Chapter

Bioecology of Jasmine Mite, *Tetranychus urticae* in Different Jasmine Cultivars

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Abstract

Jasmine is a genus of shrubs and vines in the olive family (Oleaceae). *Jasminum sambac*, *Jasminum auriculatum*, *Jasminum grandiflorum* and *Jasminum nitidum* are the four cultivable species of *Jasminum*. The two-spotted mite, *Tetranychus urticae,* is a key pest of *Jasminum* sp. To compare the lifecycle of the notorious mite in all the cultivable *Jasminum* species, a detailed laboratory study was conducted at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, India. The observations on lifecycle parameters of two-spotted mite, *T. urticae,* revealed that the life cycle consists of egg, larva, protochrysalis, protonymph, deutochrysalis, deutonymph, teleochrysalis and adult. The lifecycle and duration of each stage are found to be the shortest in *J. nitidum* and the longest in *J. sambac*.

Keywords: *Jasminum sambac*, *Jasminum auriculatum*, *Jasminum grandiflorum*, *Jasminum nitidum*, two-spotted mite

1. Introduction

Flowers are inseparable from the social fabric of human life. Flowers, being adorable creation of god, befit all occasions. Jasmine is an important traditional flower, cultivated nearly throughout the tropical and subtropical parts of the world for its fragrant flowers [1]. *Jasminum sambac* is ravaged by several pests and the growers were forced to undertake frequent sprays of pesticides, with their excessive usage causing health hazards, outbreaks of secondary pests, environmental pollution, objectionable pesticide residues and adverse effect on non-target organisms and degradation of resources.

Jasminum is the generic name of shrubs and vines in the olive family (Oleaceae). Although more than 200 species are known, 40 species have been identified in India and 20 species are cultivated in South India [2–4], of which only 3 species are used for commercial cultivation namely *Jasminum sambac* (gundumalli/Madurai malli), *Jasminum auriculatum* (mullai) and *Jasminum grandiflorum* (jathimalli/pitchi). The angel jasmine, *Jasminum nitidum*, with sweetly fragrant, snow-white, pinwheel-shaped flowers, is recently introduced for commercial cultivation in Tamil Nadu, India.

1.1 *Jasminum sambac*

Jasminum sambac is an evergreen vine or shrub reaching up to 0.5–3 m (1.6–9.8 ft) tall. The flowers bloom all throughout the year and are produced in clusters of 3–12

***J. sambac* plant** ***J. sambac* flower** **Flower bud**

Figure 1.
Jasminum sambac.

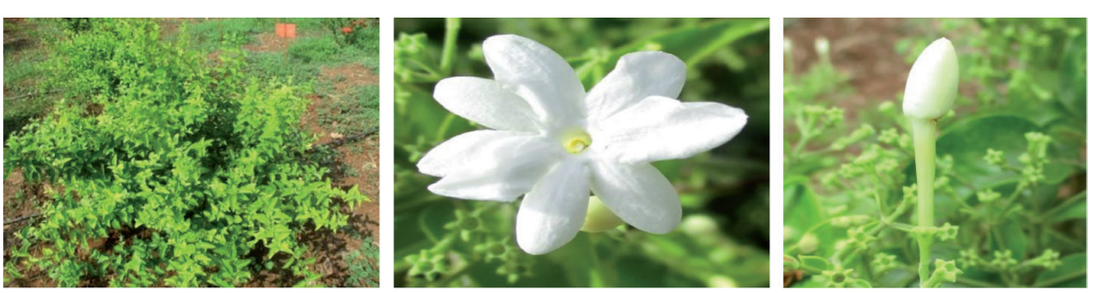
together at the ends of branches. They are strongly scented, with a white corolla 2–3 cm (0.79–1.18 in) in diameter with 5–9 lobes. The flowers open at night (usually around 6–8 in the evening) and close in the morning, a span of 12–20 hours. The sweet, heady fragrance of *Jasminum sambac* is its distinct feature. It is widely grown throughout the tropics from the Arabian peninsula to Southeast Asia and the Pacific Islands as an ornamental plant and for its strongly scented flowers [5] (**Figure 1**).

1.2 *Jasminum auriculatum*

Jasminum auriculatum is a species of jasmine, in the family Oleaceae. It is found in India, Nepal, Sri Lanka, Bhutan and the Andaman Islands. Due to essential oil contained in the flowers, it is cultivated commercially in India and Thailand. It is used for decorative purposes and festivals in India. It is a stunning, small climbing bushy plant with simple ovate dark green small leaves and powdery satin white flowers. Leaves are opposite, ashy-velvety, sometimes hairless, simple or trifoliolate. Lateral leaflets are much smaller, rarely exceeding 4 mm in diameter, the central one up to 3.5 cm long and 1.5 cm broad, ovate, shortly pointed. Nerves are few, lowest oblique. Bracts are linear, 4 mm long. Flowers are fragrant, in many-flowered cymes. Flower-stalks are up to 5 mm long. Calyx 3 mm long, pubescent, teeth minute. Flowers are white, tube 1.5 cm long, lobes elliptic, up to 8 mm long. Berry is 5 mm in diameter, globose, and black [6]) (**Figure 2**).

1.3 *Jasminum grandiflorum*

Jasminum grandiflorum, also known variously as the Spanish jasmine, Royal jasmine, and Catalan jasmine, among others, is a scrambling deciduous shrub growing to 2–4 m tall. The leaves are opposite, 5–12 cm long, pinnate with 5–11 leaflets. The flowers are produced in open cymes; the individual flowers are white



***J. auriculatum* plant** ***J. auriculatum* flower** **Flower bud**

Figure 2.
Jasminum auriculatum.

Figure 3.
Jasminum grandiflorum.

having corolla with a basal tube 13–25 mm long and five lobes 13–22 mm long. The flower's fragrance is unique and sweet. It is widely cultivated as an ornamental plant in warm temperate and subtropical regions. By the method of solvent extraction, the Jasmine flowers are converted into jasmine concrete and jasmine oleoresin (sold as Jasmine Absolute). Both products have a huge demand in the fragrance industry. Methyl jasmonate isolated from the jasmine oil of *Jasminum grandiflorum* led to the discovery of the molecular structure of the jasmonate plant hormones [7] (**Figure 3**).

1.4 *Jasminum nitidum*

This twinning climber has slender stems and forms a dense habit. The dark glossy green leaves are lanced-shaped and the fragrant white star-shaped flowers appear throughout summer in clusters. The angel wing jasmine is grown for its flowers and glossy foliage. It is planted in small or large gardens for its fragrance or to grow over lattice or a pergola. It is suitable for coastal subtropical regions and establishes in 1–2 years. It is also used in containers and grown under glass in cold climates. Once established, it has a high-water requirement, and responds to occasional deep watering particularly during dry periods [8] (**Figure 4**).

The production of jasmine is affected by various factors, among which, insect pests are the most devasting factor. The major pests affecting jasmine are jasmine bud worm (*Hendecasis duplifascialis* Hampson), leaf webworm (*Nausinoe geometralis* Gurnee), gallery worm (*Elasmopalpus jasminophagus* Hampson.), leaf roller, (*Glyphodes unionalis* Hubner), and the two-spotted mite (*Tetranychus urticae* Koch.). Of these, budworm and two-spotted mite gain major economic importance, as they cause excessive damage to the buds and leaves, respectively. Of these, two-spotted mite has achieved the status of a major pest causing severe economic loss by reducing the vitality of the plants, thereby reducing the productivity of flowers. *Tetranychus urticae* (Koch, 1836) commonly known as two-spotted mite is a species

Figure 4.
Jasminum nitidum.

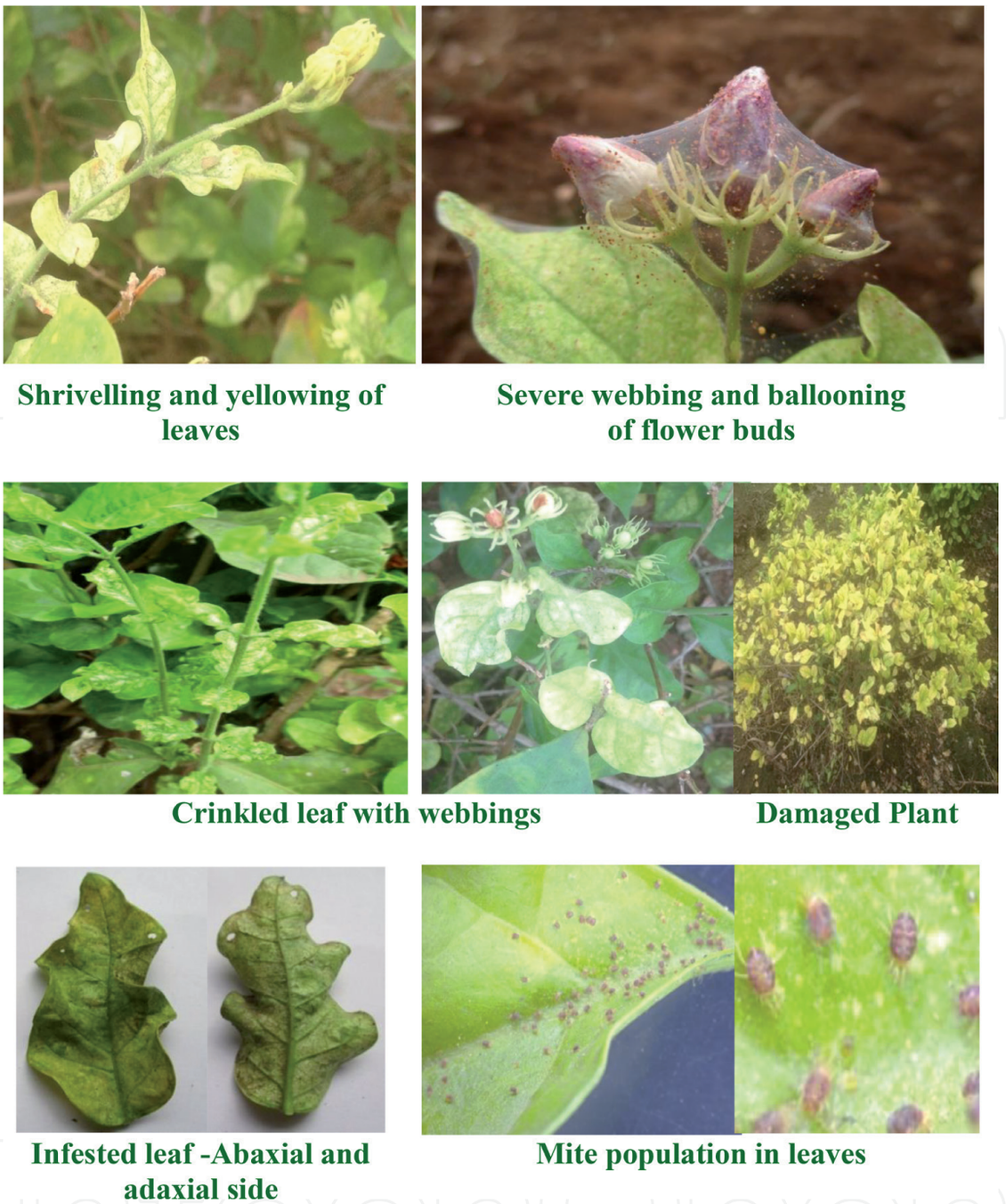


Figure 5.
Symptoms of damage of two-spotted mite, Tetranychus urticae.

of plant-feeding mite that is generally considered as a pest. It is the most widely known member of the family Tetranychidae or spider mites. Spider mites are named so because many members of this family produce silk webbing on the host plants. In jasmine, flowering commences during March–April and comes to peak in May–July. During this period, the weather is too hot and is favourable for multiplication and so the population increases rapidly. These tiny eight-legged arthropods lay eggs on the underside of leaves. An adult female can lay more than 100 eggs in 3 weeks. Eggs hatch in 4–5 days and the entire lifecycle from egg to adult is completed in 1–3 weeks, depending on the temperature. The life-cycle of *T. urticae* consists of five different stages such as egg, larva, protonymph, deutonymph and adult. Mites are typically found on the underside of leaves, but may colonise entire plants during outbreaks. The mites suck sap from cells on the underside of plant leaves, in the early stages, and characteristic white speckles can be seen from the upper leaf

surface. As mite number increases, these white speckles also increase and the leaf exhibits a bleached appearance [9].

In case of severe infestation, the whole plant becomes pale in colour, and affects production and size of the flower buds. Damage to the leaves inhibits photosynthesis, and severe infestations can result in premature leaf fall, shoot dieback, and decreased plant vigor. Although the individual lesions are very small, attack by hundreds or thousands of spider mites can cause thousands of lesions and thus can significantly reduce the photosynthetic capability of plants [10]. Such buds fetch a low market price. Silk webbing on the undersides of leaves is a characteristic sign of spider mites. Under high population densities, the mites move to the tip of the leaf or top of the plant and congregate using strands of silk to form a ball-like mass, which will be blown by winds to new leaves or plants, in a process known as "ballooning' (**Figure 5**).

As the infestation by the two-spotted mite, *T. urticae,* and the jasmine leaf webber, *Nausinoe geometralis* Guenee, coincides with the flushing stage, the silky foliage of jasmine is severely affected, and thereby, the photosynthetic efficiency of plant is affected, hence affecting flower production. The rapid developmental rate, short generation time, and high net reproductive rate of *T. urticae* allow them to achieve damaging population levels very quickly when growth conditions are suitable, resulting in an equally rapid decline of host plant quality.

Management of this pest has become a menace for the jasmine growers. The knowledge on life history of the pest as well as the life-table on different varieties is essential for developing IPM in better management of any pests. The knowledge of the sequence of developmental stages, their duration, and number of generations and method of overwintering is essential to know the 'weakest link' in the lifecycle. This would help to aim control measures effectively at the most vulnerable stage of the pest. The biology of jasmine two-spotted mite is attempted in the four cultivable jasmine species, that is, *Jasminum sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*. The objective of the study is to compare the different life stages of two-spotted mite in different Jasmine species.

2. Materials and methods

The life history of red spider mite was studied under laboratory conditions at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, India with the prevailing weather parameters. Pure culture of red spider mite, *Tetranychus urticae*, was initiated by collecting the adults from jasmine field and was maintained in the laboratory. The mites were reared on jasmine leaves following the technique suggested by Rodriguez [11] and Gilstrap [12]. Field-collected mites from the field-infested jasmine leaves were reared continuously on the leaf discs of fresh mulberry leaves cut into squares of 8 cm^2 size placed on foam pads on plastic trays facing the basal side upward. Distilled water was used to keep the foam pad wet and to maintain the leaf discs in turgid conditions which were changed when they started turning yellow. Further, in order to prevent the migration of *T. urticae* colonies from one disc to other, the leaf squares were fenced with wet cotton threads. Cut infested jasmine leaf samples were first examined for predators (*i.e.*, predatory thrips or mites) to avoid possible contamination of culture. The leaves were then laid on top of the clean mulberry leaves (**Figure 6**). After establishment of the culture, the biology was studied.

About 20 mated females were released on a fresh leaf in the petridish and allowed overnight, in order to obtain the eggs. Next morning, the eggs were carefully lifted with the help of a moistened 00 size camel hairbrush and transferred

Figure 6.
Mass culturing of Tetranychus urticae.

to previously prepared leaf discs at the rate of one egg per leaf disc per Petri plate. Such 35 plants were maintained to study the biology. The development of various stages of the mite was observed twice a day with the help of stereoscopic binocular microscope. The observation on life history included incubation period (days), duration of larva, (days) protonymph, deutonymph, quiescent stages, preoviposition, oviposition and post oviposition periods, fecundity and longevity of adults, sex ratio and the viability of eggs. The midpoint between two observations was considered as the time of moulting whenever a change to next stage was observed. But, if moulting was just taking place at the time of observation, then it was taken as the time of moulting. When the mites reached the adult stage, the other sex of the mite that developed on the leaf disc was released on to the leaf disc to observe mating, pre-oviposition, oviposition and post-oviposition and also fecundity and longevity of the mite.

To study the biology in different *Jasminum* species, the mites were cultured in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum* placed inside Petri dishes, and the following parameters were recorded.

2.1 Fecundity rate

The female deutonymphs and male adults were collected from the respective cultures and released at one pair per Petri dish. They were allowed to oviposit, and observations on the number of eggs laid per day, egg period and total number of eggs laid throughout the oviposition period were recorded.

2.2 Duration of life stages

One pair of matured female and male mites was released per Petri dish. After a few hours of oviposition, the mites were removed using a camel hair brush retaining only five eggs in each petri dish. Hatching was observed, and the duration of different immature stages followed by adult longevity was recorded.

2.3 Percentage of larvae becoming adult

The female deutonymphs and adult males were collected from the respective cultures and released at three pairs per petri dish. Two days after oviposition, mites were removed leaving only the eggs. The numbers of larvae successfully reaching the adult stage were counted in each petri dish and the percentage was worked out.

3. Results and discussion

The biology of two-spotted mite, *T. urticae* on *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum* as host plants was investigated under controlled conditions, and the results are presented in **Table 1**. The different life stages are described hereunder.

3.1 Egg

The freshly laid eggs were brown or translucent white in colour, which gradually turned to deep brown and then creamy pinkish as they approach hatching. The spherical-shaped eggs were laid singly. The incubation period ranged from 1 to 3 days. The average incubation period was 2.2, 2.0, 1.5 and 1.5 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively (**Figures 7** and **8**).

The newly hatched larvae were almost spherical in shape and creamy white in colour. Two bright and prominent red spots (simple eyes) were present on the dorsal sides of the propodosomal region. The larva possessed only three pairs of legs. The larval period ranged from 2 to 3 days. The average larval period was 2.5, 2.2, 1.9 and 1.7 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively.

3.2 Protochrysalis

The dark green matured larva entered into the quiescent stage by anchoring itself to the leaf surface. The stage was dark green. The average period of

Life stages of two-spotted mite	**Duration of different life stages of *T. urticae* in four *Jasminum* species Mean ± SD (in days)**			
	J. sambac	***J. auriculatum***	***J. grandiflorum***	***J. nitidum***
Incubation period	2.2 ± 0.91	2.0 ± 0.81	1.5 ± 0.84	1.5 ± 0.84
Larval period	2.5 ± 0.52	2.2 ± 0.42	1.9 ± 0.31	1.7 ± 0.483
Duration of protochrysalis	2.2 ± 0.42	1.9 ± 0.32	1.6 ± 0.52	1.20 ± 0.42
Duration of protonymph	2.4 ± 0.52	1.7 ± 0.48	1.5 ± 0.53	1.1 ± 0.32
Duration of deutochrysalis	2.5 ± 0.53	2.0 ± 0.47	1.7 ± 0.48	1.4 ± 0.52
Duration of deutonymph	2.7 ± 0.48	2.3 ± 0.48	2.0 ± 0.67	1.0 ± 0.48
Duration of teleochrysalis	2.9 ± 0.32	2.2 ± 0.63	1.5 ± 0.71	1.1 ± 0.32
Adult longevity	21.7 ± 1.64	21.3 ± 1.64	21.1 ± 2.23	19.9 ± 1.37
Total developmental period (egg-adult)	24.9 ± 1.37	24.0 ± 1.83	23.9 ± 1.37	22.8 ± 1.55

**Mean of three observations.*

Table 1.
Life stages of two-spotted mite, Tetranychus urticae, on four Jasminum species.

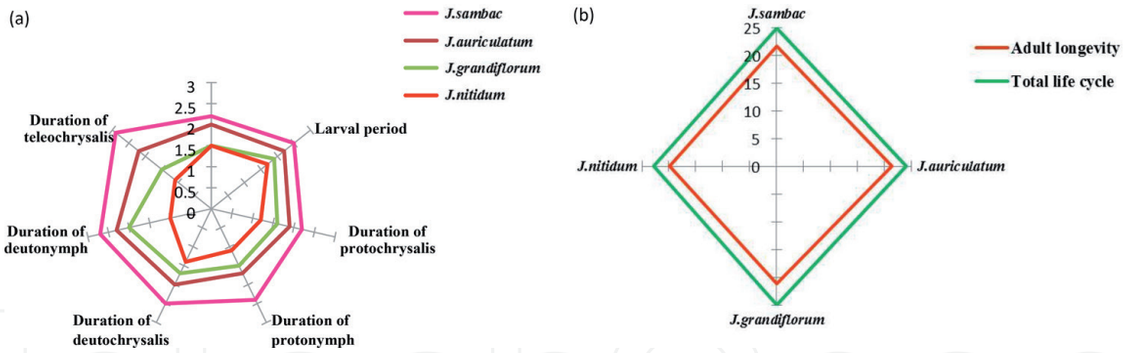


Figure 7.
Radar representation of biology of two-spotted mite, Tetranychus urticae on different Jasminum species. (a) Egg and larval period, (b) Adult longevity and total lifecycle.

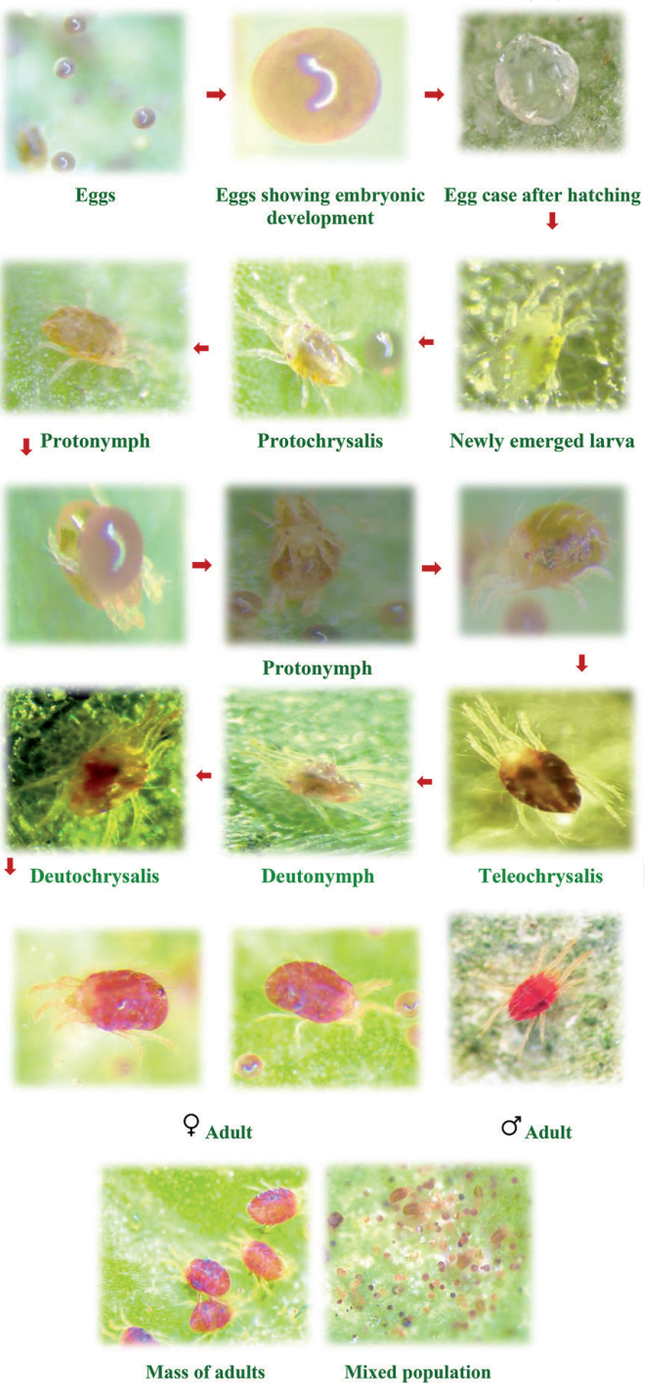


Figure 8.
Biology of two-spotted mite, Tetranychus urticae.

protochrysalis was 2.2, 1.9, 1.6 and 1.2 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively.

3.3 Protonymph

The protochrysalis moulted into protonymph. The body was oval in shape with four pairs of legs and dark green in colour in the beginning, which later turned into amber colour. The average period of protonymph was 2.4, 1.7, 1.5 and 1.1 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively.

3.4 Deutochrysalis

The matured protonymph entered into quiescent, a stage which is known as deutochrysalis. The body also shrinked and decreased in size and attained a dark green colour. The average period of protochrysalis was 2.5, 2.0, 1.7 and 1.4 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively.

3.5 Deutonymph

The deutonymph emerged from deutochrysalis. The body was red coloured, larger and broader than protonymph. The average period of deutonymph was 2.7, 2.3, 2.0 and 1.0 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*.

3.6 Teleochrysalis

The deutonymph at its maturity enters into a quiescent stage known as teleochrysalis. In this stage, the body shrinks and decreases in size. The colour of this stage is light red to creamy. The average larval period of protochrysalis was 2.9, 2.2, 1.5 and 1.1 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*.

3.7 Adult

The body of the adult male was narrow with a distinct abdomen, greenish in colour which later turned pinkish. The first pair of legs was longer than the rest of the pairs. Males were smaller than females and lived for 11–12 days. The newly emerged females looked dull red which later turned to deep brick red. The simple eyes were seen as two red spots on the sides of the dorsal propodosomal region. The adult female survived for 19–24 days. The pre-oviposition period varied from 2 to 3 days with an average of 2.7 days. The oviposition period lasted for 11–14 days with an average of 12.0 days. Each female laid about 123–160 eggs with an average of 146.6 eggs. The mean number of eggs laid was 10–12 eggs per day. The maximum number of eggs laid by a female was 11–12 eggs per day. The average adult longevity is 21.7, 21.3, 21.1 and 19.9 in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively.

3.8 Total developmental period

The total developmental period (egg to adult) ranged from 24.9, 24.0, 23.9 and 22.8 days in *J. sambac*, *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively (**Figure 6**).

The biology of the two-spotted mite, comprising egg, larva, protochrysalis, protonymph, deutochrysalis, deutonymph, teleochrysalis and adult stages was completed in 24.9 days. The results are in agreement with Rajakumar et al. [13], who reported that the total developmental period of mites in jasmine was 22.80 days for

♂ and 31.08 days for ♀. The outcome of the study was also in conformity with Vinoth Kumar et al. [14] who also suggested that the developmental period ranges from 26 to 27 days in brinjal and Premalatha [15] who stated that the total developmental period of two-spotted mites lasted from 24.71 to 25.71 days. But the egg-to-adult developmental period was lesser *viz*., 24.0, 23.9 and 22.8 days in other *Jasminum* sp., *J. auriculatum*, *J. grandiflorum* and *J. nitidum*, respectively, which proves that mites did not prefer them as *J. sambac*. The biochemical contents of the plant like high phenols, low sugar, protein or other biophysical factors like leaf surface wax could be the probable reason for the less preference which resulted in shorter life cycle. Different leaf characters like leaf area, leaf hair density, length of leaf and leaf thickness have a significant impact on the searching capability of mites [16]. Saber and Momen [17] reported that leaf toughness and thickness are very important factors, which influence the reproduction and development of phytoseiid mite population.

4. Conclusion

The observations on life cycle parameters of two-spotted mite, *T. urticae,* revealed that the life cycle consists of egg, larva, protochrysalis, protonymph, deutochrysalis, deutonymph, teleochrysalis and adult. The lifecycle and duration of each stage are found to be the shortest in *J. nitidum* and the longest in *J. sambac*.

The use of moderately resistant varieties as a part of the IPM strategy can enhance the biological and chemical tools of insect pest management. One of the techniques to decrease the pest damage is use of the cultivars or species which show higher resistance to insect pests such as *J. nitidum* and *J. grandiflorum* in areas where the incidence of jasmine mites is high. *J. grandiflorum* is a commercially cultivated species of jasmine, well known for its mesmerizing fragrance as well as usage for concrete recovery. But, *J. nitidum* is a new *Jasminum* species with star-shaped fragrant flowers newly introduced for commercial flower cultivation. Hence, utilizing this least preferred species in breeding programs of jasmine will yield better varieties with greater degree of resistance to jasmine pests.

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