Volume : 3 | Issue : 4 | April 2014 • ISSN No 2277 - 8160

Research Paper Zoology

Fecundity, Life Tables and Intrinsic Rate of Increase in Lace Bug *Cochlochila Bullita* (Stal), A Pest Of Medicinal Plant, Tulsi *Ocimum Sanctum* L. in Maharashtra, India

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ABSTRACT

Tulsi Ocimum sanctum L. (Liniaceae) is an important ayurvedic medicinal plant with diverse uses in the perfumery, toiletry, cosmetic industry and food stuff confectionery. It is cardiotonic, depurative, themogenic, condimentive and also has fungicidal insecticidal and antifeedant activities against insects. Cochlochila bullita (Stal) (Hemiptera : Tingidae) is very destructive pest of O. sanctum. Therefore, conservation and protection of this plant is essential part. Hence, fecundity, life tables and intrinsic rate of increase of C. bullita on O. sanctum under laboratory conditions (27±1oC, 70-75% RH, 12 hr photoperiod) have been reported. The average period of immature stages was 18 days. Adult longevity and oviposition days averaged 20.1 days and 10.8 days respectively. The progeny production averaged 77.8 individuals with average sex ratio (male : female) 1:2.02. The mean maximum female progeny production per female mx was 10.9 on 5th day. The first adult mortality was noted on 10th day and the intrinsic rate of increase was 0.177 per female per day and population multiplied 51.32 times in mean generation time 'T' of 22.24 days.

KEYWORDS : Fecundity, life tables, intrinsic rate of increase, Cochlochila bullita, Tulsi Ocimum sanctum.

Introduction

Ocimum sanctum L. (Tulsi) (Family – Liniaceae) is an important ayurvedic medicinal plant with diverse uses in the perfumery, toiletry, cosmetic industries, food stuff confectionery and condiments. It acts as cardiotonic, depurative and therogenic in epidemiology. It has also fungicidal, insecticidal and antifeedant activities against insect pests. The genus *Ocimum* is widely distributed in Indian subcontinent with about 160 species. However, *O. sanctum* and *O. basilicum* are very prominent in Kolhapur region. Some hybrids are also being cultivated in India (Balyan & Pushpangadan, 1988). However, the lace bug *Cochlochila bullita* (Stal.) (Hemiptera : Tingidae) is a very destructive pest of *O. sanctum* (Arvind Kumar, 2013). Its biology, morphometrics and damage has been studied by some workers (Butani, 1982; Dhanasekaran, 2009) on *O. sanctum;* Palaniswami & Pillai (1983) on Chinese potato and Sajap & Peng (2010) on *Orthosiphon stamineus* Bentham.

For control of insect pests, the essential objects are to make the estimates of the rate of growth of the pest insects (Howe, 1953). The inherent characteristic of the animals are collectively called the "innate capacity for increase". Thompson (1924) for the first time developed mathematical model for population dynamics of insects. Later, Lotka (1925) derived a function to investigate intrinsic rate of natural increase which was elaborated by Birch (1948) and Watson (1964). In past, life tables and intrinsic rate of increase in hemipteran insects were attempted by Messenger (1964), DeLoach (1974), Verma & Makhmoor (1988), Sundararaju & Babu (1998), etc. But no attempt has been made on the present form C. bullita either on O. sanctum or other crop plants. Keeping in view all above facts, present work was carried out.

Materials And Methods

Life tables of *C. bullita* were constructed as per the methods given by Birch (1948), Howe (1953) and Watson (1964). The culture of *C. bullita* was started in the laboratory (27±1°C, 70-75%, 12 hr photoperiod) on host plant Tulsi *O. sanctum*. The observations were taken on immature stages, life cycle, progeny production, sex ratio, adult longevity and oviposition period. The fecundity data was used to construct life tables and further intrinsic rate of increase was calculated (Birch, 1948; Watson, 1964). For rearing of bugs newly emerged adult sexes were placed separately in vials and then caged with pair (1 male and 1 female) either in individual test tube or plastic container for mating. After mating, mated females were allowed to lay eggs on *O. sanctum* twigs. The oviposited twigs then separated for further rearing of pest stages viz. nymphs and adults in glass cages (25 x 25 x 25 cm, LWH).

Results

The results are recorded in tables 1 to 5 and Fig-1. The average period of immature stages was 18 days. The adult females survived for 20.1 days (range 18 to 22 days) and oviposition days averaged for 10.8 days (range 8 to 12 days). The progeny production averaged 77.8 days (72 to 82) with an average sex ratio (male : female) 1:2.02 (range 1:1.18 to 1:3.15). The first adult mortality was noted on the 10th day and maximum mean progeny production per day, m_x was 10.90 on 5th day. The intrinsic rate of increase was 0.177 (by graph) per female per day and population multiplied 51.32 times in mean generation time 'T' of 22.24 days.

$$T_c = \frac{l_x m_x x}{l_x m_x} = \frac{1171.56}{51.32} = 22.62$$

Where 'T_c' is arbitrary 'T'

$$r_c = \frac{\log e\ Ro}{Tc} = \frac{\log e\ 51.32}{22.82} = 0.172$$

where 'r_c' is arbitrary 'r_m'

Now arbitrary r_ms are 0.15 and 0.19
r_m = 0.177 (by graph)

$$T_c = \frac{\log e\ 51.32}{0.177} = 22.24\ , \quad T = 22.24$$

In natural field, the pest is multivoltine, its population peak is from August to November but found throughout the year on *O. sanctum* from Western Maharashtra.

Discussion

Life table statistics and intrinsic rate of increase have been widely attempted in different orders of insects, Morris and Miller (1954) worked on *Choristoneura fumiferana* (Lepidoptera), Rhichards & Waloff (1961) on *Phytodecta olivacea* (Coleoptera), Mclead (1972) on *Neodiprion swainai* Midd (Hymenoptera) etc. However, very little attention is given on Hemipteran insects. Verma and Makhmoor (1988) constructed the life and fertility tables for the Cobbage aphid, *Bravicoryne brassicae* (Linn.) (Homoptera : Aphididae) under laboratory conditions on 6-7 weeks old cauliflower plants. The cohort had the maximum longevity of 33 days and the maximum period of reproduction was 15 days. The maximum average production of progeny was 5.75 nymphs per female per day on the 22nd and 25th day of life span. The species had the true generation time (T) of 21.71 days during which it multiplied 49.80 times (R_o). The intrinsic rate of natural increase (r_m) was 0.179 per female per day and the populations doubled in 3.87 days. The finite rate of increase (λ) was 1.196, the species multiplied 1.196 times per day.

The aphid started producing young ones on the 17th day with a mean production of 4.75 nymphs female/day. However, Siddiqui *et al*., (1973) reported slightly faster development with fluctuating temperatures in *B. brassieae*.

Sundararaju and Babu (1998) studied life tables and intrinsic rate of increase of *Helopeltis antoni* Sign. (Heteroptera : Miridae) on neem, guava and cashew. *H. antoni* is major pest in South India on neem, guava and cashew, wherein the net reproductive rate indicating the total female births (Ro) was 65.63, 40.21 and 22.17; the population increased with an infinitesimal rate (r_m) of 0.1255, 0.0857 and 0.1215; and finite rate (λ) of 1.134, 1.09 and 1.29 female per day and a generation was completed in 33.35, 43.12 and 25.51 days on neem, guava and cashew respectively. The stable age distribution (%) of eggs, nymphs and adults on these three hosts ranged from 65.883 to 68.499, 27.675 to 29.233 and 4.146 to 4.888 respectively. Inspite of higher Ro value on guava than cashew, the r_m value was low on guava. Actually, r_m value was influenced by T value. It was also demonstrated in cotton where shorter generation time (T) favoured high reproduction fitness (r_m) (Trichilo and Leigh, 1985). For rapid population buildup, two factors were involved. Firstly, the age of oviposition and secondly the fecundity (Birch, 1948).

In *H. antoni* prolonged oviposition was recorded on neem and guava but pest multiplied more rapidly on neem than on guava in a short period under favourable conditions and also sustained under unfavourable conditions on both the plants. On cashew it multiplied shortly only under favourable conditions while the present form *C. bullita* oviposited on *O. sanctum* for average of 10.8 days. The progeny production averaged 77.8 individuals with average sex ratio male : female 1:2.02, favouring the females. The first adult mortality was noted on 10th day and maximum mean progeny production of females per day m_x was 10.9 on 5th day. The intrinsic rate of increase was 0.177 and population multiplied 51.32 times in mean generation time 'T' of 22.24 days indicating the tremendous potential of this pest to destruct the very economical and medicinal plant *O. sanctum* in Western Maharashtra. Naturally, in the field *C. bullita* was observed from June to December on large scale from Western Maharashtra, India. However, it is found throughout the year. Kumar and Bhatnagar (2012) reported its population peak from August to November in Tamil Nadu. Inspite of heavy rain and high wind velocity in Western Maharashtra, *C. bullita* occurred on large scale causing 100% damage to crop in the region as multivoltine pest. Hence, there is need to find out any natural enemies of this pest from Western Maharasshtra as ecofriendly pest control strategy.

Table -1 : Longevity, oviposition, fecundity and sex ratio of mated females of *C. bullita*

Female No.	Adult Longevity (days)	oviposition days	Progeny production			Sex ratio
			Male	Female	Total	Male : Female
A	20	10	19	60	79	1: 3.15
B	21	12	24	57	81	1: 2.37
C	18	8	23	51	74	1 : 2.21
D	19	10	29	46	75	1 : 1.58
E	22	12	31	51	82	1 : 1.64
F	19	10	33	39	72	1 : 1.18
G	21	12	28	52	80	1 : 1.85
H	20	11	25	56	81	1 : 2.24
I	20	11	30	48	78	1 : 1.60
J	21	12	22	54	76	1 : 2.45
AVG.	20.1	10.8	26.4	51.4	77.8	1 : 2.02

Table -2 : Daily production of females *C. bullita*

Replicate	Daily production of females											
	1	2	3	4	5	6	7	8	9	10	11	Total
A	1	4	6	5	12	10	9	7	4	2	D	60
B	1	3	6	9	14	9	7	5	2	1	D	57
C	2	3	5	10	13	8	6	3	1	D	-	51
D	1	2	6	10	11	6	7	2	1	D	-	46
E	1	2	7	11	11	10	6	2	1	D	-	51
F	1	3	12	10	7	4	1	1	-	D	-	39
G	1	4	10	12	10	7	5	2	1	-	D	52
H	2	5	10	12	11	8	4	2	1	1	D	56
I	1	3	7	11	10	7	5	3	1	D	-	48
J	2	7	11	13	10	5	3	2	1	-	D	54
AVG.	1.3	3.6	8.0	10.3	10.9	7.4	5.3	2.9	1.3	0.4	0	51.4

Table -3 : Life table statistics of *C. bullita*

Pivotal age (days) x	Proportional live at age lx	No. of female progeny / female (m_x)	$l_x m_x$	$l_x m_x X$
Immature stages - 18 days				
19	1	1.3	1.3	24.70
20	1	3.6	3.6	72.00
21	1	8.0	8.0	168.00
22	1	10.3	10.3	226.60
23	1	10.9	10.9	250.70
24	1	7.4	7.4	177.60
25	1	5.3	5.3	132.50
26	1	2.9	2.9	75.40
27	1	1.3	1.3	35.10
28	0.8	0.4	0.32	8.96
29	0.0	0.00	0.00	0.00
		Σ	51.32	1171.56

Table - 4 : Provisional rm(0.15) for *C. bullita* and related values of e^{7}-$r_{mx}l_x m_x$

X	r_{mx}	^{7}-r_{mx}	e^{7}-r_{mx}	e^{7}-$r_{mx} l_x m_x$
19	2.85	4.15	63.43	82.45
20	3.00	4.00	54.59	196.52
21	3.15	3.85	46.99	375.92
22	3.30	3.70	40.44	416.53
23	3.45	3.55	34.81	379.42
24	3.60	3.40	29.96	221.70
25	3.75	3.25	25.79	136.68
26	3.90	3.10	22.19	64.35
27	4.05	2.95	19.10	24.83
28	4.20	2.80	16.44	5.26
29	4.35	2.65	14.15	0.00
				1903.66

Table - 5 : Provisional rm(0.19) for *C. bullita* and related values of e^{7}-$r_{mx}l_x m_x$

X	-r_{mx}	^{7}-r_{mx}	e^{7}-r_{mx}	e^{7}-$r_{mx} l_x m_x$
19	3.61	3.39	29.66	38.55
20	3.80	3.20	24.53	88.30
21	3.99	3.01	20.28	162.24
22	4.18	2.82	16.77	172.73
23	4.37	2.63	13.87	151.18
24	4.56	2.44	11.47	84.87
25	4.75	2.25	9.48	50.24
26	4.94	2.06	7.84	22.73
27	5.13	1.87	6.48	8.42
28	5.32	1.68	5.36	1.71
29	5.51	1.49	4.43	0.00
				780.97



Fig-1: Tulsi twig with *C. bullita*

REFERENCES

Arvind Kumar (2013). The lace bug Cochlochila bullita (Stal.), a destructive pest of Ocimum sanctum in Jharkhand, India. Phytoparasitica, DOI 10.1007/s 12600-013-0359-0 Springer. Bhasin, M. (2012). Ocimum. Taxonomy, medical potentialities and economic value of essential oil. Journal of Biosphere, 1, 48-50. Birch, L.C. (1948). The intrinsic rate of natural increase in an insect population. J. Anim. Ecol. 17, 15-26. Butani, D.K. (1982). Insect pests of tulsi (Ocimum sanctum Linnaeus) and their control. Pesticides, 16, 11-12. DeLoach, C.J. (1974). Rate of increase of population of cabbage, green peach and turnip aphids at constant temperature. Ann.ent.soc.Am; 63(3), 332-340. Dhanasekaran, S. (2009). Bioecology of Cochlochila bullita (Stal.) (Tingidae : Hemiptera). Hexapoda, 16, 141-148. Howe, R.W. (1953). The rapid determination of intrinsic rate of increase of an insect population. Appl. Biol., 40, 134-155. Lotka, A.G. (1925). Elements of physical biology. Williams & Wilkins, Baltmore, MD pp.462. Palaniswami, M.S. & K.S. Pillai (1983). Biology of Cochlochila bullita (Stal.), a pest of Chinese potato. Journal of Root crops, 9, 59-62. Sajap A.S. & Peng, T.L. (2010). The lace bug Cochlochila bullita (Stal.), (Heteroptera : Tingidae), a potential pest of Orthosiphon stamineus Bentham (Lamiales : Lamiaceae) in Malaysia. Insect Mundi, 0136, 1-5. Morris R.F. and Miller C.S. (1954). The developments of life tables for the spruce bud worm. Can. J. Zool., 32, 282-301. Messenger, P.S. (1964). Use of life tables in a bioclimatic study of an experimental aphid-braconid wasp host parasite system. Ecology, 45(1), 119-131. McLead J.W. (1972). The swaine Jack pine sawfly Neodiprion swalonei life system : Evaluating the long term effect of insecticide application in Quebec. Environ. Entomol. 1, 371-378. Richards, O.W. and Waloff, N. (1961). A study of a natural population of Phytodecta olivacea (Foerster) (Coleoptera : Chrysomelidae). Phil. Trans. Roy. Soc. London B, 244, 205-257. Sundararaju, D. and P.C.S. Babu (1998). Life table studies of Helopeltis antonii Sign. (Heteroptera : Miridae) on neem, guava and cashew. J. ent. Res., 22(3), 241-244. | Siddiqui, W.H., C.A. Barlow and P.A. Randolph (1973). Effects of some constant and alternating temperatures on population growth of the pea aphid. Acyrthosiphum pisum (Homoptera : Aphididae). Can. Ent.. 105, 145-156. Trichilo, P.G. and Leigh T.F. (1985). The use of life tables to assess varietal resistance of cotton to spider mites. Ent. Exp. Appl., 39, 27-33. Thompson, W.R. (1924). La theorie mathematiane deiaction des parasites entomophages et.le.lacteus duhasur d. Annis. Fal. Sci. Morscilla, 2, 69-89. Verma A.K. and H.D. Makhmoor (1988). The intrinsic rate of natural increase of the cabbage aphid, Brevicoryne brassicae (Linn.) (Homoptera : Aphididae) on cauliflower. Entomon, 13(1), 51-56. Watson, T.F. (1964). Influence of host plant conditions on population increase of Tetranychus telarius (Linnaeus). Hilgardia, 35, 275-322.