Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jls.htm
2017 Vol. 7 (4) October-December, pp. 20-25/Sanjai
Review Article

PARACOCCUS MARGINATUS, A 'SAP' SUCKING PEST, DAMAGES MULBERRY LEAVES

***Sanjai Kumar Gupta**
Department of Zoology, Silkworm/Entomology Laboratory, GGPGC Government Post Graduate College, Ghazipur-233001 U.P ***(INDIA)***
**Author for Correspondence: drsanjaigupta1976@gmail.com*

ABSTRACT
Silkworms primarily feed mulberry leaves, which must be fresh, tender and soft and of a grade appropriate for their different larval stage of development. Although many variables influence the success of silkworm culture, mulberry leaves are the most important, making up 38.2% of the total success. The price, quality, and quantity of silk cocoons produced are all greatly impacted by mulberry cultivation. The micronutrients, pigments, minerals and bioactive biochemical components in mulberry leaves is the source of around 70% of the silk produced by silkworms, and about 60% of the costs of producing cocoons are related to cultivating mulberry. Pests and illnesses account for around 20–25% of all crop losses. The papaya mealy bug (Paracoccus marginatus) is a significant sucking pest that feeds on young tender leaves and shoots, causing leaf curling, stunted growth, and widespread sooty mold growth, which ultimately reduces photosynthetic efficiency. The mulberry crop's yield and quality are known to be greatly impacted by sucking insects as a whole. Scale insects, spiraling whitefly, thrips, papaya mealy bug (a polyphagous pest), and the pink mealy bug are among the main harmful species; other species only inflict sporadic, minor damage that is affected by variables including mulberry variety, agricultural methods, and meteorological conditions. This subject provides crucial information on the biology, meteorological occurrence, type and severity of damage, and management techniques for mulberry sucking pests.

Keywords: Papaya Mealy bug or marginal mealy bug (Paracoccus marginatus), Sap Sucking Pest, Mulberry, Sericulture.

INTRODUCTION
Bombyx mori, the silkworm, only feeds on mulberry trees (Morus spp.). As a result, the growth and development of silkworm larvae, as well as the quality of the cocoons they create, are directly impacted by the quality of mulberry leaves. However, mulberry farming is frequently confronted with infestations by a variety of insect pests, which can drastically lower mulberry leaf production and quality. Although there are many different kinds of insects pests on mulberry trees, only a few of them cause financial harm to the crop. The mulberry tree's capacity to flourish all year long supports the silkworm's reliance on it as its only sustainable food source for mulberry silkworm larval development.
In India, about 8 million individuals work in the agriculture based industry of sericulture. Mulberry (Morus alba L) is widely grown over 230,000 hectares and is extensively utilized in the raising of silkworms and silk production. It is kept up continuously for 15 to 20 years as a perennial crop. The amount and quality of mulberry leaves, which dictate the capacity for silkworm culture and larval development, have a significant impact on silk production and farmer profitability. Regular agronomic methods, such as irrigation, fertilization, weeding, and pest and disease management, are necessary to improve mulberry leaf development and quality. There are several pests that can attack mulberry plants, some of which severely harm the nutritional and biochemical content and leaf production. Especially dangerous are sap sucking pests (Belgumpe, S et al., 2016). This negatively impacts the quality of the silk and the manufacture of cocoons by feeding on these damaged leaves. The major pests on mulberry are the

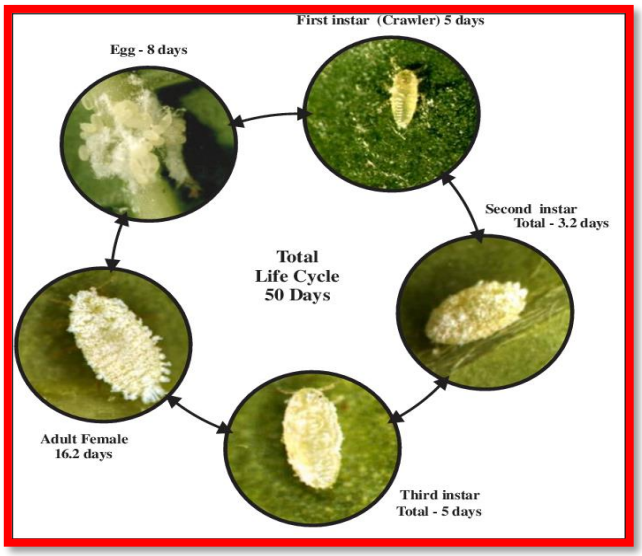
papaya mealy bug, mulberry thrips (Pseudodendrothrips mori), pink mealy bug (Maconellicoccus hirsutus), papaya mealy bug (Paracoccus marginatus), and spiraling whitefly, even though hundreds of insect pests species live there. Others stay below thresholds that cause economic harm, remaining little or secondary. Nevertheless, secondary pests can experience an unexpected population explosion in tropical environments for a variety of meteorological reasons. Sap-sucking pests have piercing-sucking mouthparts with needle-like stylets that enter plant tissues in stems or leaves to obtain nutrient rich sap, such as chlorophyll, micronutrient, pigments and bioactive compounds (Zaman, A et al., 2017). This diet causes leaf nutrient depletion and inhibits plant development in mulberry. Numerous of these pests produce honeydew, which promotes the growth of black or white sooty mold, a fungus that covers foliage, contaminates mulberry gardens, and makes leaves unpalatable during significant infestations by pests. In addition to serving as vectors for plant diseases, some species also inject toxins when they feed, resulting in wilting. Scale insects, whiteflies, mealy bugs, and thrips are among the typical sap feeders. Furthermore, mulberry sap is also consumed by certain mite species, which are not insect pests. The papaya mealy bug (Paracoccus marginatus), a tiny, polyphagous insect, infects a wide variety of host plants, including mulberry, tropical fruits, vegetables, and ornamentals. Infestations resemble cottony masses with lengthy, waxy threads on the stems and leaves. Chlorophyll rich sap is consumed by both the immature and adult stages, which makes the plant weaker. The afflicted leaves turn yellow, wrinkled, and eventually dry out. The honeydew produced by the pest encourages the development of sooty mold, which lowers photosynthetic efficiency. In addition, infestation causes substantial alterations in biochemical composition, photosynthetic pigments, and macro- and micronutrient concentrations across different mulberry cultivars.

LIFE CYCLE:

There are many distinct stages in the life cycle of the papaya mealy bug, often referred to as Paracoccus marginatus. Eggs are greenish-yellow and lay inside a waxy egg sac, which hatches between three and nine days. The first nymphal stage, known as crawlers, is yellow and mobile, spreading out in search of good feeding locations on young leaves or fruits. The second and third instar nymphal stages that follow establish themselves in one location, consuming plant sap and generating white wax. Males go through four instars of larvae, including a pre-pupal and pupal stage, while female only go through three. The length and width of adult females, who are wingless, are roughly 2.2 and 1.4 mm, respectively, and they are still coated with a thick layer of wax. Males are about 1.0 mm long, have a tiny body with an extended oval form, well developed wings, ten-segmented antennae, and a pinkish hue during the pupal and adult stages. They don't eat and live for a short period of time. Despite the average number being between 108 and 296, each female of this sexually reproducing species lays between 100 and 600 eggs. Depending on the meteorological parameter, the entire life cycle lasts between 15 and 32 days, or about a month on average, which means that there are 11–13 generations every year. Taxonomically, its classification is as follows: Phylum Arthropoda, Class Insecta, Order Hemiptera, Family Pseudococcidae, Genus Paracoccus, Species marginatus. The pest is extremely polyphagous, attacking more than 80 plant species belonging to about 25 genera, including commercially important plants like papaya, hibiscus, mulberry, citrus, cotton, tomato, eggplant, pepper, beans, peas, and sweet potato for disturbance of photosynthetic pigments. Although it is present year round, it does more harm in the summer. It consumes phloem sap from both the leaves and stems of mulberry, resulting in moisture loss and lower nutritional value, by using its sharp, sucking mouthparts. It also injects harmful compounds into the plant during feeding. Symptoms of an infestation include cholrosis (yellowing), leaf curling, premature leaf fall, stunted growth, and even plant death in extreme cases. The honeydew that the insects secrete encourages the growth of thick, black sooty mold on leaves, which reduces photosynthesis and, in severe cases, spreads throughout mulberry fields. Early detection and removal of infested plant parts, such as leaves and twigs, followed by burning to prevent spread, are all part of good management. Any crop residues that support mealy bug communities should be removed and killed. Water jets are another way to physically control pests by dislodging them from plants and rinsing them off. Biological control can be achieved at the time

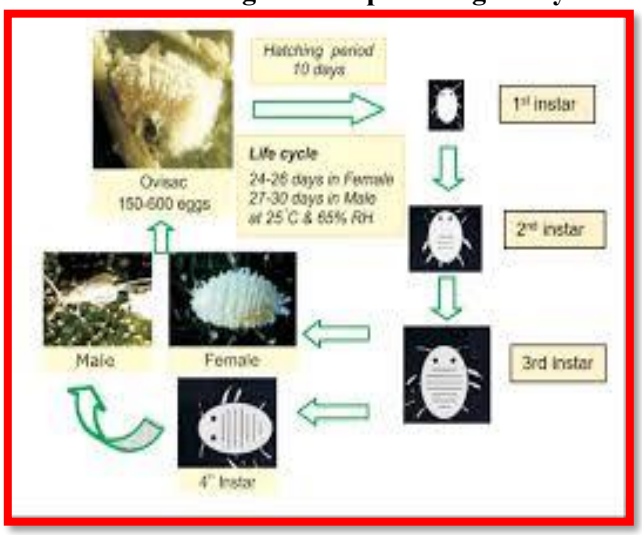
of first discovery by releasing natural adversaries like the parasitoids. In controlling papaya mealy bug populations, some parasitoids have outperformed chemical insecticides.

A- Paracoccus marginatus sap sucking larva



B- Paracoccus marginatus sap sucking life cycle

C- Paracoccus marginatus sap sucking adult



D- Paracoccus marginatus sap sucking different stages

Fig: Life Cycle Stages of Mulberry sap sucking Paracoccus marginatus (mealy bug).
(Ref. All Photographs viewed from Google site.)

ECONOMIC DAMAGE OF MULBERRY

The majority of infestations of the mealy bug Paracoccus marginatus in mulberry trees at sericulture rearers occur between July and October, depending on the prevailing agro climatic circumstances. Due to the considerable qualitative and quantitative harm that this sap sucking pest causes to mulberry plants, it has grown in importance in recent years. The larvae begin to consume the inner tissue of young leaf shoots soon after they hatch, leaving a thin cuticle layer behind. They also create

delicate, smooth threads that cover them. The leaves become unsuitable for silkworm consumption of biochemical constituent of photosynthetic pigments because these threads trap larval excrement. The presence of the pest lowers the quality of the leaves, which results in poor silkworm rearing results, particularly in the fall. Because the amount and quality of mulberry leaves available are essential to the success of sericulture, such damage has a direct impact on the output of production. The bug harms leaves, depletes vital nutrients, and inhibits the general development of mulberry plants. The impacted regions in the plantation are obvious to see. The larval stage is when most of the harm occurs, with the fourth and fifth instars mulberry larvae being the most damaging. These larvae consume the green parenchyma from inside, gradually skeletonizing the leaves by tying them together with silk. Infested leaf areas display noticeable deficits in essential components like proteins, sugars, chlorophyll, bioactive compound and moisture, as well as being covered with black, whitish fungal pathogenic growths.

MANAGEMENT AND CONTROL

The sap sucking insect pest feeds on the phloem, chlorophyll, micro and macronutrient sap of mulberry plants, extracting nutrients from both stems and leaves, resulting in moisture loss and a lower nutritional content. Cholrosis (yellowing), leaf deformation (curling), early leaf loss, delayed growth, and ultimately plant death are all frequent symptoms. Due to the honeydew produced by the pest, a thick coating of black sooty mold can grow on the leaves in extreme infestations. This mold can proliferate across the whole mulberry farm, infecting many plants and reducing their photosynthetic potential. Special management strategies are needed to keep this sap sucking pests under control.

Physically: Immediately chop and remove the affected Tukra apical tips (top 10–15 cm).
Cultural considerations: Don't use too much nitrogen fertilizer. Keep the field tidy and eliminate weeds.
Chemical: To stop the spread, spray 0.2% Dichlorvos (DDVP 76% EC) or 0.2% Dimethoate (30% EC).
Different management strategies, such as the ones listed below, can be used to manage this pest Paracoccus marginatus infestation:

1) Manually picking and removing larval stages.
2) To destroy the dormant larvae, it is dewed and deep ploughed.
3) The burning of diseased (fallen) leaves during the months of September and October.
4) Trees are tied together using straw bands.
5) Using moth light traps.
6) Applying 0. 04% DDVP to mulberry leaves can reduce the infestation by 80 to 90%.
7) Similar to Apanteles spp, the parasitoid can be used as a biocontrol agent.
8) The most effective way to get rid of the bug is to clip off the infested branches and leaves and burn them during the early stages of the infestation. It is essential to burn all crop leftovers in the afflicted garden that support mealy bug populations.
9) Water jetting uses mechanical force to dislodge and wash away the insects from infested plant components, ensuring a mealy bug-free mulberry garden.

DISCUSSION

Paracoccus marginatus sap sucker pest infests apical shoot and tender leaves together and inhibit the growth of mulberry plants. Chlorophylls are ubiquitous in all autotrophic plant tissues as green pigments and serve as the fundamental photosynthetic catalysts. They are present in chloroplasts in significant quantities. The photosynthetic rate is measured in part by the amount of chlorophyll present. It may be necessary to use chlorophyll estimates in order to correlate other biochemical alterations in the plant tissues (Mahadevan, A., 1982). In the mealy bug-infested mulberry leaves of Kanva varieties, the chlorophyll concentration fell by 4.00% and rose by 28.00% (Prasad, SK, 2002; Shree, MP., 1989). In Tukra affected Maconellicoccus hirsutus, the overall chlorophyll, chlorophyll-a, chlorophyll-b, and chlorophyll-a/b ratio were all significantly reduced. The increase in total chlorophyll, chlorophyll-a, chlorophyll-b, and the chlorophyll-a/b ratio was significant in Morus nigra, marginal in M. macroura, and

minimal in M. australis. The chlorophyll content as well as the ratio of chlorophyll-a to chlorophyll-b are both impacted by diseases. The mulberry leaves' photosynthetic efficiency and productivity are reduced as a result of the insect pests' feeding habits, which lead to the loss of pigment(s) and per of laminar area. Consequently, the nutritional content of mulberry leaves declines (Mahadeva, A et al., 2011 & Mahadeva, A et al., 2012). The overall chlorophyll concentration in mulberry cultivars was raised. The chlorophyll concentration in the mulberry cultivar S30 is lower. Changes in chlorophyll concentration, which have a detrimental impact on photosynthetic activity (Heldt, HW., 1997), also result in decreased protein production (Burd, JD., et al., 1996; Veerna, G., 1997). As a result, the mulberry leaves will have a lower nutritional value. Silkworms fed mulberry that is so low in nutrition and has pests will experience a detrimental effect on their growth and development, resulting in failures in the cocoon crop (Mahadeva, A et al 2000; Doureswamy, S et al., 1999). Because it is known that diseased or pest-infested mulberry leaves affect the quantity and quality of silk produced, they are nutritionally deficient and unsuitable for feeding the silkworm. As the sole food source for silkworms, the mulberry plant's diseases and pests must be controlled by necessary measure.

CONCLUSION

Mulberry is prone to attack by several pests and they cause abrupt reduction in leaf yield and deteriorate its quality. Feeding such leaves are to silkworm larvae results in adverse effect on the cocoon yield and silk quality. The insect pests of mulberry are grouped into sap suckers, defoliators and borers based on their mode of feeding silkworms mulberry leaves that are infested with pests can negatively impact the nutritional content of the leaves, which can in turn have an impact on the growth and development of the mulberry larvae and, ultimately, affect the quality and amount of silk produced. Given that the quantity and quality of mulberry leaves are critical to the success of silkworm culture, it is essential to use the approved integrated pest management methods to control the threat of Paracoccus marginatus sap sucking infestation of mulberry without causing significant environmental harm, particularly when autumn rearing is to be carried out commercially. The pest infestation on mulberry not only reduces quantity, it also hinders the quality leaf production by causing a deficiency or physiological disorders and they become malformed, deformed, chlorotic and nutritionally inferior. The varied nutritive status of the mulberry leaves influences the growth and development of silkworms in turns leads to the poor commercial characters of silk production. We must work on reducing the greenhouse gases by adopting conservation agricultural practices like crop residue management, cultural practices to minimize pest infestation, following region specific cropping systems which are more vulnerable to climate change and by developing robust varieties that are resilient to biotic and abiotic stress factors. All the available tactics of management has to percolate down to each and every segment of the stakeholders for managing the quarantine sucking insect pests of national importance. Therefore, the pest is detrimental and causes economic losses to the farmers at multiple levels by hindering the potential mulberry leaf production and low quantity and quality silkworm cocoon output. Hence, farmers must be informed to protect mulberry foliage from the pest attack by following suitable eco-friendly Integrated Pest Management (IPM) practices.

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