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Leaf Geometry in *Jasminum* spp. *viss-a-vis* Infestational Distribution of Crimson spider mite, *Tetranychus lombardinii* Baker & Pritchard (Acari: Tetranychidae)

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ABSTRACT: The crimson spider mite, *Tetranychus lombardinii* Baker & Pritchard (Acari: Tetranychidae) has been a significant emerging pest on different species of *Jasminum,* causing considerable damage by sucking the sap from the leaf tissues. Leaf morphological characters and nutritional contents play an important role on the distribution and survival of the pest. The study has been undertaken to understand the relationship between morphological characters (leaf morphology) and natural infestation of mites under field conditions. There were significant differences with respect to leaf length, leaf breadth and leaf thickness across the different *Jasminum* spp. Though the overall area of *J. auriculatum* leaf was the lowest (4.83 cm^2), but it harboured a greater number of mites *i.e.*, 23.60 mites/cm^2 leaf area comparable to the number of mites inhabiting the leaves of *J. grandiflorum* and *J. sambac* with 25.20 and 21.60 mites/cm^2 leaf area, respectively. It is opined that crimson spider mite infestational distribution on *Jasminum* leaves depends on the leaf area as well as the leaf geometry (*i.e.*, leaf type), which is probably associated with mite colonisation and its mobility for damaging activities such as feeding, egg laying, webbing *etc*. The information with respect infestational distribution and survival on different *Jasminum* spp. aids in the development of appropriate management measures against crimson spider mite, *T. lombardinii* in the field.

Keywords: Jasmine, *Tetranychus lombardinii*, leaf morphology, distribution.

INTRODUCTION

Jasmine, an important flower crop grown for its fragrant flowers and essential oils, used in the perfume industry worldwide and known to be infested by an array of insect and mite pests (Nirmala *et al*., 2017). In recent years, crimson spider mite, *Tetranychus lombardinii* is perceived as an emerging pest of jasmine in the South Indian states of Karnataka and Tamil Nadu, as it causes significant damage to leaves in field cultivated species of *Jasminum* (Anonymous, 2018; Chidananda, 2017). Bolland *et al*. (1998) listed many cultivated crop plants *viz*., amaranth, bean, cucumber and papaya as major host plants of *T. lombardinii* in many other countries (Australia, Indonesia, Kenya, Madagascar, Malawi, Mozambique, Namibia, South Africa, Zaire, Zambia, and Zimbabwe). As documented in the spider mite web, *T. lombardinii* has been recorded on 127 host plants in the world (Migeon and Dorkeld 2006-2022). Hitherto in India, *T. lombardinii* was reported to occur only on one cultivated plant species, *Indigofera tinctoria* (Indigo) in Assam (Gupta and Gupta 1994). Zeity (2015), while studying the tetranychid mite fauna in Karnataka (Bangalore) recorded abundant occurrence of this mite on *Jasminum sambac*. Chidananda (2017) reported severe damage of this mite on commercially cultivated jasmine species, *J. sambac, J. multiflorum* and *J. grandiflorum*, almost in the entire state of Karnataka. Majeed *et al*. (2022) reported *T. lombardinii* on *Jasminum* sp. in Shivamogga. Pooja and Srinivasa (2022) studied by no-choice mode, the biology and population performance of *T. lombardinii* on five cultivated *Jasminum* spp. (*J. sambac, J. multiflorum, J. grandiflorum, J. auriculatum* and *J. azoricum*) and three wild species (*J. cuspidatum, J. flexile* and *J. rigidum*) and they reported that crimson spider mite showed developmental preference for cultivated *Jasminum* spp. over the wild species.

It is well known that phytophagous organisms derive their shelter and food resource requirements from the host plants, as they pass through the sequential chain of events in the process of food plant selection (Painter, 1951; Panda, 1979). The initial phases of host plant selection process are mediated by the host plant anatomical features, which aid in critical recognition of food plants. Such morphological leaf features largely help the phytophagous mites to orient themselves and select the leaf-laminal areas for colonization, which in course of time leads to their infestational distribution and successful establishment as a pest, besides being naturally protected from their enemies. The intimate relationship between pest mites and host plants are hence mediated by plant architecture including plant aspects (appearance), growth habit *etc*. The chief plant factors affecting the distribution of phytophagous mites have been the plant branching pattern, leaf morphology, leaf age etc. Further, the plant nutrient factors support successful growth, development and reproduction of the pest. The main leaf features that affect the mite pest population are leaf veination, non-glandular epidermal hairs, trichomes and domatia. Many pest mites being negatively phototropic, majorly live on the underside of the leaves, where they are protected from direct sunlight and air currents which prevent the drying of their bodies and ensure least disturbance of their distribution from the undersurface of the leaf. Hence, leaf surface structures affect mite's infestational distribution on the host plants (Vacante, 2015). Intricate networking of webbing by spider mites also depends on the processes on the leaf surface and the leaf laminal area available for their trivial activities of feeding, egg laying *etc*. The silk secretion and webbing in mites not only provide protection from their predators but also useful for dispersal, mating activities, interspecific relationships and protection from climatic factors. The shifting of habitat from leaf upper side to underside offers several additional advantages as it reduces temperature variations and provides good protection against heavy rains, which might sweep-off the mites. Plant architecture and leaf morphology-related spider mite webbing forms a microhabitat which enables reproduction and feeding activities to occur even under adverse climatic conditions (Sabelis, 1985). According to Kielkiewicz and Van de Vrie (1990), the overall development and population performance of mites depends on the different parameters such as plant texture (phyllotaxy, leaf type, leaf texture, leaf shape, size, leaf tip and leaf base) and the relevant host plant physiology. Leaf trichomes usually function as a structural barrier against small herbivores, interfere with the movement to make it more difficult to access the leaf epidermis underneath, while feeding (Southwood, 1986). Generally biological processes of herbivores such as survival, development, generation time, fecundity and longevity are not only influenced by the morphological characters of the plants but largely influenced by the host plant biochemical factors (Van Emden, 1997). The present study is intended to understand the trivial relationship between the leaf morphological characters and infestational distribution of crimson spider mite on the leaves of different *Jasminum* spp., which would help in understanding the phenomenon of susceptibility or tolerance in different species of *Jasminum* and management options in relevance of infestation pattern and damage intensity by *T. lombardinii*.

MATERIAL AND METHODS

Five species of cultivated *Jasminum* were studied for their morphological characters like, phyllotaxy, leaf type (simple/ compound), leaf shape, leaf texture (pubescent/glabrous), leaf trichome density, leaf colour, shape of the leaf base and leaf thickness in relationship with the survival and infestational distribution of mites on the leaves. The leaf length (cm), leaf breadth (cm) and leaf thickness (mm) were measured separately from 6 different spots on each leaf using Vernier Calipers (from 10 medium matured leaves from middle region of the branches). Only in *J. multiflorum* whose leaves had trichomes, trichome density was recorded as the number/cm^2 leaf area under a stereo-binocular microscope in the laboratory from one sq. cm area from six spots on each leaf.

To ascertain infestational distribution of *T. lombardinii* mites on leaves of different *Jasminum* spp., the infested leaf samples during peak infestation period (April-May) were brought to the laboratory and the population of mites, as eggs and active stages (larva, nymphs and adults) was recorded from 20 leaves sampled from each of the five *Jasminum* spp., by observing under a stereobinocular microscope. The leaf area of the respective leaves (simple or compound leaf) was determined by superimposing on the centimetre-mathematical graph sheet. The mite population was expressed as the number of eggs, active stages and eggs+active stages per leaf as well as the number per cm^2 leaf area. For comparison, the mite population (number/leaf and number/cm2 leaf area) data recorded from leaves of different *Jasminum* species were statistically analysed by one-way ANOVA.

Crimson spider mite infested leaves of five cultivated *Jasminum* were brought from the field and reared separately on respective excised leaves kept on the foam placed in polyethylene trays in the laboratory, allowed to colonize and used as nucleus culture for various other biological studies including the developmental survival study using a batch of 100 eggs laid on respective *Jasminum* leaf bits under laboratory conditions (temperature of 25.8°C and relative humidity of 70-75%).

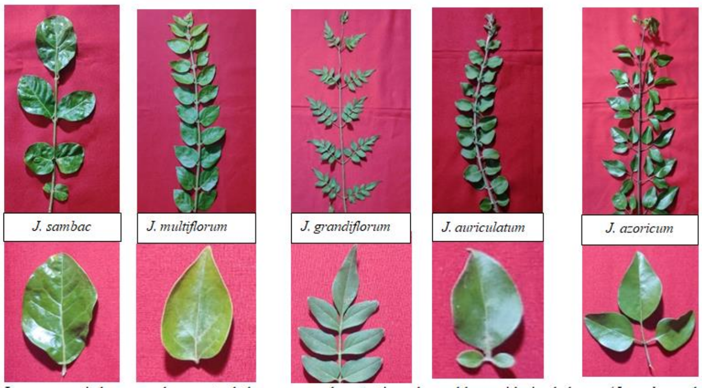
RESULTS AND DISCUSSION

As depicted in Fig. 1 the arrangement of leaves (phyllotaxy) in all the five *Jasminum* spp. is opposite. The colour of the healthy leaves varies from green to dark green with acute tip and a round base. *J. sambac* and *J. multiflorum* have leaf type simple, while *J. grandiflorum*, *J. auriculatum* and *J. azoricum* have compound leaves. There observed significant differences with respect to leaf length, leaf breadth and leaf thickness across different *Jasminum* spp. *J. sambac* had the longest (6.48 cm) and widest leaf lamina (4.48 cm), while the thickest leaf was in *J. multiflorum* (0.374 mm) (Table 1). However, the total leaf area computed for each leaf of the *Jasminunm* spp. irrespective of the leaf type was maximum of 23.58 cm^2 for *J. azoricum* (trifoliate leaf) immediately followed by the simple leaf of *J. sambac* with the leaf area of 22.63 cm^2. This eventually supported the colonisation of *T. lombardinii* to accommodate highest number of eggs (556.56/leaf) and active stages (245.56/leaf) to record the total population of 801.82 mites on the trifoliate leaf of *J. azoricum* (Fig. 2). The corresponding mean mite population on each simple leaf of *J. sambac* was 321.35 eggs, 167.43 active stages and a total of 488.78 mites. *J. grandiflorum* was next in the order, with 154.66 eggs and 88.93 active stages accounting for a total mite number of 243.59 mites per leaf.

The distribution of spider mites on leaf surface usually depends on the leaf morphological features of leaf length, leaf width as well as the actual leaf area. The comparative population distribution on the leaves of five cultivated *Jasminum* spp. at peak mite infestation shown in Table 2, gives an account of varying densities of mite on the leaf surfaces of *Jasminum* spp. Ultimately the population density of *T. lombardinii* expressed as mean number per cm^2 leaf was highest on *J. azoricum* (34) followed by *J. grandiflorum* (25.20), *J. auriculatum* (23.60) and *J. sambac* (21.60). Leaf infestational distribution was least dense on *J. multiflorum i.e*., 11 mites/cm^2, as number of mites/cm^2 was found lowest, may be accounted for the presence of trichomes (on the lower surface) and is comparable with the findings of Mishra *et al*. (1990), who observed negative correlation of *T. urticae* population density with leaf hair density on the brinjal leaves. Among the five cultivated *Jasminum* spp. included in the study, only *J. multiflorum* had bear or non-glandular trichomes (350/cm^2). Saeidi *et al*. (2007) found higher density of type IV glandular trichomes on leaves of few tomato genotypes accommodating fewer number of mites and conferring resistance to *T. urticae*. They also observed that the rupturing damage of glandular vesicles by the trivial movement of active mite adults and nymphs which released the sticky material and the mites got entrapped and eventually get killed or died.

Though the laminal area of *J. auriculatum* leaf was the lowest (4.83 cm^2) but still it harboured 23.60 mites/cm^2, which was comparable with that on *J. sambac* (21.60) and *J. grandiflorum* (25.20). It could be opined that spider mite infestational distribution not only dependant on the total leaf area, but also depends on the leaf geometry and probably associated with mites' trivial activities such as mobility, congregation, feeding, egg laying, webbing *etc*.

Comparative infestation of *T. lombardinii* shown in Fig. 2 is only a virtual assessment of ascertaining the mite damage and it was a rough indication of stunting of mite affected leaves which would finally adversely affect the floral yield of the *Jasminum* plant. The leaf morphology was presumed to affect the initial mite colonisation. The mite infestational distribution was also recorded to interfere with the survival of the crimson spider mite, which was ascertained by culturing the mites on excised leaf discs of different *Jasminum* spp. (Pooja, 2023). Of the five cultivated species, the overall mites' developmental survival from egg to adult was high of 90-92% on two commercially cultivated jasmines, *J. grandiflorum* and *J. auriculatum*. This could be attributed to more dense distribution of mites (25.20 and 23.60 mites/cm^2, respectively) in our study.



Leaves oppositely arranged, green to dark green, round, acute tip and round base with simple leaves (*J. sambac* and *J. multiflorum*) and compound leaves (*J. grandiflorum, J. auriculatum* and *J. azoricum*) with pubescent hairs (only in *J. multiflorum*)

Fig. 1. Leaf arrangement and leaf characters in of different *Jasminum* spp.

Fig. 2. Crimson spider mite infestation and damage in different species of *Jasminum.*

Table 1: Leaf morphometry in different species of *Jasminum.*

Species of *Jasminum*	Leaf length (cm)	Leaf breadth (cm)	Leaf thickness (mm)
Jasminum sambac	6.480 ± 0.937^{bc}	4.480 ± 0.183^{d}	0.310 ± 0.015^{bc}
Jasminum multiflorum	4.820 ± 0.421^{bc}	3.020 ± 0.213^{c}	0.374 ± 0.037^{c}
Jasminum grandiflorum	2.380 ± 0.381^{a}	1.140 ± 0.112^{a}	0.220 ± 0.004^{a}
Jasminum auriculatum	3.860 ± 0.337^{abc}	2.680 ± 0.156^{bc}	0.214 ± 0.016^{a}
Jasminum azoricum	4.260 ± 0.326^{abc}	2.800 ± 0.277^{bc}	0.342 ± 0.021^{c}

Mean values within the column with same alphabetical superscript are not significant according to Tukey's HSD test ($P<0.05$)

Table 2: Comparative population of crimson spider mite *T. lombardinii* on *Jasminum* at peak infestation (April-May) and mites' developmental survival.

Species of *Jasminum*	Leaf area (cm^2)	Mean number/leaf			Mean number/ cm^2 leaf area			Percent survival from egg to adult emergence
		Eggs	Active stages	Total	Eggs	Active stages	Total	
Jasminum sambac	22.63^d	321.35	167.43	488.78	14.20	7.40	21.60^b	89.47
Jasminum multiflorum	6.63^b	50.35	22.53	72.88	7.60	3.40	11.00^a	76.81
Jasminum grandiflorum	9.67^c	154.66	88.93	243.59	16.00	9.20	25.20^d	90.22
Jasminum auriculatum	4.83^a	80.23	33.83	114.06	16.60	7.00	23.60^c	92.04
Jasminum azoricum	23.58^e	556.56	245.26	801.82	23.60	10.40	34.00^e	87.25

Mean values within the column with different alphabetical superscript are significant according to Tukey's HSD test ($P<0.05$)

CONCLUSIONS

Both the host plant texture (leaf morphology) and host plant physiology imply a significant impact on survival, infestational distribution and population buildup of crimson spider mite pest on leaves of *Jasminum* spp. Understanding of plant architecture as well as biochemical profile of *Jasminum* host plants largely determine the mite infestation pattern and the intensity of mite infestation to decide on the appropriate management strategy.

FUTURE SCOPE

The current study helped in understanding the significance of leaf morphology on *T. lombardinii* infestational distribution and its survival. Leaf arrangement and leaf morphological features together with plant biochemical constituents would ultimately ascertain the susceptibility or resistance of *Jasminum* host plant to crimson spider mite infestation. This basic information of plant factors helps in understanding the mite infestation pattern and to adopt suitable management tactics.

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Conflict of Interest. None.

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