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Morphometry of different life stages of *Chrysoperla zastrowi sillemi* (Esben-Peterson) influenced by adult diets

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ABSTRACT

A study was conducted in the Biocontrol Laboratory, Department of Entomology, College of Agriculture, OUAT, Bhubaneswar, Odisha during 2020-21 to record the influence of adult diets on morphometry of different developmental stages of *Chrysoperla zastrowi sillemi* (Esben-Peterson). Six adult diets, i.e. T1 (Water: Honey: Protinex :: 40: 40: 20), T2 (Water: Honey: Castor pollen :: 40: 40: 20), T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10), T4 (Water: Molasses: Protinex :: 40:40:20), T5 (Water: Molasses: Castor pollen :: 40: 40: 20) and T6 (Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10) were evaluated along with control (T7=Water: Honey :: 50: 50). T1 was detected as the best diet which produced highest length and foot stalk length of egg, i.e. 0.96 mm and 4.53 mm with 10.34% and 12.69% increase over control. Maximum larval length was also recorded in T1 in all three instars, i.e. 2.38 mm, 3.48 mm and 4.87 mm, respectively. The cocoon diameter was recorded highest in T1, i.e. 2.57 mm. Length of adult male and female were recorded highest in T1, i.e. 10.73 mm and 15.52 mm with 12.00% and 14.79% increase over control. T1 was closely followed by T3 with respect to all morphometric measurements of developmental stages of *C. zastrowi sillemi*.

Key words: *Morphometry, C. zastrowi sillemi, Life stages, Adult diets*

Introduction

The genus *Chrysoperla* contains several important species of predatory insects of which the common green lacewing, *Chrysoperla zastrowi sillemi* (Esben-Peterson) is a potential predator on many soft bodied insects. It has significant potential for commercialization and is used as a major tactic in pest management programmes (Chakraborty and Korat, 2010). The grubs are predacious and predate on aphids, jassids, thrips, mites, whiteflies, mealybugs and, eggs and neonate larvae of many insects. The adults are not predaceous and feed on honeydew and, nectar and pollen of flowers. Well-nourished adults can produce healthy and vigorous grubs. Hence, adult food plays an important role in predatory efficiency of the predator. Six adult diets comprising carbohydrates and protein ingredients were tested in the present investigation along with one control (only carbohydrate ingredients) to measure the morphometric characters of the different life stages of this predator.

Materials and Methods

The experiment was conducted during 2020-21 in the Biocontrol Laboratory of Department of Entomology, Odisha University of Agriculture and Tech-

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nology, Bhubaneswar, Odisha. The experiment was laid out in Completely Randomized Design (CRD) with three replications each having five pairs of adult *C. zastrowi sillemi*. These adults were confined in the glass jars (3 litres capacity). Twenty one such glass jars were maintained for seven treatments and three replications. Adult diets were prepared in petri dishes mixing different food ingredients (details in the Tables) aseptically. The petri dishes were kept in the refrigerator at 5 ^{0}C for subsequent uses. The mouth of the jars were covered by black colour papers and tightened with rubber bands. Perforations were made with a pin on the black paper for aeration. Cotton swabs soaked in different adult diets were stuck on the inner wall of the respective glass jars. The cotton swabs along with the diets were changed at weekly intervals. Adults were released in the glass jars just after their emergence from cocoons. The females lay eggs on the inner side of the black papers. The black papers covering the mouth of the jars were replaced every day. The replaced papers were examined under trinocular stereo zoom microscope to measure the length and width of the egg and, length of stalk. Photographs on different developmental stages were captured with the microscope. Eggs are kept in specimen tubes along with UV light treated rice moth eggs as larval food, treatment and replication wise. After hatching of eggs, the morphometric data of first instar larvae were recorded. When the larvae reached second instar, they were separated and kept individually in small glass vials along with UV light treated rice moth eggs to prevent cannibalism. The morphometric measurements were recorded for second and subsequently third instar grubs and photographs were captured. After completion of the larval stage in three instars, the grubs pupate in small milky white silken cocoons. The diameter of the cocoons was recorded. After adult emergence, the length, breadth and head length of both the males and the females were recorded. Photographs of cocoon and adults were captured. The collected measurement data were subjected to statistical analysis after necessary transformation wherever required by using OPSTAT software for statistical interpretations.

Results

The morphometry of egg of *C. zastrowi sillemi* has been depicted in Table 1. Highest length of egg (0.96 mm) was recorded in T1 (Water: Honey: Protinex :: 40: 40: 20) with 10.34% increase in length over control (T7=Water: Honey :: 50: 50) followed by 0.95 mm and 0.93 mm in T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10) and T2 (Water: Honey: Castor pollen :: 40: 40: 20) with 9.20 % and 6.90 % increase over control, respectively. These three treatments were statistically at par and significantly superior to all other treatments. The width of egg was highest, i.e. 0.41 mm in T1, T2 and T3. However, no significant difference was observed in among the treatments for width. The stalk length of eggs followed the same trend observed in length of the egg.

Table 1. Effect of adult diets on morphometry of eggs of *C. zastrowi sillemi*

Tr. No.	Treatments	Morphometry of egg					
		Length (Nomm)		Width (mm)		Egg foot stalks length (mm)	
		Mean	Increase (%) over control	Mean	Increase (%) over control	Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	0.96	10.34	0.41	5.13	4.53	12.69
T2	Water: Honey: Castor pollen :: 40: 40: 20	0.93	6.90	0.41	5.13	4.40	9.45
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	0.95	9.20	0.41	5.13	4.47	11.19
T4	Water: Molasses: Protinex :: 40:40:20	0.92	5.75	0.40	2.56	4.36	8.46
T5	Water: Molasses: Castor pollen :: 40: 40: 20	0.89	2.30	0.39	0.00	4.19	4.23
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	0.91	4.60	0.39	0.00	4.30	6.97
T7	Water: Honey :: 50: 50 (Control)	0.87	-	0.39	-	4.02	-
	SE(m)±	0.010	-	0.008	-	0.049	-
	CD (0.05)	0.03	-	NS	-	0.15	-

Highest stalk length was observed in T1, i.e. 4.53 mm with 12.69% increase over control followed by T3 (4.47 mm) and T2 (4.40 mm) with 11.19% and 9.45% increase over control, respectively. These three treatments were at par and significantly superior to all other treatments. Lowest egg length, width and stalk length of 0.87 mm, 0.39 mm and 4.02 mm, respectively were observed in control.

The morphometric data of first instar larvae have been presented in Table-2. Maximum length of first instar larvae was recorded in T1 (Water: Honey: Protinex :: 40: 40: 20), i.e. 2.38 mm followed by T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10) i.e. 2.36 mm, T2 (Water: Honey: Castor pollen :: 40: 40: 20), i.e. 2.34 mm and T4 (Water: Molasses: Protinex :: 40:40:20), i.e. 2.32 mm with 12.26%, 11.32%, 10.38% and 9.43% increase over control (T7=Water: Honey :: 50: 50), respectively. These four treatments were statistically at par and significantly superior to all other treatments. The highest width of first instar larvae was recorded in both T1 and T3, i.e. 0.90 mm followed by T2, i.e. 0.89 mm with 3.45% and 2.30% increase over control. However, there was no significant difference among the treatments for width. The maximum head width was recorded in both T1 and T3, i.e. 0.33 mm followed by all other treatments, T2, T4, T5, T6 and T7. No significant difference was observed among the treatments for head width. The lowest length, width and head width of 2.12 mm, 0.87 mm and 0.32 mm, respectively were recorded from control.

Data presented in Table 3 depicted that the maximum length of second instar larvae was recorded in T1 (Water: Honey: Protinex :: 40: 40: 20), i.e. 3.48 mm

Table 2. Effect of adult diets on morphometry of first instar larvae of *C. zastrowi sillemi*

Tr. No.	Treatments	First instar larvae					
		Length (mm)		Width (mm)		Head width (mm)	
		Mean	Increase (%) over control	Mean	Increase (%) over control	Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	2.38	12.26	0.90	3.45	0.33	3.13
T2	Water: Honey: Castor pollen :: 40: 40: 20	2.34	10.38	0.89	2.30	0.32	0.00
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	2.36	11.32	0.90	3.45	0.33	3.13
T4	Water: Molasses: Protinex :: 40:40:20	2.32	9.43	0.88	1.15	0.32	0.00
T5	Water: Molasses: Castor pollen :: 40: 40: 20	2.25	6.13	0.87	0.00	0.32	0.00
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	2.28	7.55	0.87	0.00	0.32	0.00
T7	Water: Honey :: 50: 50 (Control)	2.12	-	0.87	-	0.32	-
	SE(m)±	0.019	-	0.012	-	0.005	-
	CD (0.05)	0.06	-	NS	-	NS	-

Table 3. Effect of adult diets on morphometry of second instar larva of *C. zastrowi sillemi*

Tr. no.	Treatments	Second instar larvae					
		Length (mm)		Width (mm)		Head width (mm)	
		Mean	Increase (%) over control	Mean	Increase (%) over control	Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	3.48	12.26	0.98	5.38	0.49	4.26
T2	Water: Honey: Castor pollen :: 40: 40: 20	3.42	10.32	0.97	4.30	0.47	0.00
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	3.46	11.61	0.98	5.38	0.48	2.13
T4	Water: Molasses: Protinex :: 40:40:20	3.38	9.03	0.95	2.15	0.47	0.00
T5	Water: Molasses: Castor pollen :: 40: 40: 20	3.28	5.81	0.93	0.00	0.47	0.00
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	3.31	6.77	0.93	0.00	0.47	0.00
T7	Water: Honey :: 50: 50 (Control)	3.10	-	0.93	-	0.47	-
	SE(m)±	0.026		0.019		0.009	
	CD (0.05)	0.08		NS		NS	

followed by T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10), i.e. 3.46 mm and T2 (Water: Honey: Castor pollen :: 40: 40: 20), i.e. 3.42 mm with 12.26%, 11.61% and 10.32% increase over control (T7=Water: Honey :: 50: 50), respectively. These three treatments were statistically at par and significantly superior to all other treatments. The highest width of second instar larva was recorded in both T1 and T3, i.e. 0.98 mm followed by T2, i.e. 0.97 mm with 5.38% and 4.30% increase over control. The widths of the predator recorded in different treatments were not statistically significant. The maximum head width of 0.49 mm was recorded in T1 followed by T3, i.e. 0.48 mm with 4.26% and 2.13% increase over control. All other treatments have same measurement with control, i.e. 0.47 mm and all the seven treatments were not statistically significant. The lowest length was recorded in control, i.e. 3.10 mm. The lowest width and head width of second instar larvae were recorded in control along with some other treatments, i.e. 0.93 mm and 0.47 mm, respectively.

Data on morphometry of third instar larva of *C. zastrowi sillemi* was presented in Table 4. Highest larval length of 4.87 mm was recorded in T1 (Water: Honey: Protinex :: 40: 40: 20) with 11.95% increase in length over control (T7=Water: Honey :: 50: 50) followed by 4.84 mm in T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10) with 11.26% increase in larval length over control. These two treatments were statistically at par and significantly superior to all other treatments. The highest larval width was recorded in T1, i.e. 1.06 mm with 7.07% increase over control followed by T3, i.e. 1.04 mm and T2 (Water: Honey: Castor pollen :: 40: 40: 20), i.e. 1.01 mm with 5.05% and 2.02% increase over control, respectively. These three treatments were at par and significantly superior to all other treatments. High-

Table 4. Effect of adult diets on morphometry of third instar larva of *C. zastrowi sillemi*

Tr. no.	Treatments	Third instar larvae					
		Length (mm)		Width (mm)		Head width (mm)	
		Mean	Increase (%) over control	Mean	Increase (%) over control	Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	4.87	11.95	1.06	7.07	0.69	2.99
T2	Water: Honey: Castor pollen :: 40: 40: 20	4.78	9.88	1.01	2.02	0.67	0.00
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	4.84	11.26	1.04	5.05	0.68	1.49
T4	Water: Molasses: Protinex :: 40:40:20	4.67	7.35	1.00	1.01	0.67	0.00
T5	Water: Molasses: Castor pollen :: 40: 40: 20	4.52	3.91	0.99	0.00	0.67	0.00
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	4.60	5.74	0.99	0.00	0.67	0.00
T7	Water: Honey :: 50: 50 (Control)	4.35	-	0.99	-	0.67	-
	SE(m)±	0.023	-	0.017	-	0.009	-
	CD (0.05)	0.07	-	0.05	-	NS	-

Table 5. Effect of adult diets on morphometry of cocoons of *C. zastrowi sillemi*

Tr. no.	Treatments	Cocoons of *C. zastrowi sillemi*	
		Cocoon diameter (mm)	
		Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	2.57	9.83
T2	Water: Honey: Castor pollen :: 40: 40: 20	2.52	7.69
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	2.55	8.97
T4	Water: Molasses: Protinex :: 40:40:20	2.49	6.41
T5	Water: Molasses: Castor pollen :: 40: 40: 20	2.41	2.99
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	2.46	5.13
T7	Water: Honey :: 50: 50 (Control)	2.34	-
	SE(m)±	0.024	-
	CD (0.05)	0.07	-

est head width was observed in T1, i.e. 0.69 mm with 2.99% increase over control followed by T3, i.e. 0.68 mm with 1.49% increase over control. Other treatments, i.e. T2, T4, T5 and T6 recorded head width of 0.67 mm, that was same as the control. These treatments were statistically not significant. The lowest larval length and width were recorded in control, i.e. 4.35 mm and 0.99 mm, respectively.

Data on diameter of cocoon have been presented in Table 5. Highest cocoon diameter of 2.57 mm was recorded in T1 (Water: Honey: Protinex :: 40: 40: 20) with 9.83% increase over control (T7=Water: Honey :: 50: 50) followed by 2.55 mm and 2.52 mm in T3(Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10) and T2 (Water: Honey: Castor pollen :: 40: 40: 20) with 8.97% and 7.69% increase in cocoon diameter over control, respectively. These three treatments were statistically at par and significantly superior to all other treatments. Lowest cocoon diameter of 2.34 mm was observed in control.

Data on body length and width of adult male have been presented in Table 6. Highest length of 10.73 mm was recorded from T1 (Water: Honey: Protinex :: 40: 40: 20) closely followed by T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10) (10.67 mm) registering 12.00% and 11.38% increase in male length over control, respectively. These two treatments were statistically at par and significantly superior to all other treatments. Highest male width of 2.09 mm was observed in T1 followed by 2.07 mm in T3 with 8.85% and 7.81% increase over control, respectively. These two treatments were statistically at par and significantly superior to all other treatments.

Data on female length and width have been presented in Table 7. Highest female length of 15.52 mm was recorded from T1 (Water: Honey: Protinex:: 40: 40: 20) closely followed by T3 (Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10) (15.18 mm)

Table 6. Effect of adult diets on morphometry of male of *C. zastrowi sillemi*

Tr. No.	Treatments	Morphometry of male *C. zastrowi sillemi*			
		Length (mm)		Width (mm)	
		Mean	Increase (%) over control	Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	10.73	12.00	2.09	8.85
T2	Water: Honey: Castor pollen :: 40: 40: 20	10.52	9.81	2.04	6.25
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	10.67	11.38	2.07	7.81
T4	Water: Molasses: Protinex :: 40:40:20	10.31	7.62	2.00	4.17
T5	Water: Molasses: Castor pollen :: 40: 40: 20	9.99	4.27	1.95	1.56
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	10.21	6.57	1.98	3.13
T7	Water: Honey :: 50: 50 (Control)	9.58	-	1.92	-
	SE(m)±	0.062	-	0.012	-
	CD (0.05)	0.19	-	0.04	-

Table 7. Effect of adult diets on morphometry of female of *C. zastrowi sillemi*

Tr. no.	Treatments	Morphometry of female *C. zastrowi sillemi*			
		Length (mm)		Width (mm)	
		Mean	Increase (%) over control	Mean	Increase (%) over control
T1	Water: Honey: Protinex :: 40: 40: 20	15.52	14.79	3.20	11.50
T2	Water: Honey: Castor pollen :: 40: 40: 20	14.79	9.39	3.11	8.36
T3	Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10	15.18	12.28	3.15	9.76
T4	Water: Molasses: Protinex :: 40:40:20	14.51	7.32	3.06	6.62
T5	Water: Molasses: Castor pollen :: 40: 40: 20	14.04	3.85	2.98	3.83
T6	Water: Molasses: Protinex: Castor pollen :: 40: 40: 10: 10	14.30	5.77	3.01	4.89
T7	Water: Honey :: 50: 50 (Control)	13.52	-	2.87	-
	SE(m)±	0.227	-	0.025	-
	CD (0.05)	0.70	-	0.08	-

registering 14.79% and 12.28% increase in female length over control, respectively. These two treatments were statistically at par and significantly superior to all other treatments. Highest female width of 3.20 mm was observed in T1 followed by 3.15 mm in T3 with 11.50% and 9.76% increase over control, respectively. These two treatments were statistically at par and significantly superior to all other treatments. Lowest female length and width of 13.52 mm and 2.87 mm were recorded from control.

Discussion

In the present investigation, six adult diets (prepared by combining two carbohydrate food ingredients, i.e. honey and molasses and, two protein food ingredients, i.e. Protinex and castor pollen) were evaluated. It was evident from results that diets containing honey were preferred over the diets containing molasses irrespective of protein food ingredients and diets containing protinex were preferred over the diets containing castor pollen irrespective of carbohydrate food ingredients. As a result, it was observed that the treatment, Water: Honey: Protinex :: 40: 40: 20 was the best followed by Water: Honey: Protinex: Castor pollen :: 40: 40: 10: 10 in increasing the body length, body width, stalk length of egg and head width of larva in different developmental stages of *C. zastrowi sillemi*, i.e. egg, grub, cocoon and adult (male and female). The morphometric data of different developmental stages recorded in the present investigation are almost similar to the values reported by Patel and Vyas (1985); Gadhia (1988) and Jalali *et al.* (2003). The size of *C. zastrowi sillemi* adults registered in present study are in agreement with the reports of Gadhia (1988); Tanwar *et al*. (2005) and, Chakraborty and Korat (2010). Hence, the results of the present study are in conformity with the findings of the above mentioned earlier workers.

Conclusion

The diet containing Water: Honey: Protinex:: 40: 40: 20 was evaluated as the best followed by Water: Honey: Protinex: Castor pollen:: 40: 40: 10: 10 for increasing the morphometric parameters of different developmental stages of *C. zastrowi sillemi*.

References

Kakar, Muhammad Qasim; Hussain, Iqbal, Shah, Arif, Ullah, Farman, Sadiq, Syed Abdul, Nasar, Abdul Razaq and Khiliji and Abdul Rasheed, 2016. Rearing of *Chysoperla carnea* (Neuroptera: Chrysopidae) on Facticious and artificial diet and its impact on the reproductive potential of the adult female. *Journal of Entomology and Zoology Studies*. 4(4): 1060-1067.

Chakraborty, Dola and Korat, D. M. 2010. Biology of green lacewing, *Chysoperla carnea* (Stephens) in middle Gujarat conditions. *Karnataka Journal of Agricultural Sciences*. 23(3) : 500-502.

Jalali, S.K., Rabindra, R.J., Rao, N.S. and Dasan, C.B. 2003. Mass production of Trichogrammatids and Chrysopids. Tech. Bull. No. 33. Project Directorate of Biological Control, Bangalore (India).

Gadhia, V.B. 1988. *Bionomics of green lacewing, Chrysopa scelestes Banks and its predatory potential on important insect pests of North Gujarat region alongwith ovicidal toxicity of certain insecticides. M. Sc. (Agri.) Thesis* Gujarat Agri. Univ. Sardar Krushinagar, Gujarat. (India).

Tanwar, R. K., Bambawale, O. M. and Singh, S. K. 2005. Production and field release of green lacewing, *Chrysoperla*. Tech. Bull. No. 12, National Centre for Integrated Pest Management, New Delhi. (India).

Patel, K.G. and Vyas, H.N. 1985. Biology of green lacewing *Chrysopa* (=*Chrysoperla*) *scelestes* Banks an important predator in Gujarat. *Gujarat Agric. Univ. Res. J.* 11 : 18-23.