

Effects of Colony Creation Method and Beekeeper Education on Honeybee (*Apis mellifera*) Mortality

Abstract

The two-part study reported here analyzed the effects of beekeeper education and colony creation methods on colony mortality. The first study examined the difference in hive mortality between hives managed by beekeepers who had received formal training in beekeeping with beekeepers who had not. The second study examined the effect on hive mortality between hives that were initiated as nucleus or package colonies. Colonies created from package bees were more likely to survive for 1 year than nucleus colonies. Colonies managed by beekeepers who had received formal education also exhibited better survival rates than those managed by non-educated beekeepers.

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Introduction

Honeybees (*Apis mellifera*) are one of the more prolific crop pollinators, and without their contribution much of today's agricultural production would come to a halt. Honeybee losses due to colony collapse, disease, adverse weather, and poor management could increase the vulnerability of some plant species to extinction (National Research Council, 2007). For the past 6 years, average annual honeybee mortality rates in the United States have been 30.5% (Kaplan, 2013). Colony mortality in the United States from 2012 to 2013 was 31%, up 9% from the prior year (Project Apis Melifera, 2013). Honeybee losses are a concern in other countries. For example in Denmark researchers found that on average one in four colonies succumbs annually (Wageningen, 2014).

Current research has focused on improving management practices to increase honeybee and other pollinator populations. A National Research Council report from 2007 stated, "Effective conservation or restoration of pollinator populations requires comprehensive knowledge of their biology, which is currently insufficient to inform the design of sustainable management and maintenance programs" (National Research Council, 2007).

Educational programs to increase the awareness of the plight of honeybees have been offered by

Extension educators. One group of educators, using an observation hive with live honeybees, taught students how bees work together to produce honey. The training explained to students the role agriculture plays in our lives. Prior to the training, only 34% of students believed that agriculture affected their lives. After the training, this percentage had risen to 61% (Luckey, Edwards, Murphrey, & Cummins, 2013). Extension educators believed that beekeepers themselves could be more successful with increased awareness and education regarding the challenges of beekeeping.

Extension educators in Southern Idaho initiated research designed to study the effects of colony creation methods and beekeeper education on honeybee colony longevity. Educators believed that through an educational workshop beekeepers would become more knowledgeable about best management practices and be better equipped to keep colonies alive through the year. Educators also wanted to learn which hive creation method resulted in increased colony longevity. In order to test this theory, an educational program was initiated. The program included lectures, hands-on workshops, and observational analysis to determine the effects of colony creation and beekeeper knowledge on the longevity of honeybee colonies. Our research question was as follows: Is the survival of the colony affected by the manner in which it was initiated or created and by the training and education of the beekeeper?

Methods

Extension educators in Southern Idaho conducted a two-part workshop in May of 2013 for new beekeepers. The workshop lasted 1 day. The two sections of the workshop constituted the two experiments of the study. The first section studied the effects of education of the beekeeper on hive longevity, and the second studied the effects of hive creation method on hive longevity.

The first section of the workshop taught the basics of beekeeping and best management practices designed to keep honeybee colonies alive. Not all of the new beekeepers were invited to attend this educational activity. Specifically, 30 beekeepers attended this section of the workshop, and an additional 26 beekeepers did not attend. This gave the authors two treatments for the first study, namely educated and non-educated beekeepers. Those who attended the workshop and received the beekeeping education will be referred to as "educated beekeepers" in this article. Beekeepers who did not receive this specific education constituted a second group referred to as "non-educated beekeepers." The study measured the effects of this single educational activity. Specifically, the study evaluated whether beekeepers who received beekeeping education had better success at keeping colonies alive until the next spring than non-educated beekeepers. The authors understand that there are many ways to learn beekeeping. Topics for this educational section of the workshop included:

- Honeybee disease identification
- Disease treatment and medication including mite control
- Honeybee feeding
- Colony health evaluation methods
- Honeybee nutrition

- Introduction of a new queen
- Protecting pollinators from pesticides
- Queen, worker, and drone identification

The second section of the workshop consisted of the distribution of two types of honey bee colonies. The second section of the workshop did not include any educational activities, hands-on training, or counseling. This section of the study evaluated the effects of colony creation methods on colony mortality rates. Two methods were used to create new colonies of honeybees. The hives were created prior to the workshop. The two methods gave the authors the two treatments for the second study. The two methods were the following.

Nucleus Colony: transferring bees, brood, honey, and pollen located on a comb taken from an existing colony. These stores were placed into a new hive box. Then a new queen was introduced to these bees. Nucleus colonies are essentially a split or a division from an older colony. The benefit of a nucleus colony is that the hive has brood, food, and comb from the inception. Other methods of colony creation begin without the benefit of these stores, and the honeybees have to expend energy to acquire them.

Package Colony: transferring a four-pound group of young bees into a new hive box and introducing a new queen. The benefit of this method is that the colony gets a fresh start. This method usually has less disease build up since no brood or comb is transferred.

Following the educational and colony distribution sections of the workshop, beekeepers were allowed to take colonies home and manage them for 1 year, from May 2013 to April of 2014. Individual beekeepers managed from one to six colonies. After 1 year, colonies were visually examined to determine if they had survived. Fifty-six beekeepers participated in the study and reported on the success or failure of 137 colonies. The reports were completed in the spring of 2014.

All observations of the colonies were recorded as counts or enumeration data. Observations of the colonies fell into two categories, alive or dead. The observational data were analyzed using a binomial distribution. Each count, or data point, was associated with the treatments of the study. These treatments included the colony creation method and the education of the beekeeper managing the colony. Treatment effects were analyzed using chi-square (χ^2) analysis. Contingency tables were calculated and ratios were evaluated to determine if treatments affected colony mortality.

Results and Discussion

Beekeeper Education

The education level of the beekeeper had a significant effect on colony mortality. Beekeepers who had been instructed in best management practices for apiaries had 14% fewer colony deaths after 1 year (Table 1). The authors assume that this reduction in deaths is due in part to an increase in awareness of the educated beekeepers of the status of the hive. It is also assumed that the results demonstrate

that educated beekeepers were better prepared to take action when threatening issues developed in the apiary. The time spent on education resulted in fewer losses of valuable honeybee stocks. Non-educated beekeepers experienced greater colony losses during the first year of establishment.

Table 1.

Honeybee Mortality Study- Beekeeper Education Analysis

Treatment	Dead	Alive	Total Colonies
Educated Beekeeper	24 (26%)	70 (74%)	94
Non-educated Beekeeper	17 (40%)	26 (60%)	43
Totals	41	96	137

The ratio of alive/dead colonies was greatest for educated beekeepers. The Chi squared statistic was 2.74, indicating a significant difference at alpha = 0.05.

Colony Creation Method

Colonies created as package colonies exhibited 23% higher survival rates (Table 2). Package colonies are created using young worker bees (Blackiston, 2002). These younger bees have less disease (Shimanuki, Knox, Furgala, Caron, & Williams, 2003), particularly nosema, a dysentery malady (Findlay, 2010) (Shimanuki & Knox, 2000). This method also introduces lower levels of pathogens because no wax comb, wooden frames, or other hive construction materials are transferred to the new colony. The use of all new equipment in package bee colonies resulted in lower disease pressure, which may contribute to higher survival rates.

Table 2.

Honeybee Mortality Study - Colony Creation Analysis

Treatment	Dead	Alive	Total Colonies
Package Colony	8 (14%)	51 (86%)	59
Nucleus Colony	29 (37%)	49 (63%)	78
Totals	37	100	137

The ratio of alive/dead colonies was greatest for package bees. The Chi squared statistic was 9.48, indicating a significant difference at alpha = 0.05.

Conclusion

Beginning beekeepers have many questions as they initially set up their apiary. Of paramount concern is the type of colony they should use to begin their operation. Colonies are either created as nucleus colonies or as package bee colonies. In the past Extension educators had no information to make a reasonable assumption as to which type should be used by beginning beekeepers. The study reported here demonstrated that colonies that were originally created as package colonies exhibited increased survival rates compared with nucleus colonies. These types of colonies do not have older materials

such as comb, honey, pollen, or brood at the onset of creation. The comb and other stores can harbor disease and also carry pesticides that would reduce the health of a new colony. Nucleus colonies are created with stores that may be contaminated. Nucleus colonies are more difficult for the beginning beekeeper to manage and keep alive due to the increased disease and pesticide pressure.

The role of education in beekeeper success also needed illumination. Beginning beekeepers needed to know if the added cost and time involved in receiving education would be valuable to the operation. The study found that beekeepers who received education were more likely to maintain healthy colonies that survived for at least 1 year. The authors assume that the increased knowledge and awareness beekeepers gained at the workshop gave them an advantage over non-educated beekeepers. The educated beekeepers learned skills to evaluate and monitor their colony. These skills helped them diagnose and treat disease earlier and more effectively. The added effort and cost of education resulted in higher survival rates of valuable honeybee colonies.

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