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# STUDY ON THE BIOLOGY OF PREDATORY MITE, *NEOSEIULUS LONGISPINOSUS* EVANS *FEEDING ON TETRANYCHUS URTICAE* KOCH

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## ABSTRACT

The biological parameters of *Neoseiulus longispinosus* feeding on *Tetranychus urticae* were examined at the IPM lab of Entomology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur following leaf disc method during March - April 2022 at 25±2$^0$C and 55±5% RH. Results revealed that the average incubation period for eggs were 2.37 days, whereas larval, protonymphal and deutonymphal average periods for male and female were 0.64 and 0.73days, 0.85 and 1.02 days, and 1.03 and 1.13 days, respectively. The total developmental period from egg to adult of predatory mite was 4.79 days for female and 4.09 days for male. Pre oviposition, oviposition and post oviposition periods were 2.25±0.06, 11.04±0.47 and 2.41±0.12 days, respectively. Morphometric measurement indicated that a gradual increase of female in size from larva to adult were larger than male. On an average female longevity was 14.74 days and male longevity was 18.12 days. Female averagely laid on 27.13±1.49 eggs in its life span when reared on *T. urticae* under laboratory conditions.

***Keywords*:**, Two spotted red spider mite, taro, protonymph, deutonymph, adult, longevity, fecundity, morphometric measurement.

## INTRODUCTION

Two spotted red spider mite, *Tetranychus urticae* (Tetranychidae: Prostigmata) has been an alarming pest on bean, brinjal, cotton, cucurbits and okra which build up from February and decline in July at north Indian conditions (Singh and Singh 1993). This has been reported on a wide range of fruit and field crops including ornamentals. This mite affects crops by direct feeding, thereby reducing the photosynthetic activity and if infestation becomes severe may cause defoliation.

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The most common method of controlling *T. urticae* is the application of chemical acaricides which results in rapid development of mite resistance only after a few applications (Stumpf *et al*. 2001). In addition, 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 safe for the environment. Among the predatory mites, the members of the family Phytoseiidae are the most promising ones because they have shorter life cycle and they can be mass produced fairly easily (McMurtry *et al.* 2013). Among phytoseiids, *Neoseiulus longispinosus* (Evans) is the most potential obligate predator of many tetranychid mites (Mallik and Channabasavanna 1983). The predatory mite *Neoseiulus longispinosus* (Evans) has been proved to be the most efficient in controlling spider mites in diverse crop ecosystems. It has a wide range of distribution and can adapt to hot temperatures within poly houses (Mallik *et al*. 1999). The use of commercially available predatory mites has gained popularity within the context of IPM programs as being one of the economically viable pest management methods (Vila and Cabello 2014, Van-Lenteren *et al*. 2018). So, there is ample scope to utilize *N. longispinosus* as a potential biocontrol agent for controlling *T. urticae* and it is possible with successful mass rearing followed by augmentative release. Biological performance of *Neoseiulus longispinosus* has been studied so far in India and worldwide (Huyen *et al.* 2017, Sharma *et al*. 2024). In most of the studies comparative data on different host species, effect of temperature etc. have been generated. Biology and life cycle of *N. longispinosus* have been studied on *T. urticae* mites in a scattered manner in different countries. However, so far it is known that its biology has not yet been studied in Bangladesh condition. For successful management of any pest by its predator, a thorough knowledge about biology of the concerned predator is necessary. Hence, it is imperative to study the biology of potential predatory mite *N. longispinosus* in Bangladesh condition for its possible inclusion in IPM programs.

In India, Madruga *et al.* (2012) observed the average development period of *N. longispinosus* about seven days under laboratory condition at 24.34 ± 2.90°C. Chauhan *et al.* (2010) studied the development of *N. longispinosus* on *T. urticae* on rose under laboratory conditions at 18.4-22.7°C and 20-91% RH and they found that the egg to adult development duration was 8.8 days.

Increased concern over adverse effects of the commonly used acaricides warrant the development of alternative management of mite pests. Documentation of biology of *N. longispinosus* could open up new scope for mass rearing and utilization of this predator in sustainable management of mite pests in Bangladesh. So keeping this in mind, an attempt was made to study the biology and fecundity of *N. longispinosus* on *T. urticae* infesting taro leaf under laboratory condition.

## MATERIALS AND METHODS

The development and life history traits of *N. longispinosus* were examined at Integrated Pest Management Laboratory in the Entomology Division, Bangladesh Agricultural Research Institute during March – April 2022 at 25±2$^0$ C and 55±5% RH.

**Maintenance of the host plant, taro in net house :** The taro plant was transplanted in 12'' dia plastic tub in the net house. Recommended dosages of farm yard manure (FYM) and fertilizer were applied to these plants and watering was done as and when required to maintain optimum moisture level in the taro-growing pots. The taro plants were allowed to grow and the *T. urticae* infested leaves from these plants were used to examine the biology of *N. longispinosus*. Taro plants were sown every 15 days interval in order to ensure continuous availability of taro leaves for biology study of *N. longispinosus* in the laboratory.

**Culturing of *T. urticae* and predatory mite :** Predatory mite *N. longispinosus* and its prey *T. urticae* were collected from different fields of Gazipur district and surrounding places. Taro plants were raised in pots for culturing *T. urticae*. Thirty-day old potted plants were inoculated with *T. urticae* with the help of camel hair brush or by keeping the already infested leaves on fresh plants in order to transfer the mites. Then, freshly potted plants were transferred beside the older plants at periodical intervals to transfer the mites from older one to fresh one so as to maintain the continuous culture of *T. urticae*. *N. longispinosus* adults collected along with the prey mites were transferred onto the taro leaves disc 4cm dia placed on plastic trays (30 × 10 × 5.5 cm) containing sponge of 1.5 cm thickness layered with the moist cotton pad. Water was added to the rearing unit as and when necessary to keep the cotton moist and thereby preventing

leaves from drying up. Gravid females of *N. longispinosus* along with prey mites *T. urticae* were examined for every 2 days to check the population of the predator. Whenever the predator population increased old leaves were cut into bits of 2 $cm^2$ and these bits were placed on a new taro leaf along with prey mites. The culture was maintained at 25 ± 2°C and 55 ± 5% RH and utilized for conducting laboratory experiments.

The biology of *N. longispionsus* was examined on taro leaves infested with *T. urticae*. The experimental arena included a Petri dish (15 cm dia) and moist foam. Moist foam was kept in each Petri dish and foam was kept moist by adding water to the rearing Petri dish as and when necessary to keep the foam moist and to prevent drying up of leaf bits and escape of the predators. Taro leaf bits (4×4 cm) were placed above the moist foam. Ten gravid females of *T. urticae* were kept on each leaf bit and allowed to lay eggs up to 24 hrs. After 24 hrs, *T. urticae* females were removed and a single-mated gravid female of *N. longispionsus* were released on each bit and allowed to lay eggs for 24 hrs. For this study, 1(one) egg of *N. longispionsus* was maintained on each leaf bit. Leaf bits and prey mites were replaced at 3 days interval. Different life stages of *N. longispionsus* were observed under stereo microscope at 3-5 hrs intervals until adult emergence. The time required to pass through different stages *viz.,* incubation, larval, protonymphal and deutonymphal periods were recorded under Olympus (SZ61) stereo zoom microscope.

Adult mites were sexed out and the development duration of different stages was recorded. Emerged males and females were maintained separately until death to determine their longevity. To study the reproductive biology of *N. longispionsus*, one female deutoymph of *N. longispionsus* was transferred to leaf bit with two adult males and allowed to mate after molting. Pre-oviposition, oviposition and post oviposition periods were recorded. The number of eggs laid by female was recorded until the death of the female. Daily oviposition rate, the average total number of eggs laid by each female (fecundity or fertility rate) was calculated. Fifteen replications were maintained for the study. The computations were performed in Microsoft Excel and values of developmental duration were expressed in mean± SE.

For morphometric measurement, different stages from egg to adult (15 of each stage) were randomly selected and length and width were recorded with the help of a standardized occular micrometer fitted to a digital camera equipped stereo zoom microscope and values expressed in mean ±SE (Standard Error).

## RESULTS AND DISCUSSION

The biology of *N. longispinosus* was examined in the laboratory on taro leaves infested with *T. urticae*. Observations recorded on the duration of life stages of *N. longispinosus* on taro leaf. The different stages of predatory mite and its developmental period were clearly distinguished. The life cycle of *N. longispinosus* consist of egg, larva, protonymph, deutonymph and adult (Fig. 1A, B, C, D, E, F). The morphological characteristics and developmental duration of different stages are presented in Table 1.

**Egg:** Eggs were oval in shape and transparent white in color, found to be laid singly or in groups near to the *T. urticae* infesting leaf surface and preferred the area closer to the midrib. Egg period ranged from 2.00 to 2.67 days with an average of 2.37 days.

**Larva:** The larva is hyaline, distinguished from other stages with three pairs of legs. It did not feed at this stage, lasted for short period of time. The mean larval period was recorded 0.64 days for male and 0.73 days for female.

**Protonymph:** Larva molted into protonymph and it was initially white to creamy in color, later changed into yellow to orange depending on prey consumption. The protonymph stage onwards, they become equipped with four pairs of legs, actively search for prey. On an average protonymphal period was 0.85 days for male and1.02 days for female.

**Deutonymph:** Deutonymph stage was confirmed with presence of exuviae of protonymph after molting. This stage was observed actively moving and feeding. Typical bright orange color was visible at this stage. It was slightly bigger and dark yellowish than protonymph. Female deutonymph was larger than male deutonymph. The mean deutonymph period was 1.03 days for male and 1.13 days for female.

A study was conducted by Ibrahim and Palacio (1994) who revealed that the development period of immature stages of *N. longispinosus* reared on *T. urticae* was approximately 0.65 days for larva, 0.87 days for protonymph and 0.95 days for deutonymph which are closer to the findings of the present study. This might be due to prevalence of more similar temperatures and relative humidity condition of both the studies.

**Adult:** The adult mite exhibit sexual dimorphism in color, shape and size. The shape of male was elongate. The hysterosoma of female was broadly round. The posterior part of the body of males was smaller than females and their colour remained yellowish throughout the life, whereas females were dark yellowish to reddish with transparent white spot on the centre of idiosoma. The total developmental time from egg to adult of females of *N. longispinosus* was 4.79 days whereas it was 4.09 days for male. Bapugouda *et al.* (2019) reported that *N. longispinosus* took from 4.18 days to 4.76 days when fed on *T. urticae* which is close to the findings of the present study. However, Sharma and Chauhan (2013) studied the development of *N. longispinosus* on *T. urticae* reared on beans and recorded the total developmental period of 7-14 days in the winter months whereas Sanchit and Shukla (2016) recorded 6.24±0.89 days for total development on the same prey which is higher than the present study.

**Adult longevity:** Adult longevity of *N. longispinosus* on the *T. urticae* cultured on taro leaves was observed. However, difference was found in the longevity of male and female and the results are presented in Table 1. The average longevity of male and female was 18.12 and 14.74 days, respectively. Observations on longevity of both sexes revealed that males lived longer than females. Abhilash and Sudharma (2002) reported a slightly lower female longevity (13.2±3.7 days) on *T. ludeni* which is agreed to the present findings.

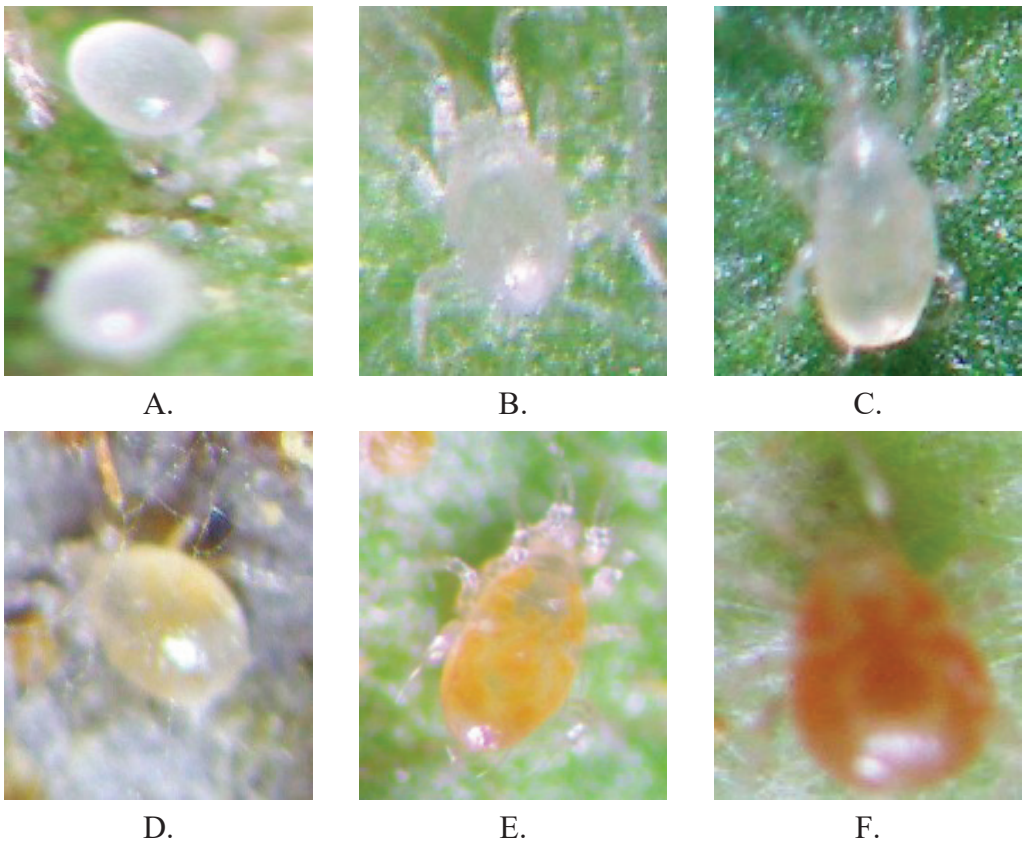



**Fig. 1.** Stereo micrographic presentation of different life stages of predatory mite *Neoseiulus longispinosus*. (A. eggs, B. Larva, C. Protonymph, D. Deutonymph, E. Adult male, F. Gravid female). Photographs were taken with a digital camera attached to Olympus (SZ61) stereo zoom microscope.

**Table 1.** Duration (day, Mean ± S E) of various developmental stages of predatory mite (*N. longispinosus*) on *T. urticae* infested taro leaf under laboratory condition

| Stage/Period | Duration in Days (Mean± SE) | | | |
|---|---|---|---|---|
| Egg/Incubation | 2.37±0.13 (2.00-2.67) | | | |
| | Male | Range | Female | Range |
| Larva | 0.64±0.01 | 0.58-0.67 | 0.73±0.02 | 0.67-0.75 |
| Protonymph | 0.85±0.01 | 0.82-0.88 | 1.02±0.02 | 1.00-1.12 |
| Deutonymph | 1.03±0.02 | 0.99-1.12 | 1.13±0.23 | 1.06-1.18 |
| Egg - Adult | 4.09±0.09 | 3.83-4.28 | 4.79±0.09 | 4.65-5.12 |
| Adult longevity | 18.12±0.54 | 16.3-19.63 | 14.74±0.43 | 13.22-15.88 |

Documentation of morphometric data of *N. longispinosus* were given in Table 2 where a gradual increase in size from larva to adults was observed. On an average the length and width of the eggs was 194.15± 0.32µm and 121.68 ± 0.34µm, respectively. Larvae were measured as 226.08±0.32µm in length and 163.06±1.04µm in width, protonymph body length and width was 277.68± 0.27µm and 172.12±0.34µm, respectively with an increased body. Deutonymph body length and width was 337.60± 0.38µm and 204.48±0.34µm, respectively. Body length and width of male was about 380.88± 0.51µm and 210.82± 0.19µm, respectively and body length and width of female adults was about 414.74±0.23µm and 250.41±0.24µm, respectively (Table 2). Sanchit and Shukla (2016) documented the morphometric data of *N. longispinosus*. They measured eggs 0.187±0.022 mm in length and 0.110±0.004 mm in width. The larvae measured on an average 0.223±0.019 mm in length and0.147±0.014 mm in width. The protonymphal stage measured 0.245±0.001 mm in length and 0.145±0.011 mm in width. Deutonymph measured 0.338±0.021 mm in length and 0.189±0.009 mm in width. The adult female measured 0.425±0.016 mm in length and 0.257±0.013 mm in width. The adult male measured 0.309±0.019 mm in length and 0.146±0.010 mm in width.

**Reproductive biology of *Neoseiulus longispinosus:*** The data of different reproduction parameters of female *N. longispinosus* are presented in Table 3. **Pre-oviposition, oviposition and post oviposition periods:** Pre-oviposition, oviposition and post oviposition periods were 2.25±0.06, 11.04±0.47 and 2.41±0.12 days respectively **(**Table 3**)**. Sanchit and Shukla (2019) recorded pre oviposition period (1.61±0.03 days), oviposition period (18.60±2.61 days), post oviposition period (3.50±1.01 days) of *A. longispinosus* reared on *T. urticae*.

**Table 2.** Morphometric of various stages of predatory mite (*N. longispinosus*)

| Stages | Length (µm) ( Mean±SE) | Breadth (µm) (Mean±SE) |
|---|---|---|
| Egg | 194.15±0.32 | 121.68±0.34 |
| Larvae | 226.08±0.32 | 163.06±1.04 |
| Protonymph | 277.68±0.27 | 172.12±0.34 |
| Deutonymph | 337.60±0.38 | 204.48±0.34 |
| Adult male | 380.88±0.51 | 210.82±0.19 |
| Adult female | 414.74±0.23 | 250.41±0.24 |

**Fecundity, daily oviposition rate, viability of eggs and sex ratio:** *Neoseiulus longispinosus* female laid eggs daily on an average 2.01±0.84 and 27.13±1.49 of its life span of which 79.87% hatched to larva. Abhilash and Sudharma (2002) reported fertility rate (25.2±3.83 eggs/ female) and daily oviposition rate (2.02±0.59 eggs/ female/day) of *A. longispinosus* on *T. ludeni* which is close to similar to the present findings. In this study sex ratio, male: female was 1:2.28. Bapugouda *et al*. (2019) reported the highly female-biased sex ratio (♂:♀; 1:3.11) of *N. longispinosus* on *T. urticae* is compared to the present study (1:2.28).

**Table 3.** Reproduction attributes of predator *Neoseiulus longispinosus* on prey species of *Tetranychus* urticae

| Reproductive attributes | Mean± SE |
|---|---|
| Pre Oviposition Period (days) | 2.25±0.06 |
| Oviposition Period (days) | 11.04±0.47 |
| Post Oviposition Period (days) | 2.41±0.12 |
| Adult Female Longevity (days) | 14.74±0.43 |
| Daily Oviposition Rate (average no. of eggs/ female/day) | 2.01±0.84 |
| Fecundity (total no. of eggs/female) | 27.13±1.49 |
| Viability (%) | 79.87±1.84 |
| Sex ratio (male:female) | 1:2.28 |

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