Timing of anti-Varroa treatment and survival of winter bees

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Colony Collapse Disorder has multifactorial causes such as habitat degradation, invasive species, pesticides, and agricultural and beekeeping practices. In this study, we focused on the effect of *Varroa destructor* on the vitality of the bee colony. Timing of anti-varroa treatment can possibly affect the transition to winter bees. The use of the chemicals or the presence of mites during the development of the winter bee pupae possibly reduces the lifespan of the bees, causing the bees to die before spring has been reached.

Assigned 12 hives to 4 groups, differing in timing of anti-Varroa treatment: July, August, September, or not treated at all. Anti-Varroa treatment consisted of three weeks of formic acid evaporation in the hives. All groups were additionally treated in December using oxalic acid trickling. Mite fall was measured to check the Varroa infestation and the affectivity of the treatments. Lifespan was measured, marking 100 newborn bees (cohort) per hive every two weeks and counting the number of survivors every two weeks during July and April the next year. The cumulative survival from these curves was used as a measure for lifespan. Brood was also counted every two weeks. Winter survival was determined by counting the number of frames occupied with bees in April the next year.

Mite fall showed that indeed more mites died during and after anti-Varroa treatment in July, August, or September than after treatment. However, treatment in December caused the largest reduction in mite fall. Cumulative survival showed that the lifespan increased during the fall (August-November), showing the transition to winter bees, and showed that the bees of the hives treated in July had the longest lifespan of all groups. Bees of the hives treated in August and September had a longer lifespan than bees in hives that were not treated. The amount of brood indeed decreased with the increase in lifespan during the season. In April the next year, the hives that were not treated with formic acid during the experiment, showed much lower probabilities for the frames in the hives to be occupied (1 out of 10 frames) with bees compared to the hives that were treated during July, August, or September (6 to 7 frames out of 10 frames).

Although beekeepers often do not like to treat their hives against *V. destructor* during July, the period that they are most probably collecting honey, treating the bees before their transition to winter bees does increase their lifespan and thus increases their chances to survive winter. Treating hives against Varroa in August or September results in lower lifespan of the winter bees than treating them in July, but a longer lifespan than not treating them at all. Differences between the numbers of frames with bees in April the next year were in this study to small to be significant between anti-Varroa treatment in July, August or September. However, it would be interesting to follow these hives for multiple years. The differences in winter survival could potentially lead to larger differences in winter survival over multiple years.