



A COMPARATIVE STUDY ON EFFICACY OF DIFFERENT HOST PLANTS ON SURVIVAL, LONGEVITY AND FECUNDITY OF ASIAN CITRUS PSYLLID, *DIAPHORINA CITRI* KUWAYAMA (HEMIPTERA: PSYLLIDAE)

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Abstract

A comparative study on biology of the Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama was studied on six different host plants viz. Nagpur mandarin, *Citrus reticulata* Blanco; Sweet Orange, *Citrus sinensis*; Acid lime, *Citrus aurantifolia*, Curry leaf, *Murraya koenigi*; Orange jasmine, *Murraya paniculata* (L.) Jack and Wood apple, *Feronia limonia* in the laboratory conditions. The average egg incubation periods was recorded significantly less on Curry leaf (2.67 days) followed by Nagpur mandarin (3.0 days), Wood apple (3.33 days), Sweet orange and Orange jasmine (3.5 days for both), Acid lime (3.67 days). As compared to other host plants, the mean nymphal period was significantly recorded less on curry leaf (12.5 days) followed by Nagpur mandarin (14.17 days) and Orange jasmine (14.5 days). The mean number of eggs laid per female was recorded significantly more on Curry leaf, *M. koenigi* (605 eggs) followed by other host plants, Nagpur mandarin (568 eggs), Orange Jasmine (544 eggs). Percent survival of eggs was recorded more on Nagpur mandarin (88.18%) followed by Curry leaf (86.94%). Mean percent survival of Nymph was recorded significantly less on Curry leaf (64.69%). Percent adult survival was recorded higher on curry leaf (91.51%) followed by Nagpur mandarin (87.99%). Total percent survival from egg to adult was recorded higher on curry leaf and Nagpur mandarin, 57.58 % & 54.14 %, respectively. The mean population generation time was recorded less on Curry leaf (30.33 days) as compared with other host plant.

Keywords: Asian Citrus Psylla, Biology, Host Plants.

Introduction

Citrus is one of the major economically important crop commercially grown in South Asia, mainly in India and Pakistan. In world, Brazil leads the production of Orange with 24% followed by US and India. India produce on an average 29 lakh tonnes of orange every year. The variety of fruits types of citrus grown in India are orange, sweet orange and lime/lemon, grape fruits. In India, citrus fruits are mainly grown in Maharashtra, Madhya Pradesh, Tamilnadu, Andhra Pradesh, Punjab, Karnataka, Uttarakhand, Bihar, Odisha, Assam, West Bengal, Gujarat, Nagaland, Mizoram, Arunachal Pradesh and some parts of Rajasthan.

The quality and quantity of citrus is severely affected by more than 250 insect species (Rao et al 2017). Among them, Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae) is one of the major destructive pests (Shivankar and Rao 2010). Both nymphs and adults of ACP suck the sap from young shoots causing heavy de-blossoming and affects the fruit set seriously. Nymphs feed on young leaves and stem, continuously secreting honeydew on which black sooty mould develops. It also exhibit a variety of symptoms including initial leaf molting and chlorosis by showing stunted growth, branch die back followed by death of the tree. ACP is very well known to transmit the disease, huanglongbing (HLB), *Candidatus liberibacter asiaticus* (Bove 2006).

The psyllid slowly spread out throughout southern Asia, the Saudi Arabian Peninsula, to some islands in the Indian Ocean, and to Reunion and Mauritius (Hall, 2008). ACP has attained pandemic pest status since 1960-62 on Nagpur mandarin, *Citrus reticulata* Blanco causing considerable loss (Shivankar and Rao 2010). Halbart and Manjunath (2004) has reported approximate 25 genera from Rutacea family as a host plant of ACP. Apart from citrus, ACP is also reported to attack other host plants viz., curry leaf plant (*Murraya koenigii* L.), orange jasmine, *M. paniculata* (L.) (Shivankar et al., 2000) and wood apple, *Feronia limonia* Swingle (Mundiwale et al., 1972). A very few information is available about the biology of *D. citri* on host plants specially its life stages and development. A thorough understanding of comparative pest biology on commonly available main host plants and other alternate host plants of the *D. citri* life stages development may play an important role in developing preventive measures of the pest.

Material and Method

Host Plants and Asian Citrus Psyllid Source: The six month old potted seedlings of Nagpur mandarin (*Citrus reticulata*), Sweet orange (*Citrus sinensis*) budded on rough lemon (*Citrus jambhiri* Lush) and Acid lime (*Citrus aurantifolia*) seed grown were purchased from local certified nursery; curry leaf (*Murraya koenigii*), wood apple (*Feronia limonia*) and orange jasmine (*Murraya paniculata*) purchased from forest nursery. Each host plant were pruned, fertilized, watered regularly and maintained at ambient condition in the screen-house of Centre for Sericulture and Biological Pest Management Research (CSBR), Nagpur. These host plants were used as test plants. ACP infested twigs were collected from Nagpur mandarin orchards and were kept on new flush of citrus seedlings being maintained at ambient condition for its further multiplication. Adult from this culture were used in the present study.

The comparative biology of the ACP, *D. citri* was studied on six host plants viz., Nagpur mandarin (*Citrus reticulata*), Sweet orange (*Citrus sinensis*), Acid lime (*Citrus aurantifolia*), curry leaf (*Murraya koenigii*), wood apple (*Feronia limonia*) and orange jasmine (*Murraya paniculata*), during 2016-17.

Development and survivor ship of Citrus Psylla Nymphs: Ten number of citrus psylla adults (mixed gender) were collected from the lab culture maintained on citrus plants released on a set of four seedlings with two-three leaf stage of respective host plant. Psyllid adults were exposed on plants till 3 days for mating and egg laying. The seedlings were covered with muslin cloth and were kept in growth chamber maintained at $26 \pm 2^{\circ}\text{C}$ and $65 \pm 5\%$ RH. Each treatment was replicated six times. Observations on egg, nymphal, adult period and survival (%) were recorded on daily basis.

Adult Longevity and Fecundity. Five pairs of 3 day old psyllid adults of mixed gender (5 males + 5 females) were aspirated from stock culture and released on a set of 3 seedlings of respective host plant with new flush and covered with muslin cloth bag. Exposed adults were aspirated after 3 days and transferred to new set of respective host plant species. These sets of seedlings of different host plants covered with a muslin cloth bag were kept in growth chamber maintained at $26 \pm 2^{\circ}\text{C}$ and $65 \pm 5\%$ RH. Observations on number of eggs laid were counted under a stereo microscope daily until the last female died.

Data Analysis:The data on egg, nymph, adult period, survival (%), longevity of female adult and number of egg/female were subjected to ANOVA.

Results and Discussion

The experimental results showed that, the mean egg period of ACP on curry leaf was found to be significantly lower with 2.67 ± 0.33 days while that of Acid lime recorded highest with 3.67 ± 0.21 days. Similar trend was also observed in nymphal period of ACP which was recorded lowest in curry leaf with 12.5 days while highest value observed on wood apple with 17.17 days. The overall mean adult period (egg to adult) was recorded lowest on curry leaf (15.17 ± 0.65 days) while the highest adult period was recorded on wood apple (20.5 ± 0.34 days). The total life span of ACP was significantly less on curry leaf (30.33 ± 1.31 days) than other host plants. Total life span of ACP on Nagpur mandarin was recorded 34.33 ± 1.43 days; Orange Jasmin 36.00 ± 1.15 days; sweet orange 40.0 ± 1.03 , Acid lime 40.0 ± 1.15 days and on wood apple 14.00 days.

Percent (%) survival of ACP eggs was recorded significantly more on Nagpur mandarin (88.18%) and curry leaf (86.94%) than other host plants (72.26- 86.67%). Similarly, percent survival of ACP nymphs was significantly more on Curry leaf (72.65%), Nagpur mandarin (69.75%) than other host plants. However, percent survival of ACP adults was significantly more on curry leaf (91.51%) as compared to other alternate host plants.

In case of mean ACP female adult longevity was recorded highest on Nagpur mandarin (19.5 ± 4.14 days) while it was lowest on wood apple (13.8 ± 3.71 days). Mean number of eggs/female recorded was significantly more on curry leaf (605 eggs/female) while it was recorded lowest in wood apple (366 eggs/ female) as shown in Table-2. The experimental results of the present study showed that the mean developmental period for egg on four host plants ranged from 2.67- 3.67 days, similar observations were noted by Catling (1970), however somewhat more prolonged developmental period for eggs was observed by Husain and Nath (1927), Pruthi and Mani (1945), Rao et. al. (2017) & Tsai and Liu (2000)

The total nymphal developmental period of ACP on these six host plants ranged from 12.5-17.17 days was found similar to the period 11 to 15 days reported by Catling (1970), 11 to 25 days reported by Husain and Nath (1927), 10-15 days reported by Pande (1971), 12.58 to 13.50 days reported by Tsai & Liu (2000). The mean female longevity on four host plants ranged from 13.8- 19.5 days which was shorter as reported by Husain and Nath (1927) and Tsai & Liu (2000).

The fecundity of adult female on host plants was ranged from 366-605 eggs indicating confirmation of results as observed by Tsai & Liu (2000), higher than the reported by Pande (1971) and lower than as reported by Husain and Nath (1927). These variations was found in developmental periods and survival percentage of different developmental stages, its fecundity and longevity of adult female might be due to type of host plants, physiological characteristic of host plants, biotypes of *D. citri*, test condition(temperature & relative humidity (RH) at which studied was performed. These factors can affect the development of *D. citri* on respective host plant. The percentage survival of all the developmental stages of ACP, from egg to adults was recorded more on curry leaf (56.45 %) followed by Nagpur mandarin (54.14%) .

The shorter developmental time and greater total reproduction on a host reflect the suitability of the plant tested (Van Lenteren and Noldus 1990). Considering the present study results, *D. citri* reared on curry leaf recorded faster development, higher nymphal and adult survival and higher reproductive rate, it proved to be more suitable host for *D. citri*. The reason for the high oviposition rate on curry leaf could be the result of physiological and physical factors of the curry leaf (Moran and Buchan 1975). The hardness of tissues of shoot, leaf, may play an important role in to development of *D. citri*. Soft tissue of curry leaf, the development and survival of ACP was recorded more superior than Nagpur mandarin.

This present study confirmed the ACP are able to survive and complete its development on curry leaf, wood apple, orange jasmine other than definitive host plant viz, Nagpur mandarin, Sweet orange, Acid Lime, their presence in the back yards, vicinity of citrus orchards, gardens, residential areas, road side or in the forest areas could serve as alternate hosts for sustaining ACP populations during the periods when young citrus shoots are not available in the citrus groves.

The results confirmed that ACP can colonize and breed on three alternate host plant species tested along with three citrus cultivars and the comparative biology studies confirmed that *M. koenigii* is the preferred alternate host plant for Asian citrus Psylla, *D. citri*.

Table 1. Developmental periods of different stages of citrus psyllid, *Diaphorina citri* on different host plants.

Host Plant	Egg Period (Days)	Nymphal period (Days)					Total Nymphal period (Days)	Egg to Adult Period (Days)	Total life span (Days)
		1st instar	2nd Instar	3rd Instar	4th Instar	5th instar			
Nagpur mandarin, <i>Citrus reticulata</i> Blanco	3.0 b	2.17 a	2.33 ab	2.67ab	3.17 ab	3.83 b	14.17 a	17.17 b	34.33 b
	0.26	0.17	0.21	0.21	0.17	0.17	0.48	0.70	1.41
Sweet Orange, <i>Citrus sinensis</i>	3.5 bc	3.17 b	2.67 bc	3.17bc	3.33 abc	4.17 a	16.5 b	20 cd	40 c
	0.22	0.31	0.21	0.17	0.21	0.17	0.56	0.52	1.03
Acid Lime, <i>Citrus aurantifolia</i>	3.67 bc	2.83 b	2.83 c	3.33 c	3.5 bc	3.83 c	16.33 ab	20 cd	40 c
	0.21	0.17	0.17	0.21	0.22	0.17	0.56	0.58	1.15
Curry leaf, <i>Murraya koenigi</i>	2.67 a	1.83 a	2.17 a	2.33 a	2.83 a	3.33 a	12.5 a	15.17 a	30.33 a
	0.33	0.17	0.17	0.21	0.17	0.21	0.56	0.65	1.31
Wood apple, <i>Feronia limonia</i>	3.33 c	2.83 b	3.17 c	3.33 c	3.83 c	4.00 a	17.17 b	20.5 d	41 c
	0.21	0.17	0.17	0.21	0.17	0.26	0.17	0.34	0.68
Orange Jasmin, <i>Murraya paniculata</i>	3.5 bc	2.33 a	2.67 bc	2.83 bc	3.33 abc	3.33 b	14.5 ab	18 bc	36 b
	0.22	0.21	0.21	0.17	0.21	0.21	0.43	0.58	1.15
CD (0.05)	0.17	0.19	0.15	0.19	0.15	0.18	0-15	0.15	0.28
CV	7.87	10.17	7.84	9.47	7.17	4.04	6.55	6.55	3.96

*Mean of 6 Replicates; values in parentheses are square root transformed values.

* values followed by same letter are not significantly different than other.

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Table 2. Oviposition and longevity of adult female psylla on different alternate host plants.

Host Plant	Mean longevity of female (days)	Mean No. of eggs/female
Nagpur mandarin	19.5 (4.14) a	568 (23.81)ab
Acid lime	17.8 (3.99)c	409 (20.95)c
Sweet Orange	16.0 (4.22)b	440 (20.20)cd
Curry leaf	18.8 (4.33)ab	605 (24.57)a
Wood apple	13.8 (3.71)d	366 (19.10)d
Orange jasmine	16.5 (4.06)c	544 (23.30)b
CD (0.05)	0.19	1.12
CV	0.14	4.3

* Values followed by same letter in a column are not significantly different (P=0.05).

Table 3. Survival (%) of different stages of citrus psylla on different host plants

Host Plant	% survival			
	Eggs	Nymphs	Adults	From Egg To Adult
Nagpur mandarin, <i>Citrus reticulata</i> Blanco	88.18 (69.97)a	69.75 (56.94) ab	87.99 (70.42) ab	54.14 (47.44)a
Sweet Orange, <i>Citrus sinensis</i>	86.67 (68.76)ab	64.47 (53.32)abc	83.75 (66.90)bc	47.03 (43.38)b
Acid Lime, <i>Citrus aurantifolia</i>	80.37 (63.72)c	66.84 (54.97)ab	80.83 (64.04) cd	43.39 (41.18)b
Curry leaf, <i>Murraya koenigi</i>	86.94 (69.66)a	72.65 (58.50) a	91.51 (73.43) a	56.45 (48.77)a
Wood apple, <i>Feronia limonia</i>	72.26 (58.31)d	58.03 (48.88)c	74.86 (59.99)d	31.30 (34.00)c
Orange Jasmin, <i>Murraya paniculata</i>	83.11 (65.81)bc	60.58 (48.88) bc	83.91 (66.51)bc	42.11 (40.45)b
CD (0.05)	3.44	5.26	4.84	5.43
CV	4.39	8.16	6.09	4.01

* Values followed by same letter in a column are not significantly different (P=0.05).

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