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Application of γ -terpinene in a Swiss bee hive

Winter treatment against *Varroa destructor* with new components of essential oils

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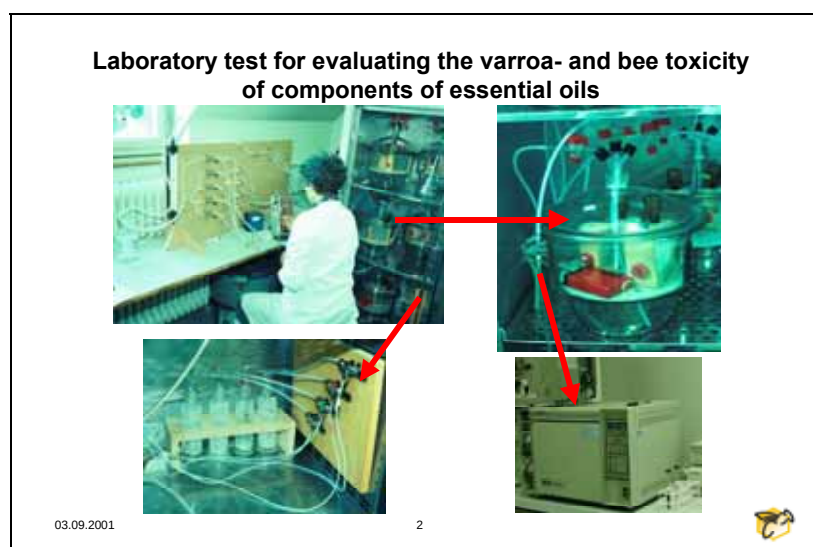
Mitteilung Nr. 46

Figure 1



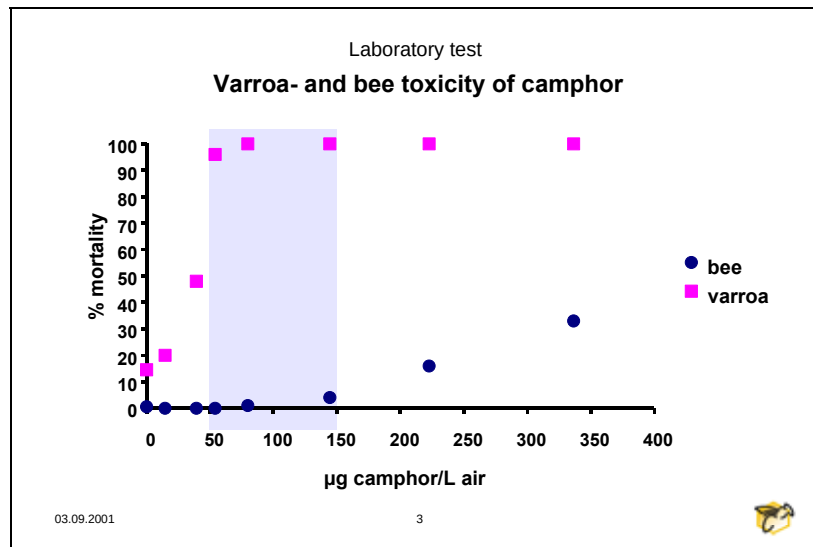
In many alternative treatment concept against *Varroa destructor*, oxalic acid is used for the late treatment in November in brood free bee colonies. Depending on the type of application, these treatments can be time consuming. Therefore a simple application of passively evaporating essential oils would be much easier.

Figure 2



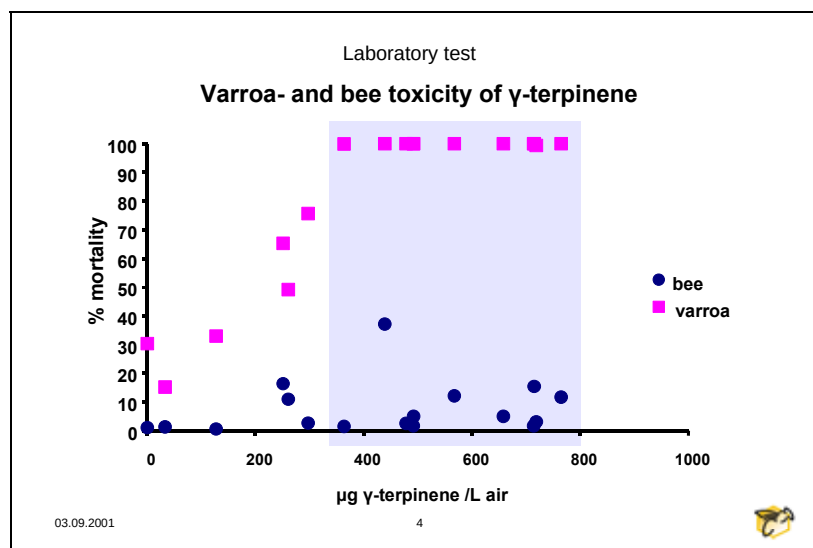
With the help of the following screening test we are searching for volatile essential oil components. The toxic effects of the volatile substances on *Varroa* and bees are examined as follows: two cages (Liebefeld type) containing each 100 bees and 20 *Varroa* were placed in a desiccator and exposed to air contaminated with volatile substances. This treatment was performed in an incubator at a temperature of 32°C and at 50 to 60% relative humidity. After 24, 48 and 72 h, the concentration of the active compounds in the desiccator is monitored by absorption on a graphite tube. The active compounds are washed out from the graphite with toluene and the extract is analysed by gas chromatography. The values of the three air samples yield the average air concentration per application. *Varroa* and bee mortality are expressed as the percentage of animals, found dead in the desiccator during the treatment.

Figure 3



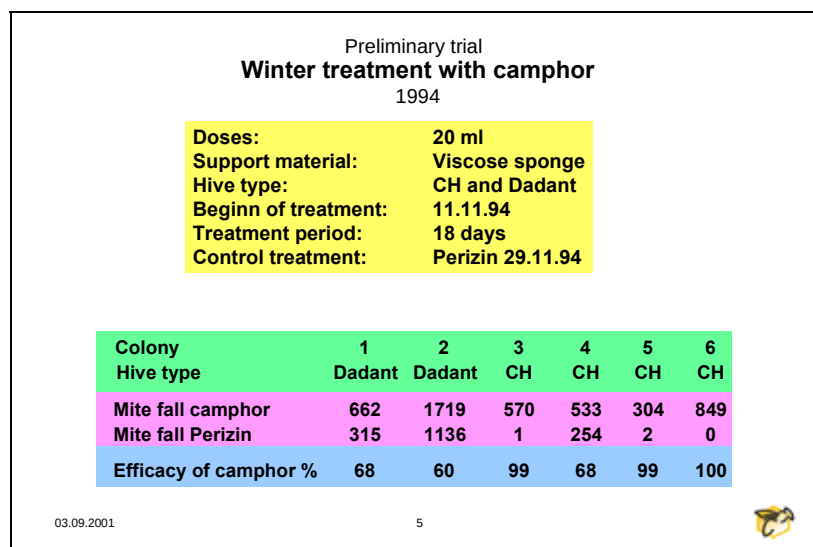
The air concentration which killed nearly 100% of Varroa without noticeable loss of bees was found to lie between 50 to 150 µg/l of air for camphor.

Figure 4



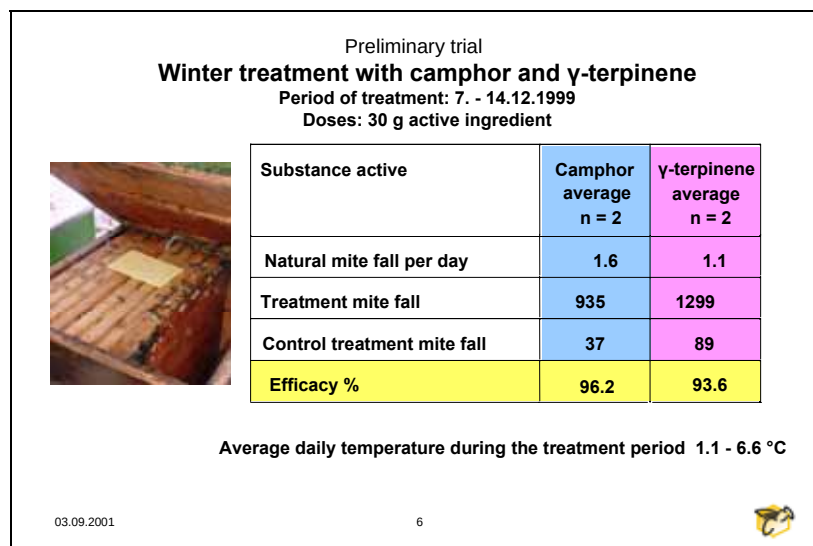
The optimal concentration of γ -terpinene lied between 350 and 800 µg/l air. Good efficacy in the hive is expected if these concentrations are attained in the hive air.

Figure 5



In 1994 we tested camphor in a first preliminary trial. The application of camphor during November resulted in 3 of 4 hives in an efficacy of 99% in Swiss hives and of 60% in Dadant hives. The camphor concentration in the hive air was not measured. But from our experience with the application of other substances like thymol we know that higher concentrations are achieved in Swiss hives compared to Dadant hives.

Figure 6



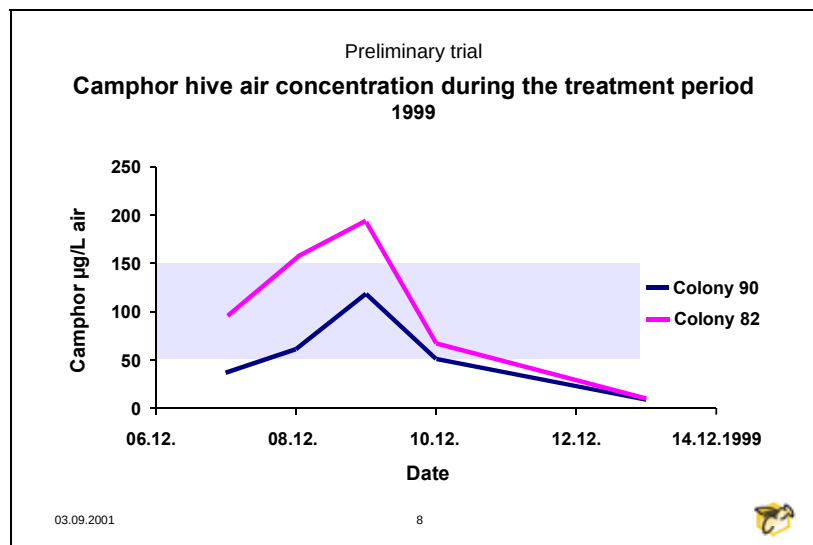
A second preliminary trial was carried out in 1999 with camphor and γ -terpinene, using 2 bee colonies for each substance. This time a higher dose of 30 g active ingredient was used. An average efficacy of 96 % for camphor and 94% for γ -terpinene were achieved after a 7 day treatment. These results demonstrate the high varroacidal potential of these two substances for short-term treatments in brood free colonies.

Figure 7



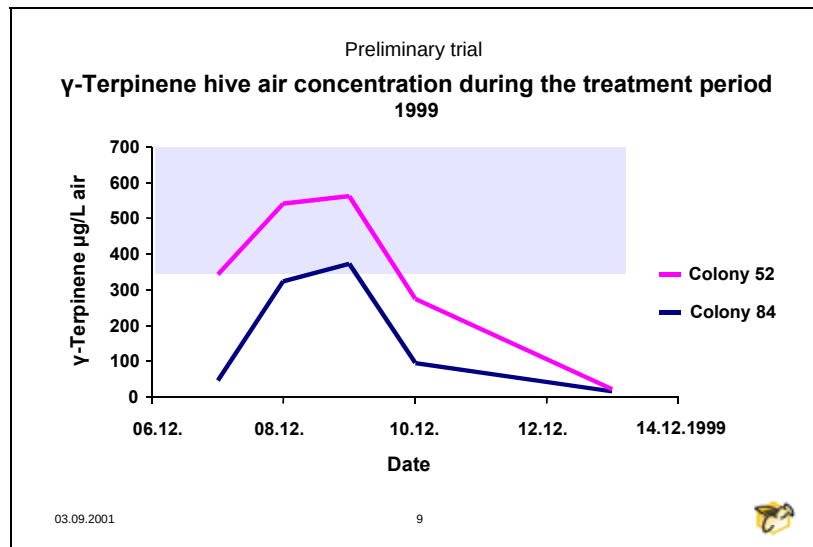
This picture demonstrates the measurement of the concentration of the active ingredient in the hive air. A certain volume of hive air is aspired with a pump through a graphite adsorbent tube. The substance is then eluted and determined as described above.

Figure 8



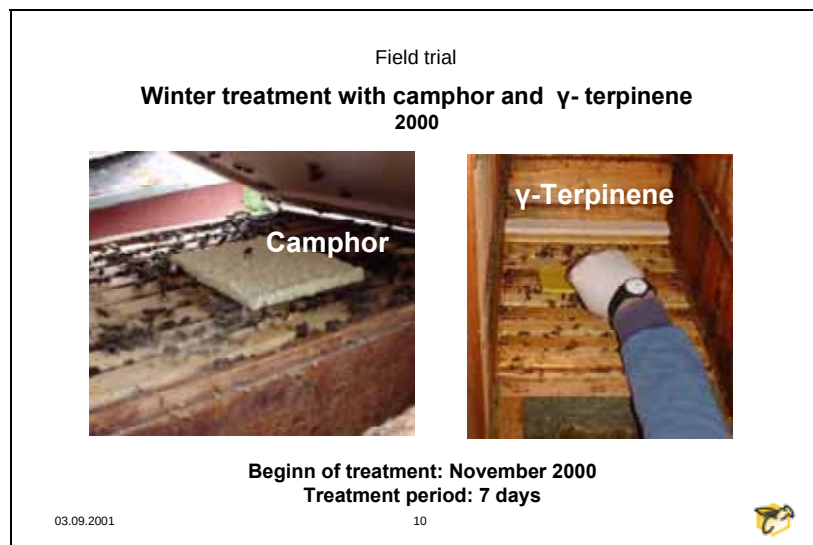
In this trial the expected hive air concentration, necessary for a high efficacy of camphor, was achieved.

Figure 9



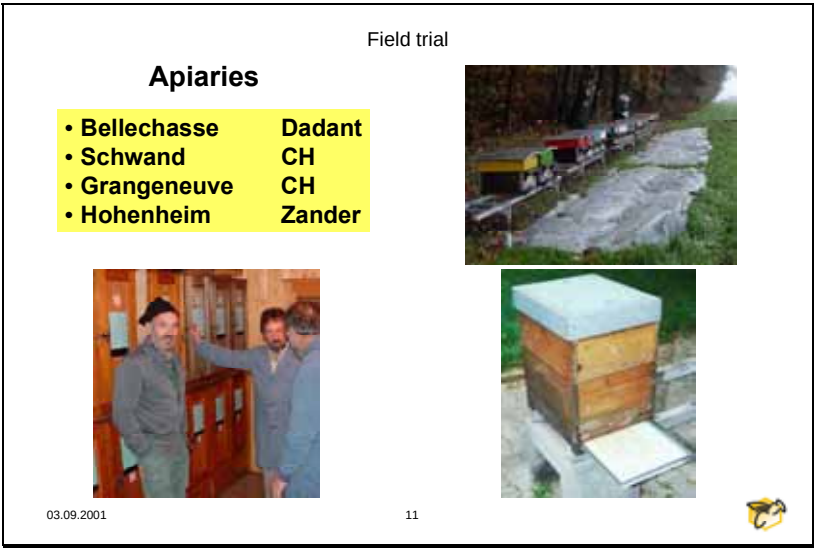
In this trial the expected hive air concentration, necessary for a high efficacy of γ -terpinene, was more or less achieved.

Figure 10



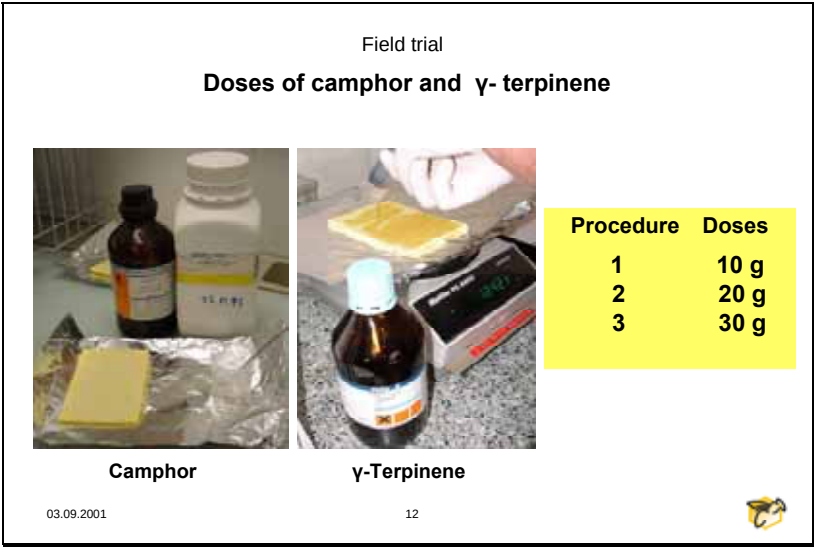
Considering the promising results from the preliminary trials, a large field trial with camphor and γ -terpinene was carried out in November 2000. The treatment period was 7 days.

Figure 11



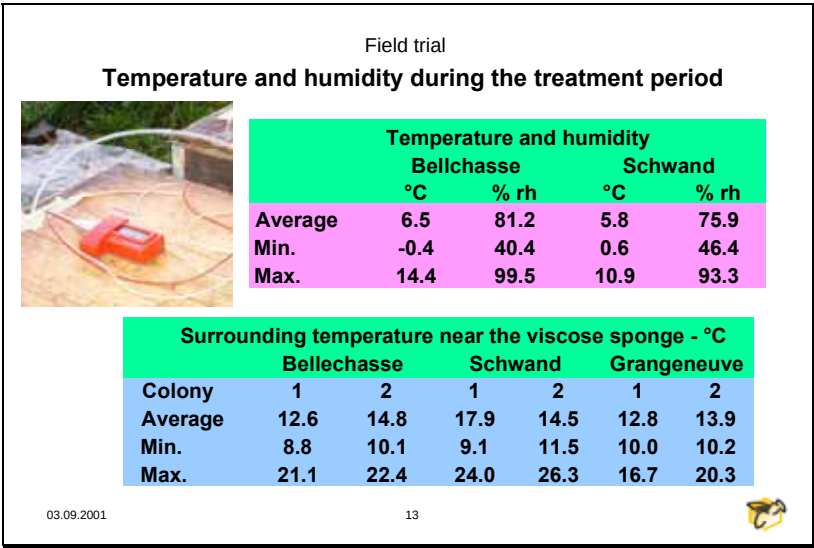
The trials were carried out in 4 apiaries with three different hive types: Swiss, Dadant and Zander hives.

Figure 12



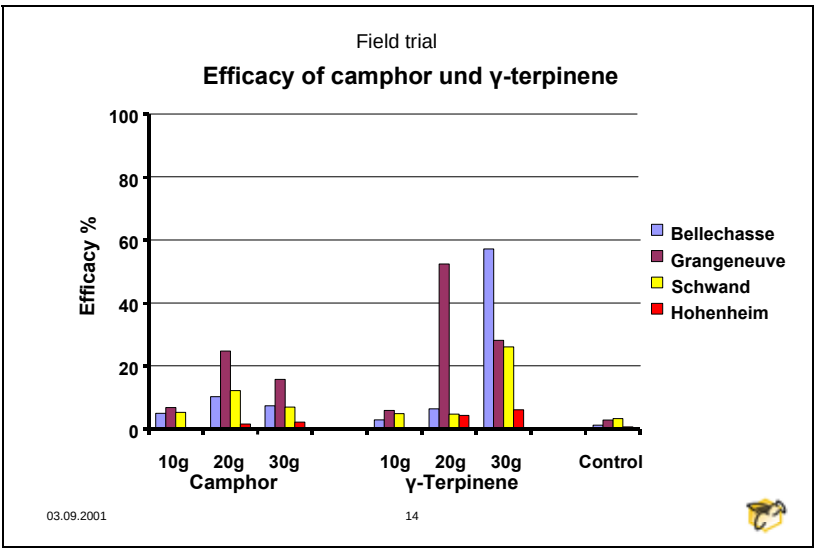
Three different doses of 10, 20 and 30 g per hive were tested. The support material was a piece (10 x 15 cm) of viscose sponge. Camphor was liquefied with alcohol, while γ -terpinene could be applied directly on the support material.

Figure 13



The average outdoor temperature as well as the maximum and minimum temperatures are given for the Bellechasse and Schwand apiaries (above). Also the surrounding temperature of the viscose sponge in all apiaries was measured during the treatment period (below).

Figure 14



Unfortunately the good efficacy of the preliminary trials could not be confirmed. The efficacy was very low in all trials.

Figure 15

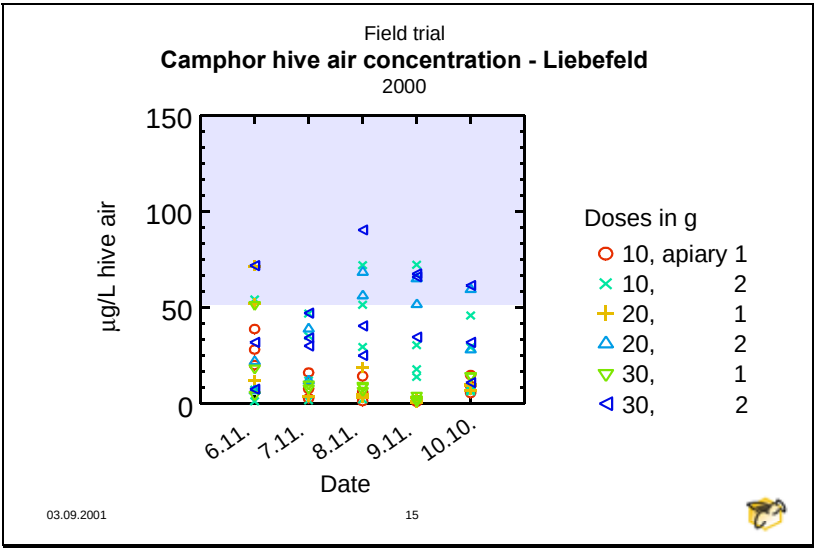


Figure 16

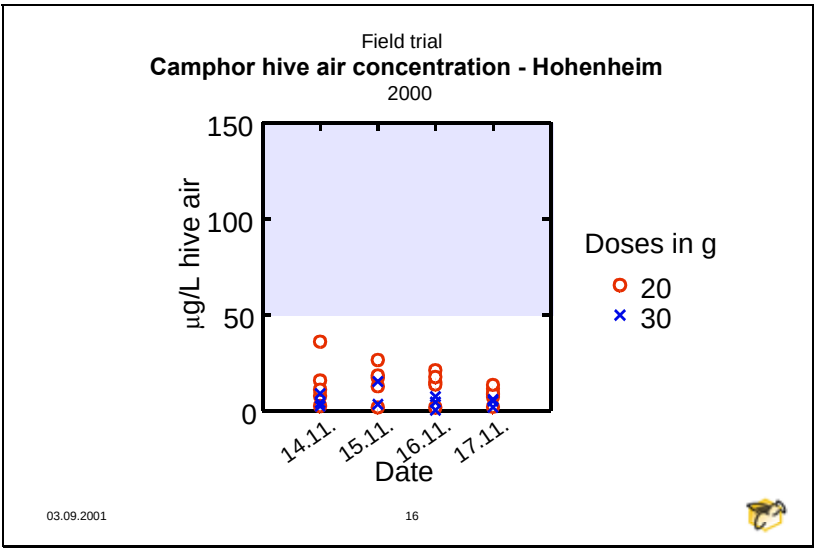


Figure 17

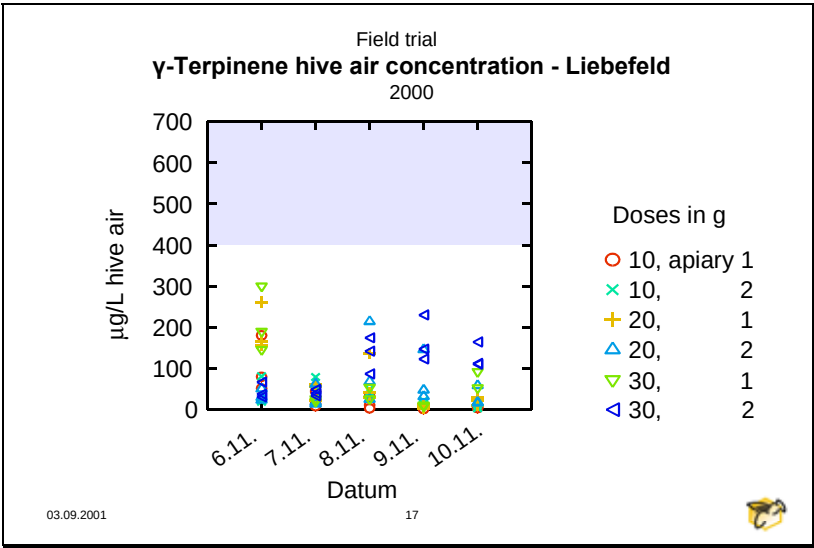
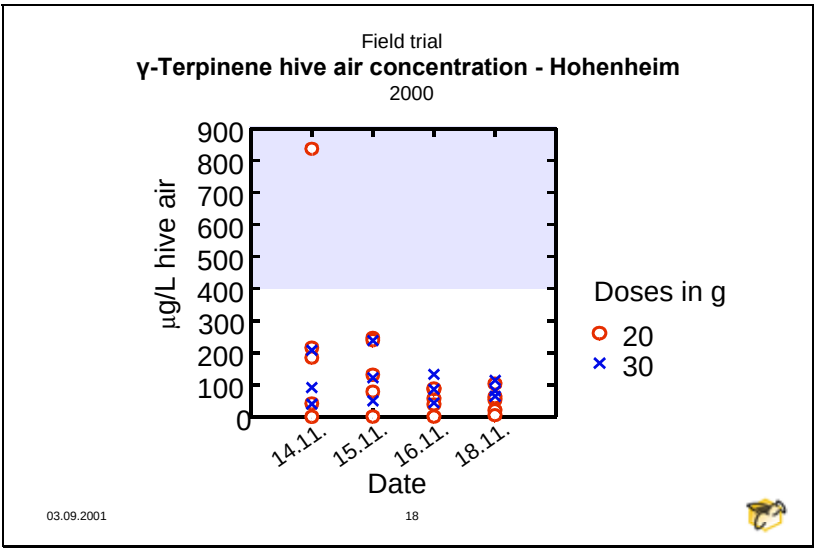
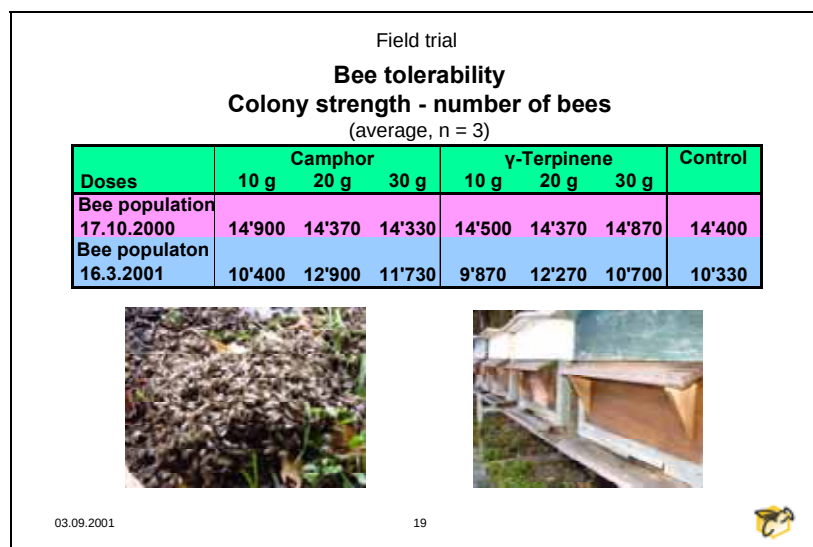


Figure 18



The results shown in figures 15 to 18 demonstrate, that the optimal hive air concentration (= boundary from light to dark on graph), which is necessary for a good efficacy, was not achieved in all trials. This is probably due to a very strong ventilation of the bees.

Figure 19



No immediate and long-term bee toxicity of the two substances could be observed. In two colonies the treatment with γ -terpinene caused that some of the bees left the hive during the first night.

CONCLUSION

- In this field study, an insufficient efficacy was observed for both camphor and γ -terpinene due to a too low concentration of the active ingredients in the hive air during the treatment period. Before the treatment period the temperature was rather high and the bees were not in a tight winter grape. Therefore they were still able to ventilate strongly, lowering the hive air concentration of the substances. In the two preliminary trials the bees were in tight winter grapes as the temperature before the treatment period was below 0°C.
- Both substances showed a very high varrocidal potential in the screening as well as in the preliminary trials. The results from the filed trials indicate, that the bees can influence the hive concentration by ventilation, which results in a decrease of efficacy. Therefore new application forms such as heat-induced evaporation or aerosol application, should be tested.