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Research article

Effect of temperature on different developmental stages of *Cunexa terminalae* : An important biocontrol agent against phytophagous mites

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Abstract

During the field survey, the author found a new predatory mite from arjun plant within the deep mangrove vegetation during February, 2017 in Sundarbans Biosphere reserve. A study on biology of *Cunexa terminalae*, seems to be important predatory mite against phytophagous mites in India, at four constant temperatures, i,e. 20, 25, 30, and 35^0C in the laboratory conditions indicated that developmental period increases with decrease of temperature while daily rate of egg laying, fecundity, longevity were highest at 25^0C and lowest at 35^0C considering relatively shorter developmental period, higher fecundity, less mortality and minimum longevity, 25^0C was found to be most preferred temperature for the development of *Cunexa terminalae* while 35^0C was most unsuitable one.

Introduction

During the surveys conducted in different trees around Sundarbans Biosphere Reserve during February, 2017, the author found that this mite is actively feeding on all the stages of different phytophagous mites. Since in recent years, a lot of emphasis is being laid on mangrove management avoiding pesticide applications, it was thought worthwhile to try this predatory mite for biological control of phytophagous mite pest [1]. As basic biological information about a predator desired to be employed in biological control programme is a prerequisite, a study was undertaken in the laboratory towards finding out effect of temperature on the rate of different developmental stages, fecundity and longevity *Cunexa terminalae* the present paper communicates the results thereof. The species was new to be described and no work on this species was done elsewhere in the Earth, it was thought desirable to under take present study.

Experimental

Materials and Methods

The predatory mite *Cunexa terminalae* was selected from *Terminalia arjuna* on which this mite found abundantly. This mite was mass cultured in the laboratory under condition on mango leaves kept on moist cotton swab in petridishes. The technique used for the culture of predatory and prey mite was followed according to Overmeer [2]. Red spider mite *Oligonychuus indicus* was provided as food during mass culture. The rate of development period, fecundity, longevity, sex ratio, etc were studied at four constant temperatures *viz.,* 200C, 250C, 300C and 350C at RH of 75%. The desired RH was maintained following Buxton and Mellanby [3]. The desiccators having the petri-dishes were kept in BOD incubators set at the desired temperatures. First of all, adult females were released on the leaves kept on wet cotton swab for allowing the females to lay eggs for a definite period. Thereafter, when sufficient number of eggs was laid, the adult females were removed and thus eggs of same age were obtained, to start with the experiment. Observations were made at 6 hourly intervals to find out if eggs were hatched. As the eggs hatched into nymphs, the individual nymphs were transferred very carefully on other leaves of Arjun tree (3 cm2 area) kept on wet cotton swab. Ten replications were maintained for each set of temperature and as such 40 petri-dishes (10 petri-dishes for each temperature x4 temperatures) were simultaneously maintained. All the petri-dishes were kept in BOD incubators maintaining desired temperature. *Oligonychus indicus* was given as food for the predatory mites, were separately cultured following conventional mass culture method. Duration of different developmental stages were recorded by taking observation under stereobinocular microscope at 12 hourly intervals. The data thus obtained are subjected to statistical analysis with the SPSS statistical software.

Results and Discussion

Results

The incubation period varied along with temperature, the maximum period (1.55 ± 0.10 days) was seen at 20^{0}C and the minimum (0.83 ± 0.12 days) at 30^{0}C. This period in other temperatures was 1.13± 0.16 days at 25 ^{0}C and 0.91 ±0.22 days at 35^{0}C (Table 1). It was apparent that the incubation period was longer at lower temperature and shorter at higher temperature. The maximum and minimum protonymphal periods were 1.50 ± 0.09 days and 0.90 ± 0.08 days at 20 and 35^{0}C respectively. The duration of this period varied inversely with temperature.

Deutonymphal period was longest 3.60 ± 0.11 days) at 20^{0}C and shortest (2.15 ± 0.10 days) at 35^{0}C. The duration at the other two temperatures was 2.55 ± 0.10 at 25^{0}C and 2.42 ± 0.23 days at 30^{0}C. Higher was the temperature; shorter was the duration of the deutonymphal period in this case (Table 1).

The total developmental period was maximum (8.53 ± 0.17 days) at 35^{0}C and was minimum (4.83 ± 0.22 days) at 25^{0}C. This period at the other two temperatures was 5.85 ± 0.23 days at 20^{0}C and 5.13 ± 0.36 days at 30^{0}C. This period varied inversely with temperature (Table 1).

All the eggs of the said species were viable making 100% hatching at all the temperatures. As regards percentage of larva attaining adulthood, at 25^{0}C, all the larvae could attain adulthood with less percentage of mortality (1.58%) while this percentage was relatively high in 35^{0}C, where it was found to be 70.34% (Table 1). The percentage of mortality in 20^{0}C and 30^{0}C was found to be 4.17% and 5.33% respectively. The observed data regarding the percentage of mortality from larva to adult, it appeared that the 25^{0}C was the most favourable temperature while 35^{0}C had most detrimental effect on the survivality of the species.

The pre-oviposition period was shortest 0.92 ± 0.07 days at 25^{0}C and longest 2.45 ± 0.43 days at 30^{0}C. This period was 1.32 ± 0.27 days at 20^{0}C and 2.15± 0.10 days at 35^{0}C. This also indicates that 25^{0}C was most favourable for this mite as it started laying eggs within shortest period. The oviposition period was longest 20.28± 0.15 days at 25^{0}C and shortest, 9.92 ± 0.07 days at 35^{0}C. The period was 16.05 ± 0.10 days and 12.90 ± 0.18 days at 20^{0}C and 30^{0}C respectively. From these observations, it appeared that this period increased with increase of temperature from 20^{0}C to 25^{0}C and thereafter decreased with increasing temperature. The longest oviposition period proved that this was the most favourable temperature. The post oviposition period was minimum at 30^{0}C (0.93 ± 0.08 days) and maximum at 35^{0}C (1.26± 0.12 days).

The highest fecundity was seen at 25^{0}C following by 20^{0}C, 30^{0}C and the lowest was at 35^{0}C. Fecundity increased with increased of temperature from 20 to 25^{0}C and decreased thereafter with increase of temperature.

The male : female ratio was found to be 1 : 4.25 in case of 20^{0}C, 1 : 3.27 at 25^{0}C, 1 : 2.50 at 30^{0}C and 1 : 1.67 at 35^{0}C. The present study shows that the female production decreased with increase of temperature.

The maximum longevity of the species was reported to be 53.52 ±0.84 days at 25^{0}C and minimum was 26.08 ± 0.35days at 35^{0}C (Table 1). According to this data longevity was increased with increase of temperature from 20 to 25^{0}C while the same was decreased with the increase of temperature.

Table 1. Duration of different life stages of *Cunexa terminalae* on Arjun (*Terminalia arjuna*) leaves feeding on *Oligonychus indicus* at different temperatures

Stages	20^{0}C	25^{0}C	30^{0}C	35^{0}C
Egg	1.55 ± 0.10 Days	1.13 ± 0.16 Days	0.83 ± 0.12 Days	0.91 ±0.12 Days
Protonymph	1.50 ± 0.09 Days	1.08 ± 0.12 Days	0.93 ± 0.10 Days	0.90 ± 0.08 Days
Deutonymph	3.61 ± 0.11 Days	2.55 ± 0.10 Days	2.42 ± 0.23 Days	2.15 ± 0.10 Days
Total dev. period	5.85 ± 0.23 Days	4.83 ± 0.22 Days	5.13 ± 0.36 Days	8.53 ± 0.17 Days
Pre-oviposition	1.32 ± 0.27 Days	0.92± 0.07 Days	2.45 ± 0.43 Days	2.15± 0.10 Days
Oviposition	16.05± 0.10 Days	20.28± 0.15 Days	12.90± 0.18 Days	9.92 ± 0.07 Days
Post-oviposition	1.05 ± 0.15 Days	1.07 ± 0.05 Days	0.93 ± 0.08 Days	1.26± 0.12 Days
Fecundity	20.58 ± 1.02 Eggs	26.28 ± 1.27 Eggs	13.18 ± 0.65 Eggs	8.28± 0.29 Eggs
Longevity	46.34 ± 0.29 days	53.52 ±0.84 days	33.37 ± 0.57	26.08 ± 0.35days
% of Mortality	4.17	1.58	5.33	70.34
% of hatching	100%	100%	100%	100%
Sex Ratio Male : Female	1 : 4.25	1 : 3.27	1 : 2.50	1 : 1.67

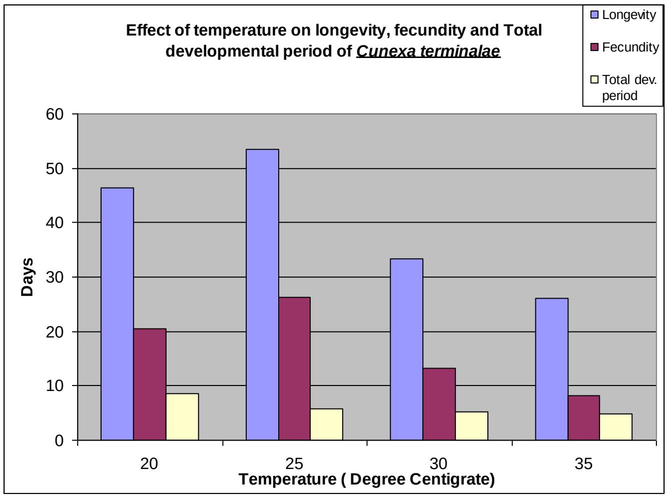

Figure 1. Effect of Temperature on different developmental stages of *Cunexa terminalae*

Discussion

The trend of results obtained in the present study, i.e. developmental period decreased with increased temperature was also observed in *Amblyseius fallacies* (German) by Smith and Newsom [4], in *Amblyseius citrifolins* (Denmark & Muma) by Moraes [5], In *Amblyseius swirski* by Yousef *et.al.* [6] and in *Amblyseius mesembrinus* by Aboula-Selta & Childeers [7]. Regarding percentage of hatching as it was 100 percent at all the four temperatures, it was found 98% in *Tetranychus occidentalis* by Lee & Davis [8], 97% in *Phytoseiulus macropilis*, 97.5% in *Phytoseiulus persimilis* by Stenseth [9]. The record of cent percent hatching at all temperatures is a useful feature of this predatory mite. The record of 70.34% mortality obtained regarding larva attaining adulthood at 35^{0}C came closer to the earlier observations made by Hamamura *et. al.* [10] who reported higher mortality in respect of *Phytoseius persimilis* about 32.5^{0}C. The increase of ovipositional period with increase of temperature is a common occurrence in phytoseiids and such findings were also recorded by some earlier workers like Smith and Newsom [4], Ma & Laing [11] and Tanigoshi *et.al.* [12]. More or less similar result was found by Gupta, *et.al.* [13].

Conclusion

From the overall observation of results it appeared that 25^{0}C was the most suitable temperature for this species as at this temperature the total developmental period was quite short with very less mortality and also having longer ovipositional period, higher fecundity and longer longevity. As because, the species is a very good biocontrol agent it can be applied on the field for biological control of phytophagous mite pests during the season when the mean temperature remains more or less around 25^{0}C (Figure 1). The mite can be applied in the field during post monsoon season for biological control of harmful phytophagous acarine pests.

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