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Differential Development and Population Performance of Crimson Spider Mite, *Tetranychus lombardinii* Baker and Pritchard (Acari: Tetranychidae) on *Jasminum* Spp.

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Abstract

Crimson spider Mite, *Tetranychus lombardinii* has been referred as an emerging pest of Jasmine plants in the entire state of Karnataka since 2017. The mite is known to infest the major cultivated species of *Jasminum* such as *J. sambac, J. multiflorum* and *J. grandiflorum*. Development, reproduction and demography of *T. lombardinii* was studied under laboratory conditions (25.8^{0}C temp.; 70- 75% RH) on eight different species of *Jasminum* (five cultivated- *J. sambac, J. multiflorum, J. grandiflorum, J. azoricum* & *J. auriculatum* and three wild types- *J. flexile, J. cuspidatum* and *J. rigidium*). Development of female mite was faster (10.73 days) on *J. auriculatum*, while the development of male mite showed marginal differences across different species of *Jasminum*. Longevity (15.26 days), fecundity (21.52 eggs/day) and oviposition duration (10.08 days) were also maximum for *J. auriculatum* when compared to other *Jasminum* species. Gross reproduction rate and net reproduction rate of *T. lombardinii* were found favourable on *J. auriculatum*, which ultimately responsible for the mite's highest r_m value of 0.1740 female offsprings / female / day. Differential development and demography of *T. lombardinii* on different species of *Jasminum* are discussed in the light of leaf biochemical constituents of host plants and their utility in the management of crimson spider mite infestation on cultivated species of *Jasminum*.

Keywords : Crimson spider mite, *Tetranychus lombardinii*, Jasmine, Developmental biology, Demography

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Members of spider mite family, Tetranychidae damage all types of economically important cultivated crops like field crops, vegetable crops, fruit crops, ornamental & flower crops and medicinal & aromatic crops (Vacante, 2015). Jasmine is commercially important flower crop cultivated for its attractive and fragrant flowers in the Southern and Eastern parts of India. In Karnataka jasmine is grown in area of 6,360 hectares with a production of 43,600 tonnes of flowers (Nirmala *et al.,* 2017). Jasmine plants are infested and damaged by an array of insect pests such as bud worm, gallery worm etc. (Byatanal, 2002; Samata *et al.,* 2019) and mite pests such as erenium Mite, *Aceria jasmini*, spider Mite, *Tetranychus* spp. etc. (Rajkumar *et al*., 2005). In recent years, Jasmine is found occasionally damaged by crimson spider mite, *Tetranychus lombardinii* Baker & Pritchard in different parts of the country. Meyer and Rodriguez (1966) first recorded *T. lombardinii* on a wild jasmine, *Jasminum nudiflorum* in South Africa. Jasmine is a genus of shrubs and vines under Oleaceae, which comprises of nearly 200 species, native to tropical and warm temperature regions of Eurasia and Oceanica. It is an important flower crop cultivated worldwide for its fragrance of flowers and its essential oils are used in the perfume industry.

In India, earlier *T. lombardinii* was reported only on one cultivated plant, *Indigofera tinctoria* (Indigo) in Assam (Gupta and Gupta, 1994). Zeity (2015), while

studying the tetranychid mite fauna recorded this mite on *Jasminum sambac* in Karnataka (Bangalore). 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, like Bangalore, Bilagi (Bagalakote dist.), Belagavi, Muddebihal (Bijapur dist.), Malur (Chikkaballapur dist.), Dharwad, Haveri, Balagere (Kolar dist.), Agalkera (Koppal dist.), Malavalli (Mandya dist.), Eklaspur (Raichur dist.) and considered *T. lombardinii* as a futuristic potential pest of *Jasminum* spp. cultivated in the country. But Bolland *et al*. (1998) has listed many cultivated crops *viz*., bean, papaya, amaranth and cucumber as host plants of *T. lombardinii* in many other countries of the world (Australia, Indonesia, Kenya, Madagascar, Malawi, Mozambique, Namibia, South Africa, Zaire, Zambia, and Zimbabwe). As of now, *T. lombardinii* is known to infest 127 host plants in the world (Migeon and Dorkeld 2006-2022).

Recently *T. lombardinii* is found expanding its host range and infesting other cultivated species of *Jasminum* like *J. auriculatum* and *J. azoricum* (present study). This demanded a detailed study to understand the potentiality of *T. lombardinii* as an emerging pest of *Jasminum* species. Potential status of a pest in general largely depends on its successful growth, development and multiplication on its probable host plant. In support of this, the present study intended on the development and reproduction biology inclusive of population characteristics of *T. lombardinii* on eight different species of *Jasminum* (five cultivated and three wild types), mainly to ascertain its potential pest status and to work on the management strategy of using the phenomenon of host plant resistance in the plant genus *Jasminum*. The study generated data on development and population performance of the emerging spider mite pest of Jasmine.

Material and Methods

Initially, Jasmine leaves infested by *T. lombardinii* in field were brought to the laboratory and reared on excised leaves kept on wet foam placed in polyethylene trays, allowed to colonize and were further used in biological studies. Using this as nucleus culture, the developmental biology of *T. lombardinii* was studied on eight *Jasminum* spp. (*J. sambac, J. multiflorum, J. grandiflorum, J. azoricum, J. auriculatum, J. flexile, J. cuspidatum and J. rigidium*) in the laboratory (Temperature of 25.8°C and relative humidity of 70-75%). A cohort of 30 eggs laid on respective *Jasminum* leaf were transferred individually using a fine camel hair brush on to 30 separate 1.5 cm × 1.5 cm respective *Jasminum* fresh leaf discs kept on wet foam placed in 9 × 6 polyethylene trays. Duration of different developmental stages from egg to adult was recorded such as, egg hatching, larva, larvochrysalis (quiescent 1), protonymph, deutochrysalis (quiescent 2), deutonymph and teliochrysalis (quiescent 3), Sex of the emerging adult was recorded to work out the duration of development for male and female mites separately.

To study reproduction and population parameters, 30 teliochrysalis females were released individually on separate excised leaf discs along with two male adults. After female emergence, pre-oviposition, oviposition, post-oviposition, longevity, fecundity and proportion of male & female off-springs (♂ : ♀ ratio) in the succeeding generation were recorded to construct the age specific life table of *T. lombardinii* for different species of *Jasminum*. Demographic characteristics (Doubling time, Mean Generation Time, Net Reproduction Rate, Gross Reproduction Rate, Finite Rate of Increase in number & Intrinsic Rate of natural Increase) were computed following the standard procedure suggested by Atwal & Bains (1974).

Data with respect to development and reproduction of *T. lombardinii* on different species of *Jasminum* were expressed as mean ± standard error. Data of mite development (female and male) were analysed by one-way ANOVA followed by Tukey's HSD 'T' test. The bootstrap technique with 1000 replications was used to estimate the mean and SE for each of the demographic parameters using software SPSS 23. Further, demographic parameter data were subjected

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to one-way ANOVA followed by Tukey's HSD test ($p<0.05$) for comparing the mite's demographic parameters across different species of *Jasminum*.

Results and Discussion

The data in respect of developmental biology of *T. lombardinii* studied on five cultivated (*J. sambac, J. multiflorum, J. grandiflorum, J. azoricum* and *J. auriculatum*) and three wild species (*J. flexile, J. cuspidatum* and *J. rigidium*) of *Jasminum* are presented in Table 1 and depicted in Fig. 1 & 2. The developmental duration of *T. lombardinii* (from egg to adult) on eight different species of *Jasminum* was 12.05, 13.45, 12.91, 12.09, 10.73, 15.05, 13.08 and 16.29 days for female. Male mite completed development in 10.33, 11.97, 10.50, 10.88, 10.63, 13.42, 13.12 and 14.59 days on respective species of *Jasminum*. These results are comparable with the findings of Chidananda (2017), according to him the developmental period of female on *J. sambac*, *J. multiflorum* and *J. grandiflorum* was 10.81, 13.54 and 14.46 days, respectively and of male was 10.52, 11.20 and 11.56 days, respectively. The present study additionally generated data on the developmental duration of *T. lombardinii* on five other species of *Jasminum*, of which two were cultivated including *J. auriculatum*, a widely cultivated *Jasminum* species in Northern Karnataka. It is evident that spider mite female completed its development in a shorter period of 10.73 days compared to 12.05 to 13.45 days on other cultivated *Jasminum* species. The female had longer developmental period (upto 16.29 days) on wild species of *Jasminum i.e*., *J. flexile* & *J. rigidium* (Table 2). However, development of male mite showed a marginal difference among cultivated (10.33 to 11.97 days) as well as wild types of *Jasminum* (13.12 to 14.59 days).

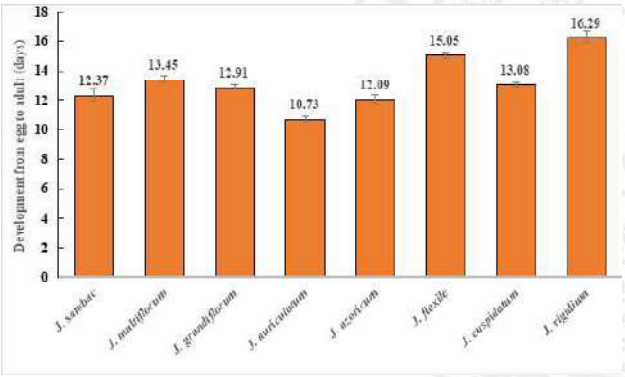

Fig. 1: Development of *T. lombardinii* female on different species of *Jasminum* under laboratory conditions (Temperature: 25.8°C and Relative humidity: 70-75%)

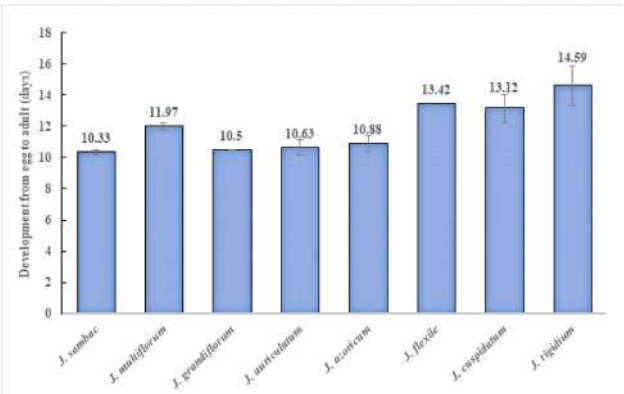

Fig. 2 : Development of *T. lombardinii* male on different species of *Jasminum* under laboratory conditions (Temperature: 25.8°C and Relative humidity : 70-75%)

The reproduction parameters of *T. lombardinii* on eight different species of *Jasminum* are shown in Table 3. *T. lombardinii* also preferred *J. auriculatum* for its reproduction as evident by its longer female longevity (15.62 days), longer oviposition period (10.08 days) and higher fecundity of mated female (21.52 eggs / female). The high proportion of females *i.e*., highest female biased sex ratio (4.64: 1) was more evident on *J. auriculatum*. Reproduction of *T. lombardinii* has been studied on *J. auriculatum* for the first time in the present study. However, the present result of *T. lombardinii* female longevity of 15.62 days on *J. sambac* is comparable to the longevity of 15.80 days of another species of *Tetranychus* (*T. urticae*) recorded on *J. sambac* by Rajkumar *et al*. (2005). But Chidananda (2017) recorded the higher longevity of *T. lombardinii* (19.26 days) on *J. sambac*. Interestingly, differential reproduction response of *T. lombardinii* of lower order was noticed, when reared on wild *Jasminum* species in the present study and it needs to be related to leaf biochemical constituents of different *Jasminum* species in the further studies.

Age specific survival of the mite depicted in Fig. 3 revealed that ovipositing females of *T. lombardinii* survived for a longest period of 24 days on

TABLE 1

Development of *Tetranychus lombardinii* on different species of *Jasminum* spp. under laboratory conditions

Stages of development	Mean duration of development (hours)							
	Jasminum sambac		*Jasminum multiflorum*		*Jasminum grandiflorum*		*Jasminum azoricum*	
	Female (n=17)	Male (n=5)	Female (n=21)	Male (n=4)	Female (n=27)	Male (n=2)	Female(n=15)	Male(n=2)
Egg	122.94±0.50	120.80±0.80	117.24±0.28	116.25±0.75	116.22±0.47	114.00±0.00	116.80±0.62	114.00±0.00
Larva	26.43±2.03	21.60±2.91	38.43±3.20	37.50±7.09	34.22±2.54	13.50±7.50	22.60±1.78	16.50±4.50
Larvochrysalis	21.00±1.09	25.80±2.24	21.71±0.82	19.50±0.87	23.55±0.97	28.50±1.50	19.20±1.40	24.00±0.01
Protonymph	30.37±3.32	20.40±3.72	41.57±2.97	29.25±4.48	44.33±2.98	27.00±0.00	27.80±2.10	19.50±1.50
Nymphochrysalis	19.87±1.09	16.80±1.20	22.14±1.44	21.75±0.75	20.22±1.20	12.00±3.00	23.00±1.84	21.00±3.00
Deutonymph	45.56±6.08	23.40±1.75	52.00±3.31	44.25±2.84	43.44±3.83	31.50±1.50	57.40±5.03	48.00±15.00
Teliochrysalis	24.00±1.41	19.20±1.20	29.71±2.26	18.75±1.44	27.89±1.15	25.50±1.50	23.40±1.58	18.00±6.00
Total development (egg to adult)	289.25±6.23 12.05 days	248.00±4.11 10.33 days	322.81±4.88 13.45 days	287.25±5.79 11.97 days	309.89±3.98 12.91 days	252.00±0.01 10.50 days	290.20±7.40 12.09 days	261.00±12.00 10.88 days
'T' test	Sig.		Sig.		Sig.		Sig.	

continued.....

TABLE 1 continued.....

Stages of development	Mean duration of development (hours)							
	Jasminum auriculatum		*Jasminum flexile*		*Jasminum cuspidatum*		*Jasminum rigidium*	
	Female (n=26)	Male (n=3)	Female (n=21)	Male (n=4)	Female (n=27)	Male (n=2)	Female(n=15)	Male(n=2)
Egg	81.54±0.27	76±0.01	115.19±0.19	115±0.01	117.43±0.45	115.50±0.50	136.41±.37	135±0.01
Larva	49.27±2.77	55±8.89	59.25±3.87	88.50±28.50	52.56±1.94	63.00±24.00	48.00±5.88	40±10.58
Larvochrysalis	21.23±0.55	21±1.73	22.50±1.09	19.50±1.50	19.69±.77	24.00±3.00	19.94±1.14	21±1.73
Protonymph	31.38±2.42	33±6.00	56.25±3.09	61.50±28.500	34.83±1.82	25.50±1.50	68.47±5.35	53±8.89
Nymphochrysalis	17.19±0.66	20±1.00	20.62±1.09	13.50±1.500	19.83±1.01	25.50±1.50	21.00±1.29	18±3.46
Deutonymph	33.23±2.12	25±2.00	63.94±3.54	10.50±4.50	44.22±2.05	33.00±9.00	73.76±6.65	61±13.23
Teliochrysalis	23.54±1.16	25±5.29	23.44±1.65	13.50±4.500	25.43±1.41	28.50±4.50	23.29±1.11	22±2.64
Totaldevelopment (egg to adult)	257.38±4.25 10.73 days	255±11.53 10.63 days	361.18±5.45 15.05 days	322.00±0.01 13.42 days	314.00±4.25 13.08 days	315.00±22.00 13.12 days	390.88±8.65 16.29 days	350±31.00 14.59 days
'T' test	Non-significant		Sig.		Non-significant		Sig.	

Data expressed as Mean ± SE subjected to one- way ANOVA followed by Tukey's HSD test ($p<0.05$)

TABLE 2

Comparative development of *T. lombardinii* on different species of Jasminum under laboratory conditions

Species of *Jasminum*	Total developmental duration from egg to adult (days)	
	Female	Male
Jasminum sambac	12.05 ^{b}	10.33 ^{a}
Jasminum multiflorum	13.45 ^{d}	11.97 ^{abc}
Jasminum grandiflorum	12.91 ^{bcd}	10.50 ^{ab}
Jasminum azoricum	12.09 ^{bc}	10.88 ^{ab}
Jasminum auriculatum	10.73 ^{a}	10.63 ^{ab}
Jasminum flexile	15.05 ^{e}	13.42 ^{bc}
Jasminum cuspidatum	13.08 ^{cd}	13.12 ^{abc}
Jasminum rigidium	16.29 ^{f}	14.59 ^{c}

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

J. auriculatum compared to other cultivated species of *Jasminum* (16 to 22 days). Age specific fecundity depicted in Fig. 4 also indicated peak egg laying by *T. lombardinii* mated female from 4th to 7th day of its emergence on *J. auriculatum* leaf discs.

Demographic parameters or population performance characteristics of *T. lombardinii* on different species

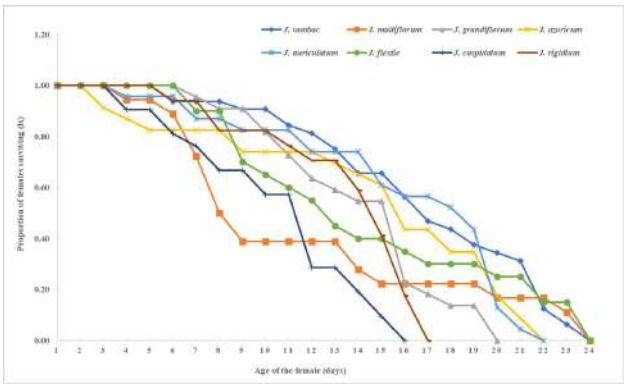

Fig. 3 : Age specific survival of *T. lombardinii* on different species of *Jasminum* under laboratory conditions (Temp.: 25.8°C and Relative humidity: 70-75%)

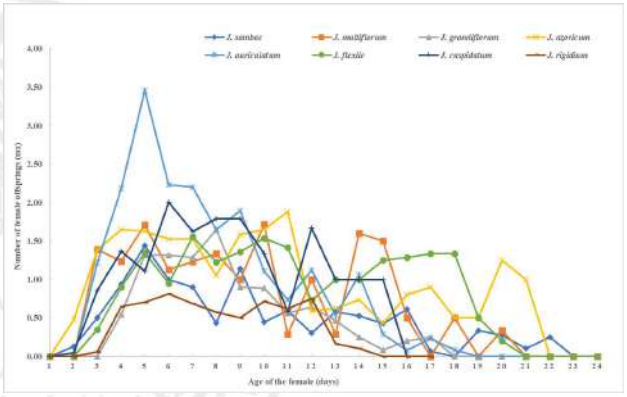

Fig. 4: Age specific fecundity of *T. lombardinii* on different species of *Jasminum* under laboratory conditions (Temp.: 25.8°C and Relative humidity: 70-75%

TABLE 3

Reproduction attributes of *Tetranychus lombardinii* on different species of *Jasminum* under laboratory conditions

Species of *Jasminum*	Reproduction attributes					
	Pre-oviposition (days)	Oviposition (days)	Post-oviposition (days)	Female longevity (days)	Number of eggs / mated female	Sex ratio (female : male)
Jasminum sambac	2.40±0.22 ^{a}	9.93±0.80 ^{a}	3.28±0.34 ^{c}	15.62±0.88 ^{b}	12.51±1.61 ^{ab}	2.98±0.33 ^{ab}
Jasminum multiflorum	2.44±0.16 ^{a}	6.55±1.33 ^{a}	2.05±0.31 ^{abc}	11.05±1.52 ^{ab}	12.22±2.83 ^{ab}	3.15±0.42 ^{ab}
Jasminum grandiflorum	3.77±0.29 ^{b}	6.81±0.59 ^{a}	2.63±0.32 ^{ac}	13.22±0.81 ^{ab}	11.36±1.21 ^{ab}	4.15±0.64 ^{b}
Jasminum azoricum	1.68±0.17 ^{a}	9.81±1.06 ^{a}	2.54±0.43 ^{abc}	14.04±1.31 ^{ab}	20.31±3.72 ^{b}	3.36±0.34 ^{ab}
Jasminum auriculatum	2.34±0.71 ^{a}	10.08±0.80 ^{a}	2.83±0.41 ^{bc}	15.26±1.07 ^{b}	21.52±2.55 ^{b}	4.64±0.46 ^{b}
Jasminum flexile	2.30±0.14 ^{a}	9.25±1.12 ^{a}	1.80±0.25 ^{abc}	13.35±1.33 ^{ab}	16.20± 2.50 ^{ab}	3.43±0.45 ^{ab}
Jasminum cuspidatum	2.55±0.36 ^{a}	6.33±0.72 ^{a}	1.16±0.28 ^{a}	10.05±0.83 ^{a}	15.44±2.20 ^{ab}	3.67±0.505 ^{ab}
Jasminum rigidium	2.58±0.12 ^{a}	7.76±0.70 ^{a}	1.64±0.25 ^{ab}	12.00±0.84 $^{a\ b}$	7.94±0.88 ^{a}	2.24±0.26 ^{a}

Values with the same alphabetical superscript within the column are not significant according to Tukey's HSD test (p< 0.05)

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TABLE 4

Demography of *Tetranychus lombardinii* on different species of *Jasminum* under laboratory conditions

Species of *Jasminum*	Demographic parameters					
	Mean Generation Time (T)	Doubling Time (DT)	Gross Reproduction Rate (GRR)	Net Reproduction Rate (R)	Finite Rate of Increase (λ)	Intrinsic Rate ofNatural Increase (r_m)
Jasminum sambac	20.24±0.18 [b]	6.60±0.08 [a]	10.92±0.06 [c]	26.06±0.11 [g]	1.127±0.001 [e]	0.119±0.001 [c]
Jasminum multiflorum	21.00±0.24 [a]	6.97±0.12 [a]	16.67±0.09 [d]	32.64±0.16 [h]	1.129±0.002 [f]	0.121±0.002 [d]
Jasminum grandiflorum	21.16±0.27 [e]	7.26±0.14 [d]	10.40±0.07 [b]	8.88±0.07 [b]	1.133±0.002 [bc]	0.121±0.00 [d]
Jasminum azoricum	19.90±0.15 [d]	5.23±0.05 [b]	21.64±0.08 [h]	14.80±0.08 [e]	1.155±0.001 [c]	0.143±0.00 [f]
Jasminum auriculatum	18.50±0.21 [c]	4.70±0.07 [b]	20.00±0.14 [g]	17.40±0.13 [f]	1.193±0.002 [d]	0.174±0.07 [g]
Jasminum flexile	23.98±0.20 [f]	6.87±0.07 [d]	19.29±0.09 [f]	12.04±0.07 [d]	1.117±0.001 [b]	0.111±0.00 [b]
Jasminum cuspidatum	20.03±0.19 [d]	6.21±0.08 [c]	17.26±0.08 [e]	10.60±0.07 [c]	1.139±0.001 [bc]	0.129±0.00 [e]
Jasminum rigidium	23.88±0.26 [f]	10.66±0.30 [e]	6.35±0.04 [a]	5.52±0.074 [a]	1.084±0.001 [a]	0.080±0.00 [a]

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

of *Jasminum* are presented in Table 4. Population progression of *T. lombardinii* on *J. auriculatum* was found supported by its lowest doubling time of 4.70 days and shortest mean generation time of 18.50 days. The mite also enjoyed the favorable Gross Reproduction Rate of (20) and Net Reproduction Rate of 17.40 female offsprings / female / generation on *J. auriculatum*, which ultimately was responsible for the maximum intrinsic rate of natural increase (r_m) of 0.1740 female offsprings / female / day.

Except that of Chidananda (2017), no study / data are available with respect to development and reproduction of *T. lombardinii* on different *Jasminum* spp. The present study generated additional biological data on two other cultivated *Jasminum* spp., *J. auriculatum* and *J. azoricum*. From the present findings, it could be said that *J. auriculatum* is the most preferred host plant for both development and multiplication of *T. lombardinii* (with shorter development time of 10.65 days and highest r_m value of 0.1740 female offsprings / female / day).

As a consequence of *T. lombardinii* is expanding its host range, would more potentially damage *J. auriculatum* and *J. sambac* compared to other cultivated species of *Jasminum*. Also, the formulation of suitable management strategy is much necessary. Differences in development, longevity, reproduction (fertility) and population performance of tetranychid mites across species or varieties of crop plants are common, often attributed to differences in host plant texture, biochemical constituents of host plants and host plant physiology (Ben Chaaban *et al*., 2011). Such differences in development and demography of *T. lombardinii* when reared on eight different species of *Jasminum* are evident in the present study.

Slower development and poor population performance of *T. lombardinii* noticed when reared on wild types of *Jasminum*, *J. cuspidatum* and *J. rigidium,* may be further investigated from the angle of host plant resistance and be explored for the management of *T. lombardinii* in the event of its severe occurrence and damage in future days.

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