INFESTATION OF VARROA MITE (*VARROA DESTRUCTOR*) IN HONEY BEE (*APIS MELLIFERA*) COLONIES AT SINTKAING TOWNSHIP, KYAUKSE DISTRICT

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Abstract

A total of 45 honey bee (*Apis mellifera*) colonies with adult bees and broods were investigated from November 2021 to April 2022 at Sintkaing Township, Kyaukse District. Those colonies were divided into non-treatment (15) colonies and treatment (30) colonies. Among the total bee populations of 728000 bees, a total sample of 42000 bees was observed, and it was found to be infested with some 759 varroa mites. The total number of estimated infested bees was 13422 individuals, with 2002.5 individuals from non-treatment colonies and 11419.5 individuals from treatment colonies. The infestation rates of the year 2022 were found to be higher than those of the year 2021. The highest mortality rate was 53% in January 2022 in non-treatment bee colonies. In this study, the mortality rate of bees may be correlated with the infestation of varroa mites, as well as food and the use of insecticide on the plantation.

Keywords honey bee, mite, ectoparasite, infestation, *Varroa destructor*

Introduction

Honeybees are the most efficient pollinators of 80% of the crops worldwide, and farmers prefer their services because they greatly improve crop yields. The decline of pollinators in recent decades is threatening the structure and function of natural and agricultural tree reproduction that require pollination assistance. Large-scale production of food crops in the agricultural system is, in many cases, only possible with the assistance of pollinators, primarily honeybees (USDA, 2009).

Most honey bee researchers consider the ectoparasitic mite *Varroa destructor* to be the most damaging enemy of the honey bee. It has been recently identified as one of the major factors responsible for colony losses worldwide (Broadschneider *et al*. 2010).

Honey bee health has become a primary focus of researchers in response to several episodes in which commercial colonies were lost at unusually high rates in the United State and Canada. Although not fully understood, high colony mortality stemmed from multiple factors that included the parasitic mite *Varroa destructor*, viruses vectored to bees by varroa mites, pesticide exposure, residues of agrochemicals in hives, and poor nutrition (Horris J *et al*., 2016).

Beekeepers control *Varroa* levels in colonies using synthetic acaricides, organic acids, essential oils, and a wide variety of management techniques, which has helped to improve survival rates (Rosenkranz *et al*., 2010).

Mite numbers increase slowly within a hive. It may not be until the fourth year of infestation that numbers are sufficiently high for honey bee larvae to be parasitized by several females when this occurs, newly emerged adult bees with deformed wings, legs, and abdomens may be found at the hive entrance. Patchy broad patterns may also be seen in advanced infestations. Colonies affected to this extent will usually die (Agriculture Victoria, 2022).

In this research, beekeeping sites in Sintkaing Township was chosen as a survey area to observe the occurrence of varroa mite disease in their bee colonies. Sintkaing Township

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contributes 15 percent of overall honey production, according to the Apiculture Division. Sunflower honey, palm honey, and sesame honey were highly demanded in local markets. This research will also inform the infestation of varroa mites in honeybee colonies at Sintkaing Township and their effects on local apiculture farms.

Materials and Methods

Study area

This study was conducted around latitude 21º 43' 59" North and Longitude 96º 7' 0" East with an elevation of 81 m above sea level in Sintkaing Township, Kyaukse District.

Study sites

The study sites were located at Development Apiculture Sub-department, Sintkaing Township. A total of 60 bee colonies were raised in this study sites.

Study period

The present study was carried out from November 2021 to April 2022.

Sample of bee collection

A total of 5 colonies were randomly selected from 45 colonies in each beekeeping in the study area. Samples were collected from November 2021 to April 2022. Adult bees were taken from both sides of three uncapped broad combs of 7 frames in each hive. Collected bee samples were kept individually in a bottle containing 30% ethanol and then the number of mites on the bee was counted.

The 45 colonies were divided randomly into 15 colonies of nontreatment and 30 colonies of treatment. Treatment colonies were applied with formic acid (35cc) in each colony weekly every month during the study period.

Monitoring and determining the infestation rate of bee colonies, and varroa population levels in honey bee colonies were generally estimated using two methods; (1) determining the number of mites per 100 bees (infestation rate) within a subsample of adult bees and (2) determining the colony varroa population using natural mite fall (Jack C *et al.*, 2020). Infestation rates were determined by (1) collecting a subset of adult bees into a container, (2) removing the mites from the bees with a dislodging agent, and (3) counting the mites.

Methods of removing the mites from the bees

(1) Alcohol / Soap Wash method

This method involves adding isopropyl alcohol or soapy water to the container of bees, shaking the container to dislodge the mites, washing the mites from the bees, and counting the mites.

(2) Natural mite fall method

In a natural setting, *Varroa* may either be groomed off by the bee or naturally fall from the bees or combs through the action of natural hive activity. Consequently, one can sample varroa by collecting them from the below colony.

Visual signs of problematic infestation

There are several visual signs of problematic infestation, but visual inspections don't provide a reliable estimate of the potential risk to the colony; (1) decreased colony productivity, (2) abnormal or spotty brood pattern, (3) abnormal adult behavior, (4) the excessive number of dead or discolored, sick, greasy-looking adult bees inside or outside the hive, (5) visual sightings of other pests or disease symptoms, (6) deformed adult wings and/or brood bodies, (7) failure to use supplemental food and or lack of "normal" honey bee bread reserves.

Calculation of bee population using the formula

According to Delaplane *et al*. (2013)

$$N = 3 \times \left(\frac{f}{0.0138}\right)$$

N = number of bees in the hive

F = number of bees seen leaving the nest in one minute

Note that the value of 0.0138 is based on the average amount of the spend foraging for an average honey bee colony on an average day, and that this value will actually change considerably depending on the amount of food available, weather conditions and so on.

In the present study the average amount of th spend foraging was 69 to 92 bees in one colony on an average day.

Data analysis

According to Jack. *et al*.(2020)

$$\text{Infestation} = \frac{\text{the number of mites captured}}{\text{the number of bees in sample}} \times 100\%$$

$$\text{Treatment thresholds by honey bee colony phase } \% = \frac{\text{Total mites}}{100 \text{ adult bees}}$$

Meteorologic data

Meteorological data of the study area was obtained from the Department of Meterological and Hydrology, Sintkaing Township.

Figure 1 Location map of Sintkaing Township (Source: Google Map)

Results

The honeybee *Apis mellifera* under order Hymenoptera and the mite *Varroa destructor* belonging to order Mesostigmata were collected from the study area and identified.

The adult bees and brood with a total bee population of 162750 bees of non-treatment bee colonies and 565250 bees of treatment bee colonies from the 45 colonies were investigated. The total number of 10500 bees from non-treatment colonies and 31500 bees in treatment colonies were examined (Table 1 and 2).

Among them, a total number of 150 varroa mites in non-treatment colonies and 609 varroa mites in treatment colonies were collected. The total number of estimated infested bees of 2006.5 was collected from non-treatment colonies and 11419.5 bees from treatment colonies. (Tables 1 and 2).

Treatment thresholds by non-treatment bee colonies were observed at 0.83% and 0.94% (acceptable) respectively in November and December 2011, and 2.51% (danger) in January 2022 (Table 3).

Treatment thresholds by treatment bee colonies were observed at 0.43% and 0.66% (acceptable) respectively in November and December 2021. Infestation rates of 1.66% (caution) in January 2022, 2.1%, 3.67%, and 2.56% (danger) from February to April 2022 were recorded (Table 4) respectively.

The total infestation of the bee population of 2006.5 bees, the total dead population of 304 bees, and the highest mortality rate of 53% in January 2022 were recorded from non-treatment bee colonies (Table 5).

The total infestation of the bee population of 11419.5 bees, the total dead population of 1714 bees, and the highest mortality rate of 31.9% and 31.5% in March and April were recorded from treatment bee colonies (Table 6).

According to the meteorological data, the infestation rate of varroa mites was high from January to April 2022 (Table 7).

Table 1 Monthly infestation rate of non-treatment bee colonies during the study period

Months	Bee colony	Population of adult bees and broods	Total sample of bees observed	Total varroa mites collected	Estimate Infestation Bees	Infestation rate (%)
November	5	52500	3500	29	439	0.83
December	5	52500	3500	33	495	0.94
January	5	57750	3500	88	1072.5	2.51
February	-	-	-	-	-	
March	-	-	-	-	-	
April	-	-	-	-	-	
Total	15	162750	10500	150	2006.5	4.23

Table 2 Monthly infestation rate of treatment bee colonies during the study period

Months	Bee colony	Population of adult bees and broods	Total sample of bees observed	Total varroa mites collected	Estimate Infestation Bees	Infestation rate (%)
November	5	52500	3500	15	225	0.43
December	5	52500	3500	23	345	0.66
January	5	57750	3500	58	957	1.66
February	5	126000	7000	147	2646	2.1
March	5	136500	7000	187	3646.5	2.67
April	5	140000	7000	179	3600	2.56
Total	30	565250	31500	609	11419.5	10.93

Table 3 Treatment thresholds by non-treatment bee colony phase

Months	Colony phase	Acceptable	Caution	Danger
November	Population decrease	0.83%	-	-
December	Dorment without brood	0.94%	-	-
January	Dorment with brood	-	-	2.51%
February	Population increase	-	-	-
March	Population increase	-	-	-
April	Peak population	-	-	-

Colony phase

* Acceptable - Futher control not needed (<1-2%)
* Caution - Control may be warranted (1-5%)
* Danger - Control Promptly (>2-5%)

Table 4 Treatment thresholds by treatment bee colony phase

Months	Colony phase	Acceptable	Caution	Danger
November	Population decrease	0.43%	-	-
December	Dorment without brood	0.66%	-	-
January	Dorment with brood	-	1.66%	-
February	Population increase	-	-	2.1%
March	Population increase	-	-	2.67%
April	Peak population	-	-	2.56%

Table 5 The mortality rate of non-treatment bee colonies during the study period

Months	Total no. of bee infested	Total no. of bees dead	Mortality rate (%)
November	439	69	23
December	495	74	24
January	1072.5	161	53
February	-	-	-
March	-	-	-
April	-	-	-
Total	2006.5	304	100

Table 6 The mortality rate of treatment bee colonies during the study period

Months	Total infestation of bees population	Total dead Population of bees	Motality rate (%)
November	225	34	1.98
December	345	52	3.03
January	957	144	8.4
February	2646	397	23.1
March	3646.5	547	31.9
April	3600	540	31.5
Total	11419.5	1714	100

Table 7 Meterological data and infestation rate during the study period

Months	Minimum temperature (ºC)	Miximum temperature (ºC)	Average rainfall (mm)	Humidity (%)	Infestation rate (%)
November	18	28	10	65	0.83
December	11	25	28	70	0.94
January	10	24	8	56	2.51
February	7	24	4	36	2.1
March	8	29	4	30	2.67
April	16	32	42	37	2.56

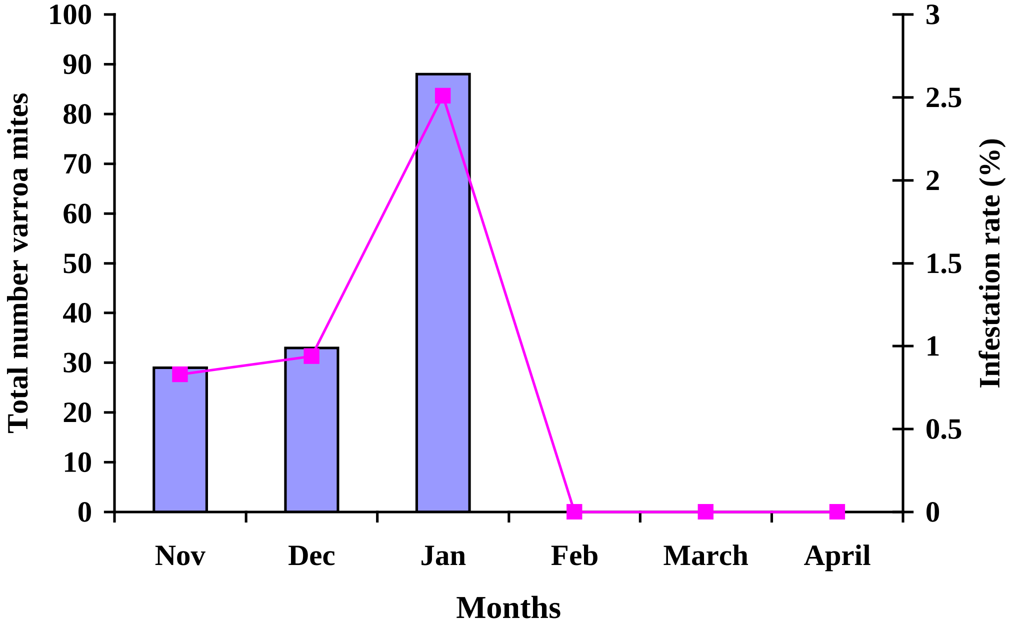

Figure 2 Monthly total number of varroa mites and infestation rate from non-treatment bee colonies

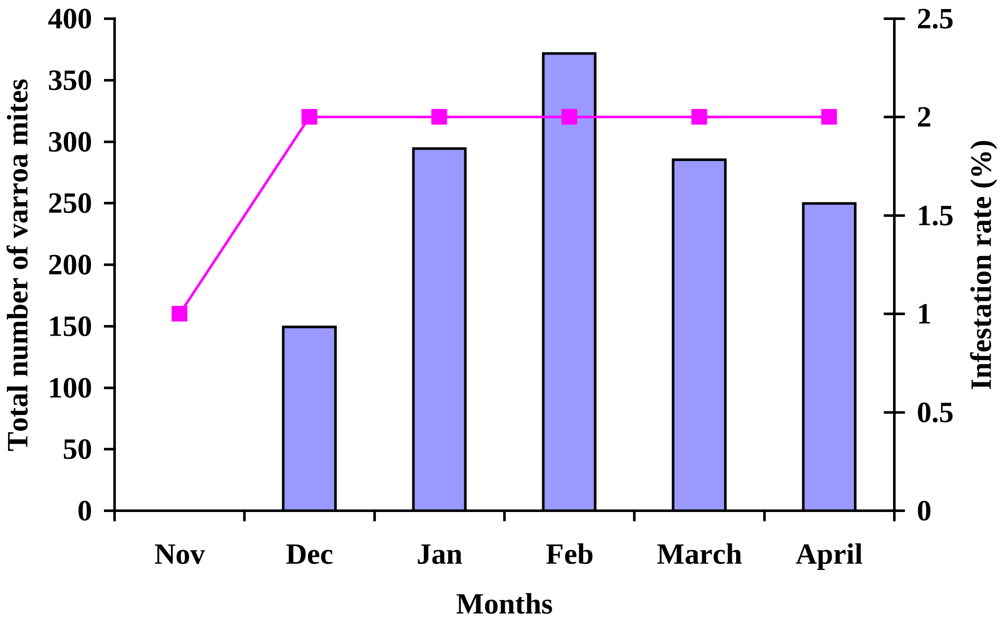

Figure 3 Monthly total number of varroa mites and infestation rate from treatment bee colonies

Plate 1 Varroa mite infestation and treatment thresholds by bee colony

Discussion

The honeybee *Apis mellifera* populations with reduced mite reproductive success may have unique ways of achieving this specific mite-resistant mechanism that could include changes in brood volatiles, adult VSH behavior selectively removing reproducing mites, or even both mechanism control (Barbara Locke, 2015).

Bees on frames containing brood comb had significantly more mites than frames without brood, but the difference is small biologically. Greater levels on brood combs were probably due to mites preferring nurse bees, which tend to stay on brood combs (Pernal *et al*., 2005).

In the present study, a total number of 45 bee colonies with adult bees and broods include non-treatment (15) colonies and treatment (30) colonies. Total population of 162750 bees with total sample of 10500 bees were found with total varroa mites 150 individuals and estimate infested bees 2006.5 individuals in non-treatment colonies. Total population of 565250 bees with total sample 31500 bees were found with total varror mites 609 individuals and estimate infested bees of 11419.5 individuals in treatment colonies. Infestation rate was highest in January, 2022 in non-treatment colonies and highest in January to April, 2022 in treatment colonies.

Mohmood *et al*., (2012) found that (3.2%) oxalic acid treatment had higher effectiveness in controlling *Varroa* than flornic acid and flumethrin strip (Bayvarol). Thus, oxalic acid was used in control treatment. Botreinic *et al*., (2001) concluded that formic acid had significant effectiveness against varroa for honey bee colonies in Iran.

In the present study, treatment threashold by non-treatment bee colony phase was observed at 0.83% and 0.94% (acceptable) in November and December 2021 and (2.15%, danger) in January 2022. Treatment thresholds by treatment bee colony phase was observed at 0.43% and 0.66% (acceptable) in November and December 2021, infestation rate (1.66%, caution) in January 2022 and (2.1%, 3.67% and 2.56%, danger) from February to

April 2022. The results indicated that bees from treatment colonies had more resistance to mites infestation than non-treatment bee colonies.

The causes of the recorded mortality of honeybee colonies remains undetermined, most scientists agree that it is likely due to a combination of several factors ranging from viruses, parasites and diseases, single-source diets, compromised disease, inclement weather and pesticides (Stankus, 2008).

In the present study, the total dead population of 304 bees and the highest mortality rate of 53% in January 2022 were recorded from non-treatment bee colonies. The total dead population of 1714 bees and the highest mortality rate of 3.19% and 31.5% in March and April 2022 were recorded from treatment bee colonies respectively. The results indicated that total infestation of the bee population was correlated with invading of varroa mite disease and their food resources.

Conclusion

The present study emphasized the need for research attention to focus on sustainable solution to the threat of *Varroa* mites for the economic viability of apiculture and agriculture, as well as for honeybee health, conservation, and ecosystem services. Understanding the natural interactions and adaptations between honeybee and *Varroa* mites is an essential for beekeeper. In this study, the mortality rate of bees may be correlated with the infestation of varroa mites, as well as food and the use of insecticide on the plantation.

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