

Management of Mites Through Different Tactics; A Review

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Cotton is one of the most commercially important crops and distributed throughout the world. Cotton has long bearing period and the habit of growing substantially. In the lengthy period, it is often damaged by various insect pests and plant diseases. Mites are belong to acari, and feed on the plants to suck the cell sap which affect the plant and reduce the cotton yield. A single female can lay 50-70 eggs on the undersurface of the leaf during the life. All stages such as adult and larvae are suck feeder. Due to severe infestation of mites, leaves or parts of leaves turn to yellow or red and to drop. Due to sucking insect pests including mites cause about 5%-15% economic losses at present yielding condition. The several types of control measures such as cultural, biological, entomopathogens and chemical are used for the management and control of insect pest and diseases. Every method has drawback such as chemical cause pollution, pest resistance, harmful for biological fauna and diseases in human. Biological control should be adopted for control of pest such as mites.

Keywords: Cotton; Mites; Acari; Management Tactics**Introduction**

Cotton, *Gossypium hirsutum* L. is one of the most commercially important fiber crops throughout the world. It is mostly grown in tropical and sub-tropical regions of the world. It is a perennial semi-shrub grown as an annual crop in both tropical and warm temperate regions. Its products are used for various purposes such as food, oil and lint [22]. There are large number of insect pests such as *Microtermes obesi*, *Agrotis ipsilon*, *Thrips tabaci*, *Amrasca biguttula biguttula*, *Bemisia tabaci*, *Aphis gossypii*, *Sylepta derogate*, *Dyesdercus koenigii*, *Tetranychus macfarlanei*, *Mylokerus undecimpustuletus maculosus*, *Earias insulana*, *Pectinophora gossypiella* and *Helicoverpa armigera* which attack on the cotton [6]. Sucking insect pests are the major one which highly reduce 10-40% losses in cotton production [10].

Mites are belong to in phylum Arthropoda subphylum Chelicerata- subclass Acari. The body is different from all other arthropods [33]. A chelicerate is present, mandible, maxillae and antennae absent. The mites are most diversified organisms adapting

themselves in every suitable habitat such as terrestrial, marine and fresh-water. Mites are the pest of horticultural and agricultural crops and distributed throughout the world [31]. There are about 900 species of host plants. Arkansas palmer amaranth, goose grass, curled dock, hedge bindweed and entire leaf morning glory are the major reservoirs of mite populations [30]. Mites are affect the plants by sucking the plant cell sap.

The common spider mites are usually attack on the leaves, changing its color from brown to red which leads to leaf drop. Mites are mostly attack on the upper leaves and then on the lower leaves. These pierces and digest the cellular content of plant cells. As the leaf drops, less energy will be available for the plants to produce cotton bolls thus affecting the cotton production and producing lower yields [1,4,15,26,27]. Cotton losses are occurred due to mite infestation and environmental conditions. Environmental conditions such as biotic and abiotic factors influenced the mite populations [14,25]. As reported, globally the mites alone receive a large amount of pesticides beside the other pests of cotton [36].

Sampling

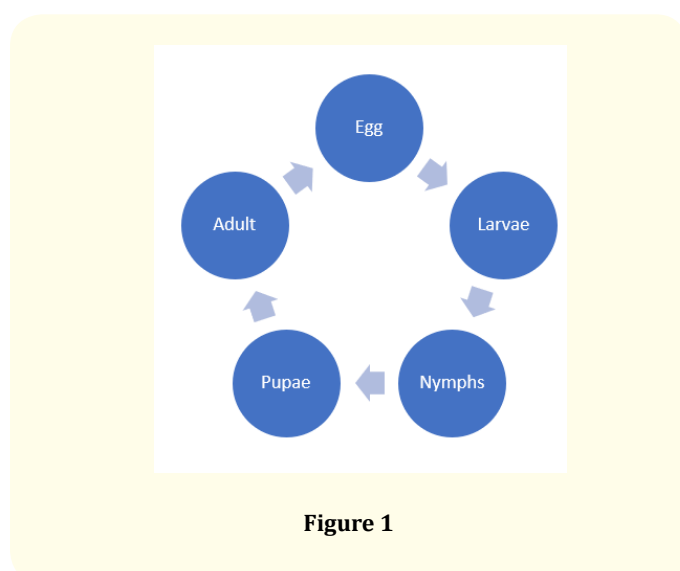
1. Mites can be detected through the early stages of cotton i.e. in seedling stage.
2. In response of favorable conditions (temperature) an increase in its population will occur [18].
3. Under low population, these are undetectable. So, a better way to access them is the only absence / presence of mites.
4. Infestation on 30% plants, represents its high population in the field [2].

Taxonomy

The class Arachnida and Order Acari represents the mites. Around the world, 55 000 species have been recorded up till now. It has been said, more study to be conducted still to identify half million species of mites. The size of mite ranges from 0.8 mm to 1 cm.

Life cycle

The general life cycle has been depicted below.



Its mature and young both are problematic for the cotton as both feeds. The larvae can be easily distinguished from nymphal stage as it possesses 6 legs and in nymphal stage it bears 8 legs. After a total of 19 days it changes into adult. Surprisingly, all the biological stages of mites (two spotted spider mite) can undergo the overwintering stage while females only do the phenomena in nurseries.

The important super families are:

Tetranychoidae

It includes the following families.

Tetranychidae

The mentioned family presents the mites important to agriculture. Fairly a good number of species has been depicted by the family i.e.

1250. Among the number, only 100 are known as the pest of agriculture but 10 species are the major pests. Regarding the spread of virus, no species has been found responsible in its dispersal. Species included in this show very minute size i.e. 200 – 900 µm.

Tenuipalpidae

Mites of family Tenuipalpidae shows red color and are also known as false spider mites. The mites are elongate and dorsoventrally flattened.

Eriophyoidea

It is divided into three families.

Eriophyidae

These present most of the fauna present in Europe. These mites are known as four legged mites. Eriophyidae mites damage to the broad-leaved plants. Its attack can be identified by the formation of galls. Also, the species in this family also spread viruses among the different cotton plants. Species such as *Epitrimerus resukt* discolors the plant during the infestation thus causing unbearable damage to the host.

Phytoptidae

Monocots and conifers are the preferred host of the species present in Phytoptidae. These are obligate plant feeding species and some of the species have been recorded to feed on feeds on dicotyledons. Legs are same as mentioned in Eriophyidae family and are vermiform. Family of Eriophyidae contains 56 species and the four-alien species that are present in Europe.

Diptilomiopidae

No damage has been recorded by the species excluding the exceptions [13]. The preferred host for them is dicotyledons.

Tarsonemoidea

These are responsible for causing the damage at economical level. This also include some of the specceis which act as a biological agent and feed on the bark beetle eggs and the eggs of tetranychid eggs.

Astigmata

These are not much important as the other as the mites included in it contains which cause damage to animals the only. Some also act as a parasite of rodents [35].

Oligonychus mangiferus

Distribution:

Pakistan, Israel, Egypt

Hosts

Cotton, Pomegranates, Grapes.

Activity and Damage

The upper leaves are the preferred sites for attacking the plant. Thus, making a clear identification for its attack. As many as 21 generations / year has been recorded in Egypt in which a single female can lay 20 – 35 eggs. Life cycle is completed in 14 days and the peak season has been recorded in the month of April. Temperature is playing an important factor as its life cycle is disturbed when the temperature exceeds or lowers then the 24-28 °C [9].

Tetranychus ludeni

Distribution

North and South America, Asia, Europe, Australia and in New Zealand.

Hosts

Cotton, Beans, Eggplant Cucurbits.

Tetranychus urticae

Distribution

North America and Europe.

Hosts

Cotton, Rosses, Apple, Pears.

Activity and Damage

Popularly, called as caramente spider mite. The colonies are usually developed underside the leaves where the actual damage occurs and then spread in the entire field thus reducing cotton production. Its population will increase at 25-30 °C and will take a period of two weeks for its complete life cycle. Single female lays 100 eggs. Wind play an important role as these are easily dispersed by it. Amazing behavior has been shown by these mites as these undergo reproductive diapause in the winter. As the temperature in the environment becomes favorable it starts laying eggs on a favorable host.

Tetranychus turkestanii

Distribution

Globally present.

Hosts

Cotton, Strawberry, Almond, Apple, Fig, Pear, Peach.

Activity and damage

The attack is the same as for *Tetranychus urticae* has been mentioned. Females usually go to diapause stage in the winter months. In some countries, like Israel this pest is over looked but now this pest is recorded as a major pest and becomes problematic for them.

Eutetranychus orientalis

Distribution

Afghanistan, Australia, Bangladesh, China, Cyprus, Egypt, India (Assam, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh,

Meghalaya, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh), Iran, Israel, Jordan, Kenya, Lebanon, Malawi, Mauritania, Mozambique, Nigeria, Pakistan, the Philippines, Senegal, South Africa, Sudan, Swaziland, Taiwan, Thailand, Turkey, and Yemen [34].

Management

Seed treatment

Seed treatment as an important factor in reducing the pest population. In a study conducted by Smith and colleagues, researchers conducted twelve experiments in field and single experiment was carried out in lab conditions. During the experiment, seed was treated with three products with the following combinations; Avicta (thiamethoxam + abamectin), Aeris (imidacloprid + thiodicarb), and acephate. Aldicarb was used as furrow application on seeds. The end products depicted the best results in case of Avicta (thiamethoxam + abamectin) as 34% less mites were found during the attack at seedling stage. The results of lab were positive with the field ones [28].

Quarantine control

In this modern era, modern techniques had been devised to manage the mite population. Radiations has been found to be useful to control the mite pest entering into the country with commodity. Experimental study depicted that multiple series of rays were used to identify the most useful rays for its management. The tested rays frequencies are 0, 200, 250, 300, 350, 400, and 450 Gy. Groups were made which includes the 0 - 24 and 48 – 72 hrs old female. In the study, it was concluded young females lying in 0-24 hrs old females showed more tolerance level than at lower dose as compared to old ones. The egg laying capacity was reduced at 250 Gy and the hatching ability was reduced to a zero level at 350 Gy. Thus, radiation can be used successfully in case of mites by using 350 Gy [21].

Biological control

Predators

The insects included in the order Coleoptera, Thysanoptera, Hemiptera, Diptera, and Neuroptera are known to act as a biological agent of mites.

Coccinellidae

The families of insects which include predators are Coccinellidae (ladybirds, lady bugs and lady beetles) [16]. Some of the insects are generalist feeder these are *Coleomegilla maculate*, *Hippodamia convergens* and *Harmonia axyridis* feeds on mites. The specialist feeder are *Stethorus punctum*, *Stethorus punctillum* and *Stethorus gilvifrons*. It has been documented that *Stethorus* genus especially include the predators of mites. If in a field there is much population of *Stethorus* sp. it is evident that mites have been attacked by them and is under control [12].

Staphylinidae

It includes the well-known insect i.e. rove beetles. The general appearance is the presence of short elytra. The elytra cover a little to its abdomen giving the appearance of naked body. The life cycle includes the three stages of larvae, prepupa and the pupae stage. In rove beetles, pupae are formed in the soil. Thus, special care should be done during the cultural practices [8]. The beetles in the genus *Oligota* (Holobus) act as a biological agent and feeds on the biological life of mites. The important predators are *O. coffeae*, *B. arborea*, *O. yothersi*, *P. ulmi*, *T. urticae*, and the notably the significant predator are *O. flavicornis* and *O. oviformis*.

Thysanoptera

One of the important and notorious pests of cotton crop i.e. Thrips act as a biological control of mites. It feeds by puncturing the leaves thus sucking the leaf contents. However, besides its huge damage it feeds on the mites. The families of Phlaeothripidae, Aeolothripidae and Thripidae includes the predatory species which are problematic for the survival of mites. Aeothripidae the largest family in Thysanoptera order which includes 50% Thrips becomes problematic to the plants but the remaining feeds on the mites. Thrips have been reported to feed on the soft bodied mites and especially the mites present on the floral tissues. The important predator belonging to Thrips are six spotted thrips *Scolothrips sexmaculatus* feeds on *Eotetranychus sexmaculatus*, *T. urticae*, *P. citri*, *O. punicae*, and *P. ulmi* [23].

Hemiptera

Hemiptera order presents insects of varying size and colors. Also, the insects present in it are very diverse than others.

Anthocoridae

Anthocoris, Orius, and Tetrableps genera; includes the predatory insects. *Orius* feeds on the eggs and larvae and on the adult of mites and on the other insects such as aphids. Some species such as *Orius tristicolor*, *Orius albidipennis* and *Orius insidiosus* have been used globally in the biocontrol programs of different countries [17]. Some efforts have been made to rear *Orius* sp. on the artificial diet for further use [7].

Miridae

Green house mites are attacked by the predators of Miridae family. Predators of Miridae are known to be used on large scale in European region [24]. Notable species is *Macrolophus caliginosus* feeds on the two-spotted spider mite [20].

Lygaeidae

Geocoris sp. is noted to feed on many species of mites. It only feeds on the adults and eggs of mites. It has been observed that a single predator of *Geocoris* sp. can eat 1600 spider mites during in its young stages and at the older stages an adult can consume 80 mites per day.

Diptera

A famous order also includes predators and parasitoids which possess threat to the mites and other pests too such most likely to scale insects and white flies. Cecidomyiidae family; includes the zoophagous, phytophagous and saprophagous or species. The *Feltiella acarisuga* are used as biocontrol agents in different countries e.g. for its application eggs of the *Feltiella acarisuga* are placed and as the egg hatches it start eating on the stages of mites. Also, the *Feltiella acarisuga* is available in high markets [37].

Neuroptera

Following families are included.

Chrysopidae

The globally famous insects *Chrysoperla carnea* is being included in this family. Feeding on the small arthropods like aphids and collect nectar and pollen to continue its daily life activities. Eggs of *Chrysoperla carnea* is available in markets to be used in controlling the mites. However, it has not been seen that augmentative release can suppress the mites [12]. *Mallada basalis*, *Mallada boninensis* and *Chrysoperla carnea* are potential predators of mite pests such as *T. urticae*, *T. kanzawai*, *P. citri* and *T. ludeni* [32].

Coniopterygidae

The common feature of these insects are the appearance of dusty wings and adults and larvae spend their life by consuming spider mites, scale insects, whiteflies and the other important arthropods. *Conwentzia psociformis* feeds primarily on the spider mite [11].

Hemerobiidae

Fauna of Hemerobiidae is found all over the world and commonly known as the brown lace wing. They have been watched to feed on spider mites. However, these are generally feed on the aphid and known as aphidophagous [29].

Predatory mites

Mites are also threatened by its own species. The species are included in the family of Aceosejidae, Ameroseiidae, Antennoseiidae, Anystidae, Ascidae, Bdellidae, Cheyletidae, Cunaxidae, Eviphidae, Laelapidae, Macrochelidae, Parasitidae, Phytoseiidae, Stigmaeidae, Tydeidae, and Veigaiidae.

Pathogenic control

A few records have shown that on the different crops pathogenic control is successful to control mites. The crops are bean and corn. *Neozygites floridana* a fungus controlled the mite population. But temperature affected the working of fungus [19].

Mechanical control.

Water pressure sprays

An effective tool to manage the mites and other small bodied arthropods. A forceful stream of water should be used on where the mite population are high while on the sturdy plants take measures to avoid damage. Care should be taken that the water should be used early in the morning thus helping the fields to dry out and make the less chances of disease and other fungus attack.

Insecticidal soaps

Use to manage insect by lower cost and has been found affective in case of mites. A variety of Insecticidal Soaps are available in the market with different brands. Also, the same can be manufactured at home as this possess the same chemical properties.

Horticulture oils

Available in markets by various names. They are divided into two categories i.e. dormant and summer use on the fruits, agricultural crops and in orchards. It has been suggested to use more sulfur to kill the mites (A).

Cultural control

It has been recommended by using the precise use of water and controlling the humidity will prevent the building up of mite population [3].

Pheromone traps

Scientists found the male (two spotted spider mite) attraction to the female after the startup of quiescence male. The attraction was low during the starting (40 – 85%) and then increased to the maximum. The time noted was 40.4 hours at 24 °C and 23.4 hours at 30 °C. it was also found that some of the occasional males was not attracted. The observations are the attraction was at peak 30 °C and 20-30% relative humidity than at 30 °C and 90-95% relative humidity. Also recommended that sufficient replications should be used to determine the male behavior [5].

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