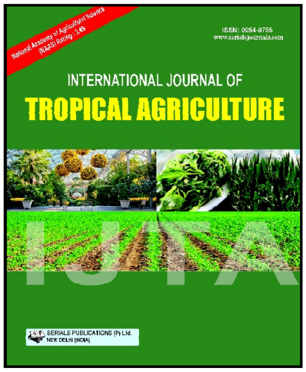

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www.serialsjournals.com

© Serials Publications Pvt. Ltd.

Volume 36 • Number 4 • 2018

Crowding as a Stressful Factor in Development of *Chrotogonus trachypterus* Blanchard (Orthoptera: Acrididae)

Shashi Meena and Vinod Kumari

Department of Zoology, University of Rajasthan, Jaipur-302004, India
E-mail: drshashimeena15@gmail.com; vins.khangarot@yahoo.com

Abstract: Development and behavior of locusts and grasshoppers profoundly change in crowded condition. Responses in nymphs as well adults of *Chrotogonus trachypterus* in crowding condition was observed in laboratory conditions. Growth and development of nymphs retard when bred collectively in a crowd with increasing temperature. Crowding results as a decrease in developmental period and longevity and also has marked reduction in the number of eggs laid. In crowd pre-oviposition, oviposition and post oviposion period reduced in comparison to isolation and significantly affected by rising temperature.

INTRODUCTION

Crowding condition has marked influences on morphology, physiology and behavior of insects. Insects respond to stress and stimulations of crowding to adapt their life by reflecting rapid metabolism to favor greater mobility [3, 16 & 17]. Surface grasshopper, *Chrotogonus trachypterus* Blanchard belonging to family Acrididae in the order Orthoptera, is one of the important polyphagous pest, which occurs through the year in semiarid area and damage wide variety of crops in seedling stage. The important host plants of this pest are jowar, maize, groundnut, sugarcane, millet etc [1, 6]. It was found in warm, sunny conditions for optimal growth and reproduction. During rainy season (June-August) its population reaches at peak [9,10]. Biology of grasshoppers greatly correlated with temperature range and affected by crowding condition. This is adaptation for insect's successfully survival in the stress by changing metabolism to favour greater physiological activities. This study is aimed to revealed out impact of crowd on development and growth of *C. trachypterus* in the Entomology laboratory, Department of Zoology, University of Rajasthan, Jaipur.

MATERIAL AND METHODS

For maintaining stock culture adult male and female grasshoppers were paired and kept in glass jars (10X15 cm) for mating at 32±2°C and 60±5% R.H. A card board with a beaker containing sterilized and moist sand for oviposition was fitted in glass jars covered by muslin cloth and tied with a rubber band. Total numbers of eggs laid by female were recorded by digging sand and counting the number of eggs. The incubation period (i.e. the duration between egg laying and hatching of first instar nymphs) and percent hatching were recorded. Adequate food (cabbage leaves) was supplied to insects daily. Moisture was maintained during incubation period. The beakers containing egg pods were removed and kept in big jars for hatching. Newly hatched nymphs were kept in glass tubes (2.5 cm in diameter) for rearing till the emergence of adult and all the tubes were covered with muslin cloth and tied with a rubber band. Developmental period studied in crowd by putting newly hatched nymphs collectively in glass jars. The period from emergence of an adult to first egg laying was recorded as pre-oviposition period, the period from first egg laying to last egg laying was recorded as oviposition period and post- oviposition period was recorded from the last egg laying till the death. Total number of egg pods laid by female in her life time was recorded. Ten replicas were used for each experiment. The study also carried out at different levels of temperature viz. 20, 25, 30, 35 and 37 °C and 60±5% R.H in B.O.D. incubator (Narang Scientific works Pvt. Ltd. New Delhi) [9,10].

RESULTS

Results indicate that crowding is the most influential factor affecting population growth of *C. trachtpterus*. In isolation pre- oviposition period ranged from 10.5±0.38 to 31.6±0.92 days with a mean value of 31.6±0.92, 22.2±1.19, 18.2±0.38, 12.4±0.52 and 10.5±0.38 days at 20, 25, 30, 35 and 37^{0}C, respectively. In crowd pre-oviposition period reduced in comparison of isolation recorded as 25.5±3.39, 20.7±2.02, 12±1.29, 8.3±1.65 and 6.5±1.25 days at 20, 25, 30, 35 and 37^0 C, respectively. Pre- oviposition period decreased with increasing temperature or inversely proportional to temperature. Oviposition period was recorded to be 42.1±0.88, 54.6±2.21, 51.2±0.55, 48.1±1.16 and 45.5±0.83 days at 20, 25, 30, 35 and 37^{0}C, respectively in non crowding condition. The duration of the oviposition period reduced and ranged from 58.4±2.64 days at 20°C to 37.4±3.45 at 37 °C, in crowd. Post-oviposition period ranged from 8.4±2.07 to 31.5±2.10 days in crowd than 11.3±0.81 to 35.4±1.79 days in isolation. In isolation maximum fecundity was recorded to be 242.1±2.55. Fecundity increased to 212±7.03 in crowd with increase in temperature up to 35^0 C beyond it total number of eggs per female decreased. A female during its life time on an average laid higher number of eggs under isolated conditions at 35 °C and 30 °C, which was significantly greater than those laid at 25 °C. The female bred collectively laid lesser number of eggs and was lower at 25 °C than at 30 or 35 °C. The female survived for longer duration at low temperature bred in isolation and crowded. (Table 1 & 2).

In isolation average longevity of female was 109.1±1.90, 101.7±1.97, 90.6±2.63, 76.4±1.03 and 67.1±2.05 days. Average male longevity was with an average of 98.4±1.07, 82.8±0.93, 75.6±4.08, 62.1±0.65 and 51.1±0.23 days at 20, 25, 30, 35 and 37^0 C, respectively. In crowd longevity of male and female in crowded condition also varied at different levels of temperature. The male longevity varied from 84.3±3.56, 80.3±4.63, 67.5±1.96, 50.06±2.34 and 39.4±2.66 days at 20, 25, 30, 35 and 37^{0}C, respectively. Likewise longevity of female was 92.3±1.47, 88.3±4.88, 78.4±6.03, and 64.9±3.70 and 57.3±3.20 days when reared at 20, 25, 30, 35 and 37 ^{0}C, respectively (Table 1 & 2).

The mean of total nymphal duration for males was 120.2±3.19, 99.5±1.49, 91.9±2.18, 87.3±3.01

and 78.14±2.30 days, while females developed in 138.7±3.25, 115.2±2.21, 101.3±3.54, 98.8±2.63 and 92.06±2.44 days when reared at 20, 25, 30, 35 and 37^0 C, respectively in isolation. Nymphal period was significantly affected in crowd as maximum developmental period for nymphs was recorded as 94.03±3.45 and 105.3±3.16 days for males and females at 20^0 C and minimum (50.3±0.55 and 60.2±2.44 days) was at 37^{0}C, respectively. The mean nymphal duration was recorded as 94.03±3.45, 87.5±1.89, 60.4±1.47, 52.1±1.90 and for males and 105.3±3.16, 100.1±3.44, 73.7±4.43, 62.9±1.22 and for females at 20, 25, 30, 35 and 37^0 C, respectively. *C. trachypterus* developed more rapidly under crowded condition than isolated condition (Table 3 & 4).

Table 1
Effect of temperature on fecundity pre-oviposition, oviposition, post-oviposition period and longevity of *Chrotogonus trachypterus* Blanchard at 60±5% R.H. (isolation condition)

Temperature °C	*Pre-oviposition period (days)*	*Oviposition period (days)*	*Post-oviposition period (days)*	*Longevity (days)*		*Fecundity*
				Female	*Male*	
20	31.6±0.92	42.1±0.88	35.4±1.79	109.1±1.90	98.4±1.07	51.1±1.69
25	22.2±1.19	54.6±2.21	24.9±1.48	101.7±1.97	82.8±0.93	145.3±3.42
30	18.2±0.38	51.2±0.55	20.6±0.81	90.6±2.63	75.6±4.08	202.2±1.90
35	12.4±0.52	48.1±1.16	16.4±0.66	76.4±1.03	62.1±0.65	242.1±2.55
37	10.5±0.38	45.5±0.83	11.3±0.81	67.1±2.05	51.1±0.23	239.1±3.65
F- value	213.880**	71.116**	250.072**	903.674**	1004.457**	3202.98**
S-Em±	0.7509	1.2645	1.1945	1.9937	1.9511	2.9237
C.D. at 5% level	2.3658	3.9842	3.7638	6.2819	6.1476	8.6248
CV	6.83	4.53	9.51	3.88	4.57	3.62

**= F- test significant

Table 2
Effect of temperature on fecundity, pre-oviposition, oviposition, post oviposition period and longevity of *Chrotogonus trachypterus* Blanchard at 60±5% R.H. (crowded condition)

Temperature °C	*Pre-oviposition period (days)*	*Oviposition period (days)*	*Post-oviposition period (days)*	*Longevity (days)*		*Fecundity*
				Female	*Male*	
20	25.5±3.39	58.4±2.64	31.5±2.10	92.3±1.47	84.3±3.56	48±3.22
25	20.7±2.02	50.6±2.38	21.7±2.64	88.3±4.88	80.3±4.63	144.3±5.05
30	12±1.29	46.5±4.13	18.9±2.06	78.4±6.03	67.5±1.96	198.3±2.41
35	8.3±1.65	41.1±1.80	12.3±2.70	64.9±3.70	50.06±2.34	212±7.03
37	6.5±1.25	37.4±3.45	8.4±2.07	57.3±3.20	39.4±2.66	202.3±3.39
F- value	201.596**	94.406*	239.402**	671.514**	1117.787**	1406.25**
S-Em±	2.056	2.9936	2.3306	4.1499	3.1763	4.524
C.D. at 5% level	6.4783	9.4324	7.3435	13.0759	10.008	14.2546
CV	24.36	12.11	21.73	9.43	8.55	4.87

**= F- test significant

Table 3
Effect of various temperatures on nymphal duration and survival percent of *Chrotogonus trachypterus* Blanchard at 60±5% R.H (crowded condition)

Temperature °C	*No. observed*	*Average nymphal duration (days)*		*No. fledged into adults*	
		Male	*Female*	*Male*	*Female*
20	100	94.03±3.45	105.3±3.16	24	23
25	100	87.5±1.89	100.1±3.44	36	39
30	100	60 .4±1.47	73.7±4.43	34	36
35	100	52.1±1.90	62.9±1.22	26	30
37	100	50.3±0.55	60.2±2.44	22	28
F- value		170.741**	157.529**		
S-Em±		2.3556	2.9224		
C.D. at 5% level		7.4222	9.208		
CV		5.61	6.84		

**= F- test significant

Table 4
Duration of different nymphal instars of *Chrotogonus trachypterus* Blanchard at different levels of temperature at 60±5% R.H. (isolation condition)

Temperature°C	*Sex*	*No. of instars observed*	*Average nymphal period of instars (days)*							*Totalduration (days)*
			I instar	*II instar*	*III instar*	*IV instar*	*V instar*	*VI instar*	*VII instar*	
20	Male	50	17.1	20.2	24	20.3	18.5	20.4		120.2±3.19
	Female	50	16.2	18.3	22.2	19.5	17.2	19.6	16.4	138.7±3.25
25	Male	50	15.1	15.2	20	18.3	16.4	14.5		99.5±1.49
	Female	50	14.2	16.3	15.2	19.5	18.2	16.6	15.4	115.2±2.21
30	Male	50	14	16.1	19.2	24.1	18.4			91.9±2.18
	Female	50	13.5	12.2	16.2	18.3	22.5	18.6		101.3±3.54
35	Male	50	14.2	15.3	20.4	21.5	15.9			87.3±3.01
	Female	50	13.3	13.4	15.5	17.8	21.8	16.9		98.8±2.63
37	Male	50	13.2	14.1	18.4	16.5	15.9			78.1±2.30
	Female	50	12.3	13.4	15.2	16.8	19.8	13.9		92.06±2.44
F- value										353.756**(Male) 145.492**(Female)
S-Em±										2.012 (Male) 2.286 (Female)
C.D. at 5% level										5.9368 (Male) 6.7455(Female)
CV										4.55(Male) 4.45(Female)

**= F- test significant

DISCUSSION

Crowding affected potentially the nymphal duration and fecundity of acridids. Both developmental period and fecundity reduced in crowded as compared to isolated condition. Our results are in consonance with Rizvi *et al* [13] who reported that the nymphs of *Hieroglyphus nigrorepletus* developed at a faster rate under crowding than under isolation. On the contrary, Singh *et al* [15] reported that nymphs of *Atractomorpha crenulata* Fab. took more time under crowded condition than under isolated condition for male and female, respectively to become adults. Majeed and Aziz [8] observed the effect of crowding on the fecundity and viability of eggs and development of different stages under different density at constant temperature and relative humidity. Khan and Aziz [4, 5 & 6] observed the effect of crowding on the hopper developmental periods on *Oedaleus abruptus* and *Eyprepocnemis alacris* under controlled conditions. According to Mittal *et al* [11] fecundity of *C. trachypterus* was more in isolation than crowd. Our results are also in consonance with the result of Chandra *et al* [2] who noticed that the number of eggs laid per pod by female of *C. trachypterus* was more at low temperature but decreased with increase in temperature when females bred collectively, probably due to the less internal time lying but it increased with the increase in temperature, when female bred isolated with males and was significantly higher at 35 or 30 °C than at 55 °C, probably due to absence of crowding stress affecting the metabolic activities. Moonis and Aziz [12] studied the effects of crowding on the development and fecundity of *Trilophidia annulata*. Schmidt (14) excellently examined effect of density on adult *Locusta migratoria* cinerascens on its behavior, reproduction and morphology in successive generations. Lazarevic *et al* [7] observed longer larval development period in gypsy moth comparing of uncrowded ones. It could be revealed that in crowded condition due to metabolic stress fecundity, developmental period and survivability of *C. trachypterus* decreased than reared in isolation.

ACKNOWLEDGEMENT

The authors are thankful to the University Grants Commission for providing financial assistance in the form of research fellowship. The study was also supported by Head, Centre for Advanced Studies in Zoology, University of Rajasthan, Jaipur for providing laboratory facilities to carry out the work.

REFERENCES

Chahal, B.S. and Sohi, G.S. (1964). Bionomics of *Chrotogonus trachypterus* Blanchard (Acrididae: Orthoptera). Parts I & II. *Indian Cott. Grow. Rev.,* **18** (2): 98-106.

Chandra, R.; Singh, N.P.; Kumar, B. and Agrawal, P.C. (1983). Effect of temperature and crowding on the fecundity of *Chrotogonus trachypterus* Blanchard (Orthoptera : Acrididae). *Bull. Pure and Appl. Sci.*, **2A**: 10-16.

Esperk, T.; Tammaru, T. and Nylin, S. (2007). The intraspecific variability in number of larval instars in insects. *J. Econ. Entomol.,* **100**(3): 627-645.

Khan, H.R. and Aziz, S.A. (1973). Influence of different levels of temperature and moisture on the development and hatching of eggs of *Oedaleus abruptus* Thunberg (Orthoptera : Acrididae). *Indian J. Ent.,* **35**(1): 29-31.

Khan, H.R. and Aziz, S.A. (1974). Effect of temperature and humidity on the incubation and hoppers development periods of *Eyprepocnemis alacris* Serville (Othoptera : Acrididae). *Acrida,* France, **3**: 47-53.

Khan, M.W.H.; Ahmad, J. and Aziz, S.A. (1980). Soil and moisture preference for oviposition of *Chrotogonus trachypterus* Blanchard (Orthoptera: Acrididae). *J. Entomol. Res., New Delhi,* **4**: 215-216.

Lazarevic J, Peric-Mataruga V and Cvetanovic D. (2004). Effect of rearing density on larval growth and activity of digestive enzymes in *Lamantria dispar* L. (Lepidoptera: Lymantriidae). *Folia Biologica,* **52** (1-2).

Majeed, Q. and Aziz, S.A. (1980). Preference of sand moisture for oviposition and development of eggs of *Gastrimargus transversus* Thunb. under different conditions of temperature and relative humidity. *J. Ent. Res.,* **4**(1): 51-56.

Meena and Singh NP. (2016). Effect of certain food plants on key demographic parameters of Chrotogonus trachypterus Blanchard (Orthoptera: Acrididae), *J. of Entomol. and Zool. Studies,* **4**(2): 406-410

Meena S and Singh N. P. (2010). Studies on the consumption and utilization of different food plants by *Chrotogonus trachypterus* (Blanchard) (Orthoptera : Acrididae). *Entomon,* **35**(2): 135-138.

Mittal, V.P. (1979). Effect of crowding on the fecundity of *Chrotogonus trachypterus* Blanchard (Orthoptera : Acrididae). *Sci. and Environ.,* I, **1**: 65-68.

Moonis, M.J. and Aziz, S.A. (1975). Biology of *Trilophidina annulata* Thunberg (Orthoptera: Acrididae) under constant ecological conditions. *Indian J. Ent.,* **36**(1): 81-90.

Rizvi, S.K.A.; Ali, S.; Yadav, S.K. and Khan, S. (1975). *Cuur. Sci.,* **44**: 286-287.

Schmidit, G. H. (2001). Effect of population density of adult *Locusta migratoria cinerascens* (Caelifera: Acrididae) on behavior reproduction and morphology. Entomologia Generalis. 23(3): 205-218.

Singh, N.P.; Chandra, R. and Mittal, V.P. (1978). Effect of crowding on nymphal duration of *Atractomorpha crenulata* Fab. *Geobios,* **5**(1): 31-32.

Wilson K and Cotter S. (2011). Density dependant Prophylaxis in insects, Phenoptic plasticity of insects, **10**(2).

Zaelor J and Kitthawee S. (2018), Growth response to population density in larval stage of darkling beetles (Coleoptera: Tenebrionidae) *Tenebrio monitor* Zophobas atratus. *Agriculture and Natural Resources,* in press