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## Biology and life table studies of predatory mite, *Neoseiulus longispinosus* (Evans) on *Tetranychus urticae* Koch multiplied on pole bean (*Phaseolus vulgaris* L.)

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### Abstract

Investigations were carried out on the biology and life table studies of *Neoseiulus longispinosus* (Evans) on *Tetranychus urticae* Koch reared on pole bean. Among five temperatures studied total developmental time from egg to adult for *N. longispinosus* females and males in the laboratory was lowest at 28 °C (100.41 h) and 97.30 h, respectively and was highest at 36 °C (114.43 h) and 106.3 h, respectively. The mean generation time (T) was 14.31 days, male to female ratio in the progeny was 1:3.11, the Intrinsic rate of natural increase ( $r_m$ ) was 0.23, the finite rate of increase ( $\lambda$ ) was 0.10, the female adult longevity was 22.55 days while  $R_0$ , the number of female offspring's per female per generation was 28.77.

**Keywords:** Biology, life table, pole bean, *Neoseiulus longispinosus*, *Tetranychus urticae*

### Introduction

Mites, belonging to the subclass Acari of the class Arachnida, are very diverse with worldwide distribution inhabiting all types of terrestrial and aquatic habitats. 54,000 species of mites have been described so far which may be classified as phytophagous, predatory, parasitic, saprophytic and detritivorous on the basis of their feeding behaviour.

Among phytophagous mites two-spotted spider mite (TSSM) *Tetranychus urticae* Koch (Acari: Tetranychidae) is an extremely polyphagous mite that has been reported feeding on many economically important agricultural and ornamental plants. It feeds on more than 1000 plant species of which about 150 plant species have a very high economic value. It is a major pest of annual and perennial field crops including cotton, okra, papaya and others (Bolland *et al.*, 1998; Jeppson *et al.*, 1975) <sup>[1, 2]</sup>. It is also one of the major pests of greenhouse vegetable and ornamental crops. This mite affects crops by direct feeding, thereby reducing the area available for photosynthetic activity and if infestation is severe may cause defoliation (Leeuwen *et al.*, 2005) <sup>[3]</sup>.

The most common method of control of *T. urticae* is by using chemicals. A major problem in the control of *T. urticae* by chemicals is the mite's ability to develop resistance rapidly after a few applications (Stumpf *et al.*, 2001) <sup>[4]</sup>. In addition, intense and continuous use of chemicals causes environmental pollution and disruption of ecological balance. To overcome these limitations it is essential to go for alternative methods for controlling this mite. Utilization of natural enemies of mites especially the use of predatory mites is a better alternative and is much safer to the environment. Among the predatory mites, the members of the family Phytoseiidae are the most promising ones, since they have shorter life cycle and they can be mass produced fairly easily (Gerson *et al.*, 2003; McMurtry *et al.*, 2013) <sup>[5, 6]</sup>. More than 2700 phytoseiid mite species are known in the world (Demite *et al.*, 2016) <sup>[7]</sup> and about 189 species from India (Chinnamade Gowda, 2009) <sup>[8]</sup>. Among phytoseiids, *Neoseiulus longispinosus* (Evans) is the most potential obligate predator of many tetranychid mites in India (Mallik and Channabasavanna, 1983) <sup>[9]</sup>. This has been reported on a wide range of fruit crops, field crops and ornamentals. Keeping this in view, the present investigation was carried out.

### Material and Methods

#### Maintenance of the host plant, pole bean in polycarbonate house

The pole bean variety Classic NZ was sown in 12" diameter earthen pots in the polycarbonate house. Recommended dosages of FYM and fertilizer were supplied to these plants and the plants were watered as and when required to maintain optimum moisture in the pots. The pole bean plants were allowed to grow and the leaves from these plants were used for biology and life table house was staggered sown every 15 days in order to ensure continuous availability of pole bean leaves for biology and life table studies in the laboratory.

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### Maintenance of *N. longispinosus* on *T. urticae* cultured in the laboratory

Predatory mite *N. longispinosus* and its prey *T. urticae* were collected from field from different places in Bengaluru and surrounding places like GKVK campus, Sadahalli and Jangama kote on different crops. These mites were reared on excised mulberry leaves, kept on moist cotton wads placed in Petri plates in the laboratory and mites were allowed to lay eggs and colonize for 10-15 days. Later, both adult female and male mites were picked randomly from each leaf and they were mounted on the glass slides separately for species confirmation. After confirming the species the leaf with the spider mite species *T. urticae* and predatory mite, *N. longispinosus* were pooled and used as a starter culture for further use. The mulberry leaf bits were maintained in turgid condition by watering daily and leaf bits were replaced with fresh leaf bits periodically.

### Biology of *N. longispinosus* on *T. urticae* in the laboratory

Biology of *N. longispinosus* was studied in the laboratory at five different temperatures viz., lab temperature (25-26 °C), 24 °C, 28 °C, 32 °C and 36 °C on pole bean (*Phaseolus vulgaris* L.) infested with *T. urticae*. For this study pole bean leaves from plants maintained in the polycarbonate house were used. The pole bean leaves were cut into bits of one sq. inch and 40 such bits were arranged on cotton wad/foam in the Petri plates. On each leaf bit, ten mated females of *T. urticae* were released and were allowed to lay eggs for 24 h. After getting sufficient number of eggs after 24 h, on each leaf bit one freshly laid predatory mite egg was transferred and allowed to develop. After transferring the predatory mite eggs, the Petri plates were kept in an incubator set at desired temperature. The observations were recorded every three hours using Zeiss Stemi 2000C stereo zoom microscope to record growth and development of predatory mites. The time taken for development like incubation period, larva, protonymph and deutonymph were recorded. Care was taken to maintain the cotton wad/foam wet by watering as and when required.

### Life table of *Neoseiulus longispinosus* (Evans) on *T. urticae* in the laboratory

Life table of predatory mite *N. longispinosus* was studied in the laboratory on pole bean infested with *T. urticae* at lab temperature (25-26 °C). For this study the detached leaves of pole bean plants maintained in the polycarbonate house were used. The pole bean leaves were cut into pieces of 2 sq. inch size, 40 such leaf pieces were arranged on wet foam sheets in plastic trays). On each leaf bit, ten mated females of *T. urticae* were released and were allowed to lay eggs for 48 h. After 48 h, on each leaf bit, a single freshly emerged adult female predatory mite along with two males were released to ensure mating. Daily egg laying by these female predatory mites was recorded and these eggs were transferred to fresh leaf bits containing prey mites every day. Daily egg laying records were maintained for all the 40 females, till they ceased to lay eggs and died naturally. The predatory mite eggs were allowed to hatch and develop into adults by feeding on *T. urticae* on pole bean leaves. The adults that developed were sexed, the number of males and females were recorded and the sex ratio worked out. During this study, the predatory mites were transferred to fresh leaf bits with Tetranychid mites once every three days or as and when the leaf bits went dry or turned yellow, in order to ensure the availability of adequate food to the developing predatory mites. Following observations were recorded viz., Daily egg laying by each female predatory mite, oviposition

period, female longevity, no. of eggs hatched of each female, no. of larvae develop into adults, no. of females emerge out of the eggs of each female and the sex ratio in the progeny of the predatory mite.

Different life table parameters were computed by following the methods suggested by South wood (1978) <sup>[10]</sup> and Taylor (1988) <sup>[11]</sup>.

The data were tabulated as follows:

$l_x$  = Proportion of females alive at age interval  $x$

$m_x$  = The number of female offsprings produced per surviving female at the age interval ( $x$ )

$l_x m_x$  = The number of female offsprings produced per original female at the age interval ( $x$ )

1. The net reproductive rate ( $R_0$ ) = The average number of new born females produced by a female during its entire life time. This was calculated as below

$$R_0 = \sum l_x m_x$$

2. Mean generation time ( $T$ ) was calculated using the formula

$$T = \frac{(\sum x \cdot l_x m_x)}{R_0}$$

3. The finite rate of increase ( $\lambda$ ) was calculated using the formula

$$\lambda = \frac{\log_e R_0}{T}$$

Where,  $R_0$  and  $T$  are specifically defined.

4. The intrinsic rate of increase ( $r_m$ ) was calculated from the data on survival and fecundity of individuals of known age. This was calculated using the formula

$$r_m = \ln \lambda$$

## Results

### Biology of *N. longispinosus* on pole bean

Biology of *N. longispinosus* was studied in the laboratory at five different temperatures on pole bean leaves infested with *T. urticae*. Observations recorded on the duration of life stages of *N. longispinosus* females on pole bean are presented in Table 1. It is evident that the lowest time taken by *N. longispinosus* for completing its development from egg to adult was at 28 °C. At this temperature, the time for incubation, larval, protonymphal and deutonymphal stages was 46.88, 12, 20.37 and 21.16 h, respectively. The maximum time taken by *N. longispinosus* female for completing its development from egg to adult was at 36 °C. At this temperature, incubation, larval, protonymphal and deutonymphal stages was 56.49, 13.50, 21.56 and 22.88 h, respectively. The total time taken for development from egg to adult by females of *N. longispinosus* was 100.41 h at 28 °C which was the lowest and this was on par with the total duration recorded at 32 °C (101.25 h), 24 °C (102.62 h) and at lab temperature (103.98). The maximum time taken for total development of female (114.43 h) was at 36 °C temperature, which was significantly higher than the duration of development at 24 °C, 28 °C, 32 °C and laboratory temperature.

The data recorded on the duration of life stages of *N. longispinosus* male on pole bean are given in Table 2. The least time taken by *N. longispinosus* male for completing development from egg to adult was at 28 °C (97.3 h). At this temperature, the time for incubation, larval, protonymphal and deutonymphal stages was 44.8, 12, 19.5 and 21 h, respectively. The maximum time taken by *N. longispinosus* males for completing development from egg to adult was at 36 °C. At this temperature, the time for incubation period, larval, protonymphal and deutonymphal stages was 49.3, 13.5, 21 and 22.5 h, respectively. The total time for development from egg to adult by male was 97.3 h at 28 °C, which was the lowest and on par with development at 24 °C (99.70 h), lab temperature (99.75 h) and at 32 °C (99.93 h). The maximum time for development of male was 106.3 h at 36 °C, which was significantly higher than the development at all other temperatures (Table 2).

Mean development of *N. longispinosus* (female & male) is presented in Table 3. At 28 °C *N. longispinosus* completed the life cycle in a shortest period of 100.11 h, with incubation, larval, protonymphal and deutonymphal duration of 46.68, 12,

20.29 and 21.14 h, respectively; this was on par with developmental time at 32 °C (100.90 h), 24 °C (102.08 h) and lab temperature (102.83 h). The longest time for total development was at 36 °C (113.52 h), significantly more than the developmental time at 24 °C, 28 °C, 32 °C and lab temperature.

#### Life table studies of *N. longispinosus* on *T. urticae* on pole bean

The life table parameters of *N. longispinosus* on *T. urticae* on pole bean viz., Oviposition by *N. longispinosus* females reached peak, eleven days after emergence and each female laid an average 27.78 eggs. The Intrinsic rate of natural increase ( $r_m$ ) was 0.23, while  $R_o$ , the number of female offsprings per female per generation was 28.77. The finite rate of increase ( $\lambda$ ) was 0.10. The mean generation time (T) was 14.31 days. The pre-oviposition period was 24.9 h. Oviposition period of mated females was 21.17 days while the post oviposition period was only 1.38 days. Male to female ratio in the resulting progeny was 1:3.11. The female longevity was 22.55 days.

**Table 1:** Development of *N. longispinosus* female on *T. urticae* reared on pole bean leaves at different temperatures

Temperature	Duration of development (h)				
	Egg	Larva	Protonymph	Deutonymph	Total development
Lab temp (25-26 °C) (n=29)	50.3 ± 1.55	12 ± 0.0	20.79 ± 0.77	20.89 ± 0.97	103.98 ± 2.13
24 °C (n=22)	47.66 ± 1.78	12.27 ± 0.88	20.59 ± 1.05	22.09 ± 1.48	102.62 ± 2.77
28 °C (n=19)	46.88 ± 1.30	12 ± 1.41	20.37 ± 1.26	21.16 ± 1.21	100.41 ± 3.03
32 °C (n=22)	47.12 ± 1.89	12.68 ± 1.29	20.32 ± 1.29	21.14 ± 0.64	101.25 ± 2.34
36 °C (n=16)	56.49 ± 2.99	13.50 ± 1.55	21.56 ± 1.63	22.88 ± 1.50	114.43 ± 1.50

**Table 2:** Development of *N. longispinosus* male on *T. urticae* reared on pole bean leaves at different temperatures

Temperature	Duration of development (h)				
	Egg	Larva	Protonymph	Deutonymph	Total development
Lab temp (25-26 °C) (n=29)	46.3 ± 1.34	12 ± 0.00	20.73 ± 0.90	20.73 ± 0.90	99.75 ± 1.21
24 °C (n=22)	46.3 ± 2.12	12 ± 0.00	20.4 ± 1.34	21 ± 0.00	99.7 ± 3.29
28 °C (n=19)	44.8 ± 2.12	12 ± 0.00	19.5 ± 2.12	21 ± 0.00	97.3 ± 0.00
32 °C (n=22)	46.68 ± 1.92	12 ± 0.00	20.25 ± 1.39	21 ± 0.00	99.93 ± 1.92
36 °C (n=16)	49.3 ± 4.23	13.5 ± 2.12	21.0 ± 0.00	22.5 ± 2.12	106.3 ± 4.24

#### Discussion

The total developmental period for females (100.41 to 114.43 h) and males (97.3 to 106.3 h) recorded in the present study is slightly more than the developmental time reported by Mallik and Channabasavanna (1983) [9], who recorded 99 h for females and 95 h 30 min for males. This difference is attributed to the host plant (FB) and prey mite species *T. ludeni* used by them. The total developmental period from egg to adult of *N. longispinosus* (females + males) at 24 °C (102.08 h) and 28 °C (100.11 h) recorded in the present study are comparable to the total developmental period recorded by Ibrahim and Palacio (1994) (102.50 h) for both the sexes at 25-28 °C. The total development period of 4.25 days for both sexes at 24 °C recorded in present study was low compared to Madruga *et al.* (2012) [13] who observed under laboratory condition at 24.34 ± 2.90 °C the average development period of about seven days. Thongtab *et al.* (2001) [14] observed that the total developmental period of *N. longispinosus*, fed on *Eotetranychus candanai* Rimando was 4.79 ± 0.61 days from egg to adult compared to 4.28 ± 2.71 days recorded in the present study. The difference in the developmental period observed in these studies could be attributed to prey mite species. Chauhan *et al.* (2010) [15] studied the development of *A. (=N.) longispinosus* on *T. urticae* on rose under laboratory conditions at 18.4-22.7 °C & 20-91 % RH and found that the egg to adult development duration was 8.8 days. The lower

developmental duration recorded in the present study could be attributed to the differences in the host plant.

Hariyappa and Kulkarni (1988) [16] conducted studies on the biology of *A. (=N.) longispinosus* on *Polyphagotarsonemus latus* (Banks) at 23-27 °C and 65-70 % RH and recorded that the mean durations of the egg, larval, protonymphal and deutonymphal stages were 45.67, 14.27, 23.18 and 24.41 h, respectively in females and the respective durations in males were 46.45, 14.10, 2.78 and 22.71 h. The female and male developmental duration recorded in the present study at 24 and 28 °C was almost comparable with the results of this study.

The mean generation time (14.31 days) and female longevity (22.55 days) were lower and net reproductive rate (28.77) and intrinsic rate of natural increase (0.23) were higher in the present study than reported by Rahman *et al.* (2013) [17] for the predatory mite *N. longispinosus* reared on the red spider mite, *Oligonychus coffeae* (Nietner). The higher temperature (30 °C) in their studies may be one of the causes for lower values of the above parameters. The difference in temperature has had an influence on the mean generation time, which in turn influenced other parameters.

The range in  $r_m$  values of predator recorded in the present study (0.23) is in line with the  $r_m$  values of *N. longispinosus* on *Panonychus citri* (McGregor) by Puspitarini (2010) [18] (0.25), whereas, Kongjarean (2006) [19] observed lowest  $r_m$  values of 0.128 on *T. truncatus* and Rachman and Yanti (2012) [20]

recorded the highest  $r_m$  values of 0.44. The differences in these values in the present study could be attributed to the differences in rearing temperature and RH in the laboratory and also the differences in the host plants and prey.

## References

- Bolland HR, Gutierrez J, Flechtmann CHW. World Catalogue of the Spider Mite Family (Acari: Tetranychidae), with references to taxonomy, synonymy, host plants and distribution. Leiden: Brill Academic Publishers, 1998, 392.
- Jeppson LR, Keifer HH, Baker EW. Mites injurious to economic plants. Berkeley: University of California Press, Berkeley, USA, 1975, 614pp.
- Leeuwen TV, Pottelberge SV, Tirry L. Comparative susceptibility and detoxifying enzyme activities in field collected resistant and susceptible strains of *Tetranychus urticae*. Pest Management Science. 2005; 61(5):499-507.
- Stumpf N, Zebitz CPW, Kraus W, Moores GD, Nauen R. Resistance to organophosphates and biochemical genotyping of acetylcholinesterase's in *Tetranychus urticae* (Acari: Tetranychidae). Pesticide Biochemistry and Physiology. 2001; 69(2):131-142.
- Gerson U, Smiley RL, Ochoa R. Mites (Acari) for Pest Control. Blackwell Science Ltd, Cambridge, 2003, 539 pp.
- Mcmurtry JA, Moraes GJD, Sourassou NF. Revision of the life styles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. Systematic and Applied Acarology. 2013; 18:297-320.
- Demite PR, Moraes GJD, Mcmurtry JA, Denmark HA, Castilho, R. C., Phytoseiidae Database. Available from, 2016. [www.lea.esalq.usp.br/phytoseiidae](http://www.lea.esalq.usp.br/phytoseiidae).
- Chinnamadegowda C. Fauna of Phytoseiid Mites (Acari: Phytoseiidae) associated with plants in Southern Karnataka. Ph. D. Thesis, University of Agricultural Sciences, Bangalore, 2009, 208.
- Mallik B, Channabasavanna GP. Life history and life tables of *Tetranychus ludeni* and its predator *Amblyseius longispinosus* (Acari: Tetranychidae: Phytoseiidae). Indian Journal of acarology. 1983; 8:1-12.
- Southwood TRE. Ecological methods. The English Language Book Society and Chapman and Hall, 1978, 524.
- Taylor MFJ. Field measurement of the dependence of life history on plant nitrogen and temperature for an herbivorous moth. Journal of Animal Ecology. 1988; 57:873-891.
- Ibrahim YB, Palacio VB. Life history and demography of the predatory mite, *Amblyseius longispinosus* Evans. Experimental and Applied Acarology. 1994; 18:361-369.
- Madruga YP, Alonso-Rodríguez D, Chico R, Rodriguez H. Biology and feeding behaviour of *Neoseiulus longispinosus* (Evans) on *Tetranychus tumidus*. Revista De Proteccion Vegetal. 2012; 27(3):174-180.
- Thongtab T, Chandrapaty AA, Baker GT. Biology and efficacy of the predatory mite, *Amblyseius longispinosus* (Evans) (Acari Phytoseiidae) as a biological control agent of *Eotetranychus cendanai* Rimando (Acari: Tetranychidae). Journal of Applied Entomology. 2001; 125:543-549.
- Chauhan U, Ram Kumar, Thakur M. Winter survival and reproduction of *Amblyseius longispinosus* (Acari: Phytoseiidae), a potential predator of spider mites on roses in Himachal Pradesh, India. Trends in Acarology, 2010, 435-437.
- Hariyappa AS, Kulkarni KA. Biology and feeding efficiency of the predatory mite *Amblyseius longispinosus* (Evans) on chilli mite *Polyphagotarsonemus latus* (Banks). Journal of Biological Control. 1988; 2:131-132.
- Rahman VJ, Babu A, Roobakkumar A, Perumalsamy K. Life table and predation of *Neoseiulus longispinosus* (Acari: Phytoseiidae) on *Oligonychus coffeae* (Acari: Tetranychidae) infesting tea. Experimental and Applied Acarology. 2013; 60:229-240.
- Puspitarini RD. The Biology and Life Table of Predatory Mite *Amblyseius longispinosus* Evans (Acari: Phytoseiidae). The 8<sup>th</sup> International Symposium on Biocontrol and Biotechnology, Pattaya, Thailand, 2010.
- Kongjarean S. Efficiency of Predatory Mite, *Neoseiulus longispinosus* (Evans) (Acari: Phytoseiidae) for biological control of Broad Mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae). M.Sc. Thesis, Department of Entomology, the Graduate School, Kasetsart University, 2006, 58p.
- Rachman, Yanti MN. The Biology and Predation Rate of Predatory Mite, *Neoseiulus longispinosus* Evans (Acari: Phytoseiidae), on its Prey *Tetranychus kanzawai* Kishida (Acari: Tetranychidae). IPB (Bogor Agricultural University), 2012.