A. Grant Data

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· Title: **Efficacy of Queen Bee Replacement for Varroa IPM**
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B. Nontechnical Summary.

The European honey bee is being threatened by a mite (varroa) that first came into the United States in 1988. Initially, miticides were the recommended way to control the mite and to prevent colonies from dying. Beekeepers, researchers, and extension agents want to stop the exclusively use miticides in honey bee colonies because varroa mites have become resistant to these chemicals and the possibility of contamination of hive products, e.g., honey, wax, etc. We have been testing methods to reduce varroa numbers in colonies without the use of chemicals. Varroa are dependent on the honey bee's reproductive cycle for its reproduction. Just before nurse bees seal the bee larva in its brood cell for the last stage of development before adulthood, female varroa enter the cell. Once the cell is capped, the mite begins to reproduce and the offspring reach adulthood before emerging with honey bee. If honey bee brood rearing is interrupted, mites are unable to reproduce. We choose to interrupt the bee's reproduction in mid summer because this is when mite populations are beginning to reach the point where its population will explode. The method we used to interrupt the bee's reproduction was to requeen the colony. Beekeepers need to requeen periodically and this mite control method would not add any work to the beekeepers already difficult job; it would only change when the requeening would happen. Old queens were removed and new queens were kept caged, thus preventing her from laying eggs, for 5-15 days before the new queens are released to begin again the rearing of new bees. Thus far we know that the caging of queens needs to be for longer, rather than shorter lengths of time.

C. Introduction.

The European honey bee (Apis mellifera) is an essential pollinator for over 90 fruit and vegetable crops. Without honey bees the yield of many of our fruits and vegetable crops would be below potential and the resulting product would not be of as high quality. The annual economic benefit from honey bees is estimated to be over $14 million dollars. Since the introduction of the mite, Varroa destructor (varroa), honey bee populations have plummeted, resulting in a large decrease in the number of managed and feral colonies and beekeepers and an

increase in the cost to rent colonies for pollination or the inability to find beekeepers to provide pollination colonies.
When varroa was first introduced in 1988 beekeepers in the United States began using fluvalinate, a pyrethrod, to control mite populations. Resistance to this chemical became widespread by 1998 and coumaphos, an organophospate, was approved for use (Section 18). Since 1998 resistance to coumaphos has been reported. Beekeepers are losing their colonies because chemical methods of mite control are no longer effective. Additionally, fluvalinate, coumaphos and other pesticides have been detected in honey and wax and are known to concentrate in beeswax. Queens, drones and workers have been shown to be adversely impacted when exposed to approved concentrations of the miticides. Non-chemical alternatives need to be developed because chemical methods of mite control are failing, exposure to approved levels are causing harm to honey bees, and humans may be exposed to organophosphate or pyrethroid pesticides in the honey they consume.

D. Objectives.

The objectives of this proposal were to 1) evaluate the efficacy of mid-summer queen replacement or caging and queen removal on varroa population levels in year one and 2) evaluate the efficacy of the best strategy test in year one (a. removal of old queen, new queen caged for 5, 10 or 15 days, b. cage existing queen for 10 or 15 days and c. removal of old queen with emergency queen replacement) combined with screened bottom boards.
Objective one was completed in 2004. When total number of mites or mean number of mites dropped per day was compared among treatments, no significant differences were observed. When the mean number of mites per day was compared at the end of the season; fewer mites ($p=0.01$) were observed in colonies whose queens had been caged for 15 days. Based upon these results, it was concluded that any significant difference in mite populations would result only from those colonies whose brood production was interrupted for the longest time. Therefore, we choose to evaluate the removal of the old queen followed by caging of a new queen for 15 days prior to release and allowing the colony to produce a new queen (emergency queen replacement).
Objective two was completed in 2005. The data analysis thus far indicates that no significant differences occurred between treatment groups. The data analysis is no complete yet as one of the locations for the study (Delaware) is not yet finished with its mite counting. Once these data are added to the data from Pennsylvania and Maryland the analysis will be re-run. In the Pennsylvania apiaries we notice during the 2004 season what seemed like very high levels of queen replacement by the colonies. During 2005 we collected data concerning when and how often colonies requeened themselves. Over half the colonies in the study replaced their queens. This uncontrollable action by a colony may account for the lack of difference in mite levels between treatment groups.

E. Approach.

Thirty colonies in each of three apiaries (Pennsylvania, Delaware and Maryland) were established in 2004. Treatments were assigned randomly. The study design was to be a randomized complete block but the treatments assigned in each apiary were not identical due to factors beyond our control.
Colonies were supered as necessary. Prior to the queen manipulation in July, colonies in each

apiary were equalized to ensure similar colony size and similar mite levels. One week after adjustment of colony size, natural varroa drops were assessed in all colonies to determine if mite levels were equal and to provide a pretreatment assessment of mite levels. Following the assessment of mite levels at the three apiaries, each colony was randomly assigned to a treatment group and queen manipulations were performed. Within each apiary, the queen manipulations were completed on the same day. In 2004 the colonies were manipulated as follows: 1) control colonies - no queens replaced or confined, 2) removal of old queen, new queen caged for 5, 10 or 15 days, 5-6) cage existing queen for 10 or 15 days and 7) removal of old queen with emergency queen replacement. On the first day of queen manipulation, natural varroa drop assessments were begun and continued until all queens were released. Mite drop assessments were change to every 14 days and continued until the end of the season, approximately mid-October.
The experimental design for 2005 was similar. Colonies were supered, as necessary, and were equalized to ensure similar colony size and similar mite levels. One week after adjustment of colony size, natural varroa drops were assessed. Following the assessment of mite levels, treatments were randomly assigned. Within each apiary, the queen manipulations were completed on the same day. The colonies were manipulated as follows: 1) control colonies - no queens replaced or confined, 2) removal of old queen followed by caging of new queen for 15 days and 3) removal of old queen and allowing colony to produce a new queen (emergency queen replacement). Continuous natural varroa drop assessments continued until all queens have been released. In Maryland and Delaware mite drop assessments were changed to every 14 days and continued until the end of the season, approximately mid-October.

F. Progress.

Objective one was completed in 2004. No significant differences among treatments were observed except when the mean number of mites per day was compared in October 2004; significantly fewer mites ($p=0.01$) were observed in colonies whose queens had been caged for 15 days. Any difference in mite levels will be observed in those colonies whose queen did not lay eggs for greater than 10 days. Thus, we chose to evaluate the removal of the old queen followed by caging of a new queen for 15 days and allowing the colony to produce a new queen (emergency queen replacement) as our two treatments in 2005.
Objective two was completed in 2005. Treatments groups were controls (no manipulation), queen removal plus caging of new queen for 15 days and queen removal followed by emergency queen replacement by colony. We have not completed the analysis but the data analysis thus far indicates that no significant differences occurred between treatment groups.
One possible explanation for the lack of difference in mite levels is that colonies may ber requeening themselves more frequently than expected. In the Pennsylvania apiaries we notice during the 2004 season what seemed like very high levels of queen replacement by the colonies. During 2005 we collected data concerning when and how often colonies requeened themselves. Over half the colonies in the study replaced their queens. This uncontrollable action by a colony may account for the lack of difference in mite levels between treatment groups.