NORTHEAST SARE Sustainable Agriculture Research & Education

They Keep Bees

Anarchy Apiaries

UMass Extension

Roads to Royalty:

Comparing three methods of queen production

During 2019-2021, UMass Extension collaborated with queen breeders from They Keep Bees (Montague, MA) and Anarchy Apiaries (Hudson Valley, NY) to conduct research on queen rearing methods in the Northeast. There are many benefits to keeping northern queens in northern climates[1]; however, queen rearing is too complicated for many backyard beekeepers (who comprise ***most*** beekeepers in states like Massachusetts). Unfortunately, there hasn't been much research on simpler queen rearing methods.

We wondered: could simpler methods produce queens that are *as good as* those produced through traditional methods? This fact sheet summarizes the results from that research. *Click here to find more information about the project, including a research talk and a multi-media Queen Rearing Guide.*

METHODS: Overview

WE RAISED QUEENS IN THREE WAYS:

Traditional 10-day grafting method (94 queens)

Invented in the late 19th century, this is the gold standard for queen rearing. The beekeeper grafts young larvae into queen cups, which are placed in a nutrient-rich starter hive. 10 days after the graft, the queen pupae are transferred into mating nucs. This method is the most complicated, but gives beekeepers the most control over rearing conditions, and reliably produces high quality queens.

*Queen pupa, **10 days** after grafting*

Abbreviated 2-day grafting method (113 queens)

This is an abbreviated version of the 10-day method, where queens are placed into mating nucs 2 days after the graft. It is easier than the 10-day method, but gives beekeepers less control over larval rearing conditions. It is a new and unstudied technique.

*Queen larva, **2 days** after grafting*

Walk-away method (108 queens)

Beekeepers can also rear a new queen by splitting a colony (one of the subsequent hives receives the old queen; one rears a new one). This is a common and relatively easy queen-rearing method, but it gives the beekeeper little control over rearing conditions, and there is little research on it. In order to simulate this method, we removed queens from mating nucs, and allowed them to raise a new queen.

A frame with eggs could become queens

METHODS: Detailed

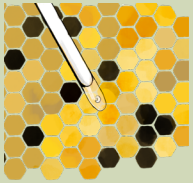
*Queens in **starter hive***

*Queens in **mating nuc***

10-Day Grafting Method

Day 0: *egg laid by origin queen*

Day 2: *beekeeper makes queenless starter hive*



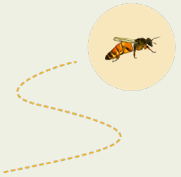
Day 3: *beekeeper grafts young larvae and places in starter hive*

Day 5: *beekeeper checks graft and leaves in hive*

Day 8: *worker bees cap the queen cells*

Day 12: ***10 days after grafting****, queen pupae are put in mating nucs*

Day 15: *queen emerges*



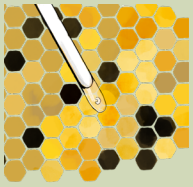
Days 16-29: *queen matures and goes on mating flights*

Day 30+: *beekeeper checks nuc for laying queen*

2-Day Grafting Method

Day 0: *egg laid by origin queen*

Day 2: *beekeeper makes queenless starter hive*

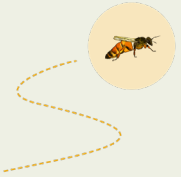


Day 3: *beekeeper grafts young larvae and places in starter hive*

Day 5: ***2 days after grafting****, queen larvae are put in mating nucs*

Day 8: *worker bees cap the queen cells*

Day 15: *queen emerges*



Days 16-29: *queen matures and goes on mating flights*

Day 30+: *beekeeper checks nuc for laying queen*

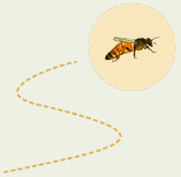
Walk-Away Method

Day 0: *egg laid by origin queen*

Day 2: *beekeeper removes origin queen from mating nuc*

Day 8: *worker bees cap the queen cells*

Day 15: *queen emerges*



Days 16-29: *queen matures and goes on mating flights*

Day 30+: *beekeeper checks nuc for laying queen*

METHODS: What we measured

ON DAY 30, WE CHECKED THE NUCS TO EVALUATE **QUEEN QUALITY***:

Field Data (all 314 queens)

1. Was the queen in the hive and **successfully mated**?

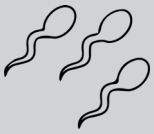
2. Worker population size in the nuc: small, medium or large?

Lab Data (subset: 51 queens)

*We sent a subset of the queens to the Tarpy Lab at NCSU, where they were analyzed for **markers of queen quality**, including:*

1. Morphological features (weight, size)

2. Insemination features (amount and viability of stored sperm in spermatheca)

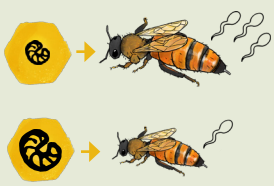


*What is **Queen Quality?**

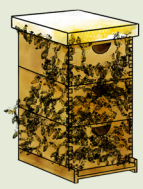
1 Queen Quality refers to the queen's **reproductive potential** or her ability to lay lots of viable eggs, that will grow into healthy bees

2 Queens mate during a two-week window after they emerge, and then store sperm in their bodies for the rest of their lives. Their reproductive potential is largely determined by the **amount of sperm** that they store, and the **viability of that sperm.**[2,3]

3 **Rearing conditions** affect sperm storage and viability: the younger a larva when she begins to receive a lavish queen diet, the more queen-like she becomes: bigger, with better-developed reproductive organs, and the ability to store more viable sperm.[4]



4 More complicated queen rearing methods (like 10-day grafting) give a beekeeper more control over larval age and nutrition, and therefore (theoretically), more control over queen quality.

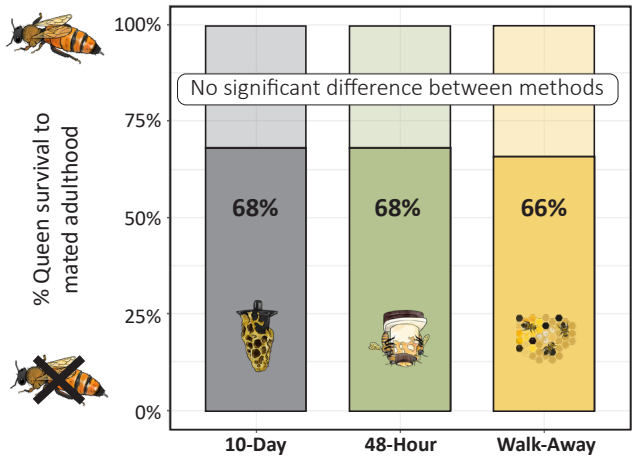


RESULTS

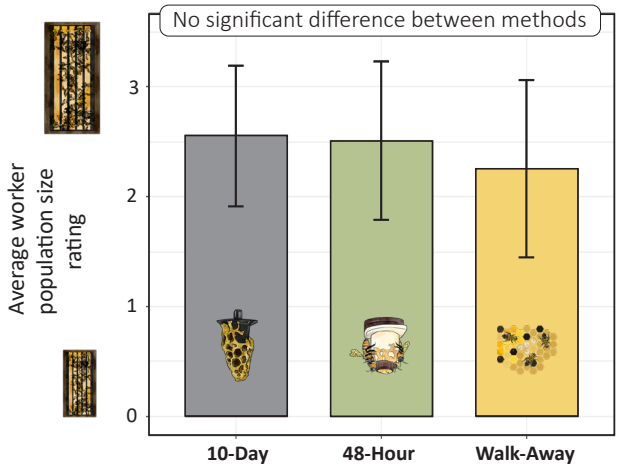
**Morphological grade incorporates weight, thorax width and head width. Insemination grade incorporates sperm count, viable sperm count, % sperm viability, spermatheca size and % spermatheca filled. For all figures, error bars show standard deviation.*

FIELD DATA

% Queen Survival

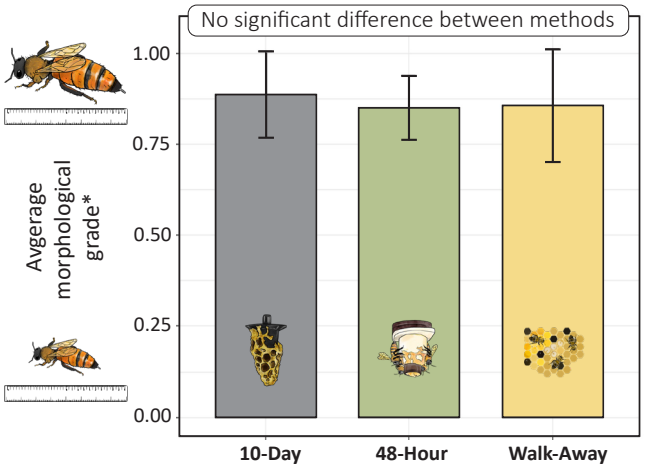


Nuc Population Size

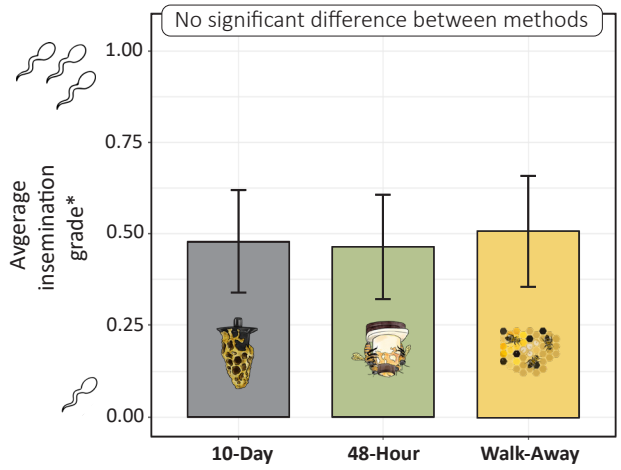


LAB DATA

Queen Size



Mating Characteristics



CONCLUSION

Queen SURVIVAL, SIZE and MATING CHARACTERISTICS, as well as NUC POPULATION SIZE, did not differ by rearing method

This is a surprising and promising finding.

It suggests that 2-day and walk-away methods could be ***as effective as*** traditional grafting methods for producing high quality queens.

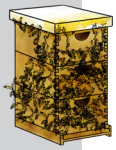
FUTURE QUESTIONS

These results open up new questions, including:

1. It appears that these three queen types are equivalent physiologically, but how do they perform once placed in a hive?

What would we find if we compared brood pattern, overwintering, disease, etc.?

2. It appears that walk-away splits are as good as grafting methods for producing high quality queens.



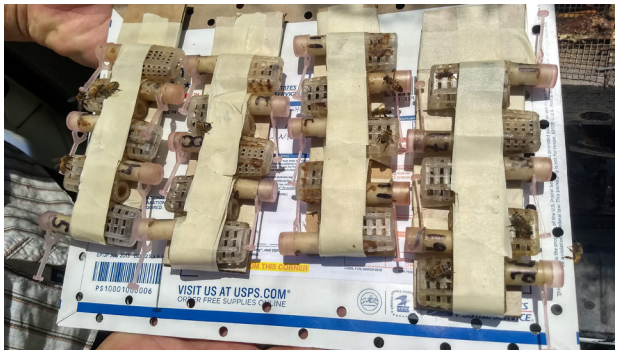
Yet there are many ways to make a walk-away split: which method is the best?

PHOTOS

Ang Roell (right) and Bi Kline check nucs for laying queens

Sam Comfort catches a newly mated queen

Warre mating nucs at Anarchy Apiaries



Queens ready for shipment to the Tarpy Lab for analysis

Text and design by Hannah Whitehead. Original artwork by Hang Tran, Artist, created for Queen Rearing Calendar by They Keep Bees. Photographs by Hannah Whitehead. Editing help from Lynn Adler and Ang Roell. Research conducted in collaboration with They Keep Bees (Ang Roell, Bi Kline) and Anarchy Apiaries (Sam Comfort). This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under subaward number ONE19-326.

Citations:

1. MacGregor-Forbes, E. 2014. "Sustainable Agriculture Research and Education (SARE) Outreach, USDA- National Institute of Food and Agriculture (NIFA) Annual Project (FNE12-1756)
2. Rangel, J., J. J. Keller, and D. R. Tarpy. 2013. "The Effects of Honey Bee (Apis Mellifera L.) Queen Reproductive Potential on Colony Growth." Insectes Sociaux 60 (1): 65–73. https://doi.org/10.1007/s00040-012-0267-1.
3. Amiri, Esmaeil, Micheline K. Strand, Olav Rueppell, and David R. Tarpy. 2017. "Queen Quality and the Impact of Honey Bee Diseases on Queen Health: Potential for Interactions between Two Major Threats to Colony Health." Insects 8 (2). https://doi.org/10.3390/insects8020048.
4. Tarpy, David, J J. Keller, Joel Caren, and Deborah Delaney. 2011. "Experimentally Induced Variation in the Physical Reproductive Potential and Mating Success in Honey Bee Queens." Insectes Sociaux 58 (November): 569–74. https://doi.org/10.1007/s00040-011-0180-z.