A College Farm Pursues

ORGANIC BEEKEEPING

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Stock selection, forage availability, mite treatments and supplemental food all can be challenges to an organic program.

Stock selection is fundamental to any type of livestock operation, including honey bees. Beekeepers select for or against traits, including honey production, resistance to parasites and diseases, and aggressive behavior, when they manage and propagate hives. In 2007 we began an on-farm research project at Berea College to select honey bee stock that would be well suited for organic production. The horticultural enterprise of the farm where the apiary is located was already certified organic, but previous attempts at managing commercially-available Italian stock without the use of synthetic inputs, especially miticides for *Varroa destructor*, had ended in unacceptably high hive mortality. Therefore we decided to develop an organic management plan and impose it on five different stocks, four of which came with claims or evidence of *Varroa* resistance or tolerance. The fifth was the commercial stock we had been using previously which served as a control for comparisons. The first objective was to find out if there really were differences among the stocks and if the claims of *Varroa* resistance had validity. The other goal was to systematically select for breeding stock most suitable for the organic management system we planned to use.

It's important to understand what meant by "organic management" in general and specifically when applied to bees. The term refers to a production system that is certified by an accredited inspector to be in compliance with the standards described in the Organic Foods Production Act (OFPA) enacted under the 1990 Farm Bill. This generally means that the use of synthetic substances is not permitted, though it does not ensure that products are free of prohibited substances such as synthetic pesticides. Although USDA-certified organic honey and other bee products are widely available in the United States today, the standards are vague and questions remain about what this really means.

According to the National Organic Program (NOP, 2009) honey bees are considered livestock and therefore should be fed only organic feed and given no prohibited substances. Certifiers, producers, and suppliers of organic honey are using the draft apiculture standards developed by the National Organic Standards Board's (NOSB) Apiculture Task Force (Riddle et al. 2001), assuming these will be incorporated officially into the NOP eventually. The Task Force was charged with developing these standards to "establish allowed and prohibited production practices for organic apiculture operations based on the requirements of the Organic Foods Production Act" (Riddle et al. 2001). According to the NOSB Apiculture Task Force Report, hives should be: 1) under organic management no less than 270 days prior to the removal of the product; 2) managed according to an organic apiculture plan that includes adequate record-keeping; 3) located on certified organic land; and 4) provided with sufficient organic or "wild" forage (Riddle et al. 2001). Honey bees are permitted on non-organically managed land as long as adequate forage from organic and/or wild (defined in OFPA § 205.207) areas is available. Any supplemental feed, if given, must be certified organic and no sugar syrup can be provided within 30 days of a honey harvest. Hives cannot be located in areas where the certifier deems there is a significant risk of contamination within four miles. And of course pests in the hive must be managed without the use of prohibited synthetic or non-synthetic materials.

The honey bees evaluated in our project included four Italian stocks and one cross of New World Carniolan and Russian (NWC/Russian) stocks, as indicated by the suppliers (Table 1). The NWC/Russian stock was purchased from a semi-commercial source in northeastern Georgia and produced from open mating according to the breeder. One of the Italian stocks was derived from a survivor hive at Berea College established in 2001 that had had no synthetic chemical pesticides applied to it (referred to hereafter as "Berea survivor stock" or BSS). The remaining three Italian stocks were purchased from commercial sources. The Italian-A stock was from southern Georgia and had no claims of *Varroa* resistance or any other particular traits. This was the stock we had used in previous years with little success. The Italian-B and Italian-C stocks were from Texas and both were advertised as having been developed under non-chemical management for *Varroa* resistance. The Italian-C stock also came with the claim of having the SMR (suppressed mite reproduction) trait. All of the hives were established in April or May, 2007, with three to six colonies of each of the five stocks (Table 1).

All of the colonies were managed for *Varroa* mites with screen bottom boards and regular population monitoring using bottom board sticky traps (Great Lakes IPM, Vesta-

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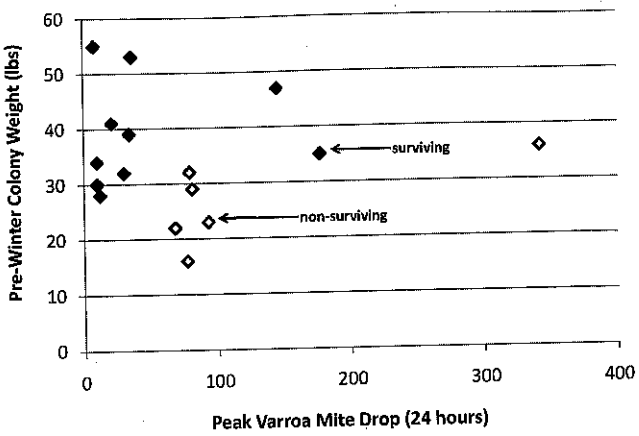

burg, Michigan). Traps were installed every three to five weeks during the non-Winter months and left in place for a three-day sampling period. A threshold of 50 mites per day (24 hours) was used based on work reported by Caron (1999), Strange and Sheppard (2001), and Delaplane et al. (2005). If hives exceeded the threshold, about a half liter (1 pint) of powdered sugar was applied evenly to all bees in the brood area by taking out each frame individually and dusting all bees present using a canning jar with a screened top. A single application was made each time a hive's sticky trap exceeded the threshold. Although some research indicates that the effectiveness of this method is questionable, our limited experience before beginning the project indicated that it worked nearly as well as commercial thymol-based products.

Due to the high cost of certified organic sugar and protein sources, we provided colonies with a minimal amount of supplemental feed. Colonies were provided with the equivalent of two to four pounds of sugar per hive in granular or syrup form in the late Fall and early Spring. Colony weight was periodically monitored and compared among stocks by first subtracting the weight of the woodenware so that the total hive weight included only adult bees, brood, comb, and food. Honey supers were harvested in July of each year only from the heaviest hives to minimize colony stress and the need for supplemental feeding.

Colonies began exceeding the *Varroa* mite threshold on stick traps in early August, 2007. Mite counts differed somewhat among the stocks, but there was also considerable variation within stocks. The average mite count in the Italian-A hives reached a peak of 160 per day by mid-September, two to four times higher than any other stock. At the end of the first complete year (May, 2008) only nine of the original 20 colonies were still surviving. All five of the NWC/Russian colonies survived while all six of the Italian-A colonies had died. The other three stocks had intermediate levels of survival (Table 1). The average peak *Varroa* mite count in colonies that survived the Winter was 48 while in those that did not it was 123. Likewise, pre-Winter weights of surviving colonies measured in November, before supplemental feeding, averaged 39 lbs while in those that did not survive it was only 26 lbs (Figure 1). Both *Varroa* counts and colony weight were statistically significant factors in explaining Winter survival in the first year.

During the second year (2008) the general pattern of *Varroa* mite counts was similar but some hives began to exceed the threshold of 50 mites per day by late July. Peak *Varroa* mite counts averaged 62 in surviving hives and 194 in non-surviving colonies. The average pre-Winter (and pre-feeding) weight of surviving colonies was 51 lbs while in non-surviving colonies it was 30 lbs. After two years of the study only four of the original 20 colonies were still surviving – one BSS and three NWC/Russian.

The project findings confirmed that differences among stocks and sources can have important consequences for the success this beekeeping operation. Though there was variability within stocks, clear differences between the stocks emerged. Combined we lost 50% of the NWC/Russian and BSS colonies over the two years but 100% of the commercial Italian colonies. The Italian stock we had originally attempted to use in previous years was clearly not suited for this management system. Even in the two Italian stocks from Texas with claims of *Varroa* resistance, colony mortality was unacceptably high. Clearly the most promising stocks were the NWC/Russian produced by a beekeeper using organic methods and the local survivor colony. We found that both peak *Varroa* mite counts and pre-Winter colony weights were predictors of survival and could be used as a basis for selecting stock for propagation or possibly for more immediate management intervention to improve colony survival odds if necessary. In addition, the threshold of 50 mites per day seems to be a reasonably effective gauge for action. None of the hives with peak mite counts below 50 in a given year died in the subsequent Winter, while two-thirds of the hives that exceeded the threshold did not survive the Winter.

Table 1. Honey bee stocks evaluated and colony survival over two years under organic management, Berea, KY.

Stock	Description of stock	Initial number of hives	Number (percentage) surviving after one year[1]	Number (percentage) surviving after two years
Berea survivor stock	(BSS) Survivor stock derived from a single hive, probably of Italian stock established in 2001 that had not been treated with any miticides.	3	1 (33%) ab	1 (33%)
Italian-A	Commercial Italian stock from Georgia with no particular claims about traits.	6	0 (0%) b	0 (0%)
Italian-B	Commercial Italian stock from Texas with claims of varroa mite resistance and that no chemical miticides were used in the breeding operation.	3	2 (67%) ab	0 (0%)
Italian-C	Commercial Italian stock from Texas with claims of the SMR trait and that no chemical miticides were used in the breeding operation.	3	1 (33%) ab	0 (0%)
New World Carniolan/ Russian (NWC/Russian)	Semi-commercial stock from Georgia with claims that the bees are derived from open mating of New World Carniolan and Russian stocks and have been managed without chemical miticides.	5	5 (100%) a	3 (60%)

[1]Values within this column with different letters indicate significant differences in survival according to Fisher's exact test with Bonferroni's adjustment for multiple comparisons.

The apiary now consists of 13 hives, 11 of which are either original surviving colonies or new colonies derived from those two stocks (with open mating). Our immediate plan is to continue using the 50-mite threshold for treatment with powdered sugar, though the efficacy of the method is still unclear. We will also continue to propagate new colonies from those with the lowest peak mite levels and highest pre-Winter weights in order to maintain 10-20 hives. We've submitted an organic apiculture management plan to the Kentucky Department of Agriculture's Organic Program and are awaiting a verdict. With or without USDA organic certification, we'll continue to select stock that can survive with minimal intervention and no synthetic pesticides and explore alternative methods of suppressing mite populations. BC

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