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A study on seasonal variation of *Varroa destructor* infestation among honey bee (*Apis mellifera*) colonies in and around different regions of Lucknow, Uttar Pradesh, India

Anurag Kumar Sonker[1*]

[1*]*Department of Zoology, School of Life Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.)-226025, IndiaE-mail – kumaranurag5904@gmail.com*

Abstract

Apis mellifera is the most beneficial insect and significant pollinator in the ecosystem. The incidence of parasitic mite (*Varroa destructor)* in *Apis mellifera* colonies become a threat to beekeepers worldwide. This study was done to find out the percentage of *V. destructor* infestation per colony in different apiaries located in and around different regions of Lucknow, Uttar Pradesh. The study was conducted from March to February for two different years (2019-2020 & 2021-2022). Month-wise and seasonal infestation of *V. destructor*s was recorded and it revealed that the highest infestation was found in May (43.13%) and June (45.74%) whereas the lowest rate of infestation was reported in July (6.91%) and August (6.40%) for the year (2019-2020). Similarly in the year (2021-2022), the highest infestation was recorded in May (54.57 %) and June (62.63 %) while the lowest infestation was reported in July (5.72 %) and August (6.79 %).The finding of the overall study showed that the highest infestation of *V. destructor* was very high in the summer season from March to June and moderate in the winter season, from November to February, whereas the lowest rate of infestation was reported in the monsoon season from July to October. This study may be useful to understand the impact of *V. destructor* infestation in *Apis mellifera* colonies in different months and seasons and further used for the management of this parasitic mite to prevent damage to the honey bee *Apis mellifera* population.

Keywords: Honey bee, *Apis mellifera,Varroa destructor*, mite and beekeeping.

1. INTRODUCTION

The honeybee, *Apis mellifera* is the most significant single-species pollinator in ecosystems globally. Agriculture and the beekeeping industry both suffered considerably economically when the honeybee, *Apis mellifera* was eradicated (Melathopoulos *et al*., 2000).

Similar to other animals, honey bees are susceptible to a wide variety of diseases and natural enemies, including viruses, bacteria, fungi, mites, and protozoa. The parasitic mite, viz. *Varroa destructor*, constitutes one of them, a most important issue experienced by beekeepers. The majority of *V. destructor* mite species are parasitic and feed on pollen as well as on bees also, making them the most significant parasitic species in honeybees (Ahn *et al.*, 2015 and Mordecai *et al*., 2016).

The female *V. destructor* measures approximately 1.1 mm long and 1.6 mm wide, with a reddish-brown coloration (Sammataro *et al*., 1994; Sammataro, 1997). It can penetrate and rupture the host's integument and feed on the hemolymph of the honey bees. The most susceptible stage is the honey bee larval stage, and the disease is known as Varroasis (Suwannapong *et al*., 2011; Delfinado and Baker, 1987).

The *V. destructor* is a natural parasite of the Asian honey bee that was formerly confined to Asia, according to Anderson and Trueman. It is believed to be among the most harmful ectoparasitic mite that affects honey bees, especially *Apis mellifera* species (Ritter, 1981; De Jong *et al*., 1982).
Phadke *et al*. (1966) reported about the *V. destructor* in honey bees for the first time in India from Delhi. It is a natural pest of *A. cerana* in India, but it began to harm Italian bee colonies once *Apis mellifera* was brought to the country (Mishra, 1995).
Keeping in view the importance of this parasitic mite, the percentage of *V. destructor* infestation per colony was done in different apiaries present in and around different regions of Lucknow, Uttar Pradesh. The main aim of this type of study is to find out the infestation caused by *V. destructor* in *Apis mellifera* colonies in different apiaries and to establish treatment strategies that are appropriate to the species and provide direction for the execution of preventative measures to manage the parasite infection. This Study may be useful to know the impact of *V. destructor* in the honey bee, *Apis mellifera* colonies and also may be useful for further management of this damaging parasitic mite for future aspects.

2. MATERIALS AND METHODS

2.1. Study Area: The study was conducted and the sample collection was done from the different apiaries for the *V. destructor* infestation in honey bee *(Apis mellifera)* colonies in different apiaries located in and around Lucknow, Uttar Pradesh.
The area covered for the study and sample collection throughout different apiaries located in and around different regions of Lucknow, Uttar Pradesh such as Chinhat, Gosaiganj, Malihabad, Itaunja and Barabanki.

Fig.2.1. Location map of the study area showing different sample collection sites.
(Source: Created by self)

2.2. Study Period: The study was conducted from March to February 2019-2020 and from 2021-2022 for the evaluation of the infestation of *V. destructor* in honey bee *(Apis mellifera L.)*Colonies in different apiaries located in and around Lucknow, Uttar Pradesh.

2.3. Sample collection and preservation: During the present study the sample collection of *V. destructor* was done from the different apiaries and infested hives were identified by inspection of a piece of white paper placed on the bottom of the hives for more than 24 hours (hrs). Infected pupae/bees were also collected from the infected broods by visual examination in freshly collected vials and brought to the parasitology laboratory of the Department of Zoology, BBAU, Lucknow for further examination. The collected *V. destructor* mites from infected pupae/bees were preserved in 70% ethanol in collecting vials and kept at -20^{0}C temperature for further analysis.

2.4. Formulas used:

The seasonal incidence of *V. destructor* was calculated by using the percentage of mite infestation per colony and it was calculated as the percentage or rate of the total number of mites divided by the total number of bees. The percentage of *V. destructor* infestation per colony will be estimated by using the following (Margolis *et al.*, 1982).

$$\textbf{Percentage mite infestation per colony} = \frac{\textbf{total number of mites}}{\textbf{total number of bees}} \textbf{X100}$$

3. RESULTS

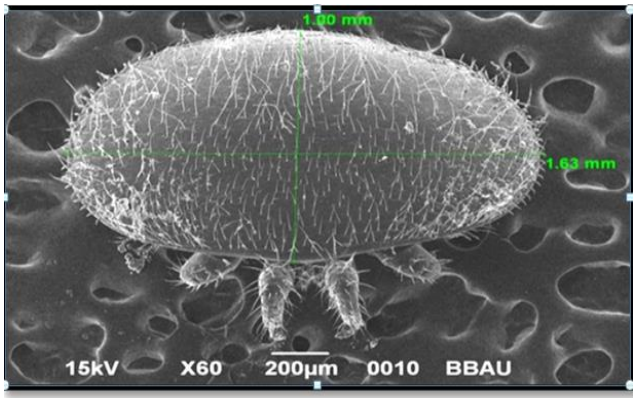

Fig.3.1. Scanning electron micrograph of Adult *V. destructor*

Table 3.1. Month-wise percentage of *V. destructor* infestation per colony (March 2019 to February 2020)

Month	Total No. of pupae/bees examined	Total No. of *V. destructor* collected	% of *V. destructor* infestation per colony
March	597	143	23.95 %
April	381	145	38.06 %
May	320	138	43.13 %
June	258	118	**45.74 % ↑**
July	275	19	6.91 %
August	203	13	**6.40 %↓**
September	179	19	10.61 %
October	111	13	11.71 %
November	167	23	13.77 %
December	314	36	11.46 %
January	183	18	9.84 %
February	401	67	16.71 %
Total	3389	752	22.19 %

Table 3.2. Month-wise percentage of *V. destructor* infestation per colony (March 2021 to February 2022)

Month	Total No. of pupae/bees examined	Total No. of *V. destructor* collected	% of *V. destructor* infestation per colony
March	623	146	23.43 %
April	402	162	40.30 %
May	317	173	54.57 %
June	281	176	**62.63 % ↑**
July	297	17	**5.72 % ↓**
August	221	15	6.79 %
September	201	18	8.96 %
October	129	14	10.85 %
November	207	26	12.56 %
December	364	23	6.32 %
January	223	19	8.52 %
February	458	69	15.07 %
Total	**3723**	**858**	**23.05 %**

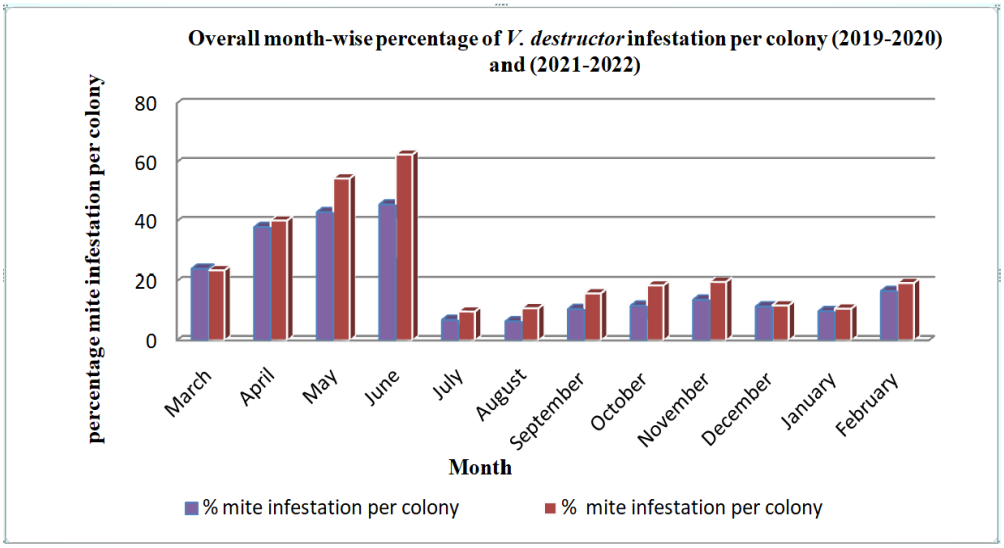

Fig.3.2. Overall Month-wise percentage of *V. destructor* infestation per colony of the year(2019-2020) and (2021-2022)

During the above study, month-wise *V. destructor* infestation per colony was done and is presented in Tables3.1 & 3.2 and Fig. 3.2. The results revealed that the highest infestation of *V. destructor*s was recorded in May (43.13%) and June (45.74%)whereas the lowest rate of infestation was reported in July (6.91%) and August (6.40%) for the year (2019-2020).Similarly in the year (2020-2021), the highest infestation was recorded in May (54.57 %) and June (62.63 %)while the lowest infestation was reported in July (5.72 %) and August (6.79 %).In addition, the data is presented in Tables 3.1 & 3.2 and Fig. 3.2. indicating the month–wise infestation of *V. destructor*s showed that the infestation rate increased from March to June while it seemed to decrease from July to October.

3.1. Season-wise *V. destructor* infestation per colony in the honey bee, *Apis mellifera* colonies

Table 3.1.1. Season-wise *V. destructor* infestation per colony (March 2019 to February 2020)

Month	Total No. of pupae/bees examined	Total No. of *V. destructors* collected	% *of V. destructor* infestation per colony
Summer	1556	544	**34.96 %↑**
Monsoon	768	64	**8.33 %↓**
Winter	1065	144	13.52 %
Total	**3389**	**752**	**22.19 %**

Table 3.1.2. Season-wise *V. destructor* infestation per colony (March 2021 to February 2022)

Month	Total No. of pupae/bees examined	Total No. of *V. destructors* collected	% *V. destructor* infestation per colony
Summer	1623	657	**40.48 %↑**
Monsoon	848	64	**7.55 %↓**
Winter	1252	137	10.94 %
Total	**3723**	**858**	**23.05 %**

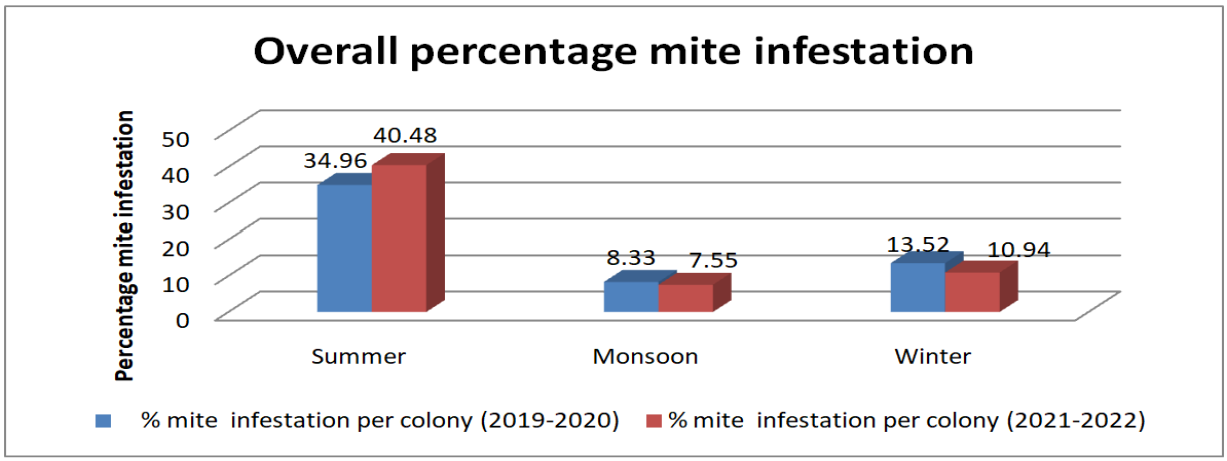

Fig.3.3. Overall season-wise *V. destructor* infestation per colony of the years 2019-2020 and 2021-2022

The seasonal infestation of *V. destructor* infestation per colony was done and is presented in Tables Table 3.1.1. & 3.1.2. and Fig.3.3.The overall study revealed that the highest infestation of *V. destructor*s was recorded in the summer season from March to June and moderate in the winter season, from November to February, whereas the lowest rate of infestation was reported in the monsoon season from July to October.

4. DISCUSSION

The incidence of parasitic mite viz. *V. destructor* in honey bee *Apis mellifera* colonies has become a significant concern for beekeepers and it has a major impact on the ecosystem as well as the beekeeping industry globally. To ensure the sustainability of beekeeping practices and diminish the negative effects of *Varroa* mites on honeybee health, it is necessary to implement effective management strategies and this research work may be useful to enhance the bee populations. Understanding mite population seasonal dynamics might be essential for developing effective management tools and sustaining healthy, persistent colonies.

The infestation of parasitic *V. destructor*s mite in *Apis mellifera* colonies from February to March 2019-2020 and 2021-2022 is presented in Tables 3.1 and 3.2. The season-wise data on *V. destructor* infestation of bee

colonies were recorded and showed that the incidence of *V. destructor* in *Apis mellifera* colonies was maximum in the summer months in all different apiaries studied in and around Lucknow, Uttar Pradesh. The *V. destructor* population appeared to increase from February followed by March, April, and May, and reached its peak during June.

Similarly, the *V. destructor* population seems to have declined during the monsoon season (July and August) and was moderate in the winter season. The infestation was estimated by examining visually the open and sealed brood cells also showed a similar trend of their infestation.

The incidence of *V. destructor* in *Apis mellifera* colonies varied greatly during different months and seasons as reported by earlier works.Poonia *et al*. (2014) investigated the bee hives in Hisar, Haryana, and recorded the maximum number of *V. destructor* in the second week of May (38 to 51 mites/per hive) and inferred that infestation was positively associated with low and high temperatures. They concluded that the *Apis mellifera* colonies were affected more frequently by *V. destructor* due to high temperatures and low flowering conditions. Asha *et al.* (2013) conducted a study in Punjab on the month-wise incidence of *Varroa destructor* in *Apis mellifera* colonies. They calculated a substantial positive correlation (r =0.77) between the percentage of mite infestation and the percentage of bee deformity, revealing that mite infestation increases the deformity in honey bees.)

The seasonal infestation of the ectoparasitic mite *Varroa destructor* infestation throughout the year 2006-08 in the Jammu division of Jammu and Kashmir, India. They found that the infestation of *Varroa* mites was a maximum (40%) in March and a minimum (21.36%) in June. During 2007-08, the maximum (31.84 %) infestation occurred in March and the minimum (12.32 percent) in August (Kotwal*et al.,*2013).

The variations among different regions and climatic conditions altered the number of broods in *Apis mellifera* colonies, resulting in the *V.destructor* population reaching its peak in Himachal Pradesh as reported by (Thakur *et al.,* 2009).

The resulting data and observation suggested based on the literature survey of different co-workers that with an increase in temperature, the population of *Varroa destructor* increases exponentially inside the brood and it was observed that the *V.destructor* population was highest in May and June and less incidence was recorded from July to January due to considerable increase in relative humidity and favorable climatic conditions which support the proliferation of *V. destructor* population.

The environmental and climatic conditions adversely affect the *V. destructor* population in *Apis mellifera* colonies in different apiaries present around Lucknow, Uttar Pradesh which tends to show a decrease in *V. destructor* population thus resulting causes a vector for various viral diseases which causes mortality and decreases the population of honey bees, *Apis mellifera.*

Several pesticides and insecticides have been used to manage this parasitic *Varroa destructor* mite in honey bee *Apis mellifera* colonies; almost all of the insecticides are acaricides, which beekeepers implement to control this mite. Additionally, to avoid some bacterial and microsporidian infections, beekeepers implement antimicrobial drugs (Johnson, 2013).Due to their detrimental impact on bees, pesticides have become increasingly recognized as an important factor that contributes to colony collapse disorder (Chensheng, 2014).

Some medicinal plants and their chemical derivatives have been investigated for their ability to reduce parasitic *V. destructor* infestations in honey bees such as Thymol, Menthol (a compound derived from mint plants),Thyme Oil, Neem oil, and Essential Oils (eucalyptus oil and wintergreen oil) and have also been explored for their *V. destructor*-controlling properties. It's crucial to use medicinal plant-based remedies according to the recommended doses and application strategies. In order to reduce the likelihood of *V. destructor* resistance, it's also essential to alternate treatments and use integrated pest management (IPM) strategies.

5. CONCLUSION

This present investigation study was useful to know the incidence of *V. destructor* in honey bee, *Apis mellifera* colonies in different apiaries present in and around different regions of Lucknow Uttar Pradesh, as the parasitic *V. destructor* plays a major role in transmitting diseases and acts as a vector for several pathogens resulting in the decline of the Honey bee, *Apis mellifera* population.

The study showed that the infestation of *V. destructor*s seemed to decline during the winter (January to December) while tending to increase in Summer (April to June) and it was diminished during the Monsoon season (July to October) in both years *viz.*, March 2019 to February 2020 and March 2021 to February 2022.

This study may also be useful to understand the impact of *V. destructor* infestation per colony and this may be further used for the management of this mite to prevent damage to the honey bee *Apis mellifera* population.

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