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REPRODUCTIVE INTERPRETATION OF SOME *BREVIPALPUS* SPECIES ON TWO TEMPERATURES DEGREE, USING LIFE TABLE PARAMETERS

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ABSTRACT

Genus *Brevipalpus* is considered one of the most important genera that belong to family Tenuipalpidae Berlese. In Egypt, *Brevipalpus* includes seven species solely, five of them are attacking citrus trees. *B. phoenicis, B. californicus* and *B. noranae* are the most dominant on Egyptian citrus. A pure culture of the three specieswere propagated on leaves of Common Navel orange variety. The mentioned species were studied at two different temperatures (25 and 30°C ± 2°C and 70 ± 5% R.H.). The obtained results enable us to conclude that between the three species of genus *Brevipalpus*, the citrus fruit most appropriate for the development of *B. noranae*, since the mite presents a reduced embryonic and post-embryonic period. The citrus fruit also provides the highest values of specific fertility, survival and of the intrinsic increase rate (rm), which indicates it as being a better suitable host for the mite which provide *B. noranae* to establish and rapid spread.

Keywords: *Brevipalpus phoenicis, Brevipalpus californicus, Brevipalpus noranae*, Navel orange variety, life table

INTRODUCTION

Genus *Brevipalpus* is considered one of the most important genera that belong to family Tenuipalpidae Berlese. Members of the genus *Brevipalpus* are phytophagous and some are serious pests of crop and ornamental plants in the world (Jeppson *et al*., 1975, Evan *et al.,* 1993). Ten species of Brevipalpus have been identified on citrus worldwide and include: *B. amicus* Chaudhri, *B. californicus* (Banks), *B. Chilensis* Baker, *B. karachiensis* Chaudhri, Akbar and Rasool, *B. lewisi* (McGregor) , *B. mcgregori* Baker, *B. obovatus* Donnadieu , *B. phoincis* (Geijskes), *B. rugulosus* Chaudhri, Akbar and Rasool and *B. tinsukiaensis* Sadena and Gupta. (Childers *et al*., 2001). The sight of infestation caused by these species are similar which are chlorosis, blistering, bronzing, or necrotic areas on leaves and fruits (Ochoa *et al*., 1994; Kitajima *et al*., 1996; Chagas *et al*., 2001; Childers *et al*., 2001; Hele *et al*., 2005; Chigira & Miura, 2005). Fortunately, only five species from genus *Brevipalpus* which are *B. californicus, B. lewisi, B. obovatus, B. phoincis* and *B. noranae* have been recorded on Egyptian citrus. (Halawa and Fawzy 2014). Developmental rates are strongly influenced by mite species, temperature, relative humidity, and host plant.

Unfertilized eggs produce only females because of these species are parthenogenetic. The temperature and humidity affected on the duration of different life stages, while the humidity below 30% is critical point for the flat mite that causes incomplete its development of life cycle. (Haramoto, 1969).

Therefore, the objective of this work is to evaluate the reproductive performance of *B. phoenicis, B. californicus* and *B. noranae* as the dominant species on Egyptian citrus in two successive parameters at temperature 25°C and 30°C from the parameters calculated from the fertility life table and biology.

MATERIALS AND METHODS

A pure culture of *B. phoenicis, B. californicus* and *B. noranae* were propagated on leaves of common Navel orange variety. Leaf discs of about one-inch in diameter were made and washed with running water to remove any possible residuals or mites which may be found on these leaves. The leaf discs were surrounded by tangle foot, which acts as a barrier to prevent mite individuals from escaping and placed on pieces of moisten cotton wool in Petri dishes of 10cm diameter, and then a couple (male and female of mite) was placed on each disc, on the lower surface of the leaf. The Petri dishes were kept at two different temperatures (25 and 30°C ± 2°C and 70 ± 5% R.H.), for 24 hours to allow mating process between male and female. Thereafter, males were removed, while females served as a source for known-age eggs, which in turn produced known-age larvae. The moisture was kept constant by adding few drops of water to the cotton wool. Hatching larvae were transferred and kept singly to leaf discs and left to continue their life span. Life history parameters - Parameters were obtained by survival data (lx) in relation to age (x) and specific fertility (mx) of 29 individualized females in citric fruits and 23 individualized females in coffee leaves (repetitions). Only females were used because *B. phoenicis* reproduces mainly by deuterotokous parthenogenesis, where non-fertilized eggs can produce either females or males. The experiments were evaluated daily at 5 h p.m. by counting the number of dead mites and oviposition until the death of all females. The sex ratio, that indicates the proportion of females, was calculated by the quotient between the number of females and the number of females added with the number of males.

Fertility life table - The fertility life table was made starting from the survival rate and specific fertility obtained from parameters of the life history and sex ratio (Birch, 1948; Dinh *et al.,* 1988). Using the data from the life table, calculations were made for the net reproduction rate (R_o) or the number of times that the population increased in each generation ($R_o = \sum m_x.l_x$) and the intrinsic rate of increase (rm) which expresses the number of females added to the population per female per day by the Lotka equation (Carey, 1993):

RESULTS AND DISCUSSION

The duration of males and females of citrus flat mites, *B. phoenicis, B. californicus* and *B. noranae* reared on leaves of Navel orange at temperature degrees 25 and 70 % R.H were recorded in tables (1). The obtained data in table (1) showed that the biological aspects of *B. noranae*, *B. phoenicis* and *B. californicus* were varied.

The citrus flat mite**,** *B. phoenicis* recorded longest incubation period to reach 8.00 day while *B. noranae* and *B. californicus* were shortest incubation period which were 6.06 and 7.05 days, respectively. Simultaneously, the life cycle of *B. phoenicis* showed longest period to reach 24.33, while *B. noranae* and *B. californicus* were shortest in life cycle which were 17.72 and 21.57 days, respectively. On contrary, the oviposition recorded longest period for *B. noranae* to reach 11.61 days, while *B. phoenicis* and *B. californicus* were shortest in oviposition period which were 9.36 and 11.45 days, respectively. Simultaneously, the fecundity of *B. noranae* increased in numbers of mites to reach 17.45 while *B. phoenicis* and *B. californicus* were decreased in numbers of mites which were 11.67and 16.71 days, respectively. The life spam of *B. phoenicis* recorded longest to reach 40.48 day while *B. noranae* and *B. californicus* were shortest life span which were 33.85 and 38.60 days, respectively.

The duration of males and females of citrus flat mites, *B. phoenicis, B. californicus* and *B. noranae* reared on leaves of Navel orange at temperature degrees 30 and 70 % R.H were recorded in tables (2). The obtained data in table (2) showed that the biological aspects of *B. noranae, B. phoenicis* and *B. californicus* were affected by rising temperature degrees which cause the duration periods becoming shortest unlike the obtained data at temperature 25° and 70% R.H.

The duration of males and females of citrus flat mites, *B. phoenicis, B. californicus* and *B. noranae* reared on leaves of Navel orange at temperature degrees 30 and 70 % R.H were recorded in tables (2). The obtained data in table (2) showed that the biological aspects of *B. noranae*, *B. phoenicis* and *B. californicus* were varied.
The citrus flat mite**,** *B. californicus* recorded longest incubation period to reach 7.05 day while *B. noranae* and *B. phoenicis* were shortest incubation period which were 4.03 and 6.10 days, respectively. Simultaneously, the life

Table 1. Average duration of life cycle, longevity and live span of *B. phoenicis, B. phoenicis* and *B. californicus* on Navel orange variety at two temperatures degrees (25°C and 70 ± 5% R.H.

Duration	*B. noranae* / day	*B. phoenicis* / day	*B. californicus* / day
incubation period	6.06	8.00	7.05
Active larvae	3.01	4.80	4.16
Quiescent larvae	0.95	0.87	0.76
Active protonymph	3.07	4.90	4.00
Quiescent protonymph	0.90	0.89	0.80
Active deutonymph	3.04	4.09	4.05
Quiescent deutonymph	0.68	0.77	0.75
Total immature	11.65	16.33	14.52
Life cycle	17.72	24.33	21.57
Generation	19.22	26.03	22.99
Pre-oviposition	1.50	1.70	1.42
Oviposition	11.61	9.36	11.45
Post-oviposition	3.01	5.09	4.15
Longevity	16.13	16.15	17.03
Fecundity	17.45	11.67	16.71
daily rat	1.50	1.25	1.46
live span	33.85	40.48	38.60

Table 2. Average duration of life cycle, longevity and live span of *B. phoenicis, B. phoenicis* and *B. californicus* on Navel orange variety at two temperatures degrees (30°C and 70 ± 5% R.H.

Duration	*B. noranae* / day	*B. phoenicis* / day	*B. californicus* / day
incubation period	4.03	6.10	7.05
Active larvae	2.04	3.11	4.16
Quiescent larvae	0.76	0.77	0.76
Active protonymph	2.56	4.15	4.00
Quiescent protonymph	0.60	0.76	0.80
Active deutonymph	2.04	3.41	4.05
Quiescent deutonymph	0.68	0.75	0.75
Total immature	8.68	12.80	14.52
Life cycle	12.71	18.90	21.57
Generation	13.82	20.57	23.00
Pre-oviposition	1.10	1.67	1.42
Oviposition	11.61	7.65	11.45
Post-oviposition	1.94	4.35	4.15
Longevity	14.66	13.67	17.03
Fecundity	23.95	16.71	16.71
daily rat	2.06	2.20	1.46
live span	27.38	32.57	38.60

Table (3): Life table parameters of *B. phoenicis, B. phoenicis* and *B. californicus* reared on Navel orange at 25 ± 2ºC and 70 ± 5% R.H.

Prey	Mean generation time	Net reproductive rate	Intrinsic rate of natural
	(T, days)	(Ro)	increase (r_m /day)
B. phoencis	15.75	7.51	0.128
B. californicus	18.19	10.26	0.128
B. noranae	17.62	9.70	0.129

Table (4): Life table parameters of *B. phoenicis, B. phoenicis* and *B. californicus* reared on Navel orange at 30 ± 2ºC and 70 ± 5% R.H.

Prey	Mean generation time	Net reproductive rate	Intrinsic rate of natural
	(T, days)	(Ro)	increase (r_m /day)
B. phoenicis	17.24	8.93	0.127
B. californicus	19.60	12.05	0.127
B. noranae	17.37	9.40	0.129

cycle of *B. californicus* showed longest period to reach 21.57, while *B. noranae* and *B. phoenicis* were shortest in life cycle which were 12.71 and 18.90 days, respectively. On contrary, the oviposition recorded longest period for *B. noranae* to reach 11.61 days, while *B. phoenicis* and *B. californicus* were shortest in oviposition period which were 7.65 and 11.45 days, respectively. Simultaneously, the fecundity of *B. noranae* increased in numbers of mites to reach 23.95 while *B. phoenicis* and *B. californicus* were decreased in numbers of mites which were 16.71 and 16.71 days, respectively. The life spam of *B. californicus* recorded longest to reach 38.6 day while *B. noranae* and *B. phoenicis* were shortest life span which were 27.38 and 32.57days, respectively.

The life table parameters of citrus flat mites, *B. phoenicis, B. noranae* and *B. californicus* reared on leaves of Navel orange at temperature degrees 25 and 70 % R.H were recorded in tables (3). The intrinsic rate of the population increase (rm) were estimated at 0.128, 0.128 and 0.129 females/female/day for *B. phoenicis*, *B. californicus* and *B. noranae*, respectively. In addition, the average duration period of a generation (T) was shortest for *B. phoenicis* 15.75 days than for *B. californicus* and *B. noranae* which were 18.19 and 17.62 days, respectively. Simultaneously, the net reproductive rate (Ro) was shortest for *B. phoenicis* reached 7.51 days than for *B. californicus* and *B. noranae* which were 10.26 and 9.70 days, respectively.

The life table parameters of citrus flat mites, *B. phoenicis, B. noranae* and *B. californicus* reared on leaves of Navel orange at temperature degrees 30°C and 70 % R.H were recorded in tables (4). The intrinsic rate of the population increase (rm) were estimated at 0.127, 0.127 and 0.129 females/female/day for *B. phoenicis*, *B. californicus* and *B. noranae*, respectively. In addition, the average duration period of a generation (T) was shortest for *B. phoenicis* 17.24 days than for *B. californicus* and *B. noranae* which were 19.60 and 17.37 days, respectively. Simultaneously, the net reproductive rate (Ro) was shortest for *B. phoenicis* reached 8.93 days than for *B. californicus* and *B. noranae* which were 12.05 and 9.40 days, respectively.

This study evaluates the effect of different temperatures on reproductive parameters of three main three citrus flat mites *B. phoenicis, B. noranae* and *B. californicus*. As shown in our research, Although the incubation period of *B. californicus* was not affected by increasing temperature, *B. noranae* and *B. phoenicis* were affected by increasing temperature from 25 to 30°C to become shorter from 6.06 and 8.00 days to reach 4.03 and 6.10 days, respectively. Simultaneously, the life cycle of *B. californicus* was not affected by increasing temperature from 25 to 30°C to reach 21.57 days, *B. noranae* and *B. phoenicis* were affected by increasing temperature to become shorter from 17.72 and 24.33 days to reach 12.71 and 18.9 days, respectively. On contrary, Although the increasing temperature did not provide any effect on oviposition period of *B. noranae* and *B. californicus, B. phoenicis* was affected by increasing temperature to become shorter from 9.36 and 7.65 days. Our data shows that *B. phoenicis and B. noranae* were significantly affected with increasing temperature over incubation period, life cycle and oviposition period unlike *B. californicus* which was negatively affected by increasing temperature, this may be resulted by presence a cryptic types within *B. californicus* which are type 1, 2 and 3, which did not specify in this study based on Childers & Rodrigues study in 2011 .

In fact, this data doesn't provide a realistic fact of the stability and spread of *B. noranae, B. phoenicis* and *B. californicus* on citrus trees. Therefore, the evaluation based on the life table parameter as far as it is a key in developing an integrated pest management strategy (Naseri *et al.,* 2011). In addition, for what can provide a comprehensive description of the survival, fecundity and fertility of the pest populations. This study clearly shows that temperature had a great effect on the reproductive parameters of citrus flat mites (Vargas *et al.,* 2000) .

From Life table parameters (table 3 and 4), Our results revealed that the optimum temperature for net and gross fecundity and fertility rates of citrus flat mite is around 25˚C.

The Intrinsic rate of natural increase (rm /day) was higher at temperature 25°C which reached 0.128, 0.128, 0.129 unlike 0.127, 0.127, 0.129 at temperature 30°C for *B. phoenicis, B. californicus and B. noranae*, respectively. Simultaneously, The Intrinsic rate of natural increase (rm /day) was higher by *B. noranae* which reached 0.129 unlike *B. phoenicis, B. californicus* which reached 0.128 and 0.128 at temperature 30°C and 0.127 and 0.127 at temperature 25°C, respectively. This maybe provide a conclusion that citrus trees are more suitable for *B. noranae* to establish and rapid spread. In addition, this can be providing an explanation of the reasons for first record of *B. noranae* in India Jalilirad *et al*., (2013), lately from the date of first description by Halawa and Fawzy 2014.

CONCLUSION

The obtained results enable us to conclude that between the three species of genus *Brevipalpus*, the citrus fruit most appropriate for the development of *B. noranae*, since the mite presents a reduced embryonic and post-embryonic period. Citric fruit also provides the highest values of specific fertility, survival and of the intrinsic increase rate (rm), which indicates it as being a better suitable host for the mite which provide *B. noranae* to establish and rapid spread.

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