Biospectra : ISSN : 0973-7057, Vol. 13(2), Sept., 2018, pp. 33-38
An International Biannual Refereed Journal of Life Sciences

Animal Science

ISSN : 0973-7057

Int. Database Index: 663 www.mjl.clarivate.com

Thermal Demand Constancy (TDC) of lady bird beetle *Coccinella septempunctata* Linn. (Coleoptera: Coccinellidae) and patterns of life cycle variation

Neetu Kumari*
University Department of Zoology, Ranchi University, Ranchi, Jharkhand, India

Received : 12th August, 2018 ; Revised :24th October, 2018

Abstract: The present investigation is a unique concern related with the total energy requirement or demand also termed as thermal demand being the function of the average temperature measured in degree celsius (°C) and number of days taken by the lady beetle, *C. septempunctata* to complete its life cycle in different seasons (life cycle duration) of the experimental year 2016-2018 growing on a particular host plant. The thermal demand mathematically computed as the product of temperature and days seems to be constant throughout the year with slight seasonal variation and accordingly the thermal demand constancy (TDC) has been also computed in terms of seasonal and annual values, found to be, STDC- 756 ± 10 (Winter), 800 ± 10 (Autumn), 805 ± 10 (Summer), 780 ± 10 (Rains) and ATDC- 785 ± 10 during 2016-2017 as well as STDC- 798 ± 10 (Winter), 770 ± 10 (Autumn), 780 ± 10 (Summer), 825 ± 10 (Rains) and ATDC- 793 ± 10 during 2017-2018. The annual thermal demand which is as a matter of fact the total thermal demand of the beetle displayed a trend of constancy as per the laws of thermodynamics and bioenergetics.

Keywords- ATDC, STDC, seasonal temperature, life cycle duration, bioenergetics, *C. septempunctata*

INTRODUCTION

In the background of the research study, it is relevant to express that non-biotic environmental parameter central to the reproduction and life cycle completion in an insect is temperature which is further integrated with the humidity.

Significant variations in these two parameters are observed in the environment of tropical regions which affect the general biology, reproduction and life cycle patterns of insects in particular. However, the energy requirement or demand of any living system or insect in its life span tends to be constant with small range of variations as per the changes in the environmental temperature and humidity quantifiable in degree celsius (°C) and relative percent (%).

*Correspondent author :
Phone : 08084491502
E-mail : neetukumari7775@gmail.com

Coccinella septempunctata L. (Coleoptera: Coccinellidae), is one of the most common species of ladybird in the Palearctic[1] and recently spread to America[2]. This species feeds mostly on aphids (Aphididae)[3,4]. It mainly occurs in fi elds, orchards and meadows where there are bushes and herbaceous plants infested with aphids. *C. septempunctata* is especially effective in reducing the population of aphids on grain crops in spring[5]. *C. semptempunctata*, usually has only one generation per year in temperate regions and avoids starvation when aphids are scarce during hot and arid periods by aestivating[6]. According to Honek (1989)[7] some individuals of *C. septempunctata* diapause under rocks and weeds when air temperature is high in August, whereas others remain active until October in Central Europe. Diapausing individuals aggregate on mountains mostly in large groups, while others remain on the plains and hibernate individually in winter. Honek (1989)[7] reports that in the former

Czechoslovakia adults of *C. septempunctata* aggregate at aestivo-hibernation sites. According to Bodenheimer (1943)[8] in areas that experience high temperatures in the Mediterranean region *C. septempunctata* adults move to higher altitudes in June after spending early spring reproducing. Similarly, *C. septempunctata* aggregates in Greece on Mount Kitheron from July, after actively reproducing in April and June in the lowlands. In Turkey, *C. septempunctata* is reported to spend summer and winter months diapausing on mountains (Bodenheimer, 1943)[8]. Several studies have shown that the durations of the aestivation and overwintering periods determine the number of generations *C. septempunctata* can complete each year. For instance, *C. septempunctata* is univoltine in Western and Central Europe[6] and bivoltine in Eastern and Southern Europe. Bodenheimer (1943)[8] assumes that the 2nd generation of *C. septempunctata* is completed in autumn because it aestivates in July and August in Israel, where the mean annual temperature is very high. In this study, we aimed to determine the population changes of *C. septempunctata* that occur in agricultural and non-agricultural areas in the region of Jharkhand, where the variation in daily temperature is high, and at aestivo-hibernation sites.

MATERIALS & METHODS

Sampling in cultivated areas of Kanke block Ranchi:-

Samples were collected every 2 weeks at 10 randomly selected sites in paddy fields, grasslands and other cultivated areas of Kanke block, Northwestern site of Ranchi city between March to September in 2017–2018. At each sampling site, *C. septempunctata* adults were collected using 100 sweeps of insect net and the number of eggs, larvae and pupae of *C. septempunctata* on 10 aphid-infested plants were recorded. In 2017, most of the sweep net sampling was done in a paddy field close to Birsa Agriculture University Campus, Kanke, Ranchi. Adult of ladybirds were collected from several sites of paddy fields and their sexes were identified by observing the ventral, abdominal and anal segments.

A group of 10 beetles with 80% male and 20% female individuals were allowed mate and propagate in separate glass jars containing adequate foodplant leaves and stem covered with porous muslin cloth. At least five replication of such setup was maintained in the Entomology laboratory, Department of Zoology, Ranchi University for observing mating, the reproductive behavior and life cycle of the insects in each and every installation. Daily observation was made to record the emergence of the larval instars and their duration of feeding as well as future molting to put on record the exact no. of days taken by each group of ladybirds in each jars for completing its life cycle.

The number of days taken by each and every larval and pupal stage was recorded regularly in every month during 2017-2018 in order to develop the data on seasonal trend of life cycle duration with respect to the changing temperature and humidity whose data were recorded separately. This was done for establishing the co relationship between the duration of the life cycle and temperature regime in each season for further computation of values degree days or thermal demand constancy as per following formula:-

DDC/TDC = duration of life cycle (stage wise) x average temperature of the season.

In the present investigation, it has been found that the value of thermal demand in the year 2016-2017 was 785+- 10 whereas in 2017-2018 it was 793+-10 which reflect unique constancy of the calorific requirement of the lady beetle in its overall biological activity, reproduction and life cycle regulation irrespective of the seasonal changes in the temperature and the relative humidity. However, due to the variation of temperature resigm in different seasons the value reflects a little variations in all the four seasons during the first year of experiment was 756-805 whereas in the second year it was 770-825. On the mathematical assesment of the thermal calories consumed by the insects, The average value of all trhe four seasons can be easily worked out (Table 1 & 2).

The graphical representation of seasonal thermal demand constancy with range of fluctuation has been displayed in figure 1 which provides the self explanatory view of fluctuation as well as contancy of the energy demand.

As per the laws of thermodynamics, every system may be nonliving or living, small or big the entire structure and function are govern by the energy and the constancy of energy in the universe also injects the similar function in the organisation of system with variable scale of life span depending upon the efficiency of the system in terms of liberating free energy and entropy. Hence, the same concept has been implimented in studying the thermal demand constancy in the present lady beetle in relation to its variable life span.[9]

Table.1- Thermal demand constancy of a ladybird beetle, *Coccinella septempunctata* in relation to its life cycle duration & seasonal temperature (November 2016- October 2017)

Seasons	Temperature regime 2018 (in ^{o}C)	Relative humidity regime (in %)	Life cycle (in days)	Seasonal Thermal Demand Constancy (STDC)	Annual Thermal Demand Constancy (ATDC)
Winter (Nov – Jan)	18 ± 5	63 ± 5	42	756 ± 10	785 ± 10
Autumn (Feb – April)	25 ± 5	50 ± 5	32	800 ± 10	
Summer (May – July)	35 ± 5	70 ± 5	23	805 ± 10	
Rains (August – October)	26 ± 5	76 ± 5	30	780 ± 10	

Table.2- Thermal demand constancy of a ladybird beetle, *Coccinella septempunctata* in relation to its life cycle duration & seasonal temperature (November 2017- October 2018)

Seasons	Temperature regime 2018 (in ^{o}C)	Relative humidity regime (in %)	Life cycle (in days)	Seasonal Thermal Demand Constancy (STDC)	Annual Thermal Demand Constancy (ATDC)
Winter (Nov – Jan)	19 ± 5	55 ± 5	42	798 ± 10	793 ± 10
Autumn (Feb – April)	22 ± 5	45 ± 5	35	770 ± 10	
Summer (May –July)	30 ± 5	64 ± 5	26	780 ± 10	
Rains (August – October)	25 ± 5	70 ± 5	33	825 ± 10	

Fig.1- Graphical representation of Seasonal Thermal Demand Constancy (STDC) of a ladybird beetle, *Coccinella septempunctata* in relation to its life cycle duration & seasonal temperature (November 2016- October 2017)

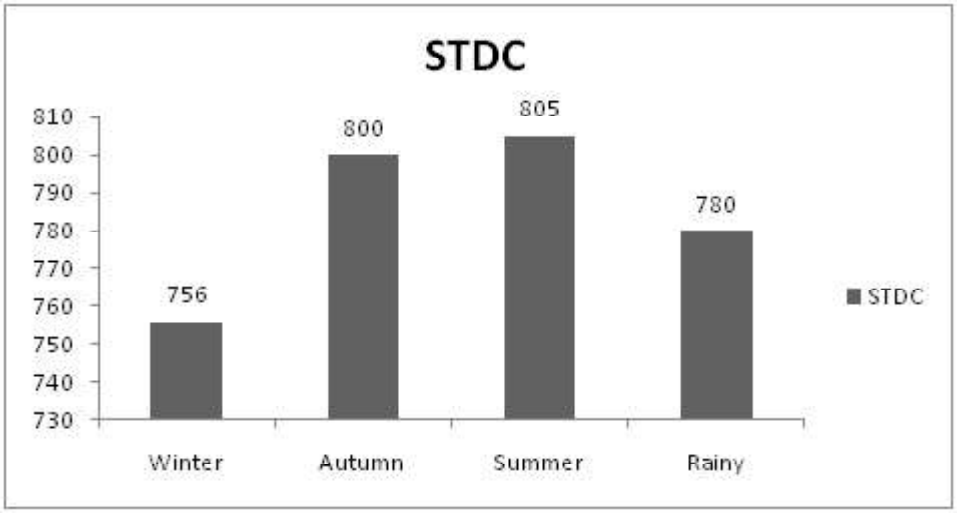


Fig.2- Graphical representation of Seasonal Thermal Demand Constancy (STDC) of a ladybird beetle, *Coccinella septempunctata* in relation to its life cycle duration & seasonal temperature (November 2017-October 2018)

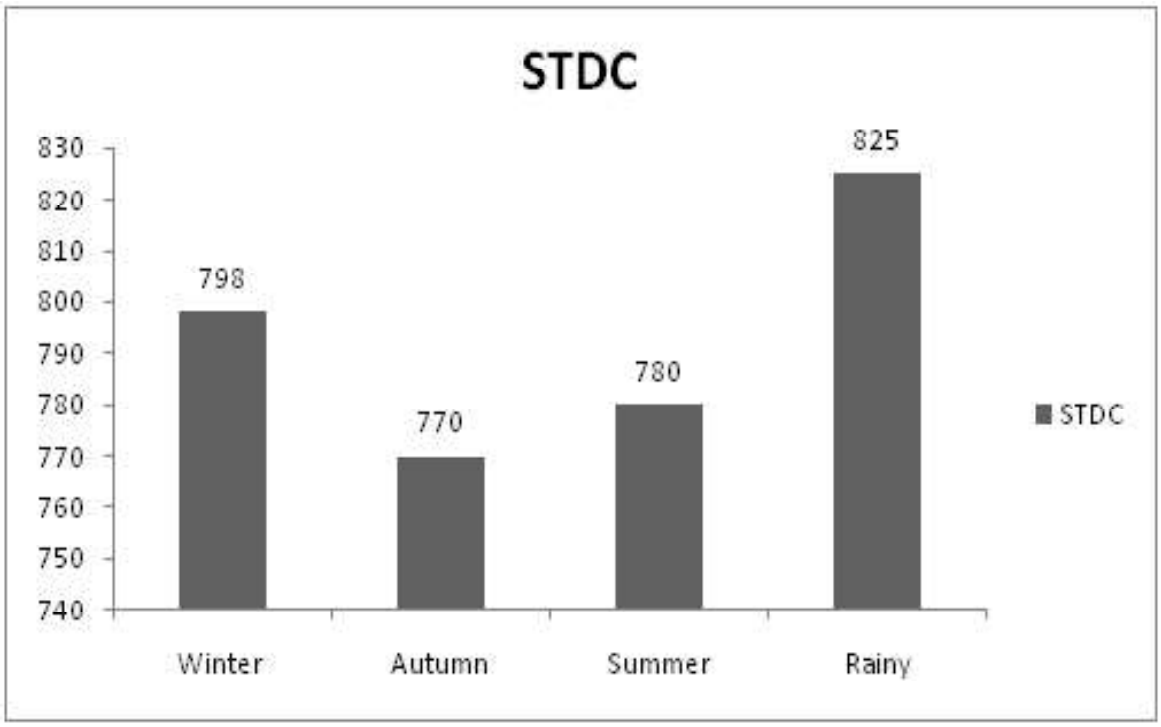
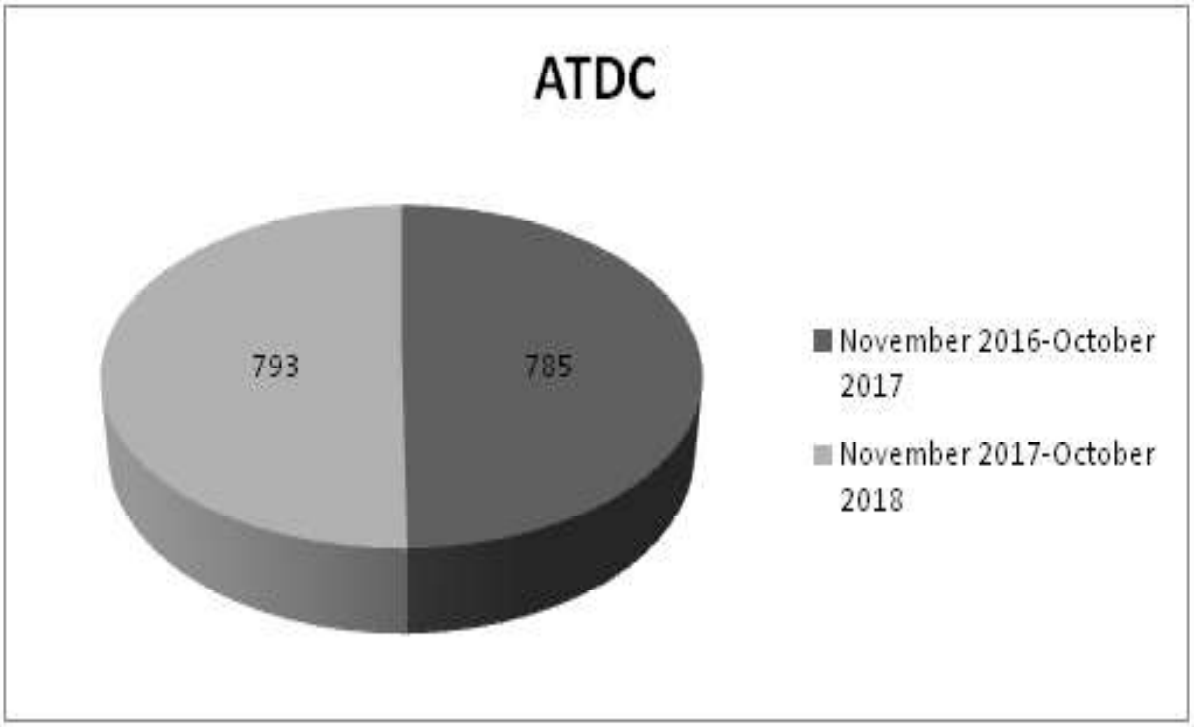


Fig.1- Graphical representation of Annual Degree Days Constancy (ADDC) of a ladybird beetle, *Coccinella septempunctata*



REFERENCES

1. **Hodek I. 1966.** Voltinizm and diapause in aphidophagous insects (Review). In Hodek I. (ed.). *Ecology of Aphidophagous Insects*. Junk, The Hague and Academic, Prague, pp. 97–102.
2. **Evans E.W. 2004.** Habitat displacement of North American ladybirds by an introduced species. *Ecology* **85:** 637–647.
3. **Kuznetsov V.N. 1975.** Fauna and ecology of coccinellids (Coleoptera: Coccinellidae) in Primorye region. *Tr. Biol. Pochv. Inst.* **28:** 3–24.
4. **Formusoh E.S. & Wilde G.E. 1993.** Preference and development of two species of predatory Coccinellids on the Russian wheat aphid and greenbug biotype (Homoptera: Aphididae). *J. Agric. Entomol.* **10:** 65–70.
5. **Hauge M.S., Nielsen F.H. & Toft S. 1998.** The influence of three cereal aphid species and mixed diet on larval survival, development and adult weight of *Coccinella septempunctata. Entomol. Exp. Appl.* **89:** 319–322.
6. **Hagen K.S. 1962.** Biology and ecology of predaceous Coccinellidae. *Annu. Rev. Entomol.* **7:** 289–326.
7. **Honek A. 1989.** Overwintering and annual changes of abundance of *Coccinella septempunctata* (Coleoptera: Coccinellidae) in Czechoslovakia. *Acta Entomol. Bohemoslov*. **86:** 179–192.
8. **Bodenheimer F.S. 1943:** Studies on the life history and ecology of Coccinellidae. I. The life-history of *Coccinella septempunctata* L. in four different zoogeographical regions. *Bull. Soc.Fouad I. Entomol*. **27:** 1–28.
9. **Lewy & Siekewitz. 1981.** Thermodynamics in the functioning of living system, Second edition PrenticeHall Publication, New Delhi.

***