The Effects Of Hive Color And Feeding On The Size Of Winter Clusters Of Russian Honey Bee Colonies

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Summary

This study determined the effects of hive color (black or white) and its interaction with feeding on colony growth of Russian colonies through the winter. One hundred and forty two colonies with pure-mated Russian queens were established. One half of them were in hives painted white and one half of them were in hives painted black. One half of each group was given only one gallon of sugar syrup to help assure survival. One other half of each group was continuously fed a small trickle of sugar syrup and pollen substitute from mid-November to mid-February. Colonies that were fed throughout the winter were 2.8 frames of bees larger than colonies that were minimally fed (Fed: 8.6 frames of bees, Minimally fed: 5.8 frames of bees). There was no difference in the size of colonies that were housed in black hives (7.3 frames of bees) and colonies that were in white hives (7.1 frames of bees).

Key Words: *Apis mellifera*, supplemental feeding, eight-frame hive, protein substitute, almond pollination

Introduction

Russian honey bees have been bred to have strong resistance to the parasitic mites *Varroa destructor* and *Acarapis woodi,* good honey production and strong overwintering abilities (de Guzman *et al.* 2001, 2002, Rinderer *et al.* 2001a, 2001b, 2001c). These breeding goals, begun in 1998, are still maintained as the Russian honey bee stock continues to undergo selective breeding by the Russian Honeybee Breeders Association (Brachman 2009). Russian honey bee stock can be used successfully, with only minimal treatment for parasitic mites, for honey production throughout the country.

However, the income base for many beekeepers in the United States has changed since 1998. Renting honey bee colonies for pollination has provided an increasingly larger share of the income of many commercial beekeepers with a large portion of this increase coming from the pollination of almonds. Colonies rented for pollination must meet size standards established in rental contracts with growers. Hence, many beekeepers who intend to rent colonies for almond pollination use colony management in an attempt to produce large colonies for mid-February (Traynor 1993).

Russian honey bee colonies build large populations in the spring after reliable natural pollen becomes available (Tubbs *et al.* 2003). Until then, the colonies are generally small and exhibit traits that favor winter survival such as using food frugally and producing a restricted late winter brood nest. That is, the colonies do not tend to grow in late winter and produce large colonies early. Italian colonies tend to produce large colonies early and often require substantial feeding to avoid starvation in early spring. It may be that restricted brood rearing in late winter contributes to overall resistance to *V. destructor* by favoring a winter die-off of mites infesting colonies. However, restricted winter colony growth is a disadvantage in attempts to produce large colonies by mid-February for almond pollination (Danka *et al.* 2006).

Typically, even among keepers of Italian honey bees, most beekeepers rely on special management procedures to build large colonies by mid-February. Italian honey bee stocks usually respond favorably to these techniques and large proportions of them remain or become large enough to be rented for almond pollination. Mostly these management techniques involve feeding individual colonies both a liquid sugar feed and a protein substitute, usually in patty form. Protein feeding is known to stimulate brood rearing (Danka and Beaman 2009, Degrandi-Hoffman *et al.* 2008, Mattila and Otis 2007, Nabors 2000, Peng *et al.* 1984, Standifer *et al.* 1973). The best timing, frequency and duration of feeding to prepare colonies for almond pollination rental are less well studied. In a study conducted by Degrandi-Hoffman *et al.* (2008), intermittent feeding of protein and carbohydrate syrup resulted in colonies that dwindled slightly while unfed controls dwindled by half. Rinderer *et al*. (2010) found that Russian colonies in eight-frame hives that were fed protein and carbohydrate syrup from October 2007 to February 2008 only dwindled slightly (0.3 frames of bees) by February. Unfed colonies lost about 2.3 frames of bees during the same period. In a second experiment, colonies in eight-frame hives fed from November 2008 to February 2009 grew about 3.2 frames of bees. Colonies in 10-frame hives that were fed grew less (2.5 frames of bees). Un-fed colonies in eight-frame hives grew only about one frame of bees and un-fed colonies in 10-frame hives remained about the same size.

One of our research goals is to identify management procedures which will improve the ability of Russian honey bees to meet the needs of pollination and especially almond pollination. The study reported here was undertaken to determine the effects of hive color (black or white) and its interaction with feeding on colony growth of Russian colonies through the winter.

Materials and Methods

The study was begun November 17, 2009 and final data were collected from the 18th to 25th of February 2010. One hundred and forty two colonies with pure-mated Russian queens were established. They were placed in five apiaries on four-way hive pallets. Colonies were in two eight-frame hive bodies with 16 Langstroth “deep” (9 5/8 in) frames of comb and one medium eight-frame hive body with four frames of honey and four empty frames.

When established, the colonies were evaluated for the presence of the queen and colony size. The numbers of bees on each side of each frame were estimated as tenths of the frame side covered with bees. Since commercial inspections of colony size for almond pollination consider 3/4 of a frame covered by bees to be one commercial frame of bees (Traynor, 1993), we calculated frames of bees by multiplying our estimate of full frames of bees by 1.25 to estimate commercial frames of bees. Colonies were equalized at the beginning of the experiment and averaged 8.9 ± 0.3 frames of bees.

Each group of colonies on a pallet was assigned one of four treatment groups: a) hives were painted black and fed through the experimental period, b) hives were painted white and fed through the experimental period, c) colonies were painted black and fed only minimally, and d) hives were painted white and fed minimally. Colonies that were fed received sucrose syrup fed from pails placed over holes in hive lids and patties of Megabee® pollen substitute. The pails had two small holes so that the bees only received a small but regular intake of syrup. The one-pound patties were placed between hive bodies over the cluster. Each week from November 17, 2009 to February 22, 2010 the colonies were inspected and feed was replenished as needed. Most colonies had adequate honey to survive the winter (8.1 ± 0.3 frames of honey) at the beginning of the experiment. However, after four weeks into the experiment all of the colonies assigned to the “minimally fed” control group (MFC) were provided 1 gallon of sugar syrup (1:1, sugar:water, w:w) to help provide adequate winter stores.

Final colony evaluations were made from February 18 to 25, 2010. Once again colonies were inspected frame by frame and colony size was estimated using the same procedures as mentioned previously. Data were standardized to correct for apiary differences. The data analyzed were in the form of “commercial frames of bees” (Traynor, 1993). Colony size could be affected by hive color and feeding, so the data were analyzed by a randomized block, two-factor analysis of variance. Data from 114 colonies were analyzed. One colony in a white hive that was fed had 21.6 frames of bees and was not included in the analysis since it was considered to be an extreme outlier. It disrupted the normality and variance of the data although its presence in an analysis of data lacking normality did not change main factor conclusions. Perhaps this colony had so many bees because of drifting. We do not know which colonies lost bees from drifting but, lacking evidence to the contrary, we assume that all treatments were equally affected. Twenty seven colonies (19%) were lost owing to queen losses, storm related mishaps (falling trees and hive covers blown off) and unknown causes. Losses were equally distributed across treatment groups (Black Fed = 7, White Fed = 4, Black MFC = 7, White MFC = 9. Shapiro-Wilk goodness-of-fit tests, along with an evaluation of the skewness and kurtosis measures, were used to evaluate the normality of the frequency distributions for colonies that were fed and colonies that were not fed. A linear regression was used to determine the relationship between initial colony size and final colony size (SAS 9.2, SAS Institute 2008).

At the evaluations at the beginning and the end of the experiment, samples of about 300 bees were taken from the brood nest of each colony. These bees were processed with a soap-washing technique (Rinderer *et al*. 2004) to remove *V. destructor* mites. Counts of both bees and mites in each sample were made and percentages of infestation were determined. Rates of infestation for each colony from the beginning and end of the experiment were used to determine mite population growth rates (MPG). MPG was standardized across apiary to control for any apiary differences and a correlation analysis was used to determine if larger colonies at the end of the experiment also had larger MPG (SAS 9.2, SAS Institute 2008).

Weather data were provided by the Louisiana Agriclimatic Information System (**http://www.lsuagcenter.com/weather**).

Results

Analysis of variance showed that there was a highly significant difference in size between colonies that were fed through the winter (Mean ± SD = 8.6 ± 0.5 frames of bees) and colonies that were fed sugar syrup only once (5.8 ± 0.5) ($P< 0.0001$) (Figure 1). The analysis also showed that there was no significant difference in the size of colonies that were housed in black hives (7.3 ± 0.5 frames of bees) and colonies that were in white hives (7.1 ± 0.6 frames of bees) ($P = 0.97$).

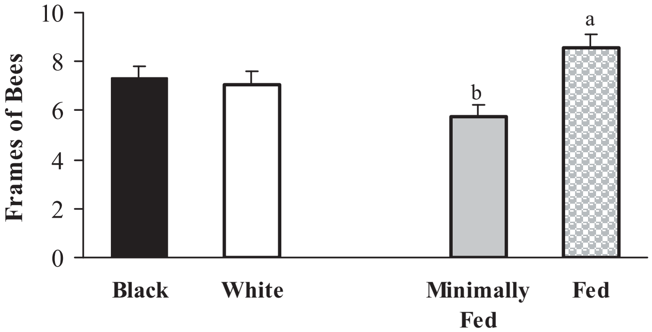

Figure 1 *– Commercial frames of honey bees in February for colonies that were overwintered in black or white hives and were either fed sugar syrup and Megabee® pollen substitute patties from November 2009 to February 2010 or fed one gallon of sugar syrup in November (minimally fed).*

An inspection of the distribution of colony sizes for colonies that were continuously fed and colonies fed only once suggests additional differences between the groups. The colonies that were fed were normally distributed for size (W = 0.99, P= 0.9008) (Figure 2). The colonies that were in the MFC group had a smaller probability of being normally distributed (W = 0.97, P = 0.2175) and appear to have a tendency to be bi-modal. Fewer mid-range colonies existed which could be included with larger colonies to make a group that met an average minimum grade.

There was no relationship ($P = 0.24$, $r^2 = 0.012$) between the initial colony size and the final colony size. While some colonies grew in size and others became smaller, the initial size did not predict the final size.

There was no relationship ($P = 0.11$, $r^2 = 0.023$) between the MPG and final colony size. There were also no differences in MPG in relation to color (Black: -0.02 ± 0.15, White: -0.07 ± 0.10, F = 0.09, P = 0.76) or treatment (Fed: 0.03 ± 0.14, MFC: -0.12 ± 0.11, F = 0.73, P = 0.39).

Discussion

Colonies that were fed had 2.8 more frames of bees than those that were miminally fed. This difference is consistent with the results of feeding in two prior years (2008 and 2009) (Rinderer *et al*. 2010). Colonies that were fed from November to February have been consistently larger through three years of experiments. In two experiments (this report and the experiment of 2008-2009), colonies that were fed continuously from November to February grew while colonies that were not fed or minimally fed became smaller.

This experiment used eight-frame hives since the experiments of 2007-2008 and 2008-2009 indicated that colonies in eight-frame hives grew a bit larger than hives in 10-frame hives from November to February. However, in all of these experiments, feeding had a much larger effect.

There are two important differences between this experiment and those reported by Rinderer *et al.* (2010). In this experiment, the surviving colonies that were fed began with 8.5 frames of bees and only grew by about 0.1 frames of bees while in 2008-2009 colonies that were fed continually from November to February grew by more than two frames of bees. It may be that the weather during the winter of 2009-2010 may have been unusually unfavorable (Figure 3). Average temperatures (and minimum and maximum temperatures) were significantly lower than average. Overall, the average daily temperature through the course of the experiment was 2.7ºC (4.9º F) below the long term average. Also, in this experiment, there was

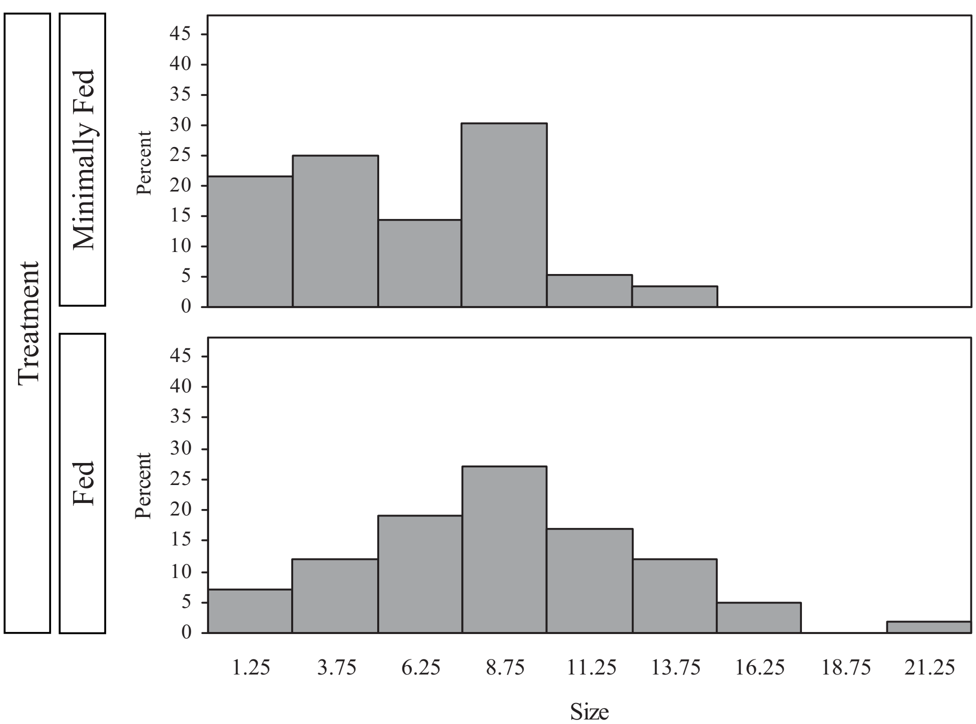

Figure 2 *– Size distributions in February of colonies that were fed sugar syrup and patties of Megabee® pollen substitute patties from November 2009 to February 2010 or minimally*

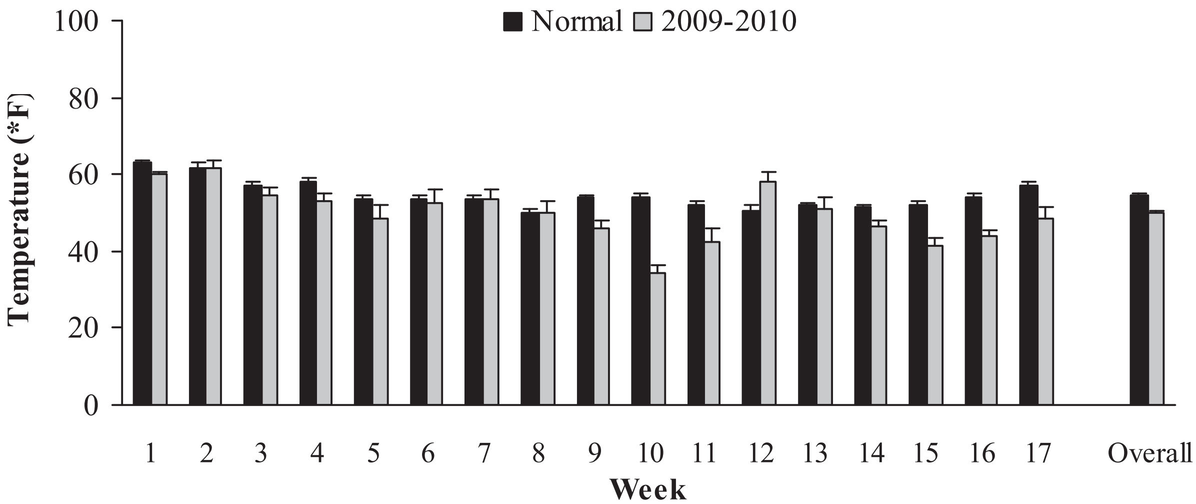

Figure 3 *– Normal average temperatures for the last 10 years and average temperatures from November 1, 2009 to February 27, 2010.*

no relationship between the initial size of surviving colonies and colony growth as there was in 2008-2009 when smaller colonies grew more. It may be that the relationship only occurs when weather is more favorable and colonies can grow substantially.

Not only did feeding produce colonies with a larger average population size, the distribution of sizes was somewhat different and together with differences in average size resulted in a positive change in the overall commercial value of the fed colonies as pollination units (Table). All surviving fed colonies averaged 8.6 frames of bees so the entire group could be used for a contract calling for an average of eight frames. In contrast, the smallest 22 colonies (39%) of the 56 that were minimally fed would need to be culled for the remainder to have an eight frame average. Also, a far greater proportion of the fed colonies were substantially larger than eight frames and were suitable for contracts requiring an eight frame minimum and contracts providing additional payment for larger sized colonies (Table). For example, 40 (69%) of the 58 colonies that were fed had eight or more frames of bees and averaged 10.5 frames while only 24 (43%) of the 56 colonies that were minimally fed had eight or more frames of bees and averaged a smaller 9.2 frames.

Painting hives was ineffective in producing larger colonies. Painting hives black was used as an alternative to wrapping colonies because it was necessary to open hives to feed protein patties. Evidently, the periodic warming of hives with solar radiation was inconsequential. It may be that insulating colonies by wrapping them would have favorable effects. However, wrapping hives would make it difficult to feed the colonies protein. Also, wrapping hives would not be a practical option for most migratory beekeeping.

The treatments had no effect on the growth of *Varroa* mite populations. The feeding produced larger colonies partly by supporting earlier brood production. However, the original numbers of *Varroa* mites were sufficiently low that the increased brood production was not accompanied by a similar increase in the numbers of *Varroa* mites.

Other techniques might be found that will enhance the development of Russian honey bee colonies through autumn and winter. However, it is clear that feeding Russian honey bee colonies syrup with a slow rate of intake and simultaneously feeding patties of pollen substitute will result in Russian colonies in February that are more than minimally acceptable for almond pollination. This is clear at least for beekeepers who overwinter their bees in the southern United States prior to moving them to California in February. This is less clear for beekeepers who overwinter in locations outside the southern states.

Treatment	Lost Colonies	All Surviving Colonies		Colonies > 6 frames			Colonies > 8 frames		
	N	N	Size	N	Percentage	Size	N	Percentage	Size
Fed	11	58	8.6	43	74	10.2	34	59	11.1
Minimally Fed	16	56	5.8	25	45	9.0	15	27	10.1

Table *– The number and average size of colonies that were fed and minimally fed, and the percentage and average size of both groups that were greater than six and greater than eight frames of bees in size.*

Conclusions and Recommendations

Russian honey bee colonies can be managed in the southern United States through autumn and winter to produce colonies which average eight frames or more of bees in February.

Colonies that are fed both sucrose syrup and protein supplement continually from November to February are much more likely to either maintain, or grow to, a large size.

Hive color does not affect colony size.

Earlier brood rearing stimulated by feeding did not result in significant increases in *Varroa* mite populations in Russian honey bee colonies.

Every successful change in beekeeping procedures requires learning and refinements by individual beekeepers. Beekeepers interested in changing their methods to include Russian honey bees, eight-frame hives or different feeding regimes should first attempt to make changes in half the colonies in one or a few apiaries. Doing their own controlled experiment will provide both an opportunity to evaluate the usefulness of changes in individual beekeeping enterprises and help develop the experience needed to perfect and adapt the changes to specific environments.

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