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Mite Culprits for Causing Mortality and Reduction in Population of Honey Bee Coloniesand Measures for Pests Control

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ABSTRACT

Like other insects, the honey bee is subjected to many diseases and their early detection allows for prompt remedial action, and help in preventing serious outbreak and economic losses. Thesediseases differ in their severity, but all of them can be prevented or controlled by proper management. This handout offers information about field symptoms and diagnoses of the most common honeybee protozoan Nosema disease and treatment recommendations for pest control. There are two forms of the microsporidian Nosema associated with clinical signs of disease in honeybees, Nosema apis and Nosema ceranae. The diseases of bee are usually divided into two classes, those that attack the developing stages (the brood), and others that attack adult bees. In general, the brood diseases are more serious, and their symptoms are more definite and distinctive than those of the adult diseases. It takes experience and close observation to distinguish a diseased larva or pupa from a healthy one, or one dead from other causes. This experience can be gained only by frequent examination of the combs of a colony. For field diagnosis, Nosema incidence in honeybee colonies peaks in early fall and early spring in only adult bees by parasitizing their midgut, impairs the digestive process and causes bee's starvation. Adult bees have difficulty with controlling their fecal discharge and in heavy infestation, hive bodies are often smeared with fecal deposits. For Nosema confirmation, adult bees must be examined microscopically wherein spores are large, oblong shaped and highly uniform. For determining the level of infestation, a haemacytometer can be used to calculate the number of spores per adult bee. Though the diseases differ in their severity, but all of them can be prevented or controlled by proper management. Such management includes knowing and recognizing the symptoms of diseases, inspecting colonies regularly, and applying control measures promptly when disease is found. This is one of the reasons why the beginning beekeeper must open the colonies regularly. There are no IPM approaches specifically targeted against Nosema disease and its management, however on the maintenance of robust colonies, there should be periodicapplication of the antibiotic Fumagilin® B. The medication is mixed in sugar syrup according to manufacturer's recommendations and fed to bees in spring and fall. As with any medication, it is applied in the off-season when there is no chance that it will contaminate marketable honey.Drugs and antibiotics are effective in preventing disease, but cannot substitute for good management practices. They must be used at the proper time and dosage to avoid contamination of honey, and any recommended product is to be used only in accordance with the directions on the product's label.

Keywords: *Nosema, Microsporidum, Protozoan, Honey bee, Colony disorder*

1. Introduction

Several species of pathogens infest honey bees in various states and elsewhere, but the extent of such damage has not been measured. Some mites found in honey bee colonies in other countries,particularly in the tropics, cause serious injury to developing brood and adult. In some parts of the world, adult bees suffer from several diseases that are usually found in most colonies, but rarely cause serious damage. Those diseases that attack the developing stages (the brood), in general, are more serious and their symptoms are more definite and distinctive than those of the adult diseases (Collison et al., 2004; Sarwar, 2015). The Nosema disease is caused by the spore forming microsporidum protozoan Nosema apis or Nosema ceranae (Sporozoa: Nosematidae), that invades the digestive tracts of honey bee workers, queens and drones. Adult bees ingest Nosema spores with food or water, spores germinate and multiply within the lining of the bee'smidgut, millions are shed into the digestive tract and eliminated in the feces. When spores into the digestive tract are eliminated in the feces, fecal staining occurs on outside of hive. The Nosema disease may be present at any time during the year, but N. ceranae appears to be more common during summer and is sometimes referred to as 'dry nosema' as heavy load of this pathogen does not cause the characteristic fecal staining associated with N. apis, which appears in fall and winter. Damage to the digestive tract may produce symptoms of dysentery (diarrhea). Especially in winter, infected workers, unlike healthy workers, may defecate in or on the outside of the hive rather than out in the field. Diseased colonies usually have increased winter losses and decreased honey production. When queens become infected, egg production and life span are reduced, leading to supersedure. The loss of the queen in colonies newly started from package bees is a serious effect of the disease. Infection in worker bees inhibits digestion of food in the stomach and production of royal jelly. As a result, the productive life of the worker is shortened and its ability to produce brood food decreases, thus retarding brood production andcolony development (Morse and Nowogrodzki, 1990; Flottum, 2010). The only way to positively identify Nosema disease is through the dissection of adult bees and comparison of healthy and diseased honey bee gut. The hind gut and digestive tract of diseased bees are chalky or milkywhite. Healthy bees, on the other hand, have amber or translucent digestive tracts. In addition, the individual circular constrictions of a healthy bee's gut are visible, whereas the gut of an infected bee may be swollen and the constrictions may not be clearly visible. More commonly, bee abdomens are masticated in a known quantity of water and an aliquot of the suspension is examined under 100 X magnification for presence of Nosema spores (Mattilla and Otis, 2006).

2. Nosema Disease of Honey Bees

The Nosema disease is an infection of the digestive organs of the adult bee by a single-celled organism, a protozoan called Nosema apis. During the normal digestive process of adult bees, healthy cells of the stomach lining are shed into the stomach. They burst open and release digestive enzymes. Infected cells are also shed in this way, but they release Nosema spores and not digestive juices. These spores can infect other healthy cells of the stomach lining and many spores pass through the intestines and are present in the feces (excreta) of the bee. Small numbers of infected bees may be found at almost any time of year in apiaries. The natural defenses of the individual and the colony against disease tend to keep it under control. However, when the bees are confined to live by poor spring weather, or subjected to stress from moving or special manipulations, such as those for queen rearing and for shaking package bees, the disease may reach damaging levels. The lives of infected bees are shortenedand affected colonies are weakened, but rarely killed. The Nosema-infected colonies do not show any symptoms that are typical of the disease. For this reason, positive diagnosis can be made only by examination of bees for the presence of spores of Nosema. To do this, ground-up abdomens or alimentary tracts must be examined under a microscope at 400 X magnification to detect the organism (Potts et al., 2010; Neuman and Carreck, 2010).

The Nosema disease is cyclical in its severity in the bee's colony, with the greatest infection in late spring and the least in late summer or fall. The spores of the nosema organism are spread within and outside the colony with food and water. Infected bees soil the combs and spread infection within the colony. However, nosema infection does not cause dysentery, but bees suffering from dysentery may or may not have nosema disease. Empty combs contaminated with spores may be heated to 120 degrees F (49 degrees C.) for 24 hours to kill the spores. It can be controlled, at least in part, by feeding the antibiotic fumagillin (Fumidil B). Complete control is difficult because of the chronic nature of this infection in the bee's alimentary canal. The antibiotic must be available to the bees for a considerable time to rid them of the organism. Treatment is worthwhile; it reduces winter losses and creates stronger colonies in the spring. Treated colonies may also produce more honey. The antibiotic is most effective if fed in the fall when the normal level of the disease is lowest. Treatment in the spring is less effective, but may be of value for nucleus or package colonies (Van-Engelsdorp et al., 2010).

2. Dysentery (Diarrhea) Disease of Honey Bees

Bee dysentery is a health problem that affects hive individuals that do not live in hygienic conditions. This occurs when the bees have been prevented for a long time to perform cleansing flights. The diseases can also be triggered by food supplies that contain lots of impurities or by fermenting honey. Although it is not a disease, dysentery is considered here because so many beekeepers think of it as a disease symptom, especially of nosema disease. However, nosema infection does not cause dysentery, but bees suffering from dysentery may or may not have nosema disease. Bees with dysentery are unable to hold their waste products in their bodies and they release them in the hive or close to it. The condition is recognized by the dark spots and streaks on combs, on the exterior of the hive, and on the snow near the hive in late winter. Dysentery is caused by an excessive amount of water in a bee's body. The consumption during the winter of coarsely granulated honey or honey with high water content is one cause of the disease. Damp hive conditions may also contribute to the problem. Heavily infected bees may show symptoms such as disorientation, climbing grass stems, inability to fly, and they may also exhibit dysentery which can be confused with signs of Nosemosis. Low temperatures are a danger for honey bees, especially if they last for two-three weeks in a row. The bees cannot engage in cleansing flights and the chances for dysentery increase. The presence of tell-tale type of signs on combs, hive frames and hive entrance is a sign that the bees are affected by dysentery. Dead bees in the hive vicinity are also a sign of the disease. Good food and proper wintering conditions are important to prevent the problem, but there is no specific control for it once the bees are affected. The colony's recovery may be helped if it is given combs of lowmoisture honey or fed heavy sugar syrup. Beekeepers having apiaries in temperate regions with harsh winters know that it is almost impossible for their bees to undergo cleansing flights in the cold season. For this reason they take out all the natural honey from combs and feed the bees with sugar syrup or a corn syrup that has a high content of fructose. These syrups are almost free of indigestible parts and thus there are fewer chances for bees to develop acute diarrhea. Bee dysentery can be treated by feeding the bees with sugar syrup enriched with medicinal plants such as mint or yarrow. The colonies can be given food supplements consisting of honey and sugar cakes or sugar syrups that can contain a bit of raw milk or powdered milk (Graham, 1992; Stiglitz and Herboldsheimer, 2010).

3. Current Disease Incidence

This section provides beekeepers with further information about Nosema, which is a serious disease of brood and adult honey bees including queen bees. In some years, Nosema may cause serious losses of adult bees and colonies in autumn and spring. In recent years, another Nosema, N. ceranae, has been found to infect honey bees in a number of countries and information on this organism appears at the end of this annotation.

3.1. Nosema apis (Sporozoa: Nosematidae)

The N. apis is currently more prevalent in cooler climates and affects honeybees primarily in the spring and early summer It has been referred to as 'spring dwindling', with dysentery and fouling of the outside of hives with feces and it is known to age bees more rapidly in that they take on the duties of older bees and subsequently die sooner than non-infected bees. These precocious foragers have been shown to be less effective and resilient than normal foragers. The Nosema is historically considered the most serious disease of adult bees, caused by a single-celled microsporidian Nosema apis, which exists in two stages- a long-lived spore and a replicating vegetative stage. When spores of N. apis are swallowed by bees they germinate within 30 minutes inside the stomach. The organism then penetrates cells of the stomach lining and it continues to grow and multiply rapidly, using the cell contents as its food supply. Large numbers of spores are produced in the host cell in 6 to 10 days. The parasite may also penetrate and infect adjacent healthy cells. This spreads the infection further and if an adult bee ingests spores they germinate into the vegetative stage which penetrates the cells lining the bee's gut. The Nosemadoes not always kill a bee outright, but may trigger associated morbidities, including reduced lifespan, reduced output of brood food, and in the case of queens, increased supersedure rates. These symptoms may also be associated with tracheal mites and the collective result is colonies with low populations and sluggish spring buildup. The disease is regarded as more damaging in cold climates or under conditions that promote a protracted period of confinement in the hive(Fries, 2010).

3.2. Nosema ceranae (Sporozoa: Nosematidae)

A second species, Nosema ceranae, a natural associate of the eastern honey bee Apis cerana, has emerged in recent years as a problem, where it is suspected of causing large-scale colony deaths. The N. ceranae is known to occur in certain localities, and it probably contributes to similar occurrences of colony morbidity. It is nearly impossible to discriminate N. apis from N. ceranaewithout molecular techniques. Being a non-natural parasite on A. mellifera, there is concern that N. ceranae may have higher virulence toward the western honey bee, a pattern typical with many non-natural parasite relationships. However, studies have failed to firmly associate Nosema disease with wide-scale colony deaths, sometimes called colony collapse disorder. The N.ceranae has been first found in Asian honey bees (Apis cerana) and also found in European honey bees (Apis mellifera). As this is a relatively new parasite in honey bees, the full effect of this species of Nosema on individual bees and colonies is still being researched. It does not appear to cause sudden, quick losses of bees as does N. apis. The N. ceranae can be detected in all four seasons, while N. apis occurs mostly in the milder seasons of autumn and spring. The N. ceranae infection affects more cells in the honey bee gut than N. apis infection at the same temperature. Researchers have suggested that this difference may explain why there is a higher mortality of bees when they are infected by N. ceranae than when they are infected with N. apis. The N. ceranae can kill bees faster than N. apis. Colonies infected with N. ceranae in summer may gradually lose adult bees resulting in reduced honey production and may even die. While dysentery may be associated with outbreaks of N. apis, signs of dysentery are markedly reduced in outbreaks of N.

ceranae. The N. ceranae has been found in honey and pollen, and recent research has shown that N. ceranae spores lose viability when they are subjected to freezing and chilling (Paxton et al., 2007; Smart and Sheppard, 2012).

4. Incidence and Spread of Nosema

Infection of Nosema does not normally pass directly from infected bees to the next generation of adults. Instead, young bees become infected when they ingest spores as they clean contaminated combs. During the summer months, most honey bee colonies carry a few infected bees with little or no apparent effect on the colony. Spores may also persist on the combs and as the weather in autumn changes; these spores may initiate an outbreak of Nosema. Losses of bees at this time of the year may be very heavy. Winter losses can also be heavy when infected bees confined in their hives due to bad weather may defecate inside the hive soiling the combs and hive interior with excreta and spores. This, together with spores produced in the preceding autumn causes infection in spring. Spring outbreaks usually begin in late August or September, when temperatures begin to rise. They may last until late spring or early summer and when the warm weather comes, the disease begins to decline due to improved flight conditions. The source of infection is largely removed because the bees are able to defecate outside the hive thereby reducing the contamination of combs. Fortunately, serious Nosema outbreaks do not occur every year. Research has indicated that the subsequent conditions appear to be associated with serious autumn outbreaks and epidemics of Nosema, for instance, heavy summer rainfall, an early autumn break in the fine weather about mid-March to early April, and bees working grey box (Eucalyptus microcarpa), red ironbark (E. sideroxylon) and white box (E. albens). The exact reasons for these apparent relationships are not known. In these epidemics, strong colonies may be seriously weakened before winter. They may be reduced to the size of a nucleus colony in a matter of days. Infected colonies that survive the winter may require a long build-up period for the population of adult bees to reach normal numbers. Spores of N. apis may occur in honey or pollen and research reports indicated that honey bee workers can transmit Nosema to queens in queen mailing cages, queen banks and queen mating nuclei (Higes et al., 2009; Valera et al.,2011).

5. Effect of Nosema on Honeybee

i. Hypopharyngeal (brood food) glands of infected nurse bees lose the ability to produce royal jelly, which is fed to honey bee brood.
ii. A high proportion of eggs laid by the queen of an infected colony may fail to produce mature larvae.
iii. Young infected nurse bees cease brood rearing and turn to guard and foraging duties usually undertaken by older bees.
iv. Life expectancy of infected bees is reduced, and in spring and summer, infected bees live half as long as non-infected bees.
v. Infected queens cease egg-laying and die within a few weeks, but infected pupae are resistant to infection.
vi. An increase of dysentery in adult bees although Nosema is not the prime cause of dysentery.

It appears that Nosema spores are transmitted by a variety of routes including honey, pollen including pollen baskets from bees, wax, royal jelly and regurgitated pellets of the European beeeater (Merops apiaster) and mixed infections are common (Forsgren and Fries, 2010).

6. Honeybee Disease Detection

Details of apiary inspection and laboratory diagnosis carried out by researchers are held on the secure pages of bee base. This enables the production of accurate up-to-date information on the distribution of notifiable bee disease data. Bees infected with Nosema either show no symptoms, or none that are specific for this disease. Many of the so-called symptoms attributed to Nosemadisease apply to other diseases or conditions of adult bees. Examination of adult bees using a light microscope is the only reliable method of diagnosing the presence of spores of Nosema(Sammataro and Avitabile, 2006; Genersch, 2010; Traver et al., 2012).

6.1. Nosema Field Diagnosis

i. Nosema incidence in honeybee colonies peaks in early fall and early spring.
ii. The disease only affects adult bees by parasitizing their midgut. Adult bees have difficulty with controlling their fecal discharge. In heavy infestation, hive bodies are often smeared with fecal deposits.
iii. The disease is often not detected because affected bees are either inside the colony (in winter) or in the field, where they die.
iv. Nosema impairs the digestive process and causes bee starvation.
v. Nosema is often confused with dysentery, which produces similar symptoms.

6.2. Nosema Laboratory Diagnosis

i. For Nosema confirmation, adult bees must be examined microscopically.
ii. Standard detection method is, collect 25 dead bees and place in mortar with 25 ml of water (i.e., 1 ml water for every adult bee). Grind up and collect one droplet of solution,place on slide and cover with coverslip.
iii. Examine under 100 X power of compound microscope whereby Nosema spores are large, oblong shaped and highly uniform.
iv. For determining the level of infestation, a haemacytometer can be used to calculate the number of spores per adult bee.
v. For Nosema confirmation, collect at least 25 dry bees in tissue paper (no plastic) and mail to the Apiculture office.

Infected colonies can lose adult bees sometimes at an alarming rate. Infected bees often die away from the hive and only a few sick or dead bees may be found near the hive entrance. The term 'spring dwindle' is often used to describe this condition. However, this should not be confused with the normal weakening of colonies caused by the natural dying of old, over-wintered bees in early spring. Sick or crawling bees outside the hive entrance, dead bees on the ground and excreta (dysentery) on hive components may be associated with Nosema infection, but may equally be caused by other diseases and abnormal conditions.

7. Control of Nosema in Honeybee

There are no IPM approaches specifically targeted against Nosema disease and its management is biennial application of the antibiotic Fumagilin® B over the colonies. The medication is mixed in sugar syrup according to manufacturer's recommendations and fed to bees in spring and fall. As with any medication, it is applied in the off-season when there is no chance that it will contaminate marketable honey. For detection, obtain at least 50 adult bees from the front entrance of suspected colonies and send to a bee testing laboratory for diagnosis. The new species of Nosema may be a problem throughout the season and beekeepers can monitor spore levels regularly (Martín-Hernandez et al., 2007).

7.1. Methods of Treatment

During spring, method of treatment is feeding to bees a mix of Fumagilin-B with sugar syrup in spring if there have a high level of infection (> 1 million spores/ bee). This threshold may not reflect the current virulence of Nosema. The only treatment for Nosema is fumagillin (an antimicrobial agent isolated from Aspergillus fumigatus), but the methods of application for treatment of N. apis may not be as effective for treatment of N. ceranae (Higes et al., 2010). Protect the Fumagilin-B medicated sugar syrup from direct sunlight when feeding to bees and the further research is in progress for addressing the virulence of Nosema through applied research.To ensure that individual colonies received the accurate dose of Fumagilin-B, mix as per label instructions and apply using direct-to-colony feeding techniques (bag feeding, pail feeding, etc.). Barrel feeding Fumagilin is not effective as the dosage is not standardized and the drug settles to the bottom of the barrel. Replace 2 to 3 old brood combs (typically darker) from the brood box to reduce the level of Nosema and accumulation of acaricides in the wax. Spring feeding with Fumagilin-B is important and current research on the seasonal patterns of Nosema demonstrates that the levels of Nosema increase in June. For the duration of late spring or summer, method of treatment is new queens and Requeen colonies when new queens are available. For the period offall treatment material includes Fumagilin-B, and method of treatment is feeding to bees a mix of Fumagilin-B with sugar syrup as described above, and the fall feeding may protect bees during the winter season. Colonies treated with fumagillin in the autumn has significantly lowerNosema intensity in spring than did colonies that received no treatment, but by late summer thereis no difference exhibited between groups (Williams et al., 2008; 2011).

7.2. Management Practices

Beekeepers use management practices to minimize the incidence of Nosema because chemical treatments for control of Nosema are not registered in some states for use in honey production beehives. Use of any such treatment is illegal and could result in unacceptable residues in extracted honey. In addition, intensive research has investigated the connection between nutrition and honey bee disease and stress resistance. Both cage studies and field studies indicated that bees with poor nutrition are under more stress, more susceptible to Nosema and Varroa destructor, and have shorter lifespan (Frank et al., 2008; Wang et al., 2014).

i. Maintain colonies with queens having a good egg-laying potential and colonies prepared for winter should have a good population of young bees.

ii. Ensure that colonies have adequate supplies of high protein pollen in autumn and this will help to ensure good populations of young bees.

iii. Ensure that hives prepared for winter have good supplies of honey. Studies have shown that colonies with generally with half, or more, of honey have lower spore counts compared to colonies wintered with less honey.

iv. Place the hives in a sunny position in the cooler months of the year, and choose apiary sites that have good air drainage and protection from cold winds. Avoid cool shady and damp sites as research has

shown that the level of Nosema infection in a colony can be reduced from about 85% to zero by placing the hive in a sun trap where it obtains maximum sun and maximum shelter from cold winds.
v. Maintain winter colonies in a minimum of hive space so that they are compact and warm, and remove supers (boxes) of combs not required by the bees.
vi. Avoid colony stress which can be caused by excessive opening of the hive, manipulation of combs, feeding and relocating colonies.
vii. Avoid stagnant water sources which may become contaminated by dead bees and bee excreta to lessen infestation.
viii. Minimize the number of squashed bees during normal hive management as any infection will be spread when their remains are cleared away by hive cleaning bees.
ix. Replace old, dark brood combs to lower the number of spores in the hive, although this will never totally eliminate the disease. Many beekeepers remove two or more old combs from the brood nest each spring, replacing them with sheets of beeswax foundation available from beekeeping supply shops.
x. Once a colony is infected with the disease, it will usually progress until the colony dies. Shaking of bees onto fresh comb has been demonstrated to be a good control method for lowering of the-infection rates.

Over the time, progress in resistance development has been made for stocks of honeybee to pests, predators and diseases with encouraging results. These stocks have been found resistant to heat, cold and to disinfectants, and are viable for many years for honey making in old combs or derelict hives (Rinderer et al., 2001; Robertson and Albert, 2006; 2007).

8. Conclusion

Honeybees are our most important honey producer or pollinator, and many kinds of pathogens, parasites, predators affect most stages of bee development, so, strong hives are important to maintain healthy colony. A healthy honeybee colony has three distinct types of individuals, a queen, workers and drones. Each type of bee has a distinct role in the colony and collectively, they make up the members of a honey bee colony. The key to protecting honey bee coloniesfrom diseases, parasites, and other harmful conditions is the ability to identify and deal with problems early. This article contributes information about the location of confirmed cases of Nosema so that beekeepers can remain vigilant when knowing the whereabouts of diseased apiaries (10 km square basis). These pages also provide details on the surveillance for exotic threats and recent disease trends in honey bee colonies. The honey bee colony diseases arecaused by the spore forming microsporidian, Nosema apis and Nosema ceranae , and spores of these organism can only be seen using a light microscope. Increased monitoring and research are starting points to shed some light on the factors involved in recent honey bee colony losses.Beekeepers have responsibilities in preventing losses to their bees and in learning to accept some damage, especially in providing pollination services. In some areas, honey bee losses anticipated and the risk weighed against the possible returns from honey or pollination Beekeepers should be familiar with commonly used pesticides and their toxicity to bees. They should know as much as possible about the relationships between their bees and the nectar and pollen plants in their territory. It is essential that the owners of bees can be located easily when a nearby crop or the surrounding area is being treated with toxic materials. Therefore, a beekeepersshould provide ther names, address and telephone numbers to owners of land on which the bees are located. This information should also be posted in the apiary in large, readable Beekeeper's organizations should compile directories of apiary locations and their owners in eachcounty, and make them available together with marked maps at the office of the xtension adviser or county agent.

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Insecticide Risk Exposes Threat to Aquatic Life in Surface Water Bodies and its Remedying

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ABSTRACT

The pesticide risk due to spray drift, runoff or drainage has significant pressure on aquatic life resources, which increases the possibility of toxic exposure and effects on aquatic ecosystems. Thus, the purpose of this paper is to present an outline of adverse effects or toxicity of pesticide active ingredients and degradates to aquatic life. Researchers have evaluated comprehensive global insecticides contamination data for agricultural surface waters and found with hints of insecticide concentration in samples, wherein potential reasons for these findings are failures of current risk assessment procedures or farmers' non-adherence to pesticide application prescriptions. What is more, due to the high toxicity of insecticides for aquatic organisms, these short-term spurts lead to substantial and long-lasting adverse effects on aquatic communities. In addition, insecticide concentrations in waters is supposedly well regulated, even then insecticides are threatening global freshwater biodiversity and scientists fear for the loss of world's freshwater ecosystems. Aquatic life contaminations may result from treatment as well as fromconditions such as improper use of pesticides, residues from preceding treatments in the soil and cross-contamination. Aquatic organisms may die as a result of pesticide contamination, or they may simply grow poorly, become more susceptible to disease, or become unsuitable for human consumption. Insecticides can adversely impact aquatic macroarthropods which play many important functional roles in wetland ecosystems including as predators of aquatic herbivores, and trophic levels effect on aquatic community composition. For remedying, those who apply chemicals to crops near aquaculture facilities should be aware of the potential risks of contaminating those facilities. Identifying insecticides that pose low risk to aquatic macroarthropods, amphibians and fishes might help to meet increased demands for food while mitigating against potential negative effects on ecosystem functions. The researchers might increase awareness and rise regulation of chemicals harmful to aquatic life, and manufacturers should effort the best for making insecticides and herbicides safer for peoples.

Keywords: *Freshwater, Ecosystem, Aquatic Life, Biodiversity Loss, Pesticide Use*

1. Introduction

As agricultural expansion and intensification increase to meet the growing global food demand, so too will increase insecticide use, a type of pesticide that are used to specifically target and kill insects, and thus the result is risk of non-target effects. Insecticide pollution poses a particular threat to aquatic macroarthropods, which play important functional roles in freshwater ecosystems. Agrochemical pollution from insecticide run-off can have important negative consequences for non-target taxa (McMahon et al., 2012; Rohr et al., 2008). Within most countries the use of pesticides in agriculture is an accepted practice as it ensures a reliable yield of good quality produce. However, the extensive use of pesticides in developing countries quite often goes along with improper use of chemicals (Ecobichon, 2001; Damalas and Eleftherohorinos, 2011). The pesticides can enter the aquatic ecosystem through various routes such as spray drift or runoff (Raschke and Burger, 1997; Schulz, 2001; 2004). This may then pose risks to various non-target organisms in the aquatic ecosystem that can cause effects at population, community and ecosystem levels. Pesticides potentially affect human health through the consumption of fish, water and macrophytes from affected surface water (Van den Brink et al., 2007).

As new pesticides are developed and approved for use, it is important that risk assessors can predict the risk of these chemicals pose to non-target wildlife. Pesticides may vary both in their toxicity to organisms and in their estimated environmental exposures, the latter of which is based on recommended application rates and the physicochemical properties of the pesticide. Insecticides with similar modes of action often have similar safe threshold values in terms of toxic units (concentrations of different pesticides that are standardized by dividing the geometric mean of reported EC50 values of the most sensitive standard test species typically Daphnia magna) (Brock et al., 2000). Therefore, pesticides of the same class (i.e., organophosphate vs. pyrethroid insecticides) might be expected to pose similar risk to focal species even thoughindividual pesticide within a class might vary in its relative estimated environmental exposures and toxicities. Specifically, despite the fact that insecticide use is regulated, and cannot surpass legally-accepted regulatory threshold levels, it appears that they are still causing problems for various ecosystems and aquatic life. For marine life in urban areas, water is much less safe. However, although pesticides seeping into rivers have become much safer for humans, they still pose a serious threat to animal life. The research team found that overall; the rivers have pesticide concentrations much higher than suggested guidelines for marine life and the study found that pesticide levels for agricultural and mixed-land-use rivers stayed fairly constant. However, there is a marked increase in pesticides found in urban rivers and streams (Gilliom et al., 2007).

Owing to extensive use of pesticides in modern agriculture, it has raised serious public concern regarding the environment especially aquatic life safety. Two common macroarthropod predators, the crayfish Procambarus alleni and the water bug Belostoma flumineum, have been tested to three insecticides in each of two insecticide classes (three organophosphates: chlorpyrifos, malathion, and terbufos; and three pyrethroids: esfenvalerate, lambda cyhalothrin, and permethrin) to assess their toxicities. Organophosphate insecticides generated consistently low-risk exposure scenarios for both P. alleni and B. flumineum. Pyrethroid exposure scenarios presented consistently high risk to P. alleni, but not to B. flumineum, where only, lambda cyhalothrin produced consistently high-risk exposures (Halstead et al., 2015). The sublethal effects of many agricultural chemicals on aquatic life are unknown. Any misused chemical can cause serious problems to an aquaculture operation. Of the various pesticides, some indicate no risk for effects to the aquatic environment, while other are identified as posing the highest risk to the aquatic ecosystem. This is probably due to differences in the physical scenario and may not difference in the pesticide properties. Also, for a larger irrigation scheme, the results for suspended sediment particles indicate higher concentrations. Increased levels of suspended sediment generally result in an increased risk, as pesticides have more substrate to bind, which can potentially affect their toxicities. These models could therefore be useful tools to educate farmers and stakeholders on the effects of pesticides on non-target organisms. They provide information on the specific risks of a pesticide at a given application rate within the specific scenario, thus making it possible for the farmers to choose the lowest risk pesticides or to decrease their pesticide application rates to ensure the least amount of risk to the aquatic ecosystem. However, it must be remembered that these models only provide the risk of pesticides due to spray drift. The potential is there that these risks are an underestimation, as runoff and drainage can potentially increase the risk of pesticides being transported to the river(Malherbe et al., 2013).

2. Mode of Pesticide Risk

Within the last few decades, scientists have learned that some pesticides can leach through the soil and enter the groundwater below. While 50% of the nation depends upon groundwater as drinking water, and almost 95% of the households in rural areas use groundwater as their primary source of drinking water. The impact of agricultural chemicals on surface and groundwater quality has become an issue of national importance globally. The states have the responsibility under a variety of statutes to protect the quality of the nation's ground water as well as direct responsibility for regulating the availability and use of pesticide products. Each pesticide product has inherent risks associated with it (Sarwar, 2015 a; 2015 b; 2015 c; 2015 d; 2015 e), and potentially detrimental impacts of pesticides include:-

1. Acute poisoning from a single or short-term exposure can result in death of aquatic life.
2. Chronic impacts of long-term exposure to pesticides, including pesticide residues in food, could also result in death of aquatic life.
3. Natural resources can be degraded when pesticide residues in storm water runoff and enter streams or leach into groundwater.
4. Pesticides that drift from the site of application can harm or kill nontarget plants, birds, fish, or other wildlife.
5. The mishandling of pesticides in storage facilities and in mixing and loading areas can contribute to soil and water contamination.

3. Preliminary Risk Assessment of Pesticides

Unlike other chemicals, agricultural pesticides are intentionally applied to the environment to help farmers to control insects, weeds and other potentially harmful pests threatening agricultural production. They can therefore affect land ecosystems but also surface waters due to runoff. Theanalysis provides a global map of hotspots for insecticide contamination that are a major risk for biodiversity in water bodies. The researchers intend to use the global map to sensitize citizens and authorities about this issue in vulnerable regions and to incite local investigations. Buffer zones along the edge of water bodies can significantly reduce negative impacts for example. Efficient environmental management and conservation efforts in the future should focus on informing authorities and farmers about the costs, impacts and alternatives. Ultimately, mitigation and management takes place at the local level, determining the extent to which a water body will be affected under the application of such chemicals (Ippolito et al., 2015; Spangenberg et al., 2015).

The global threat that insecticides pose to aquatic biodiversity has been revealed in a recent modelling study that pinpoints certain areas at greatest risk. In various localities, the pesticides are found to pollute every stream and most of wells sampled in a study by the geological survey. Pesticide residues have also been found in rain and groundwater. Studies further showed that pesticide concentrations exceeded those levels that are allowable for drinking water in some samples of river water and groundwater. Pesticide impacts on aquatic systems are often studied using a hydrology transport model to study movement and fate of chemicals in rivers and streams. During some early decades quantitative analysis of pesticide runoff has been conducted in order to predict amounts of pesticide that would reach surface waters. There are four major routes through which pesticides reach the water, it may drift outside of the intended area when it is sprayed, it may percolate or leach through the soil, it may be carried to the water as runoff or it may be spilled, for instance accidentally or through neglect, but they may also be carried to the water as runoff or it may be spilled, for instance accidentally or through neglect, but they may also be carried to water by eroding soil. Factors that affect a pesticide's ability to contaminate water include its water solubility, the distance from an application site to a body of water, weather, soil type, presence of a growing crop, and the method used to apply the chemical (Papendick et al., 2007).

4. Pesticide Risk to Aquatic life

Pesticide's surface runoff into rivers and streams can be highly lethal to aquatic life, sometimes killing all the fish in a particular stream. Fish and other aquatic biota may be harmed severely by pesticide-contaminated water. Application of herbicides to bodies of water can also cause fish kills when the dead plants decay and consume the water's oxygen, suffocating the fish. Herbicides such as copper sulfite that are applied to water to kill plants are toxic to fish and other water animals at concentrations similar to those used to kill the plants. Repeated exposure to sublethal doses of some pesticides can cause physiological and behavioral changes that reduce fish populations, such as abandonment of nests and broods, decreased immunity to disease and decreased predator avoidance. Application of herbicides to bodies of water can further kill plants on which fish depend for their habitat. Pesticides can accumulate in bodies of water to levels that kill off zooplankton, which are the main source of food for young fish. Pesticides can also off insects on which some fish feed, causing the fish to travel farther in search of food and exposing them to greater risk from predators. The faster a given pesticide breaks down in the environment, the less threat it poses to aquatic life. However, insecticides are typically more toxic to aquatic life than herbicides and fungicides (Vos et al., 2000; Arias-Estevez et al., 2008).

5. Pesticide Risk to Amphibians

Within the past several decades, amphibian populations have declined across the world, for unexplained reasons which are thought to be varied, but of which pesticides may be a part.Pesticide mixtures appear to have a cumulative toxic effect on frogs and toads. Tadpoles from ponds containing multiple pesticides take longer to metamorphose and are smaller in size, decreasing their ability to catch prey and avoid predators. Exposing tadpoles to the organochloride endosulfan at levels likely to be found in habitats near fields sprayed with the chemical, kills the tadpoles and causes behavioral and growth abnormalities. The herbicide atrazine can turn male frogs into hermaphrodites, decreasing their ability to reproduce. Both reproductive and nonreproductive effects in aquatic reptiles and amphibians have been reported. Crocodiles, many turtle species and some lizards lack sex-distinct chromosomes until after fertilization during organogenesis, depending on temperature. Embryonic exposure in turtles to causes a sex reversal and disorders such as decreased hatching success, feminization, skin lesions, and other developmental abnormalities have been reported. About similar situations occur in case of Daphnia, which is a genus of small planktonic crustaceans (Kashian and Dodson, 2002; Ansara-Ross et al., 2008; Rattner, 2009; Kohler and Triebskorn, 2013).

The mapping exercise conducted by the researchers reveals that aquatic life in water bodies within 40 per cent of the global land surface is at risk from insecticides running off the land. Thepotential insecticide contamination hotspots, explain that tropical and subtropical regions need to pay urgent attention to threats of biodiversity loss from insecticide use. Farmers in many developing countries are changing from subsistence farming to market-oriented intensive crop farming resulting in increased insecticide uses. The findings suggest that the current regulatory risk assessment schemes and pesticide authorization procedures fail to protect the aquatic environment, and these need to be changed. The researchers recommend improving basic global conventional agricultural systems and adopting approaches from organic farming as possible ways to both provide enough food for a growing human population, and protect global ecosystems from agricultural insecticides (Crain and Guillette, 1998).

It is very helpful for environmental risk assessment and environmental management to have the information on insecticide occurrence on the landmass of countries. Then it can be identifiedwhere to find exposure hotspots and where it is most relevant to plan mitigation measures.Mitigation methods include buffer strips, alongside water bodies which are free of insecticide use, who also suggest more efficient environmental management to combat the risk.The mode of action of insecticides is responsible for their higher or lower toxicity to non-target organisms. However, the large variations in susceptibility among different animal taxa indicate that certain biochemical traits particular to a group of organisms are responsible for a specific level of sensitivity. Aquatic arthropods are most susceptible to all types of insecticides because they share many physiological features with the target insects. Other aquatic organisms, such as fish and amphibians, are very sensitive to broad-spectrum neurotoxic and respiratory inhibitor insecticides, but not so much to selective insecticides such as insect growth regulators and stomach poisons. Terrestrial vertebrates are also sensitive to most neuro-toxicants and respiratory inhibitors, with the exception of those insecticides derived from natural toxins produced by plants or fungi (e.g., few pyrethroids, neonicotinoids, avermectins, spinosad), which appear to have little or no toxicity in birds and mammals (Lin et al., 2013).

6. Reducing Risk of Pesticides

Outlined below is an indication of how this phrase can be used in current practice of minimizing pesticides risk to aquatic life. The environmental risk of pesticides, which is mandatory and is conducted by regulatory agencies, is generally seen as an elaborate process, but also farmers themselves must adhere to specific application guidelines, for example, they cannot spray within 20 meters of a surface water body in order to ensure that the contamination is not exceeded in field. The risk to the aquatic environment or non-target organisms may be managed via the useof buffer zones. It is proposed that this can be accomplished through the respect of an unsprayed buffer zone of distance to be specified to non-agricultural land and surface water bodies(Lamberth et al., 2013).

6.1. Risk Phrases to Protect Aquatic Organisms

Always, do not contaminate water with the product or its container, do not clean application equipment near surface water, and avoid contamination via drains from farmyards and roads. Forprotecting groundwater or aquatic organisms, apply pesticides only according to soil type or situation to be specified to soils. To protect aquatic organisms, respect an unsprayed horizontal buffer zone distance to surface water bodies when spraying from aircraft, also do not apply on impermeable surfaces such as asphalt, concrete, cobblestones, railway tracks and other situations with a high risk of run-off.

6.2. Risk Phrases for Protection of Water

Principles show that for one or more of the labelled uses, that risk mitigation measures are necessary to avoid contamination of groundwater. For protecting groundwater or soil organismsdo not apply unknown or any other product containing unidentified active substance or class of substance, as appropriate, and more than the time period specified.

6.3. Pesticides Drift Risk

Pesticides can contribute to air pollution and pesticide's drift occurs when it is suspended in the air as particles and carried by wind to other areas, potentially contaminating them. Pesticides that are applied to crops can volatilize and may be blown by winds into nearby areas, potentially posing a threat to to aquatic life. Pesticides drift risk can be reduced by using low-volatility formulations, using low pressure, using high volume, using the largest nozzle that is practical,releasing spray near the crop or soil surface, not spraying when the temperature is high, spraying when the wind is low and blowing away from aquaculture facilities, and using spray thickeners when appropriate.

6.4. Pesticides Runoff Risk

Following that, the researchers then estimated the so-called runoff potential, in other words the amount of insecticides that enters streams and rivers through the rainwater from agricultural land. Runoff can carry pesticides into aquatic environments while wind can carry them to other fields, grazing areas, human settlements and undeveloped areas, potentially affecting other species. The study showed that rainwater will run off the land into water bodies based on the slope of the terrain and rainfall; and the runoff hazard ae related to the amount of insecticide used that is likely to contaminate water bodies. An early quantitative analysis of pesticide runoff can be conducted in order to predict amounts of pesticide that would reach surface waters.Reduce the risk of runoff by delaying application if rain is expected, irrigating in accordance with pesticide label instructions and monitoring to avoid runoff and the accumulation of excess surface water, using no-tillage or minimum tillage cropping systems that reduce pesticide runoff, using soil-incorporation methods, using adjuvants that promote the retention of pesticides on treated surfaces, grading the surface and constructing drainage ditches and dikes, and planting border vegetation (Morgan and Brunson, 2002).

With careful management it is possible to protect crops from insects, weeds and diseases while at the same time preventing pesticides from harming aquaculture operations. Near aquaculture,grow crops that require little or no pest control. Scout fields for pests and use chemicals only when necessary. When a pesticide must be used, select a product that is registered for the intended, and is the least toxic and least persistent of the products available. Always follow exactly the directions on the label. The decline in chemicals harmful to humans coupled with an increase or stagnation in chemicals harmful to other animals suggests that the federal government should impose stricter regulation on chemicals that are dangerous to fish and other marine life. It should be noted that this guidance is still relatively brief and is based on initial interpretation of these requirements, and it is intend to update this guidance occasionally as our experience grows (Relyea, 2009).

7. Conclusion

The increases of pesticides applications make the implications for the environmental and biomedical research for the communities a significant endeavor. Monitoring platforms for pesticides are scarce, particularly in aquatic life and an effective strategy for dealing with insecticide contamination in this environment should have to commence with an assessment of the extent of the problem. However, information on the quality of the state's water resources isof critical interest because it is so integrally linked to the long-term availability of water that is clean and safe for drinking and recreation, and that is suitable for industry, irrigation and habitatsfor fish and wildlife. Further research on environmental risk assessment of the pesticides used in agriculture to assess the impact on water resources particularly on fisheries and mariculture, ecotoxicological properties of the pesticides and their physico-chemical profile, simulation of the environmental behaviour of the pesticides in relation to the load applied onto the agricultural areas, pesticides approximate concentrations, chemicals at highest risk identification, and risk management measures, is needed. This study could represent a cost-effective method that may be used before engaging in expensive monitoring programs for pesticides where analytical facilities are lacking. Overall, further data would be needed to draw a firm conclusion and to refine the risk assessment of pesticides to aquatic life.

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Mites- The Tiny Killers to Push Honeybee Colonies into Collapse and Integrated Pest Management

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ABSTRACT

This article is designed to give an overview of damage to honey bee's colony by parasitic mites, integrated pest management, available treatments and information on further pest control. Parasitic mites have caused massive economic losses and expenses for beekeepers and theirdestructive power is evident from the huge number of colonies lost since the past few Parasitic mites present in most colonies in certain localities, if left untreated, these usually cause the colony to collapse. Parasitic can feed and survive on both adult bees and their brood, andfeed on the host's haemolymph (blood) through punctures made in the body wall with their sharp mouthparts. Mites transmit pathogens like viruses and bacteria, and without human intervention, infestation with mites means certain death of honey bees sooner or later. The signs of infestation may not be obvious until colonies are heavily infested, however, there are several methods that can be used to detect the mites and estimate their infestations at a much earlier stage. These include counting dead mites that collect on the hive floor and counting mites inside sealed brood cells. This is a disaster not just for beekeepers, but also to farmers in most countries where honey bees are the main pollinators of crops such as apples, oilseed rape and almonds. Mites remainedthe number one management problem for beekeepers and scientists alike, and management of parasites has now become a routine part of bee husbandry. The onset of resistance to the treatments available and the potential impact of secondary infections may make controlling ofmite more difficult in the future, and it will continue to be a serious threat to the long-term sustainability and prosperity of apiculture as well as environment. Mites control methods can be divided into two groups, management methods (biotechnical methods) and chemical controls (varroacides). There are a few effective and approved miticides (chemicals that kill mites) to immediately treat mites with one of these treatments by carefully following the directions on the package. Because mites can develop a resistance to these medications, it is prudent to alternate between two or more of these from one season to the next. In practice, the best controls result from using a combination of methods at different times of the year depending on the level of infestation is Integrated Pest Management or 'IPM, as reliance on a single approach is not a long term solution

***Keywords:** Parasitic mites; Miticides; Varroacides; Biotechnical; Honey bee*

1. Introduction

Mites are the most common, notorious and troublesome pests invading of honey bee colonies. The mites cause varroosis, which is a very serious and complex infestation of honey bees. Mitesare mobile and can readily move between bees and within the hive, however, to travel between colonies they depend upon adult bees for transporting through the natural processes of drifting,robbing, and swarming. Mites can spread slowly over long distances in this way; however, the movement of infested colonies by beekeepers is the principle means of spread over long distances. Individual bees infested with mites during their development usually survive to emergence, but may show signs of physical or physiological damage as adults. These include shorter lifespan, reduced weight, shrunken and deformed wings, and reduced natural resistance to infections. Some broods infested may die, usually at the pupal stage of development and remain in the cell until removed by adult bees. As mites feed, as well as take essential nourishment away from the developing bee, these act as the vector and can aid in virus spreading, so that in heavily infested colonies they become much more widespread and potentially harmful by reducing the bees lifespan. Mites may also worsen the harmful effects of other common bee diseases such as Acarapisosis caused by the tracheal mite, Acarapis woodi(De-Jong, 1997; Downey et al., 2000; Martin, 2001; Sarwar, 2015 a).

Varroa mite (Varroa destructor) is a shiny, reddish-brown, shield-shaped about 1.5 mm wide and 1 mm long, and this move about quickly and can be seen crawling on the surface of both adult and immature honey bees or on hive parts, and sometimes a few dead mites can be found on the bottom board of the hive. They feed on both brood and adults by puncturing the body and sucking the body fluids of the bee and reproduce in sealed brood cells. They spread rapidly from one hive to another as bees drift into the wrong hive or when bees rob honey from the colonies that are too weak to defend themselves. Tracheal mites (A. woodii) are microscopic internalparasites of adults honey bee, Apis mellifera, and the Asian honey bee, A. cerana. They primarily infest the largest breathing tubes, or tracheae, near the base of the bee's wings and feed on body fluids by puncturing the walls of the tracheae. Mites move from old bees to young bees that have just emerged from their pupal cells. Mite-infested bees have shorter life spans, a reduced ability to keep themselves warm during the winter months and can cause winter die-offs of colonies if most of the adult bees become infested (Anderson and Trueman, 2000; Hunt, 2010). Currently, there are two species of Tropilaelaps mites documented as serious parasites Tropilaelaps clareae and Tropilaelaps koenigerum, affecting both developing brood and adult honey bees. The mites are reddish brown, about 1 mm long and 0.6 mm wide, and move freely and rapidly on combs and rely on brood for feeding. The natural host of the mite is the giant Asian honey bee, Apis dorsata, but Tropilaelaps can readily infest colonies of A. mellifera, the Western honey bee. It is also associated with other Asian honey bees, including Apis laboriosa, A. cerana and Apis florea. Parasitisation by these mites can cause abnormal brood development, death of both brood and bees, leading to colony decline and collapse, and can cause the bees to abscond from the hive(Wilkins and Brown, 2005).

2. Mite Effects on Colonies and Signs of Colony Collapse

Small numbers of mites infesting a colony will usually cause it no obvious harm, however, as the level of infestation rises; the risk of harmful effects also rises. In poorly managed colonies whereinfestation is allowed to increase, signs of damage to the entire colony start to become evident. Severe infestation slows the replacement of old adult bees with healthy young bees, and may lead to the rapid spread of harmful bee viruses in the colony. At this stage, the normal processes of foraging, brood rearing and colony defense diminish and the colony's entire social organization begins to deteriorate- a process known as colony collapse. Colony collapse is usually very rapid (taking only a few weeks) and may affect even strong colonies that have shown no outward signs of damage. However, a closer look would reveal many mites on adult bees (with deformities) and heavily infested sealed drone and worker broods, often with many mites per cell. Colony collapse can occur at any time of the year, but it seems to occur most often in August and September. However, spring colony collapse, which in turn leads to mite invasion of neighboring colonies, can be quite common in March, April and possibly into May. The signs of colony collapse include a sudden decrease in the adult bee population, usually with few dead adult bees present, bees with deformed wings and abdomens, numerous mites on remaining bees, on worker and drone pupae and on the hive floor, and various abnormalities of the brood (e.g.,bald brood, poor brood pattern, patches of neglected and dead brood often discolored brown and partly removed by the bees. Researchers agree that it is a wise aim to keep the varroa population below about 1000 mites; above this level the risk of damage from the mites, associated pathogens and the effect of feeding on the bees can quickly become very significant. However, higher threshold levels of around 4000- 5000 mites are generally used. Mites populations in infested colonies increase naturally through two processes, the reproduction of mites in brood cells and the influx of new mites into the colony through invasion (Bowen-Walker and Gunn, 2001; Ball et al., 2009).

Mites can be controlled by monitoring their infestation in bee colonies and the use of appropriate control methods to keep pest numbers below levels that are harmful. Therefore, this articledescribes the harms of the mites to bees, how it can be recognized and monitored, the latest approaches beekeepers can use to control the infestation in their hives, and a look ahead to the future. The development of strains of mite resistant to treatments used against them poses new challenges to beekeepers. Following the arrival of mites, beekeepers began to use pyrethroid treatments on an annual basis. The mites have responded to certain chemicals in many parts of the world by developing resistance to these routinely used chemicals (Eischen et al., 1998; Aumeier, 2001; Buchler et al., 2008).

3. Integrated Pest Management (IPM)

The Integrated Pest Management (IPM) means using a combination of different control methods at different times of the year in order to keep the varroa mites population to such a level that these can cause no significant harm to a bee colony. The IPM allows the beekeepers to choose the products or methods appropriate to them. It encourages careful monitoring so that treatments are used in line with known risk. These offer a very simple means of controlling mite numbers effectively. It is particularly useful to beginners and should be seen as an important part of an IPM approach that can be adapted as necessary (Delaplane et al., 2005; Sarwar, 2015 b; 2015 c). As a general rule, mite populations should be monitored three or four times a year. Monitoring ofcolonies routinely can tell to beekeepers how mites infestation is developing. Beekeepers can then use this information to decide what and when control methods will be appropriate. A range of monitoring methods is available to use ranging from the quick and approximate through to the complex and more accurate. Beekeepers will have to decide which of these suit to their own individual beekeeping practices. The aim is to keep the total population below 1000 mites per honey producing colony. A number of methods are possible, but counting natural mite mortality is the simplest and highly compatible with treatments (Guzman-Novoa et al., 2010):-

i. Put the clean paper or insert under the mesh floor for 5-7 days in summer, and up to 14 days in winter.
ii. Count the number of fallen mites at the end of the monitoring period and divide by the number of days to give the daily mite drop.
iii. Multiply the daily drop by 100 in March, April, September and October, 400 in November to February, and 30 in May to August, to give a good estimate of the total number of mites in the hive. Uncapping drone brood regularly will give a good idea of mite levels. When over 10% of pupae are infested, control will be required before the end of the season.

Beekeepers are now aware that reliance on a single approach is not a long term solution, thus, current control methods used by beekeepers against mites can be divided into two main categories like varroacides (use of chemicals) and biotechnical methods (use of methods based on bee husbandry) to reduce the mites population:-

3.1. Varroacides

This is use of chemicals to kill mites or otherwise reduce their numbers. These are applied in feed, directly on adult bees, as fumigants, contact strips or by evaporation. These may include authorized proprietary veterinary medicines and unauthorized generic substances.

3.1.1. Menthol Crystals

Menthol crystals provide a fumigant action that kills tracheal mites without harming the bees at certain temperatures. The crystals start to evaporate about 70°F and will melt to a liquid at about102-105°F. Effectiveness of the product is dependent upon temperature, formulation (crystals or pellets), dosage, colony, size, condition of equipment, position within the hive and exposure time. Menthol should be used during a non-nectar flow period and after surplus honey has been removed to prevent menthol-flavored honey. Remove all menthol packets at least one month prior to a nectar flow to prevent contaminating marketable honey. Menthol crystals may reduce brood-rearing and affect clustering behavior if left on the colony beyond the recommended treatment period. Many beekeepers have reported excellent mite control with menthol packets placed on the bottom board in August and removed in November. Results may vary depending on local conditions. A yearly fall treatment should reduce the mite's population and allow good over-wintering and good spring buildup.

3.1.2. Menthol Crystals and Vegetable Shortening-Sugar Patty

A combination of menthol crystals and vegetable shortening-sugar patty treatments should give optimum mite control. A vegetable shortening-sugar patty treatment has been shown to provide good tracheal mite control. This treatment is thought to disrupt the tracheal mite's life cycle by reducing the ability of the female mite to detect young bees as hosts. The patties are made of two parts of granulated sugar and one part vegetable shortening. A baseball size patty should be flattened and placed on the top frame bars in the brood chamber. The patty can be placed on wax paper over the top frame bars, but this is optional. Patties should be placed in colonies during brood rearing periods and a fall or early spring treatment or both are recommended. Tracheal mites require their host to survive. Empty equipment that has been free of live bees for one week may be reused without mite treatment (Ellis, 2001).

3.1.3. Powdered Sugar Dusting

The dusting of colonies with powdered sugar as a means of varroa control has become quite popular with hobbyists. In an article, Oliver (2007) used the powdered sugar dusting for varroa mite management to cause phoretic (hitchhiking) mites to drop off the bees. Author found that powdered sugar has just the right size for sticking to the mite's footpads, plus has the added advantage of not adding any unwanted contamination to the hive. This research demonstrated that dusting with powdered sugar could effectively increase mite drop from a colony. When the bees are covered with powdered suga, their bodies become slippery and the varroa lose their ability to cling to the bees, the granules get into the gripping surfaces of the feet and they fall to the floor of the hive. Additionally, the powdered sugar promotes the dusty bees to clean themselves, causing more mites to be dislodged in the process. This technique has no adverse effect on adult bees and the capped brood, and the sugar particles do not enter the spiracles and their tracheal ducts in the treated bees. Here is the process described:-

i. Sift a pound of powdered sugar using a baking flour sifter, do this twice to ensure no lumps and this should be done on a day with low humidity.
ii. Put the sifted sugar into an empty and cleaned baby powder container or alternatively improvise the container.
iii. Smoke and open the hive.
iv. Remove frames one by one and dust the bees with the sugar.
v. Avoid dusting any open cells.
vi. Put the dusted frame back into the hive and repeat this process with each frame.
vii. When done, also put a little extra dusting along all the top bars.
viii. This should be repeated once a week for two to three weeks.

3.1.4. Biopesticides

Biopesticides are naturally occurring organisms or their by-products, and several have been registered for controlling mites in honey bee colonies. The efficacy of many biopesticides can equal that of conventional chemical pesticides. For instance, Apilife VAR product contains a combination of the essential oils thymol, eucalyptol and menthol to treat both varroa and tracheal mites. Several studies have shown that if used as instructed by the manufacturer, it destroys between 65 and 97 percent of the mites population within a hive. The delivery medium of this product is a vermiculite tablet, which must be broken into four pieces and placed in the four corners of the hive between the brood chambers. Each piece must be wrapped in wire mesh to prevent the bees from chewing and removing it from the hive prematurely. New tablets must be used every week for three weeks for complete effectiveness. The biopesticide sucrose octanoate, derived from the tobacco plant, has recently been developed for varroa control under the trade name Sucrocide. It is delivered by spraying adult workers with the substance once every week for three weeks to kill mites as they emerge from brood cells. Formic acid has recently been permitted the control of varroa mites, and it is the only chemical pesticide that can be used for organic honey production. There are several delivery methods for formic acid, such as placing pads soaked with liquid formic acid on top of the hive. The product cannot be used during a honey flow, and care must also be taken by the beekeeper while applying formic acid, as it is highly corrosive and poisonous to humans. Toxicity by essential oils for honey bee mite control is by direct contact of the pest. When varroa mites contact essential oils such as wintergreen or tea tree oil mixed into oil or grease, they are killed on contact usually within a few minutes (Melathopoulos et al., 2000).

3.1.5. Chemical (Synthetic Pesticide) Treatments

Conventional means of varroa control involve synthetic pesticides being administered to a colony by placing plastic strips impregnated with the active chemical within the hive. While these treatments have traditionally provided very high levels of control, the varroa mite is becoming increasingly resistant to these chemicals, which makes them less reliable in some areas. For the control of varroa mites, Apistan, with the active ingredient fluvalinate, is a synthetic pyrethroid. It is sold as a plastic strip impregnated with the pesticide, and the strips are hung between the frames of a hive just outside of the brood nest. Fluvalinate is a contact pesticide and provides up to 100 percent control of varroa mites when properly used. In recent years, however, there have been increasing reports of varroa mites developing resistance to this pesticide. It is highly recommended, therefore, that Apistan should be rotated with other treatments to reduce the development of resistance to chemical control by the mites and to ensure its efficacy. Checkmite+, the trade name for coumaphos, is also sold as a plastic strip impregnated with the pesticide, and the strips are hung between the frames of a hive just outside of the brood nest. Fluvalinate is a contact pesticide and provides up to 100 percent control of varroa mites when properly used. In recent years, however, there have been increasing reports of varroa mites developing resistance to this pesticide. It is highly recommended, therefore, that Apistan should be rotated with other treatments to reduce the development of resistance to chemical control by the mites and to ensure its efficacy. Checkmite+, the trade name for coumaphos, is also sold as a plastic strip impregnated with the active pesticide. When the bees and mites come into contact with the pesticide, it can provide up to 100 percent control when used properly. Coumaphos is a member of the organophosphate group of pesticides, and residues can accumulate in wax and be harmful to bees at high levels. As with Apistan, there have been documented cases of varroa mites developing resistance to this pesticide, so it is important to alternate its use with other approved treatments (Delaplane and Hood, 1997; Natalia et al., 2009).

3.2. Biotechnical Methods

This is use of methods based on bee husbandry to reduce the mite population through physical means alone. Many of the most popular and effective methods involve trapping the mites in combs of brood which are then removed and destroyed.

3.2.1. Physical, Mechanical, Behavioral Methods

Mites can also be controlled through nonchemical means and cost of these controls is intended to reduce the mite population to a manageable level, not to eliminate the mites completely (Schmid Hempel, 1998; Webster and Delaplane, 2001; Kassai, 2006).

3.2.2. Perforated Bottom Board Method

This method is used by many beekeepers on their hives and when mites occasionally fall off a bee, they must climb back up to parasitize another bee. If the beehive has a screened floor with mesh of the right size, the mite will fall through and cannot return to the beehive. The screened bottom board is also being credited with increased circulation of air, which reduces condensation in a hive during the winter. Studies done at over two years found that screened bottoms have no measurable effect at all. Screened bottom boards with sticky boards (glue traps) separate mites that fall through the screen and the sticky boards prevent them from crawling back up. Insecticide may also be applied to the sticky boards to help in killing the mites. It has been verified fact that in colonies with screen bottoms, the mite reproduction rate is lower. It should be stressed that cultural controls alone may not get rid of colonies of varroa mites and should be thought of as a means to delay the economic threshold and the need for a chemical application. Hopefully in the future, genetic bee stocks resistant to Varroa mites will become more available to beekeepers. Bees expressing varroa-sensitive hygienic behavior or auto-grooming are especially promising (Imdorf et al., 1995).

3.2.3. Heating Method

In this method, hive frames are heated to at least 104 degree F (40 degree C) for several hours at a time, which causes the mites to drop from the bees. When combined with the perforated bottom board method, this can control varroa sufficiently to aid in colony survival. In few countries, anti-varroa heaters are manufactured for use by professional beekeepers, and thermosolar hive has also been patented and manufactured.

3.2.4. Mechanical Control

Certain control methods involve changes in beekeeping management practices and the benefit of such mechanical control measures is that they do not use chemicals to reduce mite levels, thus they may be employed when the bees are collecting and producing honey. Research has shown some benefits from replacing the wooden bottom of a standard beehive with a wire-mesh screen or other nonsolid surface. Several studies have shown decreases in mite levels within colonies where hives have screened bottoms compared to solid bottoms. While the reasons for the decreased mite populations are unknown, the decrease may be due to better hive ventilation or to the loss of mites dropping through the floor of the hive. The benefits of bottom screens are minimal; however, such hives usually require additional methods of treatment. Varroa mites prefer to infest the drone brood in a hive, which consists of developing male honey bees. This is because drones are larger and take longer to develop, so female mites can produce more offspring per generation. Beekeepers may take advantage of this preference by placing special combs with drone-sized cells in their hives to the brood. These combs can then be removed before the drones and the mites emerge from their cells. Depending on the time of year, this practice can dramatically reduce the mite populations within colonies. Adult mites move through the hive by clinging to the backs of adult bees. Some research has shown that covering all the adults in a colony with fine dust sugar particles or certain pollen substitutes can cause the mites to lose their grip and fall off their hosts. This technique can be laborious and quite disruptive to a colony, but it requires no chemical pesticides (Elzen et al., 1998).

3.2.5. Mite-tolerant Stocks

Some of the more exciting advances in varroa mite control have been done through honey bee genetics. In recent years, much work has been done to develop particular strains of honey bees that have shown tolerance to the varroa mite. Though the mechanisms are not completely understood, some behavioral and physiological traits probably play a role in varroa resistance. Today, several strains of bees (Russian strain) are available that have been shown to reduce the number of varroa mites within their colonies that has been made available for commercial purchase (Robertson, 2005; Seeley, 2007).

3.2.6. Use Drone Comb to Capture Varroa Mites

Bee suppliers sell a special drone foundation that has larger hexagons imprinted in the sheet. The bees will only build drone comb on these sheets and that is useful, because varroa mites prefer drone brood over worker brood. By placing a frame of drone comb in each hive, beekeepers can capture and remove many mites. Once the drone cells are capped, remove the frame and place it overnight in your freezer. This will kill the drone brood and also the mites that have invaded the cells. Then uncap the cells and place the frame (with the dead drone brood and dead mites back in the hive. The bees will clean it out (removing the dead drone brood and mites). The cells will get filled again, and beekeepers can repeat the process (Fakhimzadeh and Hayes, 2011).

3.2.7. A New Way of Protecting Bees against Mites

Life in the hive is highly organized with busy honey bees working all around the queen. Worker bees distribute pollen, clean and look after larvae, or defend the entrance against enemy invaders like wasps and other honey thieves. But, the varroa mite, V. destructor, slips in unnoticed on the bodies of some worker bees, evading the strict door policy. It brings a deadly danger with it andthis tiny brown arachnid can wipe out entire bee colonies. Like a tick, it fastens itself onto a bee with its jaws and so sneaks its way into the realm of the hard-working nectar collectors. Once inside, mites reproduce by laying their eggs in the honeycombs where new bees are raised. After ten to fourteen days, their offspring spread throughout the bee population along with the newly emerged bees. Particularly at the end of the flowering period, foraging bees from healthy colonies invade colonies weakened by varroa to steal honey. They then become infected and take back large numbers of mites to their own population. The researchers want to prevent this transfer of mites, since it is vital for effective mite control to stop new pests constantly entering the hive. They have therefore concentrated on the strategically most important point, and the joint efforts have led to the creation of the varroa gate, which is a structure at the entrance to the hive. Every bee must climb through this gate when leaving or returning to its own hive. At first sight it does not look anything special, but just a plastic strip with holes through which the bees fly in and out. Only a closer look shows the immense benefits of this innovation wherein the plastic strip is coated in chemicals. Whenever a bee passes through the gate, it touches the edge. This transfers a mite poison (acaricide) to the bee and kills any mites it may be carrying. The substance needs to be permanently available on the surface of the strip so that protection can last for several weeks.

4. Conclusion

These results support the conclusion that mites weaken honey bee colony populations and integrated pest management compromises for colony buildup. Overall, results suggest that varroa mites could have a high and negative impact on the survivorship of overwintered honey bee colonies. Moreover, these mites as well as tracheal and Tropilaelaps mites infection mightsignificantly restrain the growth of honey bee colonies during the spring. General practices for all mite pests include rotation between different types of treatments whenever possible for mites management, this can prevent the development of resistance in mites (e.g., synthetic mite-strip in spring, followed by a formic acid treatment in fall). Use particular caution when using temperature - dependent treatments above recommended temperature thresholds (e.g., formic acid, thymol). Read all labels before applying any disease or mite control products to coloniesand treat all colonies that require treatment in the yard at the same time. Monitor colonies to determine levels of mites infestation because knowing the severity of the infestation will enable to make an informed management decision on their control. The presence of multiple parasites or diseases may require treatment below the recommended treatment threshold levels. Oxalic acid should be used only as a follow-up treatment in the late fall, after a primary early fall treatment, unless monitoring reveals very low levels of varroa. Treatments need to be applied before infestations or infections reach damaging levels. Use of resistant bred honey bee queens in bee keeping operation may help colonies to resist diseases and pests naturally, however, treatment can still be required. It is recommended to replace 2 to 3 old frames in the brood chamber (typically the darkest) every year with newly drawn comb or foundation. This practice can be helpful to reduce the level of parasites and miticide residues in the bee hive.

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Life History of House Fly Musca domestica Linnaeus (Diptera: Muscidae), its Involvement in Diseases Spread and Prevention of Vector

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ABSTRACT

The house fly, scientifically known as Musca domestica Linnaeus, is a well-known cosmopolitan insect that interact with our lives. The house fly M. domestica accounts for 91% of all flies that live within human habitation which is the reason that they are known as house fly. Of both farm and home, it is the most common species found on hog and poultry farms, and horse stables and ranches. Not only are house flies a nuisance, but excessive fly populations are an irritant toinhabitants and farm workers when these are nearby to human habitations to create public health problems. Indoors, they rest on floors, walls and ceilings during day, and outdoors, they can rest on plants, ground, fence wires and garbage cans. Night resting places are usually near to sources of food and 5 to 15 feet off the ground, and they prefer corners and edges or thin objects to rest on. House fly eggs are laid in almost any warm, moist material that may supply suitable food for the larvae such as a wide variety of food, including human food, animal food, carcasses, garbage and excrement. The female may lay a total of five to six batches of 75 to 100 eggs that hatch in 12 to 24 hours. Houseflies pass through the egg, larval and pupal stages in approximately 10 days, after which adult flies emerge and the average life span for a house fly is less than one month. House flies are major carriers of disease and they are known to transfer over 100 pathogens resulting in ailments, including typhoid fever, tuberculosis, cholera, dysentery, poliomyelitis, yaws, anthrax, tularemia and leprosy. House flies are covered with small hairs that serve as taste organs and collect the pathogens on their legs and mouths when feeding on feces, trash and other decaying material. Flies regurgitate and excrete wherever they come to rest and thereby mechanically transmit diseases. Measures to control flies transmitted disease are reducing or eliminating breeding sites for flies, reducing sources that attract flies from other areas, preventing contact between flies and disease-causing agents, and protecting of foods well as eating utensils and people from making contact with flies. House flies can be a real nuisance when they are flying around, so it is important to get rid of them. House fly control involves several steps, and the first step is identification, which requires different control methods. It is very important to identify places where flies have been depositing their eggs and breeding site must be cleaned up or removed otherwise flies will continue to be a problem. Next step is to eliminate adult flies and depending on the situation, it may be necessary to use fly bait, traps or an attractant application. Fly traps have long been favorite devices and there are many forms of fly traps, from disposable fly traps to electronic fly light traps with replaceable light bulbs and glue boards. Other steps in house fly control are exclusion and sanitation, and after these measures, householders can use insecticides that come in residual forms, aerosols, fogging materials and baiting forms.

Keywords: *Musca domestica, house fly, vector, Pathogen, disease.*

1. INTRODUCTION:

The common house fly Musca domestica Linnaeus (Diptera: Muscidae occurs on all inhabited continents, in all climates from tropical to temperate, and in a variety of environments ranging from rural to urban. It is commonly associated with animal feces, but has adapted well to feeding on garbage, so it is abundant almost any place where people live. The flies are inactive at night, with ceilings, beams and overhead wires within buildings, trees, shrubs, various kinds of outdoor wires and grasses reported as overnight resting sites. In poultry ranches, the nighttime, outdoor aggregations of flies are found mainly in the branches, and shrubs, whereas almost all of the indoor populations generally aggregated in the ceiling area of houses. According to a study conducted, breeding sites suitability in descending order are horse manure, human excrement, cow manure, fermenting vegetable and kitchen waste. However, another study found that structures containing swine, horse, sheep, cattle and poultry varied in fly abundance, with swine facilities containing the most and poultry the least. Fruits and vegetables cull piles; partially incinerated garbage and incompletely composted manure also are highly favored sites for breeding. Nutrient-rich substrates such as animal manure provide an excellent developmental substrate. Very little manure is needed for larval development, and sand or soil containing small amounts of degraded manure allows for successful belowground development. When the maggot is full-grown, it can crawl up to 50 feet to a dry, cool place near breeding material and transform to the pupal stage (Zhu et al., 2012; Sarwar 2015 a, 2015 b).

2. Life Cycle and Description

The house fly has a complete metamorphosis with distinct egg, larval or maggot, pupal and adult stages. The house fly overwinters in either the larval or pupal stage under manure piles or in other protected locations. Warm summer conditions are generally optimum for the development of the house fly, and it can complete its life cycle in as little as seven to ten days. However, under suboptimal conditions the life cycle may require up to two months. As many as 10 to 12 generations may occur annually in temperate regions, while more than 20 generations may occur in subtropical and tropical regions. Adult of the house fly is 6 to 7 mm long, with the female usually larger than the male. The female and can be distinguished from the male by the relatively wide space between the eyes (in males, the eyes almost touch). The head of the adult fly has reddish-eyes and sponging mouthparts. The thorax bears four narrow black stripes and there is a sharp upward bend in the fourth longitudinal wing vein. The abdomen is gray or yellowish with dark midline and irregular dark markings on the sides while the underside of the male is yellowish. Adults usually live for 15 to 25 days, but may live up to two months. Without food, they survive only about two to three days and longevity is enhanced by availability of suitable food, especially sugar. Access to animal manure does not lengthen adult's life and they longer at cooler temperatures. They require food before they will copulate and copulation is completed in as few as two minutes or as long as 15 minutes. Oviposition commences four to 20 days after copulation and female flies need access to suitable food (protein) to allow them to produce eggs, and manure alone is not adequate. The potential reproductive capacity of flies is tremendous, but fortunately can never be realized. Scientists have calculated that a pair of flies beginning reproduction in April may be progenitors (under optimal conditions and if all are live) of 191,010,000,000,000,000,000 flies by August (Lynsk, 1993; Larraín et al., 2008).

The white egg of house fly is about 1.2 mm in length, laid singly but are piled in small groups. Each female fly can lay up to 500 eggs in several batches of 75 to 150 eggs over a three to four day period. The number of eggs produced is a function of female size, which itself is principally a result of larval nutrition. Maximum egg production occurs at intermediate temperatures of 25to 30°C. Often, several flies will deposit their eggs in close proximity, leading to large masses of larvae and pupae and eggs must remain moist otherwise they will not hatch. Early instars larvae are 3 to 9 mm long, typical creamy whitish in color, cylindrical but tapering toward the head and the head contains one pair of dark hooks. The posterior spiracles are slightly raised and the spiracular openings are sinuous slits which are completely surrounded by an oval black border. The legless maggot emerges from the egg in warm weather within eight to 20 hours. Maggots immediately begin feeding and developing in the material in which the egg is laid. The larva goes through three instars and a full-grown maggot about 7 to 12 mm long, has a greasy, creamcolored appearance. High-moisture manure favors the survival of the house fly larva. The optimal temperature for larval development is 35 to 38°C, though larval survival is greatest at 17 to 32°C. Larvae complete their development in four to 13 days at optimal temperatures, but require 14 to 30 days at temperatures of 12 to 17°C. The pupal stage is about 8 mm long andpassed in a pupal case formed from the last larval skin which varies in color from yellow, red, brown to black as the pupa ages. The shape of the pupa is quite different from the larva, being bluntly rounded at both ends. Pupae complete their development in two to six days at 32 to 37°C, but require 17 to 27 days at about 14°C. The emerging fly escapes from the pupal case through the use of an alternately swelling and shrinking sac called the ptilinum, on the front of its head which it uses like a pneumatic hammer to break through the case (Lynsk, 1991; Cickova et al., 2012).

3. Damage and Medical Importance

Flies commonly develop in large numbers in poultry manure under caged hens, and this is a serious problem requiring control. The most important damage related with this insect is the annoyance and the indirect damage produced by the potential transmission of pathogens (viruses, bacteria, fungi, protozoa, and nematodes) associated with fly. Pathogenic organisms are picked up by flies from garbage, sewage and other sources of filth, and then transferred on their mouthparts, through their vomitus, feces and contaminated external body parts to human and animal food. Of particular concern is the movement of flies from animal or human feces to food that will be eaten uncooked by humans. Also, when consumed by flies, some pathogens can be harbored in the mouthparts or alimentary canal for several days, and then be transmitted when flies defecate or regurgitate. In situations where plumbing is lacking, such as open latrines, serious health problems can develop, especially if there are outdoor food markets, hospitals, or slaughter houses nearby. Among the pathogens commonly transmitted by house flies are Salmonella, Escherichia, Enterococcus, Chlamydia, and many other species that cause illness. These flies are most commonly linked to outbreaks of diarrhea and shigellosis, but also are implicated in transmission of food poisoning, typhoid fever, dysentery, tuberculosis, anthrax, ophthalmia, and parasitic worms (Forster et al., 2009).

4. Economic Threshold

The threshold density for determining of when to control flies depends on the area where the control measures will be taken. In general, at homes the threshold is very low and control actions are taken with few flies. The complaint threshold density of the house fly at waste management sites may be 150 individuals per flypaper per 30 minutes. House flies are monitored with baited traps, sticky ribbons, or spot cards on livestock facilities. Spot cards are 3-inch by 5-inch white index cards attached to fly resting surface. A minimum of five cards should be placed in each animal facility and left in place for seven days. A count of 100 or more fecal or vomit spots per card per week indicates a high level of fly activity and a need for control. Tolerance of flies depends greatly on circumstances, and in sensitive environments such as food preparation and packing facilities, restaurants and hospitals, even small numbers of flies cannot be tolerated. In the context of livestock or poultry production, however, some flies are inevitable. Serious problems occur when cities or suburban development occur near poultry production facilities, as residents usually will not tolerate the large numbers of flies emanating from such facilities(Barnard and Geden, 1993).

5. Types of Diseases Transmitted by Housefly

House flies mainly spread infectious diseases and these are caused by viruses, bacteria, protozoa and even nematodes (worms like the roundworm or threadworm). There are over 100 pathogens (disease-causing organisms) that are associated with house flies. Unlike other insects, such as mosquitoes or ticks, these pathogens do not specifically require an insect vector. The house fly plays no specific role in the life cycle of these pathogens, but the fly is simply a carrier in some instances. Diarrheal illnesses are some of the more common diseases spread by house flies. This includes bacteria such as Shigella, Enterococcus and related bacteria which commonly cause diarrheal illnesses and are found in the stool of peopled with these illnesses (Szalanski et al, 2004). Some of the diseases spread by house flies include:-
Mechanical transmission of organisms on its hairs, mouthparts, vomitus and feces:

i. Parasitic diseases: cysts of protozoa e.g., Entamoeba histolytica, Giardia lamblia, and eggs of helminths, e.g., Ascaris lumbricoides, Trichuris trichiura, Hymenolepis nana and Enterobius vermicularis.
ii. Bacterial diseases: typhoid, cholera, dysentery, pyogenic cocci, etc. House flies have been demonstrated to be vectors of Campylobacter and E. coli O157:H7 using PCR.House flies can be monitored for bacterial pathogens using filter paper spot cards and PCR
iii. Viruses: enteroviruses, poliomyelitis, viral hepatitis (A & E) etc.

It is evident that flies can spread many infectious diseases indiscriminately, but fortunately, these diseases are not frequently spread by flies. Other routes are usually more common and effective for their transmission and the house fly is able to spread disease through several routes. It does not bite like the horse fly or tsetse fly in order to inject the pathogen into a person. Instead disease-causing agents are spread on its body, in its mouth parts or through its vomitus and feces. House flies feed indiscriminately on a wide range of organic matter, from feces to food (fruits, vegetables and meat). It is through this contact with the item to that it is feeding upon and even by direct contact with people that disease-causing agents are acquired and passed on. The infective dose for each pathogen varies greatly and sometimes just a few microbes are required to cause serious disease. The contaminated matter containing these microbes and even just the microbes itself, that are acquired from one source may adhere to the fly or be passed out in its vomitus and feces. The contaminated matter and microbes are then passed onto food once the fly lands and/or feeds on it. The situation is further exacerbated if the food is not refrigerated allowing the inoculation dose of microbes to multiply before the food is eaten (Seymour and Campbell, 1993; Sheri et al., 2007).

6. Prevention of Housefly Diseases

Extensive measures to control fly populations does not seem like a concern for the average urban dweller in a developed nation. However, it is important to do so even though strong insecticides for mass spraying, dumping toxic materials in potential breeding sites and widespread distribution of fly traps are not usually necessary. Simple measures in the home front can prevent flies from causing serious diseases through implementing of three strategies (Hedges, 2004; Sarwar, 2015 c).

6.1. Breeding Sites

Although sewage is not a problem for urban dwellers in developed nations, but animal feces (dung) can still be an issue, especially with livestock. Pet excrement that is not properly disposed of can serve as breeding sites and attract flies. It may not always be possible to clean out all remnants of pet feces, especially in a carpeted home but regular washing of the carpets and use of domestic insecticides over the area can help significantly. The same applies for organic matter that is not discarded by the proper channels. Garbage disposal units have played a significant role in preventing of fruit, vegetable and food leftovers from posing a threat in regular rubbish bins. When not available, organic matter should be sealed tightly in rubbish bags before disposing. Compost heaps in the garden, especially where manure is used, can also serve as another attraction source and breeding site for flies.

6.2. Contact between Flies and Pathogens

A housefly only needs a few seconds to make contact with a source of pathogens in order to transport it elsewhere. Feces are one of the substances that are laden with a wide range of microbes, especially if it is passed from a person who is ill. Modern toilets have eliminated this risk to a large degree in developed nations. However, soiled baby diapers are still a risk if not discarded properly. Older people, who are debilitated, like the infirm, may also be a source caregivers need to ensure that any excreta are cleaned as soon as possible. Adult diapers may be useful in this regard but it has to be disposed of accordingly. Open wounds and sores and infected eyes can also serve as another source. Animal slaughter may pose another problem, particularly in areas where hunting is a common practice. Quick slaughtering and discarding of the remnants appropriately, like burying entrails, can reduce this risk.

6.3. Contact with People, Food and Eating Utensils

House flies cannot be completely eradicated and even the best efforts in the home can reduce fly populations but it can quickly return. In order to prevent diseases, the fly's contact with people, food and eating utensils should therefore be prevented or interrupted. Self-closing doors and nets/ screens over doors and windows are very effective in preventing of flies from entering the home. Even electric fans blowing air over a doorway can impede flies from entering the home. When these measures are unable to stop flies entirely, then aerosol sprays and fly traps may be alternatives. The insecticide sprays can kill some flies and repel others, and traps can attract flies more so than food in the home and eventually kill them.

7. Managements to Get Rid of House Flies

There can be four basic principles of pest management important in controlling house flies: sanitation, exclusion, non-chemical measures and chemical methods as are listed in order of lasting effectiveness.

7.1. Sanitation

Sanitation is the first measure of defense, even though there are various traps and sprays that are used to kill flies, so, it is necessary to eliminate the source in order to eliminate them. Whenever possible, food and materials on which the flies can lay their eggs must be removed or destroyed, which can isolate the egg-laying adult. Killing of adult flies may reduce infestation, but elimination of breeding areas is necessary for good house fly control management. Garbage cans and dumpsters should have tight-fitting lids and be cleaned regularly. Flies cannot breed in large numbers if their food sources are limited, so, do not allow such materials as manure, garbage, grass clippings, weed piles or other decaying organic matter to accumulate. Keep trash cans clean and tightly covered. Be careful not to wash garbage cans where the rinse water might drain into the soil as flies can breed in soil full of organic matter. Dry out maggoty garbage or dispose of it in fly proof containers or landfills. Since the house fly can complete its life cycle in as little as seven days, thus, removal of wet manure at least twice a week is necessary to break the breeding cycle. Wet straw should not be allowed to pile up in or near buildings as straw is one of the best fly breeding materials, so, it is not recommended as bedding. Spilled feed should not be allowed to accumulate, but should be cleaned up two times a week. Ordinarily, fly control from 1 to 2 km around a municipality prevents house fly infestations (Kaufman et al., 2001).

All garbage receptacles should be located as far from building entrances as possible. For control at waste disposal sites, refuse should be deposited onto the same area as inorganic wastes to deteriorate the capacity of breeding resources, or the disposed refuse should be covered with soil or other inorganic wastes (15 cm thickness) on every weekend or every other weekend. Around homes and businesses, screening or covering of windows, doors or air doors, and trash containers proves useful in denying access of flies to breeding sites. Packaging household trash in plastic bags and burying trash under at least 15 cm of soil and in sanitary landfills also helps to eliminate breeding. Trash cans and dumpsters should have tight-fitting lids; failing this, slow release fumigant insecticide dispensers are sometimes installed on the inside of the lids to reduce fly survival. In agricultural areas, manure can be scattered over fields so that it can get quickly dries and becomes unsuitable for egg and larval survival. Composting of manure can be effective if the compost is properly maintained, including regular turning. Manure can also be liquefied and stored in lagoons anaerobically, though at some point the solids need to be separated(Kaufman and Rutz, 2002).

Fly traps may be useful in some fly control programs when enough traps are used, if they are placed correctly, and if they are used both indoors and outdoors. House flies are attracted to white surfaces and to bait that give off odors. Indoors, ultraviolet light traps can collect the flies inside an inverted cone or kill them with an electrocuting grid. One trap should be placed for every 30 feet of wall inside buildings, but not placed over or within five feet of food preparation areas. Recommended placement areas outdoors include near building entrances, in alleyways, beneath trees, and around animal sleeping areas and manure piles. Openings to buildings should be tightly screened with standard window screen, thereby denying entrance to flies. Traps can be baited with molasses, sugar, fruit or meat, and often are used in combination with a device that captures the attracted flies. The sex pheromone (Z)-9-tricosene also functions as an aggregation pheromone, and is called muscalure. Muscalure is formulated with sugar as commerciallyavailable fly bait for local population suppression, as well as an enhancement for population monitoring. Ultraviolet light traps can be used to assess population levels, but also serve as a non-chemical control technique that can be used indoors in both agricultural and non-agricultural areas. They normally function by electrocuting flies that enter the trap, though those used in restaurants typically have a sticky panel. Flies do not orient to traps from a great distance, so several are normally needed for them to be effective. Placement should include within 4 to 8 m of entryways and within 1.5 m of the floor to take advantage of fly flight behavior. They should be operated continuously, although they are most effective when the room lights are off(Kaufman et al., 2005).

7.2. Exclusion

Flies can be kept outside of homes by the use of window and door screens, and make sure screens are tight-fitting without holes. Keep doors closed with no openings at the top or bottom. There should be no openings around water or gas pipes or electrical conduits that feed into the building and caulk or plug any openings. Ventilation holes can be a way for flies to enter a building; however ventilation is important to maintain adequate air circulation within the building, but screening must be used to exclude flies (Sarwar and Salman, 2015).

7.3. Non-chemical Measures

The use of such devices as ultraviolet light traps, sticky fly traps, fly swatters, baited fly traps, etc., can eliminate many flies from inside a home. A fly swatter is an economical control method for the occasional fly (Sarwar, 2015 d).

7.4. Chemical Control

Indoors, the control of flies includes automatic misters, fly paper, electrocuting and baited traps that can be used in milk rooms and other areas of low fly numbers. When the house fly is a mayor pest in commercial food production facilities, the control of this insect is by the application of adulticides, or larvicides to directly or indirectly suppress adult densities and residual wall sprays can be applied where the flies congregate. Outdoors, the control of flies includes the use of boric acid in the bottom of dumpsters, treatment of vertical walls adjacent to dumpsters and other breeding sites with microencapsulated or wet able powder formulation, and the use of fly baits near adult feeding sources. Manure can also be treated with an insecticide, though this method is highly discouraged as it interferes with biological control of flies, often resulting in a rebound of the fly population. More commonly, insecticides (especially insect growth regulators) can be fed to livestock, and residual insecticide in the manure inhibits fly breeding. In animal facilities, insecticides are often applied to the favored resting places of adults, or bait stations established to poison adults with either solid or liquid formulations.

Continuous exposure of flies to insecticides has led to development of insecticide resistance to many insecticides. Resistance to permethrin develops more rapidly in fly populations from farms on a continuous permethrin regime than in farms in which permethrin and diclorvos have been alternated. Exterior applications of insecticides may offer some relief from infestations where the task of completely sealing the exterior is difficult or impossible. Applications should consist of a synthetic pyrethroid (i.e. deltamethrin, cyfluthrin, lambda-cyhalothrin, cypermethrin, sumithrin or tralomethrin) and should be applied by a licensed pest control operator when flies begin to appear. Unfortunately, because insecticides are broken down by sunlight, the residual effect of the material will be greatly decreased and may not kill flies much beyond several days or a week. If flies are numerous inside of home, persons can use a space spray (aerosol) labeled for flying insects. Most space sprays contain pyrethrins for quick knockdown. Aerosols give temporary relief, however if there are many flies inside, persons would be wise to find out why they are there and take steps to relieve the problem through sanitation and exclusion (Scott et al., 2000; Sarwar, 2015 e).

7.5. Biological Control

Due to the increasing incidence of insecticide resistant house fly populations, rising costs of insecticides and a growing public concern about actual or potential problems associated with insecticides, interest in alternative house fly control strategies has increased. Natural biological suppression of the house fly results primarily from the actions of certain chalcidoid wasps (Hymenoptera: Pteromalidae), of which many species have been associated with house fly around the world. Among the more important are Muscidifurax and Sphalangia species. Ichneumonids and other parasitoids, as well as some predatory insects especially histerids (Coleoptera: Histeridae) and staphylinids (Coleoptera: Staphylinidae), also contribute to fly mortality, but under optimal fly breeding conditions the house fly quickly builds to high numbers. The more important in poultry facilities are the wasps M. raptor and S. cameroni. Leaving a layer of old manure in the pits when manure is removed might enhance or stabilize the suppression of the house flies densities by parasitoids and predators. Augmentative biological control (Periodic release of parasitoids during winter and spring, and following manure removal) using insectary-reared parasitoids have been quite successful in some dairies, feedlots and poultry house situations. The species most often released for biological suppression are M. raptor, M. raptorellus, S. endius, and S. nigroaenea. These different species function better under different conditions, some performing better under cooler or warmer conditions, while others parasitizing flies near the surface or deeper in the pupation medium. The tests showed that when house fly populations occur near the surface on the drier periphery of the manure, the conditions favor parasitism by M. raptor, but when the flies pupate at greater depths the conditions favor S. cameroni. The releases conducted with S. endius showed that they could successfully parasitize pupae, both above and below the soil surface. The larva of the black dump fly, Hydrotaea (Ophyra) aenescens, is also regaining popularity as a biological control agent for controlling house flies on poultry farms without the use of pesticides. The adult black dump fly is similiar in appearance to the adult house fly (Hogsette et al., 1993; Hogsette, 1996; Watson et al., 2001).

8. Integrated Fly Control

Integrated control of the house fly is not yet a reality however, the refinement of selective application procedures, based on more detailed knowledge of fly behavior, should be pursued. Concurrently, more intensive investigations on the manipulation and propagation of biological control agents against the house fly are needed. Integrated fly control programs for houses are based on the succeeding strategy, selective applications of insecticides against the adult, start insecticide control measures early in the spring before flies appear and repeat as frequently as needed through the warm months, the manure is left undisturbed throughout the warm months when fly breeding may occur, and the manure should be removed once very early in the spring before any flies appear. But, it is determined that larviciding of the manure with nonselective insecticides is detrimental to mite predator Macrocheles rnuscaeclornesticae (Scopoli) (Acarina: Macrochelidae), of the immature stages of the house fly and should not be practiced. Selective application methods for adult fly control are preferable and efforts to refine these methods should be intensified. The more commonly used control measures for house flies are sanitation, use of traps, and insecticides, but in some instances integrated fly control has been implemented and the use of biological control in fly management is still at a relatively early stage (Rutz et al., 2001).

9. Fascinating Particulars about Houseflies

The relationships of houseflies with human beings are one of the factors that are posed and have resulted to their dispersal. The feeding process of houseflies is a relatively interesting one; with these insects restricted to the consumption of liquids, their feeding habits revolve around the fly's secretion of saliva onto selected food items, which are then sucked up through the proboscis. Houseflies are usually ready to breed within five days of reaching maturation, with the copulation process lasting anywhere between two and fifteen minutes and initiated once the fly has been properly fed. The life of a housefly will end naturally following ordinary processes of degradation, unless the advent of death is speed up by a lack of food or the presence of cold conditions, though humans can prove just as effective in ensuring their termination. Houseflies can be useful especially in waste management. The ability of their larvae to feed on decaying organic matter can be used to recycle nutrients that are in nature. Studies show that an approach can be used to control the high amount of waste in the environment. Although the approach has not been fully exploited, the chances of using the insects would be highly beneficial. Humans have also used harvested maggots as feed for animals as the maggots have nutrients that are good for the animals especially in the production of broiler chickens. Flies are also interesting because they are only active during the day and persons cannot see a fly during the night unless it is for some strange reasons. The flies are active only when the sun is up and get inactive when the sun goes down. Probably everyone has a relationship with houseflies and these are everywhere in our homes and in extension in our lives. The nature of the relationship between humans and the flies is not cordial and they will get a hint whenever there is something for them within our house. The housefly has fascinated interest in biology mainly because of the sex determination of the flies. The housefly is an interesting creature because it exhibits many different mechanisms for sex determination. House flies are able to move their wings 200 times per second and can fly at the speed of 5 miles per hour. House flies defecate every couple of minutes and this is one of the factors that facilitates transmission of diseases. Houseflies are solitary creatures, like the rest of the insect world, males and females do not stick together after mating and unlike nesting insects, females do not care for or protect eggs (Dubendorfer et al., 2002;Nazni et al., 2005; Hwangbo et al., 2009).

10. Conclusion

Peoples can find house flies pretty much far and wide where there are humans or animals. Flies like things such as garbage, manure and anything else that is left out in a warm environment. House flies do not feed on human body, but they get their nutrients from spitting saliva on their food, which liquefies it so they can suck it up with their sponge-like mouths. Once the adult house fly hatches from the pupal stage, it has an approximate life span of 15 to 30 days. Females are able to start producing eggs after two days of life and will continue to lay eggs for about a month. House flies can travel up to six miles in 24 hours, but they usually prefer to stay close by their breeding ground. The easiest way to keep flies out of our home is to keep things clean, donot leave food lying around, make sure to take out the garbage on a regular basis and wipe up messes right away.

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Mite Culprits for Causing Mortality and Reduction in Population of Honey Bee Colonies and Measures for Pests Control

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A B S T R A C T

This article highlights the most serious invasion of the honey bee colonies by mite pests resulting in an irregular brood pattern or death and stresses upon tactics of maintaining minimum population level of culprits. Parasitic mites are currently the greatest pest threat to honey bees and their colonies, and infested colonies can probably perish if action is not taken to control pests. Thus, they are a significant threat to beekeeper's income and satisfaction. Mites in genera Varroa, Acarapis and Tropilaelaps are cruel parasites of honey bee brood feeding on bee adults, larvae and pupae causing brood malformation, death of bees and subsequent colony decline or absconding. Worldwide, Varroa destructor is an external parasitic mite that attacks honey bees Apis cerana and Apis mellifera, and disease caused by mites is called varroosis. Tracheal mite (Acarapis woodi) parasite of honey bee has also been discovered to spread throughout wholly regions of some states, leaving behind thousands of dead bee colonies. Tracheal mite is suspected of playing a major role in causing excessive statewide colony losses in recent years with much loss. Tropilaelaps mites (Tropilaelaps clareae and T. mercedesae) are external parasitic mites that feed on haemolymph (blood) of drone and worker bee pupae, as well as reproduce on honey bee brood. These mites can also harm to bees indirectly by serving as transmitters of several viruses that can kill bees. Virtually, all feral or wild honey bee colonies have been wiped out by these mites, and beekeepers are continuing to struggle with infestations in their hives. These secondary infections are facilitated when mites compromise to bee's immune systems with condition known as parasitic mite syndrome, which can kill colonies within months of infection. Therefore, it is vital, to understand parasitic mites and options available for their control. Monitoring hives for mite levels enables beekeepers to determine whether treatment is necessary and to make informed decisions about when to take action. Early detection of low levels of mite infestations is a key to its successful management as they can be spotted during colony inspection if present in high numbers that tends to only identify larger infestations. There are some products available that can kill mites and cause these pests to drop from bees. Treatment strips should be hung in the brood nest area of colony for approximately 4 weeks. This is to be used with sticky paper and a fine-mesh screen on bottom board of a colony to capture any mites that may have been present after removal. However, exclusive and continual use of one chemical product is more likely to result in resistance by pest. So, several different products should be used on a rotating basis and under any circumstances, and never experiment with non-approved chemical treatments. Such practices are illegal and may result in bees death, contamination of honey and wax, and severe harm to beekeepers, so, it is recommended that all beekeepers should receive training and certification. Reliance on a single approach is not a long term solution and Integrated Pest Management (IPM) using a combination of different control methods at different times is imperative in order to keep mite populations lower to cause significant harm to a bee colony.

Keywords: *Acarapis, Honey bees, Mites, Syndrome, Tropilaelaps, Varroa*

1. Introduction

Beekeepers, crop growers, scientists, official authorities and the general public are all concerned and alarmed with the mysterious die offs of honey bee (Apis mellifera) colonies that have occurred during the last three years in many countries around the world. This phenomenon has been named colony collapse disorder and many suspects have been suggested as potential culprits of these losses, but no clear explanation has yet been done attributable to weather and pesticides (Stankus, 2008). It is known for example, that the parasitic mites (Acari) Varroa destructor and Acarapis woodi are causes of colony mortality, and thus several synthetic miticides have been used successfully in their control (Wilson et al., 1997; Ellis, 2001). However, mites resistance to certain active ingredients in miticides is now prevalent. The resultson relative effect of parasite levels on mortality and populations of honey bee colonies estimatedthat most of the colonies have been infested with varroa mites during the fall (75.7%), but only 6.1% tested positive to tracheal mites. Winter colony mortality reached to 27.2%, and when examined as a fraction of all morbidity factors, fall varroa mite infestations have been the leading cause of colony mortality (associated to > 85% of colony deaths), followed by fall bee populations and food reserves. Varroa-infested colonies, with weak populations and low food reserves in the fall, significantly decreased spring colony populations, whereas varroa infestations in the spring, significantly decreased bee populations by early summer. Overall, results suggest that varroa mites could be the main culprit for the death and reduced populations of overwintered honey bee colonies (Anderson and Trueman, 2000; John, 2000; Guzman-Novoa et al., 2010; Sarwar, 2016).

2. Economic Impact of Mites

The honey bee is a suitable habitat for diverse mites, including nonparasitic, omnivorous, and pollen-feeding species and parasites. Examination of dead or weakened colonies yielded the presence of mites in most cases, which are directly or indirectly responsible for colony deaths.Many beekeepers have been become discouraged because of excessive colony losses and are no longer keeping bees. Bee management costs have been increased for most beekeepers due to having to replace dead colonies and purchase pesticides for parasitic mites control. These increased costs will have to be passed on to fruit and vegetable growers who rent hives for crop pollination. Increased management costs and rental fees, reduced honey production and pollination, and discouragement experienced by many beekeepers have resulted in a negative economic impact caused by parasitic mites (Sammataro et al., 2010). Thus, the biology and damage of the three main mite pest species Acarapis woodi, Varroa destructor, and Tropilaelapsclareae is outlined in this article along with detection and control methods.

2.1. Varroa Mites

Varroa mites Varroa destructor are external, obligate parasites of worker and drone honey bees of Apis cerana. Varroa mites are external honeybee parasites that attack both the adults and the brood with a distinct preference for drone brood. They suck the blood from the adults and the developing brood, resulting weakening and shortening the life span of the ones on which they feed. Emerging brood may be deformed with missing legs or wings. Untreated infestations of varroa mites that are allowed to increase will kill honeybee colonies. Losses due to these parasitic mites are often confused with causes such as winter mortality and queen lessness if the colonies are not examined for mites. Varroa mites are visible to the naked eye and look somewhat like a tick. The adult female mites are reddish-brown in color, flattened, oval and measure about 1 to 1.5 mm across. They have eight legs, and are large enough to be seen with the unaided eye most commonly on the thorax and on the bee's abdomen. Their flattened shape allows them to hide between the bee's abdominal segments. This mite is often confused with the bee louse, but the bee louse has only six legs, is more circular in shape and is slightly larger. Mites develop on the bee brood; female mite enters the brood cell about one day before capping and be sealed in with the larva. Eggs are laid and mites feed and develop on the maturing bee larva. By the time the adult bee emerges from the cell, several of the mites will have reached adulthood, mated and are ready to begin searching for other bees or larvae to parasitize, but. there is a preference for drone brood. Inspection of the drone brood in their capped cells will often indicate whether or not a colony is infested. The dark mites are easily seen on the white pupae when the comb is broken or the pupae are pulled from their cells (Boecking and Genersch, 2008; Carreck et al., 2010).

2.1.1. Biology of Varroa Mites

The varroa mite is an external parasite that attacks both adult bees and the developing honey bee larvae. The mated female mite enters the cell of a developing bee larva and lays as many as six eggs. The developing mites feed on the bee pupae, and depending on the number of mites, may kill it and cause it to be deformed, or have no visible effect. While the male mite dies in the cell, the adult daughter mites climb onto an adult worker bee and feed on its hemolymph (a fluid known as bee blood). The female mite can then repeat the cycle by entering cells of other developing larvae. Mites prefer drone larvae over worker larvae, but they will infest worker larvae and eventually kill the colony if preventive measures are not taken. The mites can also harm the bees secondarily as transmitters of several viruses that can kill bees. These secondary infections are facilitated when the mites compromise the bees' immune systems. They can cause a condition known as parasitic mite syndrome, which can kill colonies within months of infection. Mites spread from colony to colony by drifting workers and drones within an apiary. Honey bees can also acquire these mites when robbing smaller colonies. It is best to isolate captured swarms, package bees, and other new colonies from other colonies and examine them for mites before placing them in an apiary. The first egg laid by mite will be unfertilized and develop into a male. The subsequent eggs will be fertilized and develop into females. Varroamites are transported from colony to colony by drifting or robbing bees. Visible symptoms of Varroa mite damage can be evident on newly-emerged bees which are due to the mite feeding on the immatures within the cell. The newly-emerged bees may be smaller than normal, have crumpled or disjointed wings, and shortened abdomens. The lifespan of the newly emerged bee is also reduced. Severe infestations of varroa mites within the cell (5 or more foundresses) cause death to the pupa. The end result of unchecked mite populations is an eroding adult bee population and eventual colony death (Sammataro et al., 2000; Helen et al., 2002).

2.1.2. Controlling of Varroa Mites

Delaying treatment can be accomplished if you monitor the level of Varroa infestation in your colonies. Treatment is justified only when the economic threshold is achieved. Economic thresholds are defined as the pest level that justifies treatment in order to prevent the pest from reaching damaging levels. Traditional methods for varroa mite control have been to hang plastic strips impregnated with chemical pesticides between the wax combs of beehives. Unfortunately, the mites are rapidly developing resistance to many of the common treatments, which has prompted researchers to develop alternative methods to prevent and treat varroa mite infestations. These methods range from structurally or mechanically modifying beehives, to obtaining new stocks that are more tolerant of mites and using new biopesticides that are valuable alternatives to the standard synthetic treatments (Peter et al., 1990; Zhang, 2000; Nataliaet al., 2009).

2.2. Tracheal Mites Acarapis woodi

Tracheal mites (Acarapis woodi) have caused the loss of tens of thousands of colonies and millions of dollars. Tracheal mites infest the tracheal system of the adult honey bee, and infestation levels are highest during the winter and spring. Mites prefer adult bees less than four days old. Once they are on the bee, mites are attracted to carbon dioxide emissions and enter the spiracles located on the thorax which lead to the tracheal system. They puncture the wall of the trachea and suck the hemolymph of the bee. Tracheal mites live, breed and lay eggs in the tracheal system. The adults and eggs plug the tubes of the trachea which impairs oxygen exchange. They also spread secondary diseases and pathogens since they puncture the trachea in order to feed. Individual bees die due to the disruption to respiration, damage to the tracheae, microorganisms entering the hemolymph, and from the loss of hemolymph. Honey production may be reduced when over 30 percent of the population is infested with tracheal mites. Also, the likelihood of winter survival decreases with increasing infestation of the mite. Mites are transmitted from bee to bee within a colony and to other colonies by robbing or drifting bees. Infested bees can be seen leaving the colony and crawling on the grass just outside the hive. They will crawl up the blades of grass or the hive, fall back down and try again. The wings may be disjointed and the bees become unable to fly. The abdomens may be swollen and in late stages of infestation, bees will abscond from the hive. If beekeepers are unsure and have tracheal mites, send a sample of bees in alcohol to their local county researchers for verification (Raloff, 1998; Sarwar, 2015).

2.2.1. Biology of Acarapis woodi

Tracheal mites are microscopic in size (as long as 1.5 times the diameter of a human hair) and spend their entire life cycle within the tracheae (breathing tubes) of adult honey bees. Female mites lay single eggs in the bees respiratory tract where the developmental cycle occurs. Each female mite lays five to seven eggs 3 or 4 days after entering the tracheae and the eggs require three to four days to hatch. Adult mites (5-9 days old) emerge from their host tracheae in search of a new host. Within 24 hours after the worker bees emerge from their cells, female mites are collected within their tracheae. Studies have found that highest numbers of mites are found in 11-12 day old adult bees, and mite levels decline over 21 days old. Adult mites penetrate the tracheal wall with their piercing mouthparts and feed on bee blood. Normal thoracic tracheae are clear, colorless or pale amber in color. Severely infested tracheae are darkened with crust-like lesions and may appear black. Numerous mites in varying stages of development and mite debris inside the tracheae are thought to reduce capacity for airflow. Bee scientists have discovered a connection between tracheal mite infested bees and flight muscle damage. Flight muscles of mite infested crawler bees are degenerated which affects the ability to fly. Also, blood tests from mite infested bees show a higher than normal bacterial count. Drifting bees between hives and swarms produced from infested colonies are ways the mites are naturally spread within an apiary and between apiaries. Mites are spread within a colony by bee contact and mature female mites exit the bee trachea and climb to the tip of a body hair. Upon contact with a newly emerged bee, the mite transfers to the hairs of the new host and enters the trachea where it will complete its life cycle. If the mite fails to locate a new host within 24 hours, it will die. The tracheal mite population may vary seasonally and during the period of maximum bee population, the number of bees with mites is reduced (Collison, 1990; Skinner, 1991).

2.2.2. Symptoms of Infestation and Diagnosis

No one symptom characterizes a tracheal mite infested colony. Tracheal mites are believed to shorten the life span of adult bees, affect flight activity and result in a large number of crawling bees that are unable to fly. The wings of mite infested bees are often disjointed with the hind wing projecting 90ofrom axis of the body. However, absence of these symptoms does not necessarily indicate freedom of mites. Infected colonies may not develop normally and may exhibit symptoms of dysentery and an excessive swarming tendency. Often, however, severely infested colonies typically appear normal until their death during the winter. Colonies are most affected during winter confinement and early spring like a stress disease. Mite infestations are at a maximum in the spring when the population is comprised of primarily older bees. The susceptibility of worker honey bees to tracheal mites diminishes rapidly with age and bees over nine days old rarely become infested. Studies have shown that adult female mites transfer preferentially to young bees less than 4 days old, and newly emerged bees, less than 24 hours old, are especially attractive. Positive diagnosis can be made only by microscopic examination of honey bee tracheae. In sampling for this mite, one should try to collect either bees that may be crawling near the hive entrance or bees at the entrance as they are leaving or returning to the hive (50 bees per colony sampled). These bees should be placed in 70% ethyl or methyl alcohol as soon as they are collected. Do not collect bees that have been dead for an unknown period because they are less than ideal for diagnosis. For dissection, each bee should be grasped between the thumb and forefinger, remove front pair of legs and head by pushing them off with a scalpel or razor blade in a downward and forward motion, cut thin transverse section of the prothorax containing the major tracheal trunks with a sharp razor blade, soak disc section overnight with 8% solution of Potassium Hydroxide in water to dissolve muscle tissue, and examine disc sections with a microscope (minimum 40 X). Infested tracheae have various stages of mites and are usually discolored and darkened (Shimanuki and Knox, 1991).

2.2.3. Treatment of Acarapis woodi

One method for controlling of tracheal mites is the use of menthol, available from most bee supply companies. The temperature must be above 60 oF in order for the menthol to work. The bees breath in the vapor which, it is believed, desiccates the mites. Menthol must be removed during a nectar flow in order to not contaminate honey. Another less caustic treatment for tracheal mites is an oil extender patty. It consists of two parts sugar to one part vegetable shortening. Make a small patty about four inches in diameter and sandwich it between wax paper. Cut the wax paper around the edges so the bees have access to the patty. Center the oil patty on top of the frames within the hive body. The bees will be attracted to the sugar and oil on their bodies. The oil acts as a chemical cloak and the tracheal mites are unable to identify suitable bee hosts. The oil patties are acceptable for prolonged treatment since the oil will not contaminate honey supplies (Hall et al., 2009).

2.3. Tropilaelaps Mites

Tropilaelaps mites parasitize the brood of the Giant honey bees Apis dorsata, and two species of Tropilaelaps mites (Tropilaelaps clareae and T. mercedesae) are also able to parasitize European honey bees (Apis mellifera). Tropilaelaps mites are external parasitic mites that feed on the haemolymph (blood) of drone and worker bee pupae as well as reproduce on honey bee brood.Tropilaelaps mite infestation causes severe damage to honey bee colonies such as deformed pupae and adults (stunting, damaged wings/ legs/ abdomens), parasitic mite syndrome and colony decline. The colony may also swarm or abscond, for further spreading of the mite to new locations. Tropilaelaps mites can also spread viruses which further affect the colony's health and disease susceptibility. If Tropilaelaps mites are to become established in in locality, they would cause significant losses to managed and wild honey bee colonies, crop pollination and yields of honey products. The life cycle of Tropilaelaps mites is very similar to that of varroa mites in many ways, as both species of mites are external feeders which parasitize the brood stages of the honey bee. However, Tropilaelaps mites have a much shorter life cycle, and because of this, have a much greater reproductive rate than varroa mites. Because of this greater reproductive rate, research has shown that in some hives there can be around 25 Tropilaelaps mites to every varroa mite in a honey bee colony. However, unlike varroa mites which can survive on adult bees for quite a few months, Tropilaelaps mites can only live for around 3 days on an adult worker bee as the adult Tropilaelaps mite mouthpiece cannot pierce the adult wall membrane, and therefore, cannot feed on adult worker bees. For this reason, Tropilaelaps mites spend the majority of their life in the brood and will continue to breed and survive in a honey bee colony as long as there is brood present (Wilde, 2000).

2.3.1. Biology of Tropilaelaps Mites

A female Tropilaelaps mite will enter worker and drone brood cells that are in the process of being capped and lay 1-4 eggs (though typically 3 or 4). The development from egg to adult takes approximately one week and the adult mites (usually about 2-3) will emerge from the brood cell along with the emerging young adult bee. While in the capped cell, the larva/ nymph stage of the mite is white in color and feeds on the developing brood. Adult Tropilaelaps mites are active, red-brown mites around 1 mm in length and typically 0.5 mm wide, about one third the size of a Varroa mite. Considering that Tropilaelaps mites cannot survive for very long on adult bees, the vast majority of adult mites (> 95 percent) will typically mate and re-enter a brood cell to lay more eggs within 2 days of the adult bee emerging from the capped brood cell. The mites in the genus Tropilaelaps are particularly parasites of honey bee brood, feeding on bee larvae and pupae causing brood malformation, death of bees and subsequent colony decline or absconding. An infestation by Tropilaelaps can be recognized either visually on bees or by examining hive debris. Irregular brood pattern, dead or malformed immatures, bees with malformed wings that crawl at the hive's entrance, and especially the presence of fast-running, large, red brown, elongated mites on the combs, are diagnostic for the presence of T. clareae. An early diagnosis can be made after opening brood cells and finding immature and adult mites therein (Anderson and Morgan, 2007).

2.3.2. Treatment of Tropilaelaps Mites

The beehive (colony) may be treated with various chemicals that cause the mites to drop off combs and bees. Sticky boards on the bottom of the colony can be used to examine hive debris and mites In countries with infestations of Tropilaelaps spp., fluvalinate in slow-release formulations controls Tropilaelaps, as do monthly dustings with sulphur and treatments with formic acid. The inability of this mite to feed on adult bees or to survive outside sealed brood more than a few days, such as caging the queen for a few weeks, is being used as a non-chemical control method. Many of the same acaricides used for Varroa can also kill Tropilaelaps and strips of plastic-impregnated fluvalinate will kill mites. Alternatively, tobacco smoke in the smoker will cause mites to drop off bees. Strips of filter paper, available in some countries are prepared by soaking in an aqueous solution of 15% potassium nitrate to which two drops of amitraz (usually 12.5%) are added. After the paper dries, the strip is ignited and inserted into the hive. The smoke causes many mites to drop off. Another method is to use plates or pads soaked with 20 ml of 65% formic acid (very caustic and will burn hands and face) and the pads are placed in the colonies, near the top (Buchler, 2010).

3. Mites Detection Methods

It is difficult to simply inspect a colony and determine if it has a high level of mites. It is important, therefore, to sample beehives to estimate the degree of infestation (Fries et al., 1991; Ostiguy and Sammataro, 2000; Koeniger et al., 2002).

3.1. Sugar Shake Method

This method estimates the mite prevalence within the colony (the percentage of adult bees with mites). Obtain a clear pint jar or other container with a lid made from 8-inch hardware cloth or similar meshes material. If a researcher cannot find a jar with a mesh lid, make a mesh lid for any available container. Brush or shake approximately sufficient adult bees from a frame with an emerging brood into the jar. Close the mesh lid on the jar and add to 3 tablespoons of 6× powdered sugar through the lid. Set the jar aside for several minutes to allow the bees (and mites) to be covered in sugar. Shake the sugar (and dislodged mites) out of the jar onto a clean, flat surface (preferably white). The bees although covered in sugar are not killed and can be returned to the colony. If few or more mites are found per bee, take appropriate measures to control the mite population (a magnifying glass may be necessary to see the mites).

3.2. Sticky Board Method

This method estimates the total mite load of the colony (the total number of mites in the hive). Purchase a commercial sticky board from a beekeeping supply company. A sticky board has a pre-applied adhesive and sampling grid drawn on the surface. Alternatively, a sticky board can be constructed with a stiff sheet of white paper. Spray the upper surface of the paper (facing the bees) with an aerosol cooking spray, or apply a thin layer of petroleum jelly to the upper surface of the paper to create a homemade sticky board. Place the board or paper between two 8-mesh wire covers (with one cover on the top and one on the bottom) so that the bees do not adhere to the sticky surface. Place the sticky board on the bottom floor of the hive. A portion of the mites will fall off the bees, fall through the mesh screen and stick to the white board. Remove the board 4 hours later and count the total number of mites on it. If the number of mites is between 60 and 90 (depending on the size of the colony) then appropriate control measures should be taken.

3.3. Alcohol Wash Method

Similar to the sugar shake, this method requires that the beekeeper brush or shake adult bees from a frame into a clear container to measure the prevalence of parasitic mites. Pour two inches of rubbing alcohol (isopropyl alcohol) into a clear pint jar or container with a solid lid. Brush or shake approximately some adult bees from a frame with emerging brood into the container. Vigorously shake the container for at least 30 seconds and then examine it for dead mites sinking to the bottom. If there are few or more mites per bee, then beekeepers should treat the colony.

3.4. Drone Brood Inspection

Because of the variation in sampling, this method is not always a reliable indicator of mite levels in a colony. However, it can be used to verify the relative degree of mites infestation. Find any capped drone brood within the hive, which is typically located on the periphery of the brood nest. Uncap the cells and gently remove the pupae. Closely inspect the drone pupae for adult mites. If few percent or more of the drones are infested, then beekeepers should take appropriate measures to reduce the mite population. Current recommendations are to monitor each honey bee colony for mites infestation several times over the course of a season to determine if and when treatment is necessary. Use different sampling techniques for monitoring efforts to make sure that an accurate measure is obtained for each hive.

4. Integrated Pest Management against Mites

One of our most important honey producers and pollinators, the honey bee Apis species, faces serious threats from parasites especially the mites. Therefore, improving pest control is a highly significant way of increasing access to our food. The best way to achieve this is through Integrated Pest Management (IPM). The IPM means using a combination of different control methods at different times of the year in order to keep the mite population to such a level as it causes no significant harm to a bee colony. Chemical treatments have been used for a number of years, based on a combination of thymol based treatments and oxalic acid. These offer a very simple means of controlling mite numbers effectively. As a general rule, mite populations should be monitored three or four times a year. Most infested colonies die within 1 to 2 years if the beekeeper does not take actions against mites. If upon initial examination of colony beekeepersdo not see visible mites, use a capping scratcher on drone brood to see if mites are inside cells. Varroa mites prefer drone brood over worker or queen. If mites are detected beekeepers may need to treat in order to save bee colony. At this time there are four treatments available for varroa mite control, coumaphos, fluvalinate, thymol and fenpyroximate. Always follow manufacturer's instructions when using these products. Also, never treat colony during a nectar flow because the chemicals can contaminate the honey and never leave strips in hives after the recommended time because this encourages resistance. In recent years mite resistance to synthetic miticides has become a problem throughout the world. Therefore, rotating chemicals, delaying treatment and using cultural controls are recommended to manage mites in a more sustainable manner. It has been about few years ago that mite resistant stock has been widely available to beekeepers to avoid attacking of the pests from different angles. It is important to have a variety of sources to keep a diverse gene pool of resistant stock (Delaplane, 2001; Delaplane et al., 2005; Ibrahim, 2007).

5. Conclusion

Integrated Pest Management (IPM) is using a combination of different control methods at different times of the year. It is particularly useful to beginners and should be seen as an important part of mite control approach that can be adapted as necessary. It allows the beekeepers to choose the products or methods appropriate to them and encourages careful monitoring so that treatments are used in line with known risk. Mite levels fluctuate within andbetween seasons, and beekeepers must carefully sample the mites to prevent their populations buildup. Despite of its limitations, field studies like this are valuable because a large number of colonies have been evaluated under natural conditions, which might shed light on the causes of colony losses to manage by beekeepers. If a colony is found to be infested, all colonies at the site should be treated for mites with pesticide strips in the same manner. These strips contain the miticide fluvalinate and are not to be used during honey flow, or when there is surplus honey present in the colony that may be removed for human consumption at a later date. Therefore, late fall, after removal of surplus honey, or early spring, prior to honey flow, are the best times to treat for mites. As precautionary declaration, in order to protect peoples and the environment, pesticides should be used safely and this is everyone's responsibility especially the user. Read and follow label directions carefully before beekeepers buy, mix, apply, store or dispose of a pesticide. It is a violation of State and Federal Laws to use pesticides in a manner inconsistent with its label.

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Dr. Muhammad Sarwar, Principal Scientist, is going through 25th years of Service experience in Research orientated Department of Agriculture (16-05-1991 to 31-05-2001, Government of Punjab) and Pakistan Atomic Energy Commission (01-06-2001 to date).

Have 187 research work publications in National (126) and Foreign Journals (61) with suitable Impact Factor.

Award of Higher Education Commission of Pakistan “Post-Doctoral Scholarship Phase II, 2006” on the basis of merit for research work at Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing, China.

Shield award, Letters of Appreciation and Certificates of performance granted from Chinese Academy of Agricultural Sciences, Beijing, China.The Zoological Society of Pakistan in recognition of research contributions presented Prof. Dr. Mirza Azhar Beg Gold Medal-2010 during 30th session of Pakistan Congress of Zoology hosted by University of Agriculture, Faisalabad on March 2, 2010.

Researched on Integrated Pests Management of Rice, Cotton, Chickpea, Brassica crops, Fruit flies, and Stored grains. Undertaken research work on Predatory Mites, Ladybird Beetle Chrysoperla, Trichogramma and parasitoids of Fruit flies culturing as Bio-control agents, Integrated Management of Fruit Fly and Mosquito, and other arthropod pests control methodology.

Worked on Vertebrate pests control especially controls of rodents in field crops and storage.

Opened a new avenue on rearing of Predatory Mites as bio-control agents of insects & mites pests in greenhouse and field crops.

Explored, hitherto the unexplored 36 new species of stored grain & stored products mites belonging to 8 genera viz., Forcellinia, Lackerbaueria, Acotyledon, Caloglyphus and Troupeauia of family Acaridae; and Capronomoia, Histiostoma and Glyphanoetus in family Histiostomatidae. Identification keys, taxonomical observations, differentiation remarks, comparison of characters, similarity matrices, Phenograms and Geographical maps of new species along with 48 alien species have been prepared.

Conducted research work on Integrated Management of Cotton Leaf Curl Virus (CLCV), Pest scouting, Pest monitoring & forecasting, planning, designing and layout of different research trials & data recording for integrated pest management on different crops, vegetables and orchards. Training of the farmers and Field Staff, and provision of advisory services to the farmers regarding plant protection practices. Training of the pesticide's dealers for proper handling, distribution and storing of pesticides, their legal aspects and sampling of pesticides for their quality control.

Collaborative Research Work with CCRI, PCCI & Ayub Agricultural Research Institute for locating resistance in cotton genotypes.

Under Coordinated Research Program, collaborated with NIA, NIFA and NIAB to trace resistance sources for rice, gram, rapeseed, mustard plants, and stored cereals and pulses.

Imparted training to field staff and the progressive farmers regarding plant protection practices in some Districts of Sindh, supervised Post-graduate research wok and acting as External Examiner for Post-graduate studies, Reviewer for Scientific Journals, and joined different working Committees.

Granted Research Productivity Award-2011, by Pakistan Council for Science andTechnology.

Included in the list of Higher Education Commission (HEC) of Pakistan approved Supervisor.

Completed “Basic Management course” organized by Pakistan Institute of Engineering & Applied Sciences (PIEAS), Islamabad, held from 31 January to 18 February. 2011.

Acquired different National and International (Beijing, Bangkok, Vienna and Havana)trainings.

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