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On-farm Evaluation and Demonstration of Small Hive Beetle (*Aethina tumida*) Trapping Technology

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Abstract: On-farm Evaluation and demonstration of small hive beetle (Aethina tumida) trapping technology was conducted in the 2018/2019 in West Shoa zone, Bako Tibe district to evaluate the effectiveness of the trap, to minimize the absconded of honey bees and produce quality, honey. One representative PA was selected based on honey production potential and accessibility for field monitoring and visit. Beneficiary farmers were selected based on the criteria and objective of the AGP II (Agricultural Growth Program II,) and the willingness of farmers to participate in the demonstration. The FREG members include 20 beekeepers (5female and 15 men.) The training was given for beekeepers, Woreda experts, and DAs.20 Langstroth hives (10 treatments and 10 control colonies) were established at one apiary site. Pieces of corrugated cardboard (45 cm × 45 cm), with one surface peeled to expose the ridges, were placed on the bottom board of each beehive with the ridged side down for treatment group hive. Small hive beetle adults and larvae were trapped counted, removed, and burned. Honey bee colonies from the treatment group were not absconded whereas the control group honey bee colonies were more absconded. The honey yields were obtained from the treatment group 16Kg/hive/season and 7Kg/hive/season from the control group. The number of small hive beetle adults and larvae counted from the cardboard was decreased through data collection season. The FREG members appreciated the technology; therefore, further scaling up of this technology should be conducted in different areas of beekeeping.

Keywords: Beetle, Cardboard, Langstroth, Larvae

1. Introduction

The health of managed and wild honeybee colonies has declined substantially over the past few years [13], and a drastic decline in honeybee populations poses a threat to agricultural sustainability and food security as well as to the ecosystem. Currently the loss of honey bees increased because of different reasons. Small hive beetle is one of the causes which are decreasing the number of colonies. Small hive beetle, *Aethina tumida* is known as a major pest and scavenger of honeybees [24, 14]. During the last 25 years, Small hive beetles were introduced into many countries worldwide, leading to economic, societal, and ecological consequences for apiculture [19]. The beetle is likely to continue spreading in the future in different countries [6]. It is becoming a serious threat to the long-term sustainability and economic prosperity of beekeeping.

The small hive beetle is indigenous to Africa, where it was previously considered as a minor pest for bee colonies of African honeybees (*Apis mellifera*) [16]. Nests of social bees not only provide comparatively rich food resources for small hive beetles but also protection from a range of environmental hazards [17], e.g. almost half of the small hive beetle population (44%) was recorded outside hives during hot months, but during cooler times, small hive beetle populations were predominantly within hives [2]. However, in such nests, small hive beetles are facing defenses from the host workers thereby resulting in a trade-off scenario between highly rewarding food and the danger of injury.

Currently, the beetle is widespread in different states of the world, including Europe [5, 12, 9]. In Ethiopia, small hive beetle was lately detected in southern and southeastern parts of the country in 2000 reported by [7]. Eight years later the pest was detected with the highest distribution and prevalence rates

in most beekeeping potential areas of the country [1]. Adult and larval beetles can be a significant problem in the honey house [16]. Both the larvae and adults of small hive beetles live in honey bee colonies, where they feed on pollen, brood, and honey, but the larvae inflict the most damage [10]. On the other hand, as a minor result /effect of adult and larval feeding, stored honey in a colony is rendered useless as it quickly pollutes and ferments due to significant beetle populations, likely remaining to beetle defecation [16, 23, 10, 15]. Adults invade honey bee colonies, where they lay eggs in crevices and on the combs. For pupation, the larvae crawl out of the hive and burrow into the surrounding soil where the moisture level is suitable for pupation [20]. Upon exclusion from the ground, adult beetles search for honey bee colonies, probably identifying the host colony by a suite of olfactory cues [20]. The small hive beetles has been shown to cause significant damage to honey bee colonies that are weak or under great stress, but also effects strong bee colonies to the point of absconding [8]. As the result of Studies have shown that beetles fly before or just after dusk and attracted to odor from various hive products (honey, pollen) and particular pheromone from adult bees (isogamy acetate) [22, 11]. Small hive beetles pests are strong fliers from hive to hive, and between apiaries in search of suitable places to get food and to reproduce. In severe infestations, the bees are generally forced to leave their hive and depressingly affect the beekeeping production [22]. Moreover, the effect of this pest cause defecation in the hives and on the comb honey can cause honey fermentation that decreases the honey quality [10]. The SHB negatively affects honey bee colonies by eating unprotected bee brood, eggs, honey, and pollen [9]. At different stage especially, trapping larvae as they leave the hive to pupate might be a good way to control SHBs, as this method could break the SHB lifecycle [3] tested a larval trap that they mounted below the hive entrance.

An investigation on the effects of small hive beetle on honeybees and the effectiveness of different control methods was conducted at the Bako apiary site from the years 2010 to 2012. From all the treatments and control colonies, the control hives, trapping of adult beetles using cardboards over the bottom boards revealed about 78% control efficiency and reduces honeybee colony absconding [21].

Therefore, on-farm evaluation and demonstration of this technique was a help to develop reasonable prevention and/or control measure at the farmer's situation with the objectives of to evaluate and demonstrate the effectiveness of small hive beetle trapping at farmers level, to increase honey production and quality by preventing /controlling small hive beetle infestation, awareness creation on small hive beetle trapping technology and to minimize the loss of honey bee colonies caused due to small hive beetle infestation.

2. Material and Methods

2.1. Site and Farmers Selection

The study was conducted at Bako Tibe district of the West Showa zone. One appropriate peasant Association was purposively selected at Bako- Tibe district based on the criteria and objectives of the Agricultural Growth Program (AGP-II) project. The activity was carried out with farmers' Research Extension Groups (FREG). FREGs with 20 beekeepers (15 male and 5 female) were established to facilitate farmers participation in demonstration and training on trapping technology. Pre-training was taken for the FREG members on the implementation of trapping materials and regular monitoring of the pest.

2.2. Farmer's Training

After identifying farmers, practical and theoretical training were provided to the district experts, development agents, and farmers. Theoretical training was given for group members on small hive beetle trapping and its utilization before colony transferring. The training was one of the most important FREG approach used. The training enabled them to develop skills on the general management practices of trapping technology, when and how small hive beetle larvae and adult were controlled from honey bee colonies using cardboard.

Table 1. *Number of participants before colony establishment.*

FREGs groups	No. of beekeepers		Woreda experts		Total Participant
	Male	Female	Male	Female	
Bako- Tibe	15	5	6	0	26

Figure 1. *Training for beekeepers, how to use the trap.*

2.3. Experimental Setup

Ten Lang troth type hives were modified with open underneath on the bottom board and covered with mesh wires (treatment groups). Another 10 Lang troth type hives without modification were used as (control groups). An effort was made to reduce the number of small hive beetle adults and larvae present in colonies. All Lang troth hives were new and previously unused at the beginning of the study. A total of 20 honeybee colonies (10 into treatment and 10 in to control groups) were transferred. Both treatment and control colonies were fed 1:1 sugar/water every dearth period/season. Then for all treatment groups, pieces of corrugated cardboard (45 cm × 45 cm), with one surface peeled to expose the ridges were placed on the bottom board of each beehive with the ridged side down. Under neath of the frames on the bottom board was covered with mesh wires which allow small hive beetle to enter and hide in the corrugations, but exclude honey bees to fit the bottom board. Corrugated cardboard insert was removed after a few hours and replaced every 21 days to examine small hive beetle dropped population number measures. The cardboard creates a place for the beetles to hide where they come in contact with the insecticide [18]. Then, broken, open the cardboard peeled back and the number of adults and larvae of small hive beetles' lives were counted removed.

2.4. Data Collection

Number of small hive beetle larvae and adults, acceptance of technology, and many beetles captured in each trap, honeybee colony absconding rate, and honey yield were recorded.

2.5. Data Analysis

Quantitative data were summarized using simple descriptive statistics (average and Percentage) while the qualitative data collected using group discussion and qualitative data collected using group discussion, field observation, and oral histories were analyzed using narrative explanation.

3. Result and Discussions

3.1. Technology Evaluation and Demonstration

To have healthy and productive bee colonies beekeepers and other beneficiaries used different methods to protect and minimize the small Hive Beetle pest from their hives and apiaries. On-farm evaluation and demonstration of the bottom board trap trial was implemented on FTC (farmers training center). The evaluation and demonstration of the trial were followed by the process of demonstration approach by involving FREGs, development agents, and experts. Awareness creation on trap helped beekeepers to minimize small hive beetle adults and larvae using the effective management of bee colonies. During every observation/inspection/ time there were small hive beetle larvae and adults found in colonies. At the time of data collection larvae and adult SHB were collected by the trap. When the beetles attempt to hide from light and move to the cardboard they come into entering cardboard trap after a 24 hours the cardboard removed and the dropped small hive beetles were counted.

As the technology is simple to understand for beekeepers, all group members practically done on the entering and outward of the trap, identifies the effect of adult and larvae of small hive beetle and their effects on which product.

Table 2. *Numbers of A. tumida adult and larvae captured by the bottom board trap during trapping periods in February up to May.*

Apiary site	Hives	Total larvae	Total adult	Average	
				Larvae	Adult
Tibe-Bako	10	16	681	3.2	97.2

3.2. Farmers Research Extension Group Capacity Development

All hives and other beekeeping equipment were distributed by the fund of AGP-II for farmers group (materials incentives and technical training). Fulfilling some materials for beekeepers increases the interest of them on participating on the all parts of the works. The funded materials include the introduction of Lang troth hives, honey extractors, smokers, hive tools, hand gloves, veils, etc. Group members were trained in all aspects of the small hive trap using cardboard. A small hive beetle trapped was seen and or dropped at an experimental site in mass during the training time and demonstrated to all participants. Practical training was given for FREGs members at the apiary site on SHB trap technology, this includes mainly based on the importance of technology (hive stand making cardboard peeled and inserting, as soon as the hive opened and used the light small hive beetle move from the colonies and hide in the peeled cardboard). Training is the most important part of this activity and it was delivered to the, 20 beekeepers target farmers (15 males and 5 females. Concerning the cardboard technology, it was found that all members of the formed beekeeping groups fully agreed on the tarp irrespective of their gender.

According to the participant / beekeepers feedback small hive beetles protection /minimize is a good method for honey production and honey bee colony absconding rate minimize. All participant farmers were very much engaged and attracted to use this trap to small hive beetle minimize from their honey bee colonies.

3.3. Effect of Small Hive Beetle on Bee Colonies

When hives were opened adult beetles quickly drop away from the light, so look for adult beetles moving inside the hive, running across the combs and bottom boards to find hiding places as they do not like to be exposed to light. The number of small hive beetle adults in different months, 724, February, 327, March 133, April and 35 May, and small hive beetles larvae on 23 February, 3 March, 8 April, and 6 May. The use of trap to capture small hive beetle larvae and adults in honey bee colonies is an effective way to reduce abnormal

levels. The number of small hive beetles collected by cardboard trap decreasing from the initial data collected time to the final time, because when the small hive beetles removed honey bee colonies come strong and again strong bees actively remove larvae of small hive beetles from the hive. From the treatment group, only one honey bee colony was absconded whereas 6 honey bee colonies were absconded from the control group.

The effectiveness of small hive beetle trapping evaluation using cardboard to minimize and limit the infestation of small hive beetles adults in Bako Tibe honey bee colonies. This study is similar with study of [4] recommended using traps on the bottom board to estimate the number of SHBs in a hive. The cardboard trap was the most effective trap without any disturbing the colonies. However, in colonies with no traps (control hives), the numbers of honey bee colonies abscond.

3.4. Honey Yield

During the 2012 honey harvesting season, honey was harvested both from the treatment hives and control hives groups. Farmers measured the amount of honey harvested from the treatment and control hives at the study site in the harvesting season. The honey yield obtained from the treatment group 16kg/hive/season and 7.3KG/hive/season was harvested. The yield difference between the control hives and treatment hives brought from the implementation of small hive beetle trapping practices. Strong colonies produce high yield honey whereas weak colonies produce low /or not produced honey.

4. Conclusions and Recommendation

As the result developed from the Bako Tibe farmer beekeepers scavenger of honey bee colonies small hive beetles were affected weak colonies than strong colonies. The study showed that hives with the trap have good honey yield, colony performance (strong), and highly favored by the FREG than control groups. The small hive beetles directed the bee colonies to the absconding, unsatisfied and reduce the production of the hives because the hive becomes empty. The Performance of colonies was weak in hives without a trap and about 60% of the colonies were absconded in different seasons. Hence Small hive beetle larvae and adults effect honey yield and colony performance.

This study provides an evaluation of the small hive beetles trap underneath on the bottom board in the Bako Tibe site. Based on the finding of the study it is recommended that the concerned governmental and non-governmental organization should emphasize to promote this trap technology at small scale farmer beekeepers.

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