A Review on Varroa Mites of Honey Bees

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Abstract: Beekeeping is an important component of agriculture and rural development program in many countries. Beekeeping plays a role in providing nutritional, economic and ecological security. The hive of honeybees with its constantly maintained optimal conditions is a suitable habitat for a diverse array of parasites and pathogens. Varroa mite is the most destructive parasite of honey bees worldwide, inflicting much greater damage and higher economic costs than all other known apicultural diseases. It is an obligate ectoparasitic mite that feeds on the haemolymph of honey bees. Varroa mites depend on adult bees for transport through the natural processes of swarming, robbing and drifting, and by beekeepers. The life cycle of the mite is closely linked to the honeybee host and lacks free living stage. The mite injures the bee through repeated intake of haemolymph and transporting honeybee viruses. The direct loss from mite infestation like reduction of the production of honey, wax and other honey bee products, cost from colony collapse as well as cost incurred for treatment and control purpose, and indirect loss from reduction of crop production due to lack of pollinators are taking away the benefit of honeybee owners and nations. Rapid detection of the mite is essential for its immediate containment. For the detection of the mite debris examination, brood and adult honeybee examination, and laboratory diagnosis can be used. There is a pressing need for more effective mite control measures. Chemical treatment, biological and biotechnical controls are the basic methods to control Varroa mite.

Key words: Ectoparasite • Honeybees • Varroa mites • Control

INTRODUCTION

As beekeeping is an important component of agriculture and rural development program in many countries, useful small scale efforts have been made to encourage beekeeping intervention throughout the world [1]. Beekeeping plays a role in providing nutritional, economic and ecological security. The business almost requires no land, capital and does not take much part of the farmers’ time. Young and old people can be involved without gender restriction. It does not compete with other components of farming systems for resource. The direct contribution of beekeeping includes the value of the outputs produced including honey, bee wax, queen and bee colonies, and other products such as pollen, royal jelly, bee venom, and propolis in cosmetics and medicines [2]. Another very important contribution of beekeeping is through plant reproduction and conservation of the natural environment. It can be integrated with agricultural practices like crop production, animal husbandry, horticultural crops and conservation of natural resources [3].

However, the hive of honeybees with its constantly maintained optimal temperature, humidity, and carbon dioxide level, year round ample availability of the host bees, protinacious (pollen), carbohydrate (honey), and wax foods, is a suitable habitat for a diverse array of parasites and pathogens. Some of the most common parasites and pathogens of honeybees include viruses, bacteria, fungi, protozoa, mites including Varroa mites and insects. Among the different parasites and pathogens mentioned, the parasitic mite Varroa is becoming a global concern affecting the beekeeping industry based on Apismellifera[4]. It is not only the beekeeping industry that suffers from loss of the honeybees; rather the crop agricultural sector is also being hit by this problem because most plants are dependent on bees for pollination. It is estimated that 80% of all crop insect pollinations are accomplished by honey bees [5].

Varroa mites are obligate ectoparasitic mites that feed on the haemolymph of both brood and adult honey bees. The genus Varroa includes two species, Varroa destructor and Varroajacobsoni, but Varroa destructor is the only species of economic importance.
Varroa destructor was originally confined to *Apis cerana* but shifted to *Apis mellifera* during the first half of the last century. The parasite is now dispersed worldwide with Australia being the only large area not yet invaded and is considered a major threat for apiculture. Mites spread between colonies on drifting and robbing bees and on infested bees supplied in commercial green cape and they can also be introduced to non-infested regions on natural swarms and when beekeepers move infested colonies [6].

The life cycle of Varroa mite is closely linked to honeybee host and lacks free living stage. There are two phases in the life cycle of female mites: Phoretic phase on adult bees and reproductive phase within the sealed drone and worker brood cells. The mites cause damage to individual bees by sucking substantial amount of haemolymph from both brood and adult bees. This severely affects bee development and weakens the adult bees. In addition Varroa mite is a vector for several honeybee viruses. The effect of mite infestation depends on the degree of infestation [7]. Diagnosis of the mite infestation is based on debris examination, brood and adult honeybee examination, and laboratory diagnosis [8]. Different methods of treatment of a colony are available even though some of them are ineffective and other has limitations due to their effects on the bees or the bee keepers [9]. Regular treatment has led to a substantial increase in beekeeping costs, risk of chemical residues in honeybee hive products and risk of drug resistances [10].

Varroa mite has a major impact on apiculture industry and untreated colonies of *Apis mellifera* will collapse within two years of infection [7].

Therefore; the objectives of this paper are to:

- Review on the morphology, epidemiology, pathological effects, clinical signs and diagnosis of honeybee Varroa mites.
- Review on the impact, prevention and control of honeybee Varroa mites.

### Varroa Mites:

Varroa mites are ectoparasites that feed on the haemolymph of immature and adult honey bees) [12]. The genus varroa includes two species, *Varroa destructor* and *Varroa jacobsoni* [8]. However, *Varroa destructor* is the only species of economic importance [12].

### Taxonomy:

The taxonomic position of the arachnid *Varroa* is categorized under kingdom Animalia, phylum Arthropoda, class Arachnida, order Mestigmata, family Varroidae, genus *Varroa*, and species *Varroa destructor* and *Varroa jacobsoni* [13].

### Morphology:

The ectoparasitic mite Varroa is visible to the naked eye and its body is divided into two well defined parts, the idiosoma and the gnathosoma. The whole body, including legs and mouthparts, is covered with hairs [14].

The adult female mite is a reddish-brown in color and has a flat, oval body shape approximately 1.1mm long and 1.5mm wide. Its dorsal shell covers the entire idosoma and the mite has indistinct head and four pairs of short and segmented legs, which protrude from one side of this ellipsoid shell [7]. Its body fits into abdominal folds of the adult bee and is held thereby the shape and arrangement of ventral setae [15].

Adult male mites are yellowish with lightly tanned legs and spherical body shape measuring 0.75 to 0.98mm long and 0.70 to 0.88mm wide. The male chelicerae are modified for transferring sperm. The legs of the males are longer in relation to the body size than the legs of females [16].

### Eggs:

The eggs are oval in shape and white in color, approximately 0.30mm long and 0.20mm wide, and laid singly on a cell wall. Generally, eggs cannot be seen by the unaided eye. Nymphs: Male and female protonymphs are undistinguishable without dissection. Protonymphs have eight legs, pointed chelicerae (mouth parts), circular body and are a transparent white color. After the protonymphmolts, the mite becomes a deutonymph which resembles the adults with a reduction in setae. Mite will once again molt in to the final adult stage [12].

### Epidemiology

**Host:** Varroa mites affect honey bees and among the honeybees that serve as hosts of Varroa mites are *Apis cerana* and *Apis mellifera*. *Varroa jacobsoni* parasitizes only the honeybee *Apis cerana* and it completely lacks the ability to reproduce on *Apis mellifera* but *Varroa destructor* affects both *Apis mellifera* and *Apis cerana*. Apis species show some variation in susceptibility to *Varroa destructor* that usually causes the collapse of *Apis mellifera* colonies in contrast to *Apis cerana* which can support populations of mites without collapse. *Apis mellifera scutellata* also
Fig. 1: Mature and immature females and mature males of Varroa. Clockwise from top left: mature daughter mite, mother mite, two mature males and an immature (deutonymph) daughter [12].

Table 1: Species of the genus Varroa which parasitize honeybees

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Host</th>
<th>Pathogenesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varroa destructor</td>
<td>Apismellifera</td>
<td>Pathogenic</td>
</tr>
<tr>
<td>Varroajacobsoni</td>
<td>Apiscerana</td>
<td>Non pathogenic</td>
</tr>
</tbody>
</table>

Source: [10]

Table 2: Prevalence of Varroa destructor in different parts of Africa

<table>
<thead>
<tr>
<th>Source</th>
<th>Place</th>
<th>No. of colonies detected</th>
<th>No. of positive colonies</th>
<th>Prevalence (%)</th>
<th>Year of detection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tanzania</td>
<td>18</td>
<td>16</td>
<td>88.8</td>
<td>2009</td>
</tr>
<tr>
<td></td>
<td>Ghana</td>
<td>12</td>
<td>2</td>
<td>16.6</td>
<td>2009</td>
</tr>
<tr>
<td>[21]</td>
<td>South Africa</td>
<td>1037</td>
<td>580</td>
<td>56</td>
<td>1997</td>
</tr>
</tbody>
</table>

appears to have some resistance or tolerance to the Varroa destructor [17]. Varroa mite affects both the adult and immature honey bees, but the developing larvae and pupae are the most sensitive host stages [18].

The population growth of Varroa is affected by the amount and type of brood, and the post capping period of the brood cell. The mite needs brood to reproduce and its population increases faster in a colony having high amount of brood and it has been known for a long time that Varroa mites preferred drone brood over worker brood ([19].The duration of the post-capping stage limits the time available for the development of the mite offspring. Long post-capping period increases the mite population growth rate [10]. whereas Varroa destructor is thought to be native to the Far East where it parasitizes the Asiatic honey bee Apiscerana and is not invasive, though it has been introduced widely and is now prevalent worldwide, with the exception of New Zealand, Australia and some countries in Central Africa [17].

Varroa mite infestation is influenced by season and climate. It is proposed that varroosis in cold climate is higher than that of warm climate and its rate of incidence is greater in cold seasons (fall and winter) than hot and warm seasons (spring and summer) [22]. There are, obviously, significant differences between the population dynamics in temperate and subtropical/tropical climates with a clear tendency for lower mite population growth under tropical conditions [18]. Under temperate conditions, damage at the colony level mainly appears during fall and winter, when the host population declines, the relative parasitization increases and consequently the long-living winter bees are damaged [23].

Geographical Distribution: The geographical distribution of Varroa mites vary with the type of species. Varroajacobsoni has a wide distribution throughout Asia
**Transmission:** The mites are spread from bee to bee when bees walk past one another in the colony [12]. Natural spread between colonies is through the movement of adult bees carrying mites from one colony to another. In apiary, this could be due to natural drifting. Movement between apiaries will occur if there is any robbing. Probably, drones will play a big part in spreading the mites as they are known to move freely between apiaries many miles apart [24].

Varroa mites can also be transmitted between colonies as bees from the colonies rob (steal honey) from one another and bee keepers transferring queens, combining colonies, swapping frames of brood between colonies, and transporting inadequately screened hives and boxes of honey [19].

Mites can be introduced to non-infested regions on natural swarms and when beekeepers move infested colonies [6]. The spread of Varroa around the world has been greatly assisted by humans moving honey bees from place to place [19].

**Life Cycle:** The life cycle of Varroa mite is much synchronized with that of its honey bee host [15]. There are two distinct phases in the life cycle of female mites: Aphoretic phase on adult bees and a reproductive phase within the sealed drone and worker brood cells. During the phoretic phase, female mites feed on adult bees and are passed from bees to bees when bees walk past one another in the colony. Males and nymphal stages of the mite are short lived and can only be found within the sealed brood cells [25].

The life cycle begins after the capping of the brood cell [26]. When female mites are ready to lay eggs, they move into brood cells containing young larvae just before the cells are capped and they go to the bottom of the brood cells and immerse themselves in the remaining brood food. After the cells are capped and the larvae have finished spinning cocoons, the mites start feeding on the larvae [14]. The mite is most attracted by drone brood. Shortly thereafter, the mite lays its first egg on the surface of the cell wall which is unfertilized and will develop into a male mite. Subsequent fertilized eggs are laid by the female mites approximately every 25 to 30 hours and these hatch into female mites [12].

Each egg develops into a protonymph, then a deutonymph, and finally, into adult [26]. The period from egg to adult takes about six to seven days for the female and five to six days for the male. When male Varroa mites undergo their final molt, their piercing mouth parts are changed into hollow tubes and this structure is used to transfer sperm [14]. Then the male mates with its sister in the brood cell. The female stored the sperm in the spermatheca and will not mate again [16]. The adult males die after copulation and the old female and newly mated female mites exit the brood cell with the newly emerged bees to complete their reproduction cycle again. Life span of Varroa female is two to three months in summer and six to eight months in winter. Mite populations increase rapidly during the heavy brood rearing season [11].

**Pathological Effects:** The damage on honey bees is principally caused by the female mites whereas the male mites cause a little damage since they live only short time in the sealed brood cells of a bee colony [24].

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**Protonymph adult male**  **adult female**

**Eggs**

Fig. 2: The reproductive cycle of Varroa mite within the sealed honey bee worker brood cell, with the normal sequence of the sexes of mite offspring. A female mite enters the brood cell shortly before capping; approximately three days later the first male egg is laid followed by up to four female eggs. The numbers on the arrow correspond to the days after cell capping [10].
Effect on the Individual Honeybees: The individual honey bees are damaged in a variety of ways, with the developing larvae and pupae clearly representing the most sensitive host stages [10]. The effect of *Varroa* mites on honey bees come about either directly from the mites feeding on the haemolymph of honeybee adults, larvae and pupae or indirectly as a result of introduction of virus [19]. *Varroa* mites have piercing and sucking mouth parts and feed on haemolymph of honey bee adults, larvae and pupae. Depending on the number of mites, the feeding activities of mites may have no visible effects, may kill the bees, or cause morphological deformity, weight loss, loss of protein which particularly has a negative impact on antimicrobial peptides and immune related enzymes, that resulting in immunodeficiency, reduction in foraging and lifespan of honey bees. In drones, the spermatogenesis and flight capacity are also affected [26].

In addition to the obvious effects of mites feeding on developing and adult bees, the mites can also serve as vectors of several viruses that can kill bees. The secondary infections are facilitated when the mites compromise the bees' immune system and they can cause a condition known as parasitic mite syndrome which can kill colonies within months of infection [27].

Effect on the Colony: In a colony, *Varroa*, via its damaging, mutilating, transmitting, and immunodeficiency effects, will increase mortality rate, reduced brood area, and negatively affect harvesting. Infested honey bees are unable to maintain their social role and labor activities. Thus colonies may be weakened, allowing for an increased sensitivity to viral and bacterial diseases. High mite infestation leads to collapse of the colony [26]. *Varroa* has been identified as the cause of significant losses of both managed and feral colonies in a number of areas of the world. However, feral colonies are the most likely to succumb since they are not managed by humans and treated to control mite [19].

Clinical Manifestations: Initially, *Varroa* mite infestation is unnoticeable since damage occurs after mite population is built up and this build-up may be over several years or a couple of seasons [24]. Individual developing bees, if infested with one to two adult mites, usually emerge without visible damage and are normal in appearance. However, individual developing bees that are heavily-infested with more than two adult mites usually die in their cell without emerging or emerge with misshapen wings, deformed legs, shortened abdomen [11].

When adult bees are infested with two or more mites, they become restless and fly with difficulty. Their life span is generally shorter than unparasitized bees and they perform tasks poorly. On a colony level, the symptoms of *Varroa* mite infestation depend upon the degree of infestation [28]. Low level of infestations are difficult to detect whereas medium to high levels infestations may result in the appearance of a spotty brood pattern, as well as the presence of malformed worker and drone adults with deformed wings (may be associated with deformed wing virus) and small abdomens. Such bees are often unable to fly and can be seen crawling and sometimes be found at the hive entrance. Parasitized pupae will appear to have small, pale or dark reddish brown spots on their normal white bodies. Colonies become severely debilitated as mite population reach extremely high levels at the end of the brood rearing season [14]. The affected colony’s activity and production are reduced. The last stage of the disease is the collapse of the colony [26].

Diagnosis: Effective mite control is depends on frequent and reliable mite detection. In heavily infested area, individual colony infestations can grow from being undetectable to life-threatening levels within a few months. It is important to monitor mite levels by sampling all or most colonies on a regular basis [27]. When sampling for *Varroa* mite, remember that the number and location of mites in a colony vary according to time of the year. The number of mites is lowest in spring, increasing
during the summer, and is highest in the fall. During spring and summer, most Varroas are found on the brood. In late fall and winter, most mites are attached to adult worker honey bees [11]. There are different Varroa mite examination methods: Debris examination, brood and adult honey bee examination and laboratory diagnosis [8].

**Debris Examination:** It is the analysis of the debris collected from the bottom of a hive and examined for the presence of the fallen Varroa mites. It is carried out with the use of sticky sheet on the hive bottom for retaining the mites fallen from the body of bees. This method is sparing for bees because it does not require disruption of the colony while detection of mite infestation [29]. However, the method can be considered reliable only if there is an adequate amount of brood and on the early stages of the infestation [30].

**Brood Examination:** Varroa mites spend most of their life cycle inside sealed bee brood cells; therefore, uncapping and checking brood (pupae) for mites is a reliable detection method. To look for mites on brood, the pupae (preferably drone) are examined and mites can be easily seen against the white surface of worker or drone pupae after they are removed from their cells. It is suggested that a minimum of 100 pupae per colony be examined. The pupae can be removed from their cells by inserting a capping scraper at an angle through the capping and lifting the brood and capping upward [11]. Examination of preimaginal bee stages (larvae and pupae of workers and drones) in newly capped brood combs for the presence of mites can be carried out by looking through a strong light. However, brood examination is a protracted labor-consuming procedure and can be implemented only during the presence of brood in a hive [31].

**Direct Observation of Adult Honeybees:** When the mites are moving about on a bee, they are fairly easy to detect; but once they attach themselves between segments, they are difficult to find [32].

**Laboratory Diagnosis:** Accurate and easy methods of predicting mite levels in colonies can be carried out by using various sampling techniques. The most important methods are: Alcohol wash method, ether roll and sugar shake method [27].

**Alcohol Wash Method:** This method is simple, quick and quite accurate when applied to a larger number of colonies in the apiary. Ether roll test is simple but less accurate than the alcohol wash method because it is more difficult to obtain an accurate count of the number of mites in the sample. Sugar shake method can be used instead of ether roll where all the bees are killed [33].

**Differential Diagnosis:** The bee-louse, *Braulacoecia* (a wingless fly that lives harmlessly on adult bees) may be confused with Varroa. It can be distinguished from Varroa by its more rounded shape and its six legs which are readily visible on both sides of its body [8]. Two other mites that should be distinguished are *Tropilaelaps* species and *Melittiphisalvearius*. *Tropilaelaps* is a serious exotic pest of honey bees and is notifiable. *Melittiphis* mites are predatory mites, preying on scavenger mites that occur in bee hives. They do not harm honey bees or their brood [28].

**Treatment:** Nowadays, different chemicals are available for the treatment of Varroa mite infestation, even though some of them are ineffective and others have limitation due to their effect on the bees and beekeepers. These chemicals can be organic varroacides like essential oils and organic acids, and synthetic varroacides including fluvalinate, flumethrin and coumphous [19]. Varroacides (specific miticides) are applied in feed, directly onto the adult bees, as fumigants, using contact strips or by evaporation [34]. The challenges of treating varroosis are that the mites have developed resistance to many of the synthetic varroacides used and the wide spread use of chemical treatments lead to the presence of drug residue in honey, beeswax and other honeybee products. Re-invasion of mites in to treated colonies from untreated colonies is also a major problem in varroosis treatment [9].

Timing of treatment is crucially important for successful Varroa control. Late treatment application can result in treatment failure which will lead to colony loss. In practice, treatment is applied at the end of the bee rearing season. Another treatment can be given at the beginning of the rearing season in order to evaluate and control mite infestation [26].

**Socio-Economic Impact of Varroa Mite:** The significant potential impacts of Varroa mites include economic, social and environmental concerns. These mites have affected the apiculture industry negatively in every country that it has been introduced. Accurate estimates of the effect of Varroa on the apiculture industry is hard to find, but it is safe to assume that the mites have killed hundreds of thousands of colonies worldwide, resulting in billions of
Table 3: Varroa mite treatment chemicals

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Method of application</th>
<th>Dosage</th>
<th>Treatment efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluvalinate</td>
<td>Plastic strips hung between brood combs</td>
<td>8.8g/strip</td>
<td>95-99%</td>
</tr>
<tr>
<td>Amitraz</td>
<td>Plastic strips hung between brood combs</td>
<td>500mg/strip</td>
<td>90-99%</td>
</tr>
<tr>
<td>Flumethrin</td>
<td>Plastic strips hung between brood combs</td>
<td>3.6mg/strip</td>
<td>85-99%</td>
</tr>
<tr>
<td>Coumphous</td>
<td>Solution trickled over bees</td>
<td>32mg/application</td>
<td>85-99%</td>
</tr>
<tr>
<td>Formic acid</td>
<td>Evaporator kits</td>
<td>15ml/application</td>
<td>61-98%</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>Spray over combs of bees</td>
<td>5-6ml/comb face</td>
<td>41-99%</td>
</tr>
<tr>
<td>Oxalic acid</td>
<td>Spray over combs of Bees</td>
<td>3-4ml/comb side</td>
<td>82-99%</td>
</tr>
</tbody>
</table>

Source: MAF[35]

dollars of economic loss [12]. Apiculture is severely affected by the activities of *Varroa destructor*, either by direct parasitism or indirectly by facilitating the spread of bee viruses and diseases. If left unchecked, mites can infest hives beyond an economic threshold and lead to colony collapse within a two years period [34]. This is necessitates very careful management from beekeepers perspective to detect and treat mites as and when their population increases to critical levels. There is significant cost in materials and labor involved in Varroa management [10].

Honey bees offer an immeasurable contribution to floral biodiversity and conservation. The horticulture and agriculture sectors rely on pollinating insects such as *Apis* species. *Varroa destructor* is devastating to bee colonies and a reduction in pollinating bees could result in reduced pollination and ultimately decreased overall yields and crop quality. Insect pollinated crops are estimated to provide approximately one third of human food, and about 80% of this pollination is provided by the European honeybee, *Apis mellifera*. Thus, a loss in numbers of *Apis mellifera* due to infestation by *Varroa destructor* could lead to substantial negative but indirect impacts from lower crop yields due a lack of adequate pollinators [5]. Collapse of colonies due to *Varroamite* can also have a serious effect on peoples who rely on beekeeping for their livelihoods. Regular treatment of varroosis can cause chemical residues in honey bee products which result a great effect on the consumer [36].

**Prevention and Control:** Varroa mites cannot be eliminated from bee colonies, but beekeepers can monitor its presence and still maintain productive bees, and control methods can be used to keep mites at a manageable level [34]. Prevention and control of this mite can be carried out using different methods. These include biotechnical, biological, and chemical methods. However, they are only moderately effective when they are used alone, so that an integrated prevention and control approach is best [11].

**Biotechnical Methods:** Biotechnical methods involve beekeeping management techniques specifically designed to reduce mite levels in a colony. Biotechnical methods are generally not used as a complete means of Varroa control. However, they are often incorporated into integrated pest management systems, whether with synthetic chemicals, or more generally with organic control substances [19].

Commonly used biotechnical methods are: drone brood removal and trapping, artificial swarm, open mesh floors, and dowda method [34]. Open-screen floors in hives may interfere with mite population growth by decreasing the rate at which mites invade brood cells, leading to fewer mites, a lower percentage of mites in brood cells and more cells of capped brood compared with hives with wooden floors [37]. A high proportion of Varroa mites can be removed from bee colonies by creating an artificial swarm. This involves moving the parent colony approximately 4 m from the original colony site. A second hive containing newly drawn combs and the queen is placed on the original site, causing foragers to return to this hive, creating an artificial swarm [34].

Brood removal and trapping for control of Varroa is based on the understanding that mites are confined in brood cells once the cells are capped. The mites can therefore easily be removed from the colony without the mites being able to escape back onto the adult bees. Probably the most well-known biotechnical control method for Varroa is drone brood removal and trapping. Drone brood is generally used for this purpose because Varroa mites show eight to ten times greater preference for drone brood than for worker brood. Removal of worker brood can also reduce mite levels, but it greatly affects colony productivity and is labor intensive [19].
Dowda Method: It involves sprinkling of fine dust particles, such as powdered sugar or certain pollen substitutes on adult honey bees in a colony. The powder does not harm the bees, but interfere with the mite’s ability to maintain its hold on the bees and it is also believed to increase the bees’ grooming behavior. This causes a certain percentage of mites to become dislodged. Powdered sugar works best as an amplifier of the effect of a screened bottom board [27].

Chemical Methods: The chemical methods of mite control involve various methods of application and ways of dispersal of acaricides, which are determined by the nature of the chemicals being used. Varroacides (specific miticides) are applied in feed, directly onto the adult bees, as fumigants, using contact strips or by evaporation [34]. Various chemicals have been demonstrated an ability to control Varroa in honey bee colonies. These chemicals can be divided into organic and synthetic. The three most common synthetic chemicals which are used to control Varroa are fluvalinate (apistan), flumethrin and coumphous. Essential oils and organic acids are the two organic mite control substances [19].

However, Varroa mites have a demonstrated ability to become quickly resistant to these chemicals. This has made many acaricides useless in areas where Varroa resistance to chemicals has been developed. Many of these substances are not easy to apply and they are dangerous both to the colony and humans. The effects of chemical treatments on honey bees include reduce longevity of queen bees, reduced sperm loads in and longevity of drones, brood death, and reduced queen egg laying patterns [12].

Biological Methods: The biological Varroa control methods involve the use of the bee’s biology, perhaps its natural resistance against mites. The desirable features of bees that can be selected to establish a resistant colony include higher hygienic and grooming activities, shorter post capping periods, low attractiveness of brood to mites, and low mite fecundity factors. The selection and establishment of resistant colonies is the best and cheapest method of control of varroosis since the bees themselves deal with Varroa mites. Achievement of this control method is, however, taking longer time and short term solutions, such as biotechnical or chemical methods have to be used in the meantime to stop colony death [27].

Conclusion and Recommendations: Varroa mite is an ectoparasitic mite of honeybee with great economic importance. It is the major bottleneck of apiculture development in almost all the world. It impairs the production of honey bee products (honey, wax and other products) and crop production by causing colony collapse. Importation of queen bee from infested areas and movement of infested bee colonies for pollination allow rapid spread of the mite. Infested colonies may appear to be apparently health up to a certain level, but will suffer a population crash at a certain mite threshold. Control of this mite is crucial in improving honeybee health service and productivity. There are different control and prevention strategies. These are biotechnical, chemical and biological methods. However, each of these methods has only a moderate efficiency when they are used alone. Repeated chemical treatment can lead to development of drug resistance and honeybee products contamination.

Therefore, based on the above conclusion the following recommendations are forwarded:
- Economic losses from the mite infestation are heavy so that concerned organizations should give attention to control and prevent them.
- As the control and prevention methods of mite infestation are not efficient enough when they are used alone, integrated mite control and prevention methods should be practiced
- Since early mite infestation is unnoticeable and colony collapse will be happened if unchecked, monitoring each honeybee colony for Varroa mite infestation several times over the course of a season to determine and when treatment is necessary.
- Repeated chemical treatment may lead to drug resistance and honeybee product contamination so that treating with a specified dose and for a specified period, treating as infrequently as possible and alternation of drugs is essential.
- Importation of queen bee from infested areas and movement of infested bee colonies for pollination should be avoided since these allow rapid mite spread.

REFERENCES


