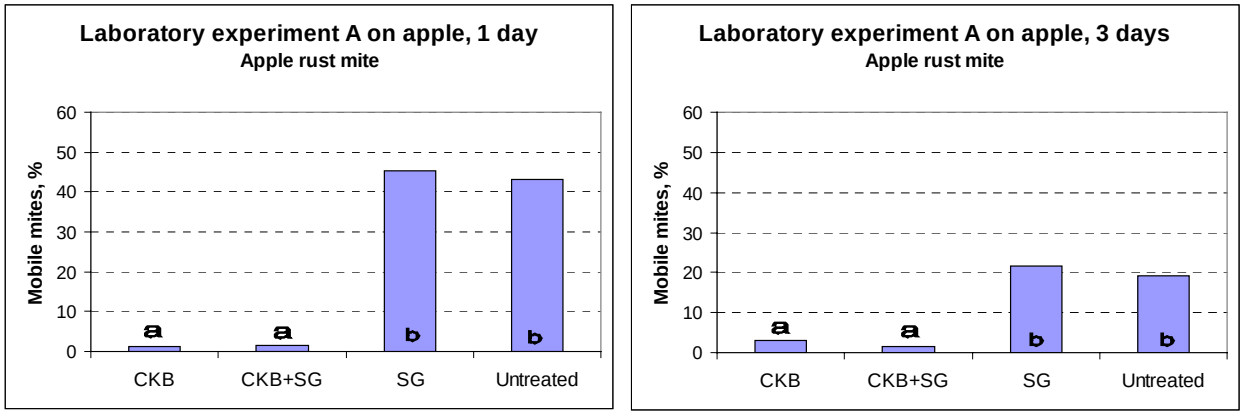

Figure 5. Laboratory test A. Effect of CKB 2.0%, CKB 2.0% + SG 0.05% and SG 0.05% treatments on the proportions of mobile apple rust mites 1 and 3 days after the treatments. Different letters in columns show significant differences between treatments (P=0.05).

In the laboratory test B the same spraying volume was used and the concentration was halved from the laboratory test A. In this case also the mere surfactant SG treatment had a significant effect on the proportion of mobile mites 1 day after the treatment. After four days, no mobile mites were found in any of the treatments and only 16% in the untreated control.

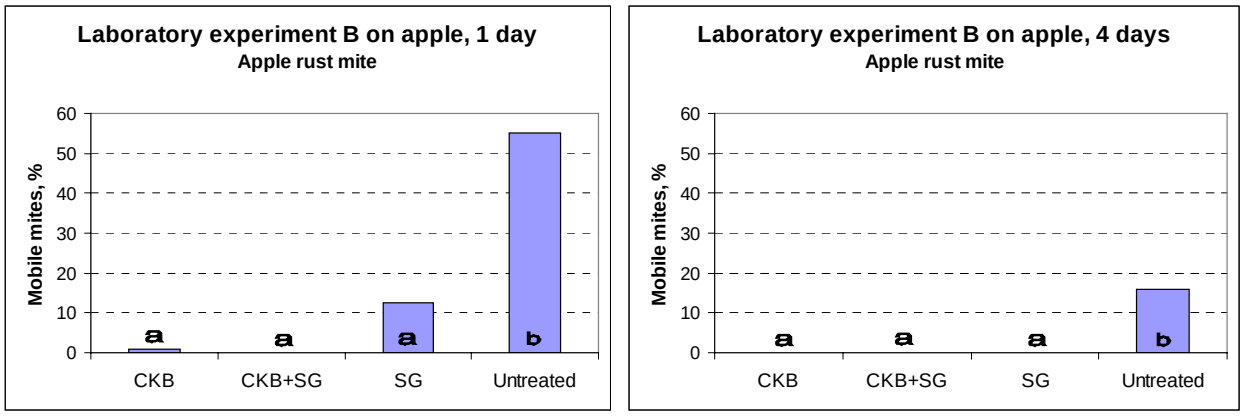

Figure 6. Laboratory test B. Effect of CKB 1.0%, CKB 1.0% + SG 0.025% and SG 0.025% treatments on the proportions of mobile apple rust mites 1 and 4 days after the treatments. Different letters in columns show significant differences between treatments (P=0.05).

The results of the laboratory tests show that all treatments affected on the apple rust mite. The effect of mere SG could not be confirmed and as an additive it had no effect at all. Although the death of the mites was confirmed by immobility observed by visual inspection the mites were definitely killed when followed one week. The spraying volume in these tests corresponds to a high volume spraying of the canopy. Both concentrations used in the tests were practically equally effective. Low proportion of mobile mites in the untreated leaves weakens the reliability of the results and further field tests are necessary to confirm these results.

The results of the field test rely on the inspections before the treatment and two weeks after the treatments. The timing of the experiment was not ideal as part of the apple rust mites were moving from leaves to over winter in the leaf base. Therefore the number of mites in the leaf samples decreased overall. The number of the apple rust mites was significantly lower in cv. Lobo, Vuokko and Y628 than in the untreated control trees (Figure 7).

Fruit tree red spider mite

In all treatments the number of the fruit tree red spider mites was lower than in untreated control trees and significant differences were found in cv. Lobo, Vuokko and Y6225 (log+1 transformed data, t-test, P=0.05) (Figure 8).

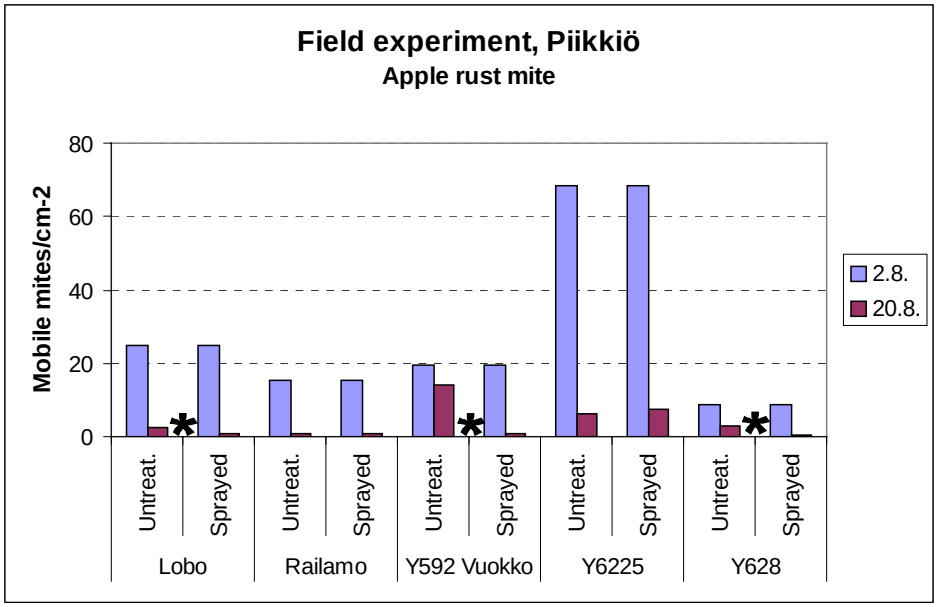

Figure 7. Number of mobile apple rust mites (mites/cm^2) on leaves of five apple cultivars 1 day before and two weeks after CKB 2.0% + SG 0.05% treatments. Significant differences between treated and untreated trees by cultivars shown by asterisk (P=0.05).

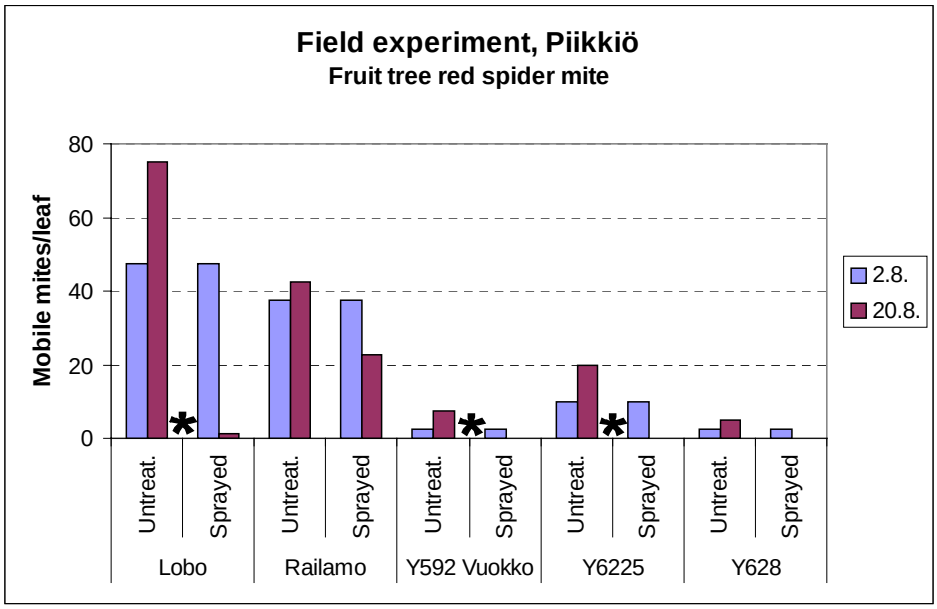

Figure 8. Number of mobile fruit tree red spider mites on leaves of five apple cultivars 1 day before and two weeks after CKB 2.0% + SG 0.05% treatments. Significant differences between treated and untreated trees by cultivars are shown by an asterisk (P=0.05).

General discussion and conclusions

Gall mites are generally difficult to control by acaricidal treatments. At the moment, in Finland only abamectin (Vertimec 018 EC) and fenbutatinoxide (Torque) are available for control of free-living eriophyid mites. Gall forming mites are even more difficult.

In these experiments we used as the basic concentration of Carbon Kick Booster (2.0%) and surfactant Silwet Gold (0.05%) based on earlier experiments in greenhouse pest control (Simula, 2005, Simula & Vänninen, 2006). These results are not readily applicable in field but give a good reason to continue trials in practical conditions

Raspberry leaf and bud mite

CKB with or without SG affected the raspberry leaf and bud mite. The injuries caused by CKB sprayings either 5% or 10% concentrations were negligible whereas the treatments had obvious positive effect on growth of the raspberry shoots.

In a greenhouse the use of 1-2% concentration sprayed in high volume is advisable if eriophyid mites are troublesome. This treatment will probably keep also the spider mite population in low level. In open field raspberry the weather conditions after the treatment may be critical, especially rain in 1-3 days may diminish the effect. Field tests are necessary to evaluate the benefits of the use of CKB in field conditions.

Apple rust mite

CKB as 1-2% concentration alone or together with SG surfactant resulted a clear control effect on the apple rust mite. The effect of SG was insignificant but may accelerate the effect of CKB. In field test the timing was not ideal as part of the mites were already seeking their way to hibernate in the shelter of the leaves' base buds. In practice, the treatments should obviously be timed either just before or after the flowering time. Although there were differences between the cultivars in the field test in all except one cultivar the number of mites in the treated leaves was reduced.

Fruit tree red spider mite

In the field test the number of the fruit tree red spider mite diminished significantly compared to the untreated trees. These results encourage to keep on spider mite control experiments in the field.

References

Simula, M., Vänninen, I. 2006. Hur påverkar fästmedlet Carbon Kick Booster skadegörare och bekämpningsorganismer?. **[**What is the effect of Carbon Kick Booster on pests and biocontrol agents?**]** Trädgårdsnytt 60(2006):2, 18-19.

Simula, M., Vänninen, I. 2006. Booster-kiinnite sopii myös tuholaistorjuntaan. **[**Booster surfactant fits also for pest control**]**. Puutarha & kauppa 10(2006):13, 20-21.

Simula M. 2005. Carbon Kick Booster-kiinnitteen vaikutus vihannespunkkiin (*Tetranychus urticae*), kalifornianripsiäiseen (*Frankliniella occidentalis*), ansaripetopunkkiin (*Phytoseiulus persimilis*), ripsiäispetopunkkiin (*Neoseiulus cucumeris*), *Amblyseius swirskii* -petopunkkiin, jauhiaiskiilukaiseen (*Encarsia formosa*) ja *Eretmocerus eremicus* -loispistiäiseen. **[**Effect of Carbon Kick Booster surfactant on two-spotted spider mite (*Tetranychus urticae*), Californian thrips (*Frankliniella occidentalis*),

predatory mites (*Phytoseiulus persimilis*, *Neoseiulus cucumeris*, and *Amblyseius swirskii*), and parasitoid wasps (*Encarsia formosa*, *Eretmocerus eremicus*)**]**. – Tutkimus, Agropolis Oy. 22 s.