Trend in Biosciences 1 (1; 2), 18-21, 2008

Effect of Varying Temperature on the Development and Predation of *Coccinella transversalis* F. (Coleoptera: Coccinellidae) on *Lipaphis erysimi* (Kaltenbach)

ARSHAD ALI AND PARVEZ QAMAR RIZVI

Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, India. e-mail: pqrizvi@rediffmail.com

ABSTRACT

A laboratory study was conducted to determine the developmental and predatory response of *Coccinella transversalis* on mustard aphid, *Lipaphis erysimi* (Kaltenbach) at three constant temperatures *viz.*, 18, 24 and 28±1ºC coupled with 65±5 % R.H. and 12 hr L:12 hr D for each. All the developmental stages (immature and adult) were significantly longer at 18±1ºC followed by 24±1ºC and 28±1ºC. The survival of individuals of all stages was more at 24±1ºC in comparison to 18 and 28±1ºC. The mortality parameters (per cent mortality and k-value) of different developmental stages were recorded maximum at 28±1ºC and minimum at 24±1ºC. Varying temperature did also show significant difference on predatory response of *C. transversalis*. Both the stages (grub and adult) devoured maximum aphids at 28±1ºC as compared to 18 and 24±1ºC. The last grub stage (Grub 4) devoured maximum aphids as compared to other grub stages. The feeding propensity of female was more than male at all the temperatures. The temperature was negatively correlated with development, while positive with predation of *C. transversalis*.

Key words *Coccinella transversalis*, *development, predation, mustard aphid*

The mustard aphid, *Lipaphis erysimi* (Kaltenbach) is a serious pest of rapeseed and mustard in India and other tropical regions in the world. Its population increases in the cold and cloudy weather on vegetative stage of mustard because of shorter developmental period and lowest production of winged morphs of aphid. When they become crowded, the winged forms appear for dispersal from one plant to another (Agarwala and Datta, 1999). It causes damage directly by sucking cell sap and indirectly as vectors of certain plant viruses (DiFonzo *et. al*., 1997).

Temperature is a crucial factor, determining the development of the mustard aphid. The high temperature shortens the life span whereas the cooler temperature increases the longevity (Sidhu and Singh, 1964). The number of nymphs produced is also influenced by temperature. A single female produced 132 nymphs at 12-15 ºC whereas at 25-28 ºC, only 26 nymphs were born (Sidhu and Singh, 1964, and Sachan and Bansal, 1975).

Almost all the species of ladybeetles are considered as a beneficial insect, predate on many soft bodied insects (Deshpande, 1937, and Deligeorgidis *et. al*., 2005). Among the group of ladybirds, *Coccinella transversalis* (Fabricius) is one of the most common species, occurring all over the world. In India, this species is active during the day and feed on aphids, thrips and coccids (Pervez and Omkar, 2005). Both grub and adult of *C. transversalis* can often be attributed to the same plants and feed on the same insect species. Although many workers have studied the development and predation of *C. transversalis* on different aphid species (Omkar and James, 2004; Omkar *et al*., 2004 and Pervez, and Omkar, 2005) but the effect of temperature on the response of this species has not been studied in detail, therefore, an attempt was made to determine the developmental and predatory response of *C. transversalis* at varying temperature on mustard aphid, *L. erysimi*.

MATERIALS AND METHODS

To maintain the culture of mustard aphid, Indian mustard (*Brassica juncea* L var. *varuna*) was sown on October 25, 2005 in the experimental field of the Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh. The natural infestation of mustard aphid, *L. erysimi* commenced in the first week of December and its population density increased from the day of infestation. For natural control of this aphid, various ladybird species were also attributed with the aphid colonies in the field. Of all the coccinellids, *C. transversalis* was found dominantly feeding on *L. erysimi*.

To determine development and predatory response of *C. transversalis* on mustard aphid under controlled environment, three constant temperatures *viz.*, 18±1ºC, 24±1ºC and 28±1ºC coupled with 70±5% RH and 12 hr L: 12 hr D photoperiod were maintained in BOD incubator. The grubs and pupae of *C. transversalis* were collected from infested field and were kept in BOD incubator for adult emergence at respective temperatures. Freshly emerged adult beetles were reared in pairs in petridishes (90 mm diameter and 10 mm height), provided with blotting paper spread over its inner surface for egg laying. The eggs laid by each female were collected with soft camel hair brush and transferred to other petridishes for hatching. After hatching, a total of one hundred newly hatched (zero day old) grubs were reared individually in plastic vials (measuring 4.0 cm in diameter and 6.0 cm in height) at respective

temperatures. For newly born grubs, 50 early instar nymphs were provided as food. The number of aphids subsequently increased reaching maximum 100 nymphs daily till grubs entered into pupal stage. Total number of aphid consumed by each grub was counted daily; dead and unconsumed aphids were replaced by fresh aphid nymphs. After the emergence of adult (male and female), they were again provided with a minimum of 100 aphid nymphs daily till their death. This way daily consumption by grub, male and female beetles was recorded. Sexing of adult was done as per suggestion of Sathe and Bhosale, 2001.

Data were subject to analysis of variance (ANOVA) and means were separated by LSD at 0.05 % level, in the course of Minitab 11 for window software. The mean values were compared by using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Development

It was inferred from Table 1 that the total developmental period of *C. transversalis* was recorded highest (58.30±1.164 days/progeny) at 18±1ºC and lowest (48.80±1.579 days/progeny) at 28±1ºC. The total grub and average adult period were also significantly longer at 18±1ºC (16.90±0.207 and 25.00±0.782 days, respectively) in contrast to shorter at 28±1ºC (14.20±0.566 and 21.30±0.706 days, respectively) on $P = 0.05$ (Table 1).

The development of immature stages of *C. transversalis* was also significantly longer at 18±1ºC as compared to 24 or 28±1ºC (Fig. 1). Similarly, adults (male and female) also registered their highest developmental period at 18±1ºC followed by 24±1ºC and 28±1ºC (Fig. 1).

Table 2 revealed that all the developmental stages of *C. transversalis* exhibited highest mortality at 28±1ºC, in contrast to lowest at 24±1ºC. However, within developmental stages, Grub 1 stage registered maximum mortality (13.19 %) at 28±1ºC and the minimum (1.35 %) on Grub 4 stage at 24±1ºC. The total generation mortality (K) was also found superior (0.2596) at 28±1ºC and inferior (0.1612) at 24±1ºC. All the mortality parameters revealed that 24±1ºC favoured the development of *C. transversalis* with high number of individuals as compared to 28 and 18±1ºC. This judgment is in complete agreement with the finding of Omkar and Pervez, 2004, who reported that at different temperature regimes (20, 25, 27 and 30ºC) 27ºC was found to be the most suitable temperature for *Propylea dissecta*.

In general the last larval stage (Grub 4) of *C. transversalis* took maximum period for its development in comparison to other grubs. Such observations are in consonance with the findings of Atlihan and Kaydan, 2002.The females survived for the longer period than the males. Similar observations have also been reported by Atlihan and Kaydan, 2002 and Omkar and James, 2004.

Predation

The overall feeding efficiency of *C. transversalis* was found significantly higher at 28±1ºC (1134.30±13.816 aphids/progeny) followed by 24±1ºC (833.85±10.975 aphids/progeny) and 18±1ºC (711.30±12.946 aphids/progeny). The total grub and average adult consumption was also recorded significantly maximum at 28±1ºC (230.60±6.034 and 903.70±7.782 aphids, respectively) in contrast to minimum at 18±1ºC (140.20±5.867 and 571.10±8.079 aphids, respectively) (Table 1).

The predatory response of different developmental stages of *C. transversalis* was statistically different at all the temperatures. The grubs devoured maximum aphids at 28±1ºC as compared to 18 and 24±1ºC. Similarly, feeding propensity of adult was also higher at 28±1ºC in contrast to lowest at 18±1ºC (Fig. 2).

The adults exhibited more response in feeding on *L. erysimi* as compared to grubs at all the temperatures and are in the full support of the judgment made by Lee and Kang, 2004. Between sexes, female consumed more aphids than the male. Similar observations have been earlier reported by Ba M'Hameed and Chemseddine, 2001; Atlihan and Kaydan,

Table 1. Development and predation of *Coccinella transversalis* on *Lipaphis erysimi* (Kaltenbach) at varying temperatures

Stage *C. transversalis*	18 ± 1 ºC	24 ± 1 ºC	28 ± 1 ºC	C.D. ($P \leq 0.05$)
Development				
Total Grub	16.90 ± 0.207c	16.10 ± 0.471b	14.20 ± 0.566a	0.57
Adult	25.00 ± 0.782c	23.75 ± 0.980b	21.30 ± 0.706a	0.69
Overall	58.30 ± 1.164c	54.65 ± 1.732b	48.80 ± 1.579a	1.50
Predation				
Total Grub	140.20 ± 5.867a	165.30 ± 6.136b	230.60 ± 6.034c	11.99
Adult	571.10 ± 8.079a	668.55 ± 4.839b	903.70 ± 7.782c	20.37
Over all	711.30 ± 12.946a	833.85 ± 10.975b	1134.30 ± 13.816c	26.95

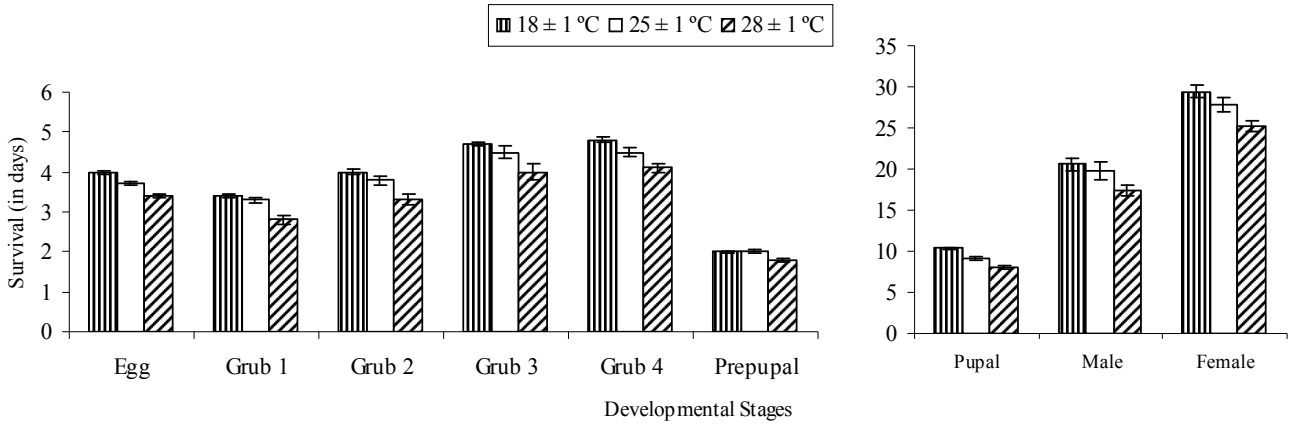

Fig. 1. Developmental period (days ± SE) of *C. transversalis* on *Lipaphis erysimi* (Kaltenbach) at varying temperatures

Table 2. Survival, mortality and k-values of *C. transversalis* on *Lipaphis erysimi* (Kaltenbach) at varying temperatures

x	l_x			d_x			$100q_x$			log l_x			k-value		
	18±1ºC	24±1ºC	28±1ºC	18±1ºC	24±1ºC	28±1ºC	18±1ºC	24±1ºC	28±1ºC	18±1ºC	24±1ºC	28±1ºC	18±1ºC	24±1ºC	28±1ºC
Egg	100.00	100.00	100.00	8.00	8.00	9.00	8.00	8.00	9.00	2.00	2.00	2.00	0.0362	0.0362	0.0410
Grub 1	92.00	92.00	91.00	10.00	9.00	12.00	10.87	9.78	13.19	1.96	1.96	1.96	0.0500	0.0447	0.0614
Grub 2	82.00	83.00	79.00	8.00	6.00	10.00	9.76	7.23	12.66	1.91	1.92	1.90	0.0446	0.0326	0.0588
Grub 3	74.00	77.00	69.00	6.00	3.00	6.00	8.11	3.90	8.70	1.87	1.89	1.84	0.0367	0.0173	0.0395
Grub 4	68.00	74.00	63.00	2.00	1.00	4.00	2.94	1.35	6.35	1.83	1.87	1.80	0.0130	0.0059	0.0285
Pre-pupa	66.00	73.00	59.00	2.00	1.00	2.00	3.03	1.37	3.39	1.82	1.86	1.77	0.0134	0.0060	0.0150
Pupa	64.00	72.00	57.00	2.00	3.00	2.00	3.13	4.17	3.51	1.81	1.86	1.76	0.0138	0.0185	0.0155
Adult	62.00	69.00	55.00	62.00	69.00	55.00	100.00	100.00	100.00	1.79	1.84	1.74	0.0000	0.0000	0.0000
													K=0.2076	K=0.1612	K=0.2596

x = developmental stages
l_x = number of individuals survive at the beginning of the stage
$100\ q_x$ = per cent mortality
log l_x = log value of surviving individuals
k = factor responsible for increase or decrease in number from one generation to another
K = total generation mortality

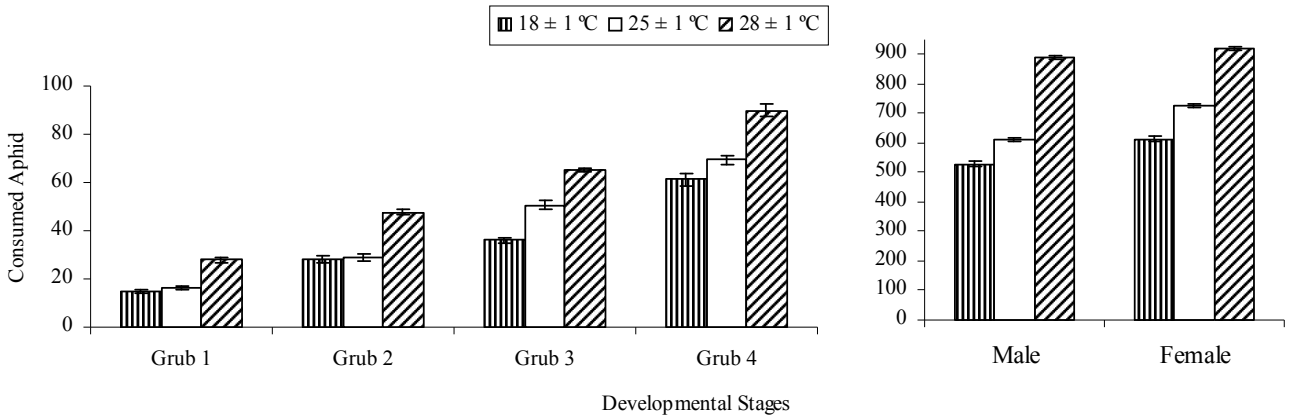

Fig. 2. Predation (number of aphids ± SE) of *C. transversalis* on *Lipaphis erysimi* (Kaltenbach) at varying temperatures

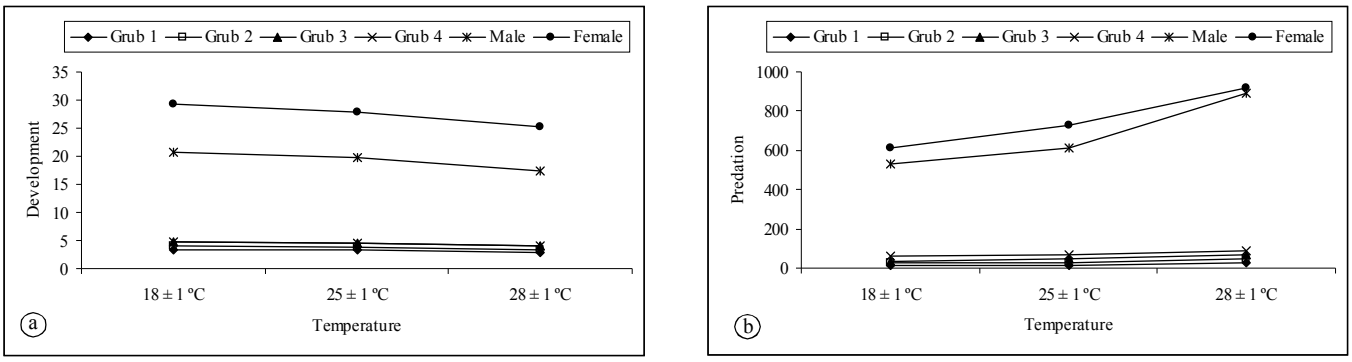

Fig. 3. Effect of varying temperature on the development and predation of *C. transversalis* on *Lipaphis erysimi* (Kaltenbach). a. Temperature vs development b. Temperature vs predation

2002; Brown, 2004; Omkar & James, 2004 and Omkar and Mishra, 2005.

Figure 3 revealed that the development of *C. transversalis* was negatively correlated with the temperature while predation was positively correlated. Such observations are in accordance with the findings of Katsarou *et. al*., (2005), who described the predation of *C. septempunctata* and *H. convergens*, increased with rise in temperature.

From the present findings, it could be concluded that the developmental period and predation at all the life stages of *C. transversalis*, were found significantly affected with change in temperatures. The temperature, 24±1ºC coupled with 65±5 % RH and 12 hr L: 12 hr D proved to be the best with regard to lowest mortality and highest yield of adults than 18 and 28 ± 1 ºC.

ACKNOWLEDGEMENT

Authors are grateful to the authorities of the Department of Plant Protection, Faculty of Agricultural Sciences, to support this research.

LITERATURE CITED

Agarwala, B. K. and Datta, N. 1999. Life history response of the mustard aphid *Lipaphis erysimi* to phenological changes in its host. *Journal of Biosciences*, **24** : 223-231.

Atlihan, R. and Kaydan, M.B. 2002. Development, survival and reproduction of three coccinellids feeding on *Hyalopterus pruni* (Geoffer) (Homoptera: Aphididae). *Turkish Journal of Agriculture and Forestry*, **26** : 119-124.

Ba M'Hameed, T. and Chemseddine, M. 2001. Assessment of temperature effects on the development and fecundity of *Pullus mediterraneus* Fabr. (Coleoptera: Coccinellidae) and consumption of *Saissetia oleae* Olivier (Homoptera: Coccidae) eggs. *Journal of Applied Entomology*, **125** : 527-531.

Brown, M.W. 2004. Role of aphid predator guild in controlling spirca aphid population on apple in West Virginia, USA. *Biological Control*, **29**: 189-198.

Deligeorgidis, P.N., Ipsilandis, C.G., Vaiopoulou, M., Kaltsoudas G. and Sidiropoulos, G. 2005. Predatory effect of *Coccinella septempunctata* on *Thrips tabaci* and *Trialeurodes vaporaiorum*. *Journal of Applied Entomology*, **129**: 246-249.

Deshpande, V. G. 1937. Cabbage Aphis-Siphocoryne indobrassicae-and Its Control with Home-Made Nicotine Spray. *Agric. and Live-Stock in India*, **7**: 756-762.

DiFonzo, C.D., Ragsdale, D.W., Radcliffe, E.B., Gudmestad, N.C. and Secor, G.A. 1997. Seasonal abundance of aphid vectors of potato virus Y in the Red River Valley of Minnesota and North Dakota. *Journal of Economic Entomology*, **90**: 824-831.

Katsarou, I., Margaritopulos, J.T., Tsitsipis, J.A., Perdikis, D.C. and Zarpas, K.D. 2005. Effect of temperature on development, growth and feeding of *Coccinella septempunctata* and *Hippodamia convergens* reared on the tobacco aphid, *Myzus persicae nicotianae*. *Biocontrol*, **50**: 565-588.

Lee, J.H. and Kang, T. J. 2004. Functional response of *Hormonia oxyridis* (Pallas) (Coleoptera: Coccinellidae) to *Aphis gossypii* Glover (Homoptera: Aphididae) in the laboratory. *Biological Control*, **31**: 306-310.

Omkar and Pervez, A. 2004. Temperature-dependant development and immature survival of an aphidophagous ladybeetle, *Propylea dissecta* (Mulsant). *Journal of Applied Entomology*, **128**:510-514.

Omkar and James, B.E. 2004. Influence of prey species on immature survival, development, predation and reproduction of *Coccinella transversalis* Fabricius (Coleptera., Coccinellidae). *Journal of Applied Entomology*, **128**: 150-157.

Omkar, Mishra, G., Srivastava, S., Avanish and Gupta, K. 2004. Ovipositional rhythmicity in ladybirds (Coleoptera: Coccinellidae): A laboratory study. *Biological Rhythm Research*, **35**: 277-287.

Omkar and Mishra, G. 2005. Preference-performance of a generalist predatory ladybird: A laboratory study. *Biological Control*, **34**: 187-195.

Pervez, A. and Omkar. 2005. Functional responses of coccinellid predators: An illustration of a logistic approach. *Journal of Insect Science*, 5:5, 6pp Available online: insectscience.org/5.5

Sachan, J. N. and Bansal, O. P. 1975. Influence of different host plants on the biology of mustard aphid, *Lipaphis erysimi* Kalt. *Indian Journal of Entomology*, **7**: 420-424.

Sathe, T.V. and Bhosle, Y.A. 2001. *Insect pest predators*. pp. 23-24 and 38-42. Daya Publishing House, Delhi.

Sidhu, H. S. and Singh, S. 1964. Biology of the mustard aphid *Lipaphis erysimi* (Kaltenbach) in the Punjab. *Indian Oilseeds Journal*, **8**: 348-359.