Sustainable Honeybee Strains for Western North Carolina

Final Report for FS10-244

Project Type: Farmer/Rancher
Funds awarded in 2010: $9,959.00
Projected End Date: 12/31/2011
Region: Southern
State: North Carolina
Principal Investigator:

Ryan Higgs
Blue Ridge Apiaries

Project Information

Abstract:

The sharp decline in the domestic honeybee population has been widely reported in recent years, as have been the consequences to a continued decline on agriculture dependent upon honeybee pollination. An annual national average for colony loss of thirty percent is not sustainable for beekeepers nor growers of pollinated crops. The culprits responsible for these losses are diverse, including varroa mites, tracheal mites, nosema, brood diseases, pesticides, and reduced forages. Thankfully, researchers have developed several strains of honeybees that have been genetically selected to include traits that are favorable to cope with some of these stresses. These improved stocks have inadvertently created a challenge for Southern beekeepers. With so many genetically improved strains appearing on the scene in a relatively short period of time, it is difficult for beekeepers to determine which strain is best suited for their circumstances. The introduction of each strain includes claims that are not only subjective, but are also relative in terms of utility and geography. For example, a colony that does well pollinating California almonds may not be the best colony to capitalize on Southern Appalachia's sourwood honey flow. Southern beekeepers need to understand how each strain will resist disease and pest pressures in their area, pollinate Southern horticultural crops, capitalize on local honey flows, and adapt to the local climate in general.

- Fall 2011

Introduction

This project studied three improved stocks: Minnesota Hygienic, New World Carniolan, and Russian bees. Each of these were developed to meet the challenges of modern beekeeping described above. It is important to understand the development of each strain as there are significantly different ideological differences.

Marla Spivak at the University of Minnesota is credited with the development of Minnesota Hygienic Bees. In the mid-nineties, she identified and genetically selected

for two recessive traits. Collectively, these traits are responsible for the behavior in honeybees involving the detection, uncapping, and removal of compromised brood from the nest. This double recessive trait has been shown to be very successful in limiting brood diseases such as chalkbrood and foulbrood, but also in reducing varroa mite pressure. Currently the University of Minnesota certifies the trait in three different commercial operations via the freeze killed brood assay, and allows those operations sell open-mated "Minnesota Hygienic" queens to the public.

Sue Cobey is credited with the development of the New World Carniolan line of bees. In establishing this strain, queens were collected from the U.S. and Canada that descended from Carniolan stock. Selected breeder queens were enrolled in a closed population breeding program that selected for brood viability, temperament, build-up, hygienic behavior, disease resistance, abscense of swarming behavior and honey production. New World Carniolan bees are available from several sources, none of which involve third-party certification.

Russian bees were imported from the Primorski region of Russia by the USDA. These bees coexisted with varroa mites for well over a century, and have adapted accordingly. After establishing the breeding program, the USDA Bee Lab in Baton Rouge handed off responsibility of the program to the Russian Honeybee Breeders Association, a small group of beekeepers dedicated to propagating the strain. The Baton Rouge Lab certifies stock for the Association via DNA analysis, who in-turn offers open-mated queens to the public.

Project Objectives:

The objective of the project was to evaluate the merits of each of the three stocks described above. The field trials conducted provided the opportunity for unique side-by-side comparisons. In conducting this research, the hope was to provide regional bee breeders with greater insight so that they could be in a better position to make informed decisions regarding their stock selection. In-turn, beekeepers purchasing such stock would be rewarded with locally adapted, genetically improved stock that fits their beekeeping needs.

- Spring 2010

Cooperators

- Seth Nagy

  seth_nagy@ncsu.edu

  Extension Agent

  120 Hospital Ave NE
  Suite 1
  Lenoir, NC 28645

  (828) 757-1291 (office)

- Dr. David Tarpy

  david_tarpy@ncsu.edu

Extension Apiculturist

North Carolina State University

1558A Gardner Hall Addition, North Carolina State University, Dept. of Entomology, Campus Box 7613
Raleigh, NC 2769-7613

(919) 515-1660 (office)

- Dr. David Tarpy

  david_tarpy@ncsu.edu

  Extension Apiculturist

  NCSU

  1558A Gardner Hall Addition, NCSU Dept. of Entomology
  Campus Box 7613
  Raleigh, NC 2769-7613

  (919) 515-1660 (office)

Research

Materials and methods:

The methodology of the project was to replicate a realistic regiment for a commercial beekeeper in Western North Carolina. This involved evaluating colonies in terms of pollinating apples, pollinating blueberries, and their ability to forage the sourwood crop. In doing so, colonies were weighed before and after each bloom with the difference representing productivity. This figure was supplemented by estimating the number of frames containing pollen or nectar in each colony before and after the bloom period for each forage.

Methodology for non-performance criteria included queen viability (size and density of brood pattern), varroa mite counts (via alcohol wash method), temperament (noting defensive behavior in response to a hand passing over top of frames), winter survival rates, and noting the presence of any brood diseases.

Each strain was represented by four colonies. Colonies that did not over-winter were replaced with representative substitutes. Outcomes should be considered in the context of the relatively small scope of the field trials. Queen quality, and consequently, colony performance can be highly variable in honeybee populations. It is inherently problematic to extrapolate broad generalizations regarding an entire strain of honeybee on the basis of the experiences involved with four representative members over the course of two seasons. Accordingly, this project is intended as a starting point for bee breeders and beekeepers in their own research regarding stocks to make their operations more sustainable.

- Summer 2010

Research results and discussion:

Foraging Related Results

This project found a direct correlation between colony size and pollination/foraging efficiency. The colonies that were the largest during a given bloom period were the colonies that were the most effective at capitalizing on those blooms. Since different stains build differently in the spring, colony populations can vary significantly when many common crops require commercial pollination. This was most evident with regard to the Minnesota Hygienic (Italian) stock versus the Russian stock. The former were on average twice the size of the later during the apple and blueberry bloom. Accordingly, the Minnesota Hygienic stock was much more efficient in pollinating those early season crops. However, by the time the Sourwood bloom occurred in July, the Russian colonies were at their peak and out-foraged the Minnesota Hygienic colonies on average. The New World Carniolan colonies were the outliers in this portion of the field trials. This stock has the reputation of explosive spring build-up, to the extent that many consider it to be a liability instead of an asset. The New World Carniolan colonies used by this project were characterized by slow spring build-up followed by moderate brood rearing throughout the season. This contradiction is suspected to be related to the late acquisition of the stock in season one and the inability to get the colonies adequately established before winter.

The correlation between colony size and pollination/foraging efficiency can be seen in the graphs attached below charting colony populations throughout the season. The data suggests that there are better bees for certain purposes than others. For example, Minnesota Hygienic (Italian) stock would appear to be the stock of choice when it comes to the commercial pollination of early flowering horticultural crops. Italian-based stocks begin brood rearing in this part of the country as early as February when the Maples begin to bloom. By contrast, Russian bees do not begin brood rearing until significant pollen and nectar is available later in the spring. The result of these contrasting genotypes can be seen as it relates to colony size in the growth curves below. On the other hand, the Russian stock used in this project showed rapid growth once adequate pollen and nectar were available and quickly caught up to the Italian-based stock by mid-summer. Therefore, beekeeping operations focused on mid to late season honey flows such as sourwood, goldenrod, and aster may benefit from using Russian stock.

- Growth Curves

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

Outreach will be offered through various western chapters of the North Carolina State Beekeepers Association.

Project Outcomes

Project outcomes:

Non-Foraging Results

Years ago the value of a colony would be judged primarily on honey production. However, times have changed, and beekeepers understand all too clearly that dead-outs do not produce honey. Therefore, this project included a number of assays and routine observations to compare the strains on non-foraging related quality concerns.

The first of these involves varroa mite resistance. For over twenty years, varroa mites have plagued the domestic beekeeping industry. All of the strains studied in this project were developed in this context and as a means to overcome it. Varroa mite counts were conducted via the "alcohol wash method" in mid-August of both seasons. This method reports infestations as a percentage, with a generally accepted 2% economic threshold at which many commercial beekeeper choose to treat. The Russian bees used in this project showed the most mite resistance (0.25%), followed by the Minnesota Hygienic (1.4%), the New World Carniolans (1.8%), and the control group (2.8%). The data highlights the benefits of selective breeding. The control group consisted of outcrossed Minnesota Hygienic queens (F1 generation) that averaged levels of infestation twice that of the certified Minnesota Hygienic colonies headed by open mated queens from an apiary saturated with hygienic drones. The same phenomenon was also seen with outcrossed Russian queens, where the rate of infestation shot up to 1.8% in F1 generation colonies. These numbers illustrate the importance of attaining stock from reputable breeders that can insure that they are providing adequate drone saturation.

Wintering-over ability was also a significant concern for the project. The Russian and Minnesota Hygienic bees each lost a colony through the winter, resulting in a 25% mortality rate. The New World Carniolan group and the control group each lost 2 colonies, resulting in a 50% mortality rate. These numbers should be considered in the context of the national average for 2010-2011 which as around 30% loss. Such dead-outs are often indicative of pest or disease problems, therefore samples were sent to the USDA where they are screened for varroa and tracheal mites as well as nosema spores. The Minnesota Hygienic dead-out tested high for nosema spores at 11 million spores/bee (treatment threshold generally considered to be 1 million spores/bee). All other dead-outs tested "clean". Admittedly, some of the colonies were borderline in terms of size going into winter, primarily due to the difficulty of acquiring the necessary stock early enough in season one. In all cases, the dead-out contained adequate honey, however the cluster may not have been able to access these stores during prolonged cold weather.

Queen quality is paramount in considering the value of any stock. It goes without saying that queen quality is highly variable. It is difficult to make accurate generalizations with only four queens per stock group to judge. Keeping this in mind, size and density of a queen's brood pattern is one objective measure of a queen's value. Brood patterns were rated on a scale of 1 to 4, with 4 being worthy of breeder queen consideration, and 1 being a candidate for requeening. The Minnesota Hygienic group scored a 3, the New World Carniolan a 2.75, and the Russian a 3. What stood out here was not the differences in brood patterns among the different stocks being studied, as much as the differences between these patterns collectively in relation to those of the control group, and more so in contrast to the brood patterns of "factory queens" witnessed in the past. During the peak brood rearing season, the Minnesota Hygienic, New World Carniolan, and Russian queens generally were laying several frames of solid brood that were in stark contrast to the spotty, smaller patterns of queens from queen producers focused on mass production.

The final non-foraging consideration to discuss is temperament. Admittedly, this is

the most subjective of the qualities being trialled. A simple assay consisting of passing a hand across open brood boxes and noting any aggressive behavior that this caused was used as a way to objectify the study. This in combination with general observations during routine hive inspections provided a well-rounded perspective of the variations in temperament among the different stocks. The New World Carnions were easily the least defensive. Even during less than ideal weather conditions or rough handling, these bees were remarkably docile. By contrast, the Russian bees were certainly the most defensive. During ideal conditions (fair weather during a good nectar flow), working these bees were very similar to the Minnesota Hygienic bees. However, working these bees in less than ideal conditions, such as poor weather, during a dearth, or shortly before sunset often resulted in aggressive behavior. The Minnesota Hygienic bees were found to be similar to their Italian parentage in that they are generally easy to work, but potentially get defensive when provoked.

- Summer 2011

Recommendations:

Potential Contributions

Use-Specific Bees

The preface to a discussion of this project's findings should always include the statement that there is no "silver bullet." There is no super bee that rids the beekeeper of all the concerns of modern apiculture. However, the hope is that through this project, beekeepers will begin to understand that some bees may be better than others for specific purposes. For instance, if you make a living pollinating early blooming horticultural crops, Minnesota Hygienic bees may be a way to lessen reliance on expensive miticides without compromising early season colony strength. By contrast, a hobby beekeeper concerned only with bottling Sourwood honey may benefit from stocking Russian bees that don't require time consuming sampling for varroa mites. Or perhaps a u-pick operation would benefit from the docile nature of New World Carniolans to pollinate their blackberries without the concern of customers getting stung.

The merits of all of these improved stocks are dependent upon several important factors. First, any stock is only as good as its source. Reputable breeders control the maternal lines by carefully selecting breeder queens based on desired characteristics that have been meticulously recorded. These same breeders should have sufficient drone mother colonies of equal quality to provide adequate drone saturation. Second, beekeepers should plan to re-queen colonies annually or bi-annually to prevent superscedure and the resulting dilution of desirable traits. Thirdly, improved stock is not a substitute for poor management

Future Recommendations

As the beekeeping industry continues to evolve and adapt to the pressures created by globalization, modern agriculture, and the changing environment, genetic selection will be an increasingly used tool in the beekeepers' toolbox. It is rather impressive when one considers how far the industry has come in a relatively short period of time. The idea of selecting for traits that enable bees to coexist with threats such as varroa mites is becoming mainstream, whereas just a few years ago the norm was treating with hard chemicals.

As research continues to lead the industry toward sustainability, genetic selection

will have to be balanced with the preservation of genetic diversity. The honeybees of the future need not only be equipped for today's problems, but also for tomorrow's. In this rapidly evolving environment, the need for further field trials and research will be of continued interest to the beekeeping industry as well as the broader agricultural sector that depends on honeybee pollination.

SARE Sustainable Agriculture Research & Education US Department of Agriculture

This site is maintained by SARE Outreach for the SARE program and is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award No. 2019-38640-29881. SARE Outreach operates under cooperative agreements with the University of Maryland to develop and disseminate information about sustainable agriculture. USDA is an equal opportunity provider and employer.
