The Bioscan 12(1): 169-172, 2017
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

BIOLOGY AND BIOLOGICAL PARAMETERS OF *MALLADA BONINENSIS* (OKAMATO) (NEUROPTERA: CHRYSOPIDAE) ON DIFFERENT ADULT ARTIFICIAL DIETS

SRAVANTHI GUNTUPALLI* AND M. KALYANASUNDARAM
Department of Agricultural Entomology,
Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, INDIA
e-mail: sravanthiguntupalli@gmail.com

KEYWORDS
M. boninensis
Adult diets
Hatchability
Emergence
Longevity

Received on :
16.06.2016

Accepted on :
04.01.2017

***Corresponding author**

ABSTRACT
In order to improve the adult artificial diets of *M. boninensis* (Okamato) in a cost effective manner and to enhance longevity and fecundity an experiment was conducted in the Department of Agricultural Entomology, Tamil Nadu Agricultural University and Coimbatore during 2014. Three combinations of artificial diets (AD 1, AD 2, AD 3) in combination with the standard diet (SD) were evaluated. Females survived for 54.2 and 54 days on AD 2 and AD3 compared to the AD 1 and SD diets tested. Hatchability percentage was 91.5, 91.9 larval survival percentage was 90.6, 91.4 and adult emergence percentage was 95.1, 95.4 on AD 2 and AD3 diets which indicated the better suitability of the egg yolk based diet to the predator *M. boninensis*. Number of eggs laid by a single female *M. boninensis* was significantly influenced by the different artificial diets tested.

INTRODUCTION

Green lacewings are considered to be one of the most effective generalist predators used in biological control. The larvae feed on pest aphids, scales, caterpillars, spider mites etc. infesting a variety of plants (McEwen *et al.*, 2001). Among various *Mallada* sps. found in the world, *M. boninensis, M. astur, M. basalis, M. desjardinsi* are the important ones. In recent years use of green lacewing species have been recommended for the IPM programmes (Nehare *et al*., 2004). Now a days, Integrated Pest Management (IPM) is well known to all of us where all the suitable pest control techniques are being used to find ecologically sound and environmentally safe ways of pest control (Abhishek shukla and Darshana S. Jadhav 2014).

The natural population of this bioagents in the field is not adequate to suppress the increased pest populations. Conservation of predators particularly green lacewings being potential predators is very necessary (Nikitha S. Awasthi *et al*, 2013). Studies on the effect of inundative releases of laboratory-cultured lacewings against different pests have given satisfactory control (Ridgeway and Jones, 1968, 1969; Lingren *et al.,* 1968; Scopes, 1969). Chang and Huang (1995) evaluated the effectiveness of using the predator *M. basalis* for the control of tetranychid mites on strawberries and the results showed that 60 to 90 per cent of *Tetranychus kanzawai* Kishida (Arachnida: Tetranychidae) population and 50 to 90 per cent of the *Tetranychus urticae* Koch (Arachnida: Tetranychidae) population were suppressed by the green lacewings. This result was not only saved the cost of control up to more than US $233 ha-1, but also increased fruit production by 15 per cent and that of first class fruit by 7.7 per cent.

Three combinations of artificial diets (Protinex (AD1), egg yolk (AD2) and royal jelly (AD3) based) were evaluated in comparison with standard diet (Protinex + Honey). All the tested diets influenced the egg-laying capacity of *M. boninensis*. The egg yolk-based diet resulted in more egg production than the other two diets. Among all diets the egg yolk-based diet is the best of the three diet combinations tested in view of high fecundity and survival rate of *M. boninensis* (Vasanthakumar *et al*., 2012).

Rearing in captivity needs good diet. Although there are so many reports available on the mass rearing procedures for several species of green lacewings (Venkatesan, 2002; Cohen and Smith, 1998; Vanderzant, 1969; Gautam and Navarajan Paul, 1987), studies focusing on the cost of effective mass rearing techniques for adult the green lacewing, *M. boninensis*, are limited. Therefore, it becomes necessary to mass produce them in cost effective manner in laboratory for release in the field. Hence the present experiment was planned using three different combinations of adult artificial diets.

MATERIALS AND METHODS

Mass culturing of *Mallada boninensis* on *C. cephalonica*

eggs

Grubs of *M. boninensis* were reared on *C. cephalonica* eggs kept inside separate small plastic bottles (3 cm diameter) closed with lid. Fresh eggs were given till the pupation of the grubs. Pupa were collected and transferred to G.I. round troughs for adult emergence. The adults were collected daily and transferred to pneumatic glass troughs or G.I. round troughs (30 cm x 12 cm). Before allowing the adults, the rearing troughs were wrapped inside with brown sheets, which act as egg receiving card. About 250 adults (60% females) were allowed into each trough and covered with georgette cloth secured by rubber band. On the cloth outside three bits of foam sponge (2 sq.inch) dripped in water is kept. Besides an artificial protein rich diet was provided in semisolid paste form in three spots on the cloth outside. This diet consisted of equal parts of yeast, fructose, honey, Proteinex R and water. The adults lay eggs on the brown sheet. The adults were collected daily and allowed into fresh rearing troughs with fresh food. From the old troughs, the brown paper sheets along with *Mallada* eggs were removed. Emerged grubs were collected and rearing was continued for getting a steady supply of grubs for different experiments. Two to three days old adults were used for various experiments.

Adult diets

Newly emerged adults from the mass culture were sexed and pairs of male and female introduced into plastic containers (12.5 cm × 12.5 cm) provided with different combinations of artificial diets. Diets were provided in cotton swabs stuck on the periphery of the container. The adult male and female kept in each container were fed with the same type of diet continuously from the day of emergence until death. Pure water was also given in swabs in addition to the diets, as described by Krishnamoorthy (1984). Fresh diets were given every day. The top and peripheral sides of the plastic containers were covered with opaque paper to prevent the penetration of light from outside and as a provision for egg laying. The adult-rearing containers were checked carefully every day until the first egg was laid to determine the pre-oviposition period. Egg masses were harvested periodically and placed in separate containers for hatching. Hatchability, survival of grubs and adult emergence were recorded. The number of eggs laid by a single female during the life span was observed to record the fecundity. Data on the oviposition period were also recorded. Experiments were continued until the death of the female to record adult longevity. Dead males were replaced with new males of the same age group from the laboratory stock culture as described by Duraikkannu vasanthakumar *et al*. (2012). Experiments were replicated five times. Diet combinations are following.

Ingredients	SD	AD 1	AD 2	AD 3
Proteinex	20gm	60gm	-	-
Yeast	20gm	-	-	-
Honey	20gm	-	-	-
Sugar	20gm	-	-	-
Glucose	-	40gm	-	-
Egg	-	-	25ml	35ml
Milk	-	-	50ml	45ml
Honey	-	-	25ml	30ml
Water	30ml	250ml	-	-

SD - Standard Diet; AD – Artificial Diet

RESULTS AND DISCUSSION

There was a marginal difference in the pre-oviposition period, when reared on different artificial diets. Lowest pre-oviposition period of 6.28 days was recorded on AD 3 and highest preoviposition period of 7.18 days was recorded on AD 1 (Table 1). Lowest oviposition period was recorded on AD 3 with 34.9 days and highest oviposition period was recorded on AD 1 with 37.1 days. Males survived for 38 days on AD 1 and AD 3 followed by 37 days on SD and 35.9 days on AD 2. Females survived for longer period on AD 2 and AD3 with 54 days followed by 52 days on AD 1 and 51 days on SD. Number

Table 1: Longevity and reproduction of *Mallada boninensis* on different adult artificial diets

Artificial Diets	Period in days (Mean ± S.E) Pre-oviposition period		Oviposition period Male	Longevity Female	No.eggs laid/day	Total No.of eggs laid
SD	6.73 ± 0.01b	36.9 ± 0.24a	37.16 ± 0.13b	51.68 ± 0.23c	6.46 ± 0.02d	232.1 ± 0.48c
AD1	7.18 ± 0.01a	37.1 ± 0.34b	38.04 ± 0.16a	52.88 ± 0.19b	5.70 ± 0.22c	210.28 ± 0.26d
AD2	6.36 ± 0.01c	35.9 ± 0.21c	35.9 ± 0.20c	54.26 ± 0.11a	10.2 ± 0.04b	367.84 ± 0.32b
AD3	6.28 ± 0.02d	34.9 ± 0.18d	38.04 ± 0.16a	54.04 ± 0.28a	10.75 ± 0.10a	377.68 ± 0.32a
SEd	0.02	0.36	0.23	0.30	0.17	0.50
CD(0.05)	0.05	0.7	0.50	0.65	0.38	1.08

Values are mean of five replications. Means followed by a common letter(s) are not significantly different by DMRT (P = 0.05). SD: Standard Diet. AD: Artificial Diet.

Table 2: Hatchability, survival and adult emergence of *Mallada boninensis* on different adult artificial diets

Artificial Diets	Hatchability (%)	Larval survival (%)	Adult emergence (%)
SD	89.28 ± 0.25c	89.44 ± 0.26c	94.68 ± 0.17a
AD1	90.48 ± 0.28b	89.20 ± 0.29c	94.78 ± 0.21a
AD2	91.56 ± 0.06a	90.66 ± 0.07b	95.18 ± 0.24a
AD3	91.96 ± 0.20a	91.48 ± 0.10a	95.42 ± 0.17a
Sed	0.30	0.29	0.29
CD(0.05)	0.65	0.63	0.02

Values are mean of five replications. Means followed by a common letter(s) are not significantly different by DMRT (P = 0.05). SD: Standard Diet. AD: Artificial Diet.

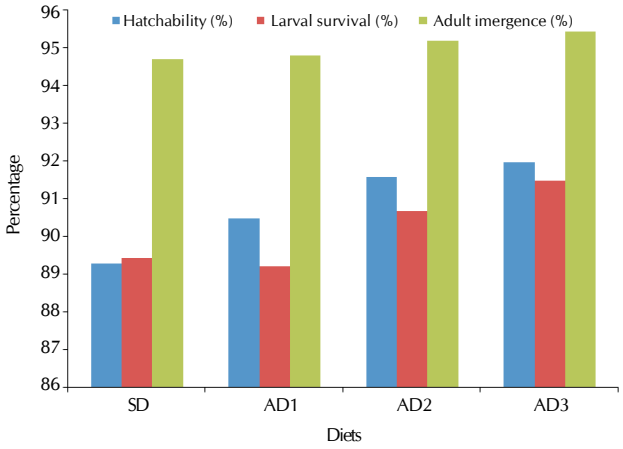

Figure 1: Hatchability, survival and adult emergence of *Mallada boninensis* on different adult artificial diets

of eggs laid per day was more with 10.75 eggs, when females were fed with AD 3 followed by AD 2 with 10.2 eggs, SD with 6.4 eggs and AD 1 with 5.7 eggs. Total number of eggs laid was significantly more on AD 3 with 377 eggs followed by AD 2 with 367 eggs, SD with 232 eggs and AD 1 with 210 eggs. Hatchability varied between 89.2-91.9 per cent in all the diets tested. Hatchability was more on AD 3 with 91.9 per cent and less on SD with 89.2 per cent. Larval survival percentage was more on AD 3 with 91.4 per cent followed by AD 2 with 90.6 per cent, SD with 89.4 per cent and AD 1 with 89.2 per cent. Adult emergence was more in AD 3 with 95.42 per cent followed by AD 2 with 95.1 per cent, AD 1 with 94.7 per cent and SD with 94.6 per cent (Table 2).

Marginal difference in the pre-oviposition period was noticed, when reared on different artificial diets. This can be attributed to variations in the amino acid content in the three different diets provided to the predator (McFarlane, 1985) because the maturation of the ovary and development of eggs occur during the pre-oviposition period (Slansky and Scriber, 1984). Results on the pre-oviposition period are in line with Lee and Lee (2005), who reported that the pre-oviposition period of *Chrysopa pallens* was influenced by different adult diets and Muhammad Nawaz *et al*. (2008), who observed that vitamin E offered to the adults of *C. carnea* (Stephens) as a supplement diet proved most suitable resulted in minimum pre-oviposition period (3.27 days), long oviposition (53.71 days) and post-oviposition period (5.90 days), longevity of male (62.54 days) and female (66.77 days), fecundity (238.87) and length of adult (8.90mm) of *C. carnea*. Females survived for longer period on AD 2 and AD3 which indicates the suitability of diet to the predator. Milevoj (1999) reared adults of *C. carnea* on adult diet consisting of milk, eggs, fruits sugars and yeast and found a favourable effect on fecundity. Higher fecundity observed in diet containing egg yolk is because as egg yolk is rich in protein (amino acids). There are 15.5% amino acids as compared to egg white and mixed egg which contain 9.8% and 11.95% respectively (Norioka *et al.*, 1984). McEwen and Kidd (1995) observed that the different components of artificial diets play an enormous role in egg productivity by adult green lacewings similarly the number of eggs laid by a single female *M. boninensis* was significantly influenced by the different artificial diets tested as adult nutrition is a very important factor for egg production and longevity in the case of insects (Morales *et al.*, 1996).

Hatchability, larval survival and adult emergence (Fig. 1) were more on AD 2 and AD3, which indicated the better suitability of the egg yolk based diet to the predator *M. boninensis*. The egg yolk-based diet resulted in a higher fecundity than the other diets. A similar result was reported by Ulhaq *et al*. (2006) in *Chrysoperla carnea,* when it was reared on an egg yolk-based artificial diet. The reason for the higher fecundity may be the presence of large amount of essential components like amino acid and the folic acids responsible for egg production as described by Ulhaq *et al*. (2006). Similar result was also reported by Duraikkannu vasanthakumar *et al*. (2012) in *M. boninensis* when reared on egg yolk based diet. Lee and Lee (2005) reported that *Chrysopa pallens* laid a maximum of 48.8 eggs per day and a minimum of 19.3 when maintained on different artificial diets. Several authors reported that the egg laying capacity of adults was influenced by artificial diets (Sundby, 1967; Gan *et al.,* 2011; Unnithan and Mathenge, 1983). Results were in contrast with the findings of Krishnamoorthy (1984) who reported that the egg hatchability of green lacewing *Chrysopa scelestes* was not affected, when this predator was fed with artificial diets. Further studies on the addition and deletion of certain components to improve the egg laying capacity and survival of *M. boninensis* are needed to make it an economically viable method for the mass multiplication of this species for utilizing them in an integrated pest management program.

ACKNOWLEDGEMENT

Authors are grateful to the Department of Science and Technology, Government of India for providing necessary help by providing Inspire fellowship to the senior author.

REFERENCES

Abhishek shukla and Darshana, S. Jadhav. 2014. Biology of *Coccinella transversalis* (fabricius) on different aphid species. *The Bioscan*. **9(1):** 17-22.

Chang, C. P. and Huang, S. C. 1995. Evaluation of the effectiveness of releasing green lacewing, *Mallada basalis* (Walker) for the control of tetranychid mites on strawberry. *Plant Protection Bulletin* (Taipei), **37(1):** 41-58.

Cohen, A. C. and Smith, L. K. 1998. A new concept in artificial diets for *Chrysoperla carnea*: the efficacy of solid diets. *Biological Control*. **13:** 49-54.

Duraikkannu vasanthakumar, Roobakkumar, A. Rahman, V. J. Kumar, P. Sundaravadivelan, C. and Babu, A. 2012. Enhancement of the reproductive potential of *Mallada boninensis* okamoto (Neuroptera: chrysopidae), a predator of red spider mite infesting tea: an evaluation of artificial diet. *Archieves of Biological Sciences Belgrade*. **64(1):** 281-285.

Gan, B. C. Lu, L. L. Wei, J. H. Xu, M. H. and Zhou, Y. K. 2011. Effects of two artificial diets on the development and reproduction of *Tirathaba rufivena* (Walker) (Lepidoptera: Pyralidae). *Biocontrol Science and Technology*. **21(5):** 563-572.

Gautam, R. D. and Navarajan Paul, A. V. 1987. An artificial diet for the larvae of green lacewing, *Chrysopa scelestes* Banks (Neuroptera:

Chrysopidae). *J. Entomological Research*. **11(1):** 69-72.

Krishnamoorthy, A.1984. Influence on the adult diet on the fecundity and survival of the predator, *Chrysopa scelestes* (Neuroptera: Chrysopidae). *Entomophaga*. **29(4):** 445-450.

Lee, K. S. and Lee, J. H. 2005. Rearing of *Chrysopa pallens* (Rambur) (Neuroptera:Chrysopidae) on artificial diet. *Entomological Research*. **35(3):** 183-188.

Lingren, P. D. Ridgway, R. L. and Jones, S. L. 1968. Consumption by several arthropod predators of eggs and larvae of two heliothis species that attack cotton. *Annals of Entomological Society of America*. **61:** 613-618.

McEwen, P. K. New, T. R. and Whittington, A. 2001. Lacewings in the Crop Environment. *Cambridge University Press, Cambridge, UK:* p. 546.

McEwen, P. K. and Kidd, N. A. C. 1995. The effects of different components of an artificial food on adult green lacewing (*Chrysoperla carnea*) fecundity and longevity. *Entomologia Experimentalis et Applicata*. **77:** 343-346.

Mcfarlane, J. E. 1985. Nutrition and digestive organs. In: Blum, M.S. (ed), Fundamentals of Insect Physiology. *J. Wiley and Sons, Inc.* New York. pp. 59-90.

Milevoj, L. 1999. Rearing of the common Green lacewing (*Chrysoperla carnea* Steph.) in the laboratory Zbornik. Biotehniske. Fakultete. *Univerze v. Ljubljani. Kmetijstvo*. **73:** 65-70.

Morales, J. Rogas, M. G. and King, E. G. 1996. Significance of adult nutrition on longevity and attainment of full fecundity of *Catolaccus grandis* (Hymenoptera: Pteromalidae). *Annals of the Entomolgical Society of America*. **89(4):** 555-563.

Muhammad Nawaz, Muhammad Ashfaq and Amjad Ali. 2008. Studies on improvement of artificial diet and its effect on biological characters of *Chrysoperla carnea* (stephens). *Pakistan Entomology*. **30(1):** 73-76.

Nikitha, S., Awasthi, Barkhade, U. P., Patil, S. R. and Lande, G. K. 2013. Comparative toxicity of some commonly used insecticides to cotton aphid and their safety to predatory coccinellids. *The Bioscan*. **8(3):** 1007-1010.

Nehare, S. K. Deotale, V. Y. Deotale, R. O. and Dawane, P. N. 2004. Biology and predatory potential of *Mallada boninensis* (Okamoto) against sucking pests. *J. Soils and Crops*. **14(2):** 427-432.

Norioka, N. Okada, Hamazume, T. Y. Mega, T. and Ikenaka, T. 1984. Comparison of nutritive value of egg yolk and egg white and whole egg. *J. Biochemistry*. **97:** 19-28.

Ridgeway, R. L. and Jones, S. L. 1968. Field cage releases of *Chrysopa carnea* for suppression of populations of the bollworm and the tobacco budworm on cotton. *J. Economic Entomology*. **61:** 892-898.

Ridgeway, R. L. and Jones, S. L. 1969. Inundative releases of *Chrysopa carnea* for control of *Heliothis* on cotton. *J. Economic Entomology*. **62:** 177-180.

Scopes, N. E. A. 1969. The potential of *Chrysopa carnea* as a biological control agent of *Myzuz persicae* on glass house chrysanthemum. *Annals of Applied Biology*. **64:** 433-439.

Slansky, F. and Scriber, J. M. 1984. Food consumption and utilization. In: Kerkut, G. A. and L.I. Gilbert (eds), Comprehensive insect physiology biochemistry and pharmacology. *Pergamon Press, Oxford*, **4:** 88-151.

Sundby, R. A. 1967. Influence of food on the fecundity of *Chrysopa carnea* (Stephens) (Neuroptera: Chrysopidae). *Entomophaga*. **12(4):** 475-479.

Ulhaq, M. M. Sattar, A., Salihah, Z., Farid, A., Usman, A. and Khattak, S. U. K. 2006. Effect of different artificial diets on the biology of adult green lacewing (*Chrysoperla carnea* Stephens). Songklanakarin *J. Science and Technology*. **28:** 1-8.

Unnithan, G. C. and Mathenge, D. N. 1983. Influence of honeydew and artificial adult diets on longevity, fecundity and fertility of the sorghum shootfly, *Atherigona soccat**a*** Rond. (Diptera: Muscidae) Zeitschrift für Angewandte *Entomologie*. **95:** 102-108.

Vanderzant, E. S. 1969. An artificial diet for larvae and adults of *Chrysopa carnea*, an insect predator of crop pests. *J. Economic Entomology*. **62:** 256-257.

Venkatesan, T. Singh, S. P. Jalalli, S. K. and Sadhana, P. 2002. Rearing of *Mallada astur* (Neuroptera: Chrysopidae) on a semi synthetic diet. *Pest Management in Horticultural Ecosystems*. **8(2):** 121-125.