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DEMOGRAPHIC RESPONSE OF *Neoseiulus longispinosus* (EVANS) ON *Tetranychus urticae* KOCH TO DIFFERENT SEASONS IN PUNJAB, INDIA

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ABSTRACT

The growth and development of *Neoseiulus longispinosus* on *Tetranychus urticae* were studied in summer, autumn, winter and spring seasons. The autumn season proved to be good for egg period, pre-oviposition, oviposition and post-oviposition period as these were observed shortest in this season. The shortest female and male longevity was also obtained during autumn. The total life cycle was completed in 7.89 days in autumn season, as compared to others. Thus, the autumn season (25-28°C temperature and 60-75% RH) proved to be best for its growth and development under laboratory conditions. We can use this predator as a biocontrol agent against *T. urticae* in the autumn season for better results.

Keywords: Biology, *Neoseiulus longispinosus*, Season, Temperature, *Tetranychus urticae*

The two-spotted spider mite, *Tetranychus urticae* Koch (Tetranychidae) is a harmful phytophagous mite pest of more than 1,200 host species belonging to more than 250 different plant families and causing economic damage to crops (Tehri, 2014). Furthermore, these arthropods can produce a large number of offspring with many generations per year due to their short life cycle. Both immature and active stages of *T. urticae* feed on leaf tissues with needle-like chelicerae which causes white specks and patches on the leaves. Webbing with silken threads is a characteristic feature of two-spotted spider mite. The heavy webbing and the dust particles deposited on it adversely affect the normal functioning of the leaves, which interferes with photosynthesis and adversely affecting the growth and vitality of the plants which results in reduction in crop yield (Gorman *et al*., 2002; Abad-Moyano *et al.,* 2009). Hence, in recent years, several new molecules of acaricides have been introduced. Presently, farmers are facing the problem of acaricidal resistance development in spider mites due to their shorter developmental period and capacity to produce more offspring's (Ahn*et al.*, 1997; Leeuwen *et al.*, 2010; Hoy, 2011). Thus, development of resistance is a great obstacle in the effective integrated mite management programmes. To overcome acaricide load, it is essential that eco-friendly approaches are explored, which would be safer to the environment and are also acceptable to the farmers. There are many natural enemies like predatory coccinellid, *Stethorus* sp., *Oligota* sp., and predaceous mites which proved to be voracious feeders of mites. Among the mite predators, phytoseid mites are most promising, since they have a shorter life cycle than other group of predators. *Neoseiulus longispinosus* (Evans) (Phytoseiidae) is reported as a potential phytoseiid predatory mite against several spider mites and was first described from Indonesia as *Amblyseius longispinosus* (Evans, 1952).It is proved to be a specialized feeder of tetranychids and has received extensive attention in Asia (McMurtry and Croft 1997; McMurtry *et al*., 2013). In India, it has been found as widely distributed and observed to feed on tetranychids on different crops (Haneef and Sadanandan, 2013;Karmakar and Gupta, 2011). Few studies on exploitation of this species as a biological control agent have been done in India. Integration of a biocontrol agent into agricultural systems will not be successful unless we know about their biology on the pest mite. In this context, there is need to determine the life history of predatory mite in different seasons which will help us for their mass production for its proper utilization as biocontrol agent.

MATERIALS AND METHODS

Stock culture of phytophagous mite

The research was conducted at Acarology Laboratory, Punjab, Agricultural University, Ludhiana, Punjab, India. The two-spotted spider mite, *T. urticae* was used as a host for the predatory mite in this study. The pure culture of two-spotted spider mite was propagated on brinjal (*Solanum melongena* L.) in pots under screen house conditions at Entomological Research Farm, Punjab, Agricultural University, Ludhiana, Punjab.

Stock culture of predatory mite

The culture of phytoseiid mite, *N. longispinosus* was procured from All India Network Project on

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Agricultural Acarology, Department of Entomology, University of Agricultural Sciences, GKVK, Bangalore and used to start the stock colony of predatory mite. For this, twenty female gravid adults of two-spotted spider mite were released onto the brinjal leaves placed on a moist cotton swab in Petri plate (10 cm diameter). Moisture was maintained by adding water to the Petri plates when necessary to avoid dryness to leaves. After one day, ten gravid females of *N. longispinosus* were released on the two-spotted spider mite infested brinjal leaves. Petri plates were checked daily for the population of predatory mites. Whenever the population of *N. longispinosus* increased, old leaves were cut into bits and these bits were placed on a new brinjal leaf along with the two-spotted spider mite.

Technique used for studying biology of predatory mite, N. longispinosus on T. urticae

Leaf-disc technique (Gupta *et al.,* 1974) was used for studying the biology of *N. longispinosus* on *T. urticae* on brinjal. All brinjal leaves used for experiments were collected from organic fields and placed in water containing a drop of dish detergent, rinsed several times with water, and examined under a stereozoom microscope to assure that no other mites were present. Study was initiated with freshly laid eggs of *N. longispinosus.* To obtain the eggs of predatory mite, ten gravid females of *T. urticae* from the stock culture were transferred on the ventral side of leaf-disc of brinjal placed over moist cotton swabs in the Petri dish. After getting eggs of *T. urticae*, female adults were removed. One gravid female of *N. longispinosus* was released on a leaf-disc containing eggs of *T. urticae.* After one day, eggs laid by *N. longispinosus* were shifted singly onto the individual leaf-discs containing eggs of *T. urticae* (Fig. 1).The leaf-discs were placed upside down on cotton kept saturated with water so that the leaves may remain in turgid condition for longer period. Total developmental period of individual larvae upto the death of adult was recorded in four seasons of Ludhiana, Punjab, India *viz.* summer (April – June 2017 in temperature range of 30-34°C and RH - 60-64 %), autumn (October – November, 2017 in temperature range of 25-28°C, RH - 60-75 %), winter (December, 2017 – January, 2018 in temperature range of 15-17°C, RH - 85-92%) and spring (February - March, 2018 in temperature range of 22-24°C, RH - 80-86%) with 20 replications. The observations were performed every twelve hours on duration of egg, larval and nymphal period, pre-, ovi- and post oviposition periods, fecundity, longevity and total development period under stereoscopic binocular microscope (Zeiss, Discovery. V8). The old leaf-discs were replaced periodically with fresh ones so as to ensure their good quality. For each treatment, a single male was provided after the last moult of *N. longispinosus* female for mating.

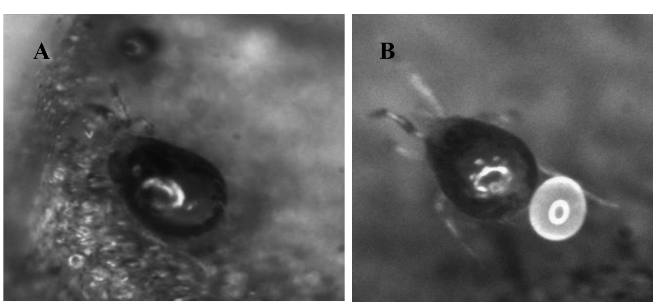

Fig. 1. *N.longispinosus* feeding on egg of *T.urticae* (A); Egg laying of *N.longispinosus* (B)

Statistical analysis

The demographic response of different seasons on the development of eggs, immature stages, pre-, ovi- and post oviposition periods, fecundity, longevity and total development period of *N. longispinosus* on *T. urticae* on brinjal was determined by using analysis of variance (ANOVA) using Completely Randomized Design (CRD).

RESULTS AND DISCUSSION

Egg and immature development period

Most of the eggs were successfully hatched in all seasons in temperature range from 15-34°C and RH - 60-92%) and there was no significant effect of temperature and relative humidity on the egg hatching. Egg period was found to be in the range from 1.97 to 5.11 days. The shortest egg period was observed during autumn season (1.97 days) which was found to be significantly different from summer, spring and winter. It was observed that in winter and spring the temperature was comparatively lowwhich resulted in the longest egg period.The larvae of *N. longispinosus* have three pairs of legs. Also, the larval duration was shorter in autumn followed by spring and winter but all these seasons were found to be significantly at par with each other. One pair of legs is added in the nymphal stage and there are four pairs of legs in nymphs (Fig.2). The data in Table 1 revealed that the nymphal period ranged from 1.00 to 1.37 days in four seasons. The nymphal period of *N. longispinosus* did not significantly differ among the four seasons examined.

Pre-oviposition, oviposition and post-oviposition period

The Perusal of data in Table 2 revealed that the average pre-oviposition period of *N. longispinosus* ranged from 0.42 to 1.05 days. The significantly shortest pre-oviposition period was observed during autumn and found to be statistically at par with spring and winter seasons. The average oviposition

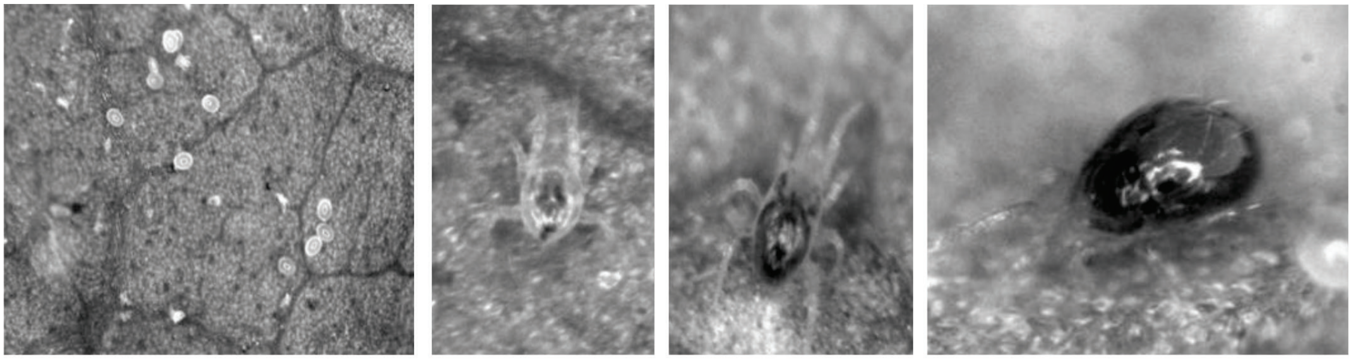

Fig. 2. Different life stages of *N. longispinosus*

Table 1. Egg, larval and nymphal period of *N. longispinosus*on *T. urticae*on brinjal (in days)

Season	Egg period	Larval period	Nymphal period
Summer	3.15(2.03)	1.65(1.62)	1.37
Autumn	1.97(1.72)	1.03(1.42)	1.00
Winter	5.11(2.47)	1.31(1.51)	1.28
Spring	5.07(2.46)	1.14(1.46)	1.21
CD (p=0.05)	(0.12)	(0.09)	NS

Figures in parentheses are square root transformed values

period of *N. longispinosus* was found to be in range from 2.70 to 7.04 days in four different seasons. The significant shortest oviposition period was observed during autumn followed by spring season. The longest oviposition period was found during summer and winter season and it was significantly at par with each other. The shortest post-oviposition period was observed in autumn and spring season which was found to be significantly at par with each other. The longest post-oviposition period was found during summer and winter season which was again found to be significantly at par with each other(Table 3).

Fecundity, longevity and total development period

The mean fecundity of *N. longispinosus* was observed to vary from 7.70 to 13.70 eggs/ female during different seasons. The maximum fecundity was observed during the summer season which was significantly different from that of other three examined seasons. The fecundity was found to be 10.30 eggs/ female during winter which was statistically different from spring and autumn season. This may be because of more longevity of females in the winter season. The average female and male longevity of *N. longispinosus* was observed to vary from 3.83 to 9.11 days and 3.42 to 7.07 days, respectively during different seasons (Table 3). The female longevity was statistically different in all the four seasons. It was significantly shortest during autumn and longest during winter. The male longevity was found to be statistically shortest during autumn followed by summer. The male longevity was longest during winter and it was at par with spring and summer.

The mean total developmental period of *N. longispinosus* was observed to vary from 7.89 to 16.82 days during different seasons and was statistically different with one another. The shortest development period was 7.89 days during autumn, followed by spring, summer and winter seasons. The rate of total development of *N. longispinosus* was increased during winter due to decrease in temperature.

The present results showed that the autumn season (temperature range from 25 to 28º C with 60 to 75 % relative humidity) was found to be more suitable for the growth and development of the phytoseiid predatory mite, *N. longispinosus* as compared to other seasons. Our results are in accordance with the studies of many authors. The study of Hariyapa and Kulkarni (1988) who observed egg period of1.90 days, larval period of 0.59 days and nymphal period of 1.98 days of *N. longispinosus* on *Polyphagotarsonemus latus* (Banks) at temperature of 23-27°C and relative humidity of 65-70 per cent. The egg and pre-oviposition period of *Amblysieus longispinosus*(Evans) was 2.21 and 1.34 days, respectively on *Tetrantchus macfarlanei* (Baker) under laboratory conditions at 23.47 to 29.60°C and RH of 49.96 to 79.78 per cent. The present results are in parallel with the study of Gotoh *et al.*(2004), who

Table 2. Pre-oviposition, oviposition and post-oviposition period of *N. longispinosus*on *T. urticae* on brinjal (in days)

Season	Pre- oviposition period	Oviposition period	Post- oviposition period
Summer	1.05(1.42)	6.30(2.69)	1.30(1.51)
Autumn	0.42(1.19)	2.70(1.92)	0.71(1.30)
Winter	0.78(1.33)	7.04(2.83)	1.29(1.50)
Spring	0.77(1.33)	3.77(2.17)	0.59(1.25)
CD (p=0.05)	(0.09)	(0.16)	(0.10)

Figures in parentheses are square root transformed values

Table 3. Fecundity, longevity and total development period of *N. longispinosus*on *T. urticae* on brinjal

Season	Fecundity (eggs/♀)	Longevity (days)		Total development period (days)
		♀ female	♂ male	
Summer	13.70(3.82)	8.65(3.09)	6.62(2.76)	14.84(3.97)
Autumn	7.70(2.93)	3.83(2.04)	3.05(2.00)	7.89(2.98)
Winter	10.30(3.35)	9.11(2.94)	7.07(2.80)	16.82(4.22)
Spring	8.00(2.96)	5.13(2.47)	7.02(2.83)	12.62(3.68)
CD (p=0.05)	(0.32)	(0.21)	(0.38)	(0.17)

Figures in parentheses are square root transformed values

observed that egg period was in range from1.20 to 5.20 days at 15 to 35.°C. However, the pre-oviposition period of *N. californicus* (McGregor) on *T. urticae* was 1.30 days at 27.5°C. The findings of Taj and Jung (2012) reported that the egg and larval period of *N. californicus* on European red mite, *Panonychus ulmi* (Koch) was 5.22 and 0.88 days, respectively at 20°C which is almost nearer to our results. Rahman *et al*. (2013) obtained similar results when *N. longispinosus* was fed on *Oligonychus coffeae* (Nietner)at 25 and 30°C. Ullah and Gotoh (2014) studied life cycle of *N. longispinosus* on different host mites and observed that the egg period of *N. longispinosus* fed on different host mites were 1.87 days (*T. kanzawai*), 2.00 days (*T. macfarlanei*), 2.05 days [*T. merganser* (Boudreaux)], 2.11 days[*T. truncatus* (Ehara)] and 1.95 days [*O. biharensis* (Hirst)] at 25 ± 1°C.Our findings were also found parallel to the findings of Rachman *et al.* (2012) and Li *et al.* (2015). They worked on different species of *Neoseiulus* at different temperature ranges. Mandape and Shukla (2017) also studied biology of *A. longispinosus* on broad mite, *P. latus* and their results suggested egg period of 2.33 days at room temperature in April to June (28 to 32°C) and relative humidity (78 to 83%).

The present data are in accordance with the studies of Shih and Shieh (1979), where they observed that mean generation time of *N. longispinosus* on eggs of *T. kanzawai* was 11.80 days and fecundity of 9.90 eggs/ female at 25 ± 1°C.The results of present research are corroborated with the findings of Xia *et al.* (2012) wherein they reported total duration of *N. barkeri* on *A. ovatus* was 7.86 days at 24°C and 85 per cent RH.

Weather factors such as temperature and relative humidity affect the growth and development of a population of predacious mites. The best favorable temperature and relative humidity was proved to be in range from 25 to 28 ºC and 60 to 75 percent for the development of *N. longispinosus*, respectively. This range is present in autumn season under Punjab conditions which proved to be very conducive for the development and growth of *N. longispinosus,* which will directly give benefit in view of management of *T. urticae* in field conditions as high population of *T. urticae occurs* in this particular season on many vegetable crops. Thus, we can use this predator as a biocontrol agent against *T. urticae* in the autumn season for its better results.

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Authors' contribution

Conceptualization and designing of the research work (PK, MBB); Execution of field/lab experiments and data collection (SS); Analysis of data and interpretation (PK, SS); Preparation of manuscript (PK).

LITERATURE CITED

Abad-Moyano R, Pina T, Dembiilio O, Ferragut F andUrbaneja A 2009. Survey of natural enemies of spider mites (Acari: Tetranychidae) in citrus orchards in eastern Spain. *Exp Appl Acarol* **47**: 49-61.

Ahn S J, Kim G H, Choi K R and Cho K Y1997. Temperature fitness of dicofol resistant strain in the two-spotted spider mite, *Tetranychus urticae* Koch. *Korean J Entomol* **27**: 93-98.

Gorman K, Hewitt F, Devine G and Denholm I. 2002.New developments in insecticide resistance in the glasshouse whitefly (*Trialeurodes vaporariorum*) and the two-spotted spider mite (*Tetranychus urticae*) in the UK. *Pest Manag Sci* **58**: 123-30.

Gotoh T, Suwa A and Kitashima Y 2004. Development and oviposition of *Tetranychus pueraricola* (Ehara) and Gotoh (Acari: Tetranychidae) on various plants**.** *J Acarol Soc Jap* **13**: 135-40.

Gupta S K, Dhooria M S and Sidhu A S 1974. Effect of food and temperature on the development, longevity and fecundity of sugarcane red spider mite, *Oligonychus indicus* (Hirst). Acarologia **16**: 436-40.

Haneef S and Sadanandan M A 2013. Survey of predatory mites (Acari: Phytoseiidae) associated with economically important plants of north Kerala. *Biol Forum* **5**: 119-22.

Hariyapa A S and Kulkarni K A 1988. Biology and feeding efficiency of the predatory mite *Amblyseius longispinosus* (Evans) on chilli mite *Polyphagotarsonemus latus* (Banks). *J Biol Control* **2**: 131-32.

Hegde M and Patil B V1994. Biology and Feeding Potential of Predatory mite, *Amblyseius longispinosus* (Evans) on Cotton Red Spider Mite, *Tetranychus macfarlallei* (Baker and Pritchard). *J Biol Control* **9**: 52-53.

Hoy M A 2011. *Agricultural Acarology: An introduction to Integrated Mite Management*. CRC Press Taylor & Francis Group.New York.410p.

Karmakar K and Gupta S K 2011. Predatory mite fauna associated with Agri-horticultural crops and weeds from the Gangetic Plains of West Bengal, India. *Zoo symposia* **6**: 62-67.

Leeuwan T V, Dermauw W, Tirry L, Vontas J and Tsagkarakou A 2010. Acaricide resistance mechanisms in the two-spotted spider mite *Tetranychus urticae* and other important Acari. *Insect Biochem Mol Biol* **40**: 563-71.

Li Y T, Jiang J Y Q, Huang Y Q, Wang Z H and Zhang J P 2015. Effects of temperature on development and reproduction of *Neoseiulus bicaudus* (Phytoseiidae) feeding on *Tetranychus turkestani* (Tetranychidae). *Syst Appl Acarol* **20**: 478-90.

Mandape S S and Shukla A 2017. Biology of predatory mite, *Amblyseius longispinosus* (Evens) (Acari: Phytoseiidae) on broad mite, *Polyphagotarsonemus latus* (Banks). *J Pl Prot***10**: 58-62.

McMurtry J A and Croft B A1997. Life styles of phytoseiid mites and their roles as biological control agents. *Annu Rev Entomol* **42**: 291-321.

McMurtry J A, Moraes G J D andSourassou N F. 2013 Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. *Syst Appl Acarol***18**: 297-320.

Rachman, Santoso M N Y and Pudjianto S 2012.*The biology and predation rate of predatory mite, Neoseiulus longispinosus (Evans) (Acari: Phytoseiidae), on its prey Tetranychus kanzawai (Kishida) (Acari: Tetranychidae)*. M.Sc. thesis, Bogor Agricultural University, Indonesia.

Rahman V J, Babu A, Roobakkumar A and Perumalsamy K 2013. Life table and predation of *Neoseiulus longispinosus* (Acari: Phytoseiidae) on *Oligonychus coffeae* (Acari: Tetranychidae) infesting tea. *Exp Appl Acarol* **60**: 229-40.

Shih C I T and Shieh J N 1979. Biology, life table, predation potential and intrinsic rate of increase of *Amblyseius longispinosus* (Evans). *Pl Prot Bull* **21**: 175-83.

Taj H F and Jung C 2012. Effect of temperature on the life-history traits of *Neoseiulus californicus*(Acari: Phytoseiidae) fed on *Panonychus ulmi*.*Exp Appl Acarol* **56**: 247-60.

Tehri K 2014. A review on reproductive strategies in two spotted spider mite, *Tetranychus urticae* Koch 1836 (Acari: Tetranychidae).*J Entomol Zool Stud* **2**: 35-39.

Ullah M S and Gotoh T 2014. Life-table attributes of *Neoseiulus womersleyi* (Schicha) feeding on five tetranychid mites (Acari: Phytoseiidae, Tetranychidae). *Int J Acarol* 40: 337-48.

Xia B, Zou Z W, Li P X and Lin P 2012. Effect of temperature on development and reproduction of *Neoseiulus barkeri* (Acari: Phytoseiidae) fed on *Aleuroglyphus ovatus*. *Exp Appl Acarol* **56**: 33-41