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Biology of *Anagyrus punctulatus* Agarwal, a Parasitoid of *Saccharicoccus sacchari* (Cockerell) and Residual Toxicity of Certain Insecticides to Adult Parasitoids

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ABSTRACT

Biology of *Anagyrus punctulatus* Agarwal, a parasitoid of sugarcane mealybug was studied. The egg to adult emergence period was 15.2, 29.0 and 12.6 days during December, January and March, respectively. The mean fecundity was 29.7 eggs per female with an oviposition period of 6.3 days. A female parasitized 6.6 hosts during its life span of 10.9 days. The female parasitoids survived longer (28.3 days) in December and shorter (5.5 days) in March. Population of females doubled that of males (2.0-3.6:1) during October-December under field conditions. Parasitism of mealybug ranged from 20.8 to 38.8 per cent during the year. Maximum parasitism was recorded during January and February and the activity ceased during August - September.

Studies on residual toxicity of nine insecticides against *A. punctulatus* adults revealed that fenvalerate, dimethoate, endosulfan and formothion were less toxic on 7th day of application. Fenvalerate had the shortest residual toxicity among all the tested insecticides.

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INTRODUCTION

The sugarcane pink mealybug, *Saccharicoccus sacchari* (Cockerell) (Homoptera : Pseudococcidae) was found associated with eight natural enemies, five parasitoids and three predators, in Saurashtra region of Gujarat State (Patel and Mittal, 1989). Among them, the encyrtid, *Anagyrus punctulatus* Agarwal was found most important in regulating the mealybug population. This parasitoid was recorded for the first time, whereas *Anagyrus saccharicola* Timberlake was reported from Hawaii (Pemberton, 1932), India (Butani, 1972), Thailand (Napompeth, 1990), Bolivia (Pruett and Colque, 1984) and Australia (Inkerman *et al.*, 1986). Patel and Mittal (1989) studied about its development. In the present investigation, studies were carried out on the biology, development and impact of insecticides on *A. punctulatus*.

MATERIALS AND METHODS

The period from egg to adult emergence was determined by releasing *A. punctulatus* adults in glass tubes (16 x 4 cm) which contained mealybugs glued to cardboard strip

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(10 x 3 cm). This cardboard strip was replaced every day. The parasitized mealybugs were kept separately for recording the adult emergence. Ten pairs of parasitoids were confined individually in glass tube containing 10 healthy mealybug glued on small cardboard strip for studying the fecundity. The host was replaced daily till the death of the female parasitoid. The mealybugs parasitized by individual female was kept separately for adult emergence. Fecundity was calculated on the basis of number of adults emerged out from the total exposed mealybugs.

Periodical collections of mealybug from the sugarcane field were made to determine the natural parasitism. The collected mealybugs which glued on the cardboard were kept in the glass tube for the parasitoid emergence. After one month the mealybugs having the parasitiod emergence holes were counted and thus the percentage parasitism was worked out.

In order to find out the residual toxicity of insecticides to *A. punctulatus* adults, one day old adults were exposed to the insecticide treated sugarcane leaf. The sugarcane leaves were sprayed with the insecticide solution at recommended concentration, using stomizer, air dried for 2 hours and then the middle piece of the leaf was held in glass tube (10 x 3.5 cm). Test insects were introduced into tube and exposed for a period of 6 hours and then adult mortality was recorded. Untreated control was maintained using sugarcane leaves sprayed with water. Each treatment was replicated three time with ten adults (females) in each replication. The treated leaves were exposed at 1, 3, 7, 14 and 21 days after treatment. The persistence and relative efficacy of different insecticides was determined as per procedure followed by Pradhan (1967). The product (PT) of average residual toxicity (T) and the period (P) for which the toxicity persisted, was used as an index of persistent toxicity. The value of corrected percentage mortalities at various specified periods were added. This sum was then divided by the number of observations in order to obtain average residual toxicity (T).

RESULTS AND DISCUSSION

Egg to adult emergence period

The adults of this parasitoid started to emerge at 9.00 AM and 82.5 per cent of adults emerged out within 12.00 AM, while the remaining emergence was completed by 15.00 PM. The period for egg to adult emergence averaged 15.2, 29.0 and 12.6 days in December, January and March, respectively (Table 1). Chandler *et al.* (1982) reported the development time of *A. pseudococci* (Girault) to be 15.5 days.

TABLE 1

Egg to adult emergence period of *A. punctulatus.*

Period of study	*No. observed*	*Egg to adult emergence period (days)*		*Temp. (°C)*	*Relative humidity (%)*
		Average	*Range*		
6-12-90 to 24-12-90	111	15.2	13-18	24.3 ± 2.4	58.1 ± 5.0
8-12-90 to 5-1-91	217	27.1	21-28	22.5 ± 2.6	62.3 ± 7.3

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28-12-90 to 29-1-91	210	29.0	26-39	20.9 ± 2.5	62.3 ± 8.5
28-1-91 to 20-2-91	200	21.8	21-23	25.2 ± 2.6	59.0 ± 14.9
19-2-91 to 13-3-91	124	18.4	18-19	27.0 ± 2.7	57.7 ± 6.9
13-3-91 to 27-3-91	85	12.6	12-14	29.4 ± 1.8	53.2 ± 11.7

Fecundity

The sexes could be distinguished on the basis of antennal and abdominal structures. The females allowed the males for multiple matings. The females preferred mostly fourth instar mealybugs for oviposition and deposited their eggs within 30-45 seconds.

The pre-oviposition, oviposition and post oviposition periods averaged 1.7, 6.3 and 3.0 days, respectively (Table 2). The fecundity ranged from 11 to 58 with an average of 29.7. A female parasitized 4 to 10 mealybugs during its life span.

Longevity

The longevity varied widely according to changes in the temperature (Table 3). The females survived longer than males. The longevity of females was 12.4, 28.3 and 10.9 days

TABLE 2

Fecundity of *A. punctulatus* at 25.1 ± 2.3°C and 60.0 ± 12.6 % RH.

Particulars	*No. studied*	*Duration in days*	
		Average	*Range*
Pre-oviposition period	10	1.7	1-3
Oviposition period	10	6.3	5-8
Post-oviposition period	10	3.0	2-5
Fecundity	10	29.7	11-58
No. of host killed/female	10	6.6	4-10
Longevity Female	10	10.9	9-12
Male	10	8.0	4-11
Sex ratio (Female : Male)	297	1:1.25	–

on an average during December, January and February, respectively. In March the female parasitoids could not survive for more than 8 days. Chandler *et al.* (1982) reported the life span of *A. pseudococci* adults to be 6.2 to 8.2 days.

TABLE 3

Longevity of *A. punctulatus* during different months.

Period of study	*Longevity in days*				*Temp. °C*	*Relative humidity (%)*
	No. Studied	*Female*	*No. Studied*	*Male*		
5-12-90 to 28-12-90	72	12.4 (7-23)	30	6.5 (3-15)	24.1 ± 2.4	60.0 ± 5.9
13-12-90 to 17-1-91	16	28.3 (21-35)	15	15.0 (4-21)	21.6 ± 2.4	63.3 ± 7.6
17-2-91 to 1-3-91	10	10.9 (9-12)	10	8.0 (4-11)	25.1 ± 2.3	60.0 ± 12.6
6-3-91 to 14-3-91	420	5.5 (5-8)	(both sexes)		29.4 ± 0.9	55.0 ± 10.9

Figures in parentheses indicate the range.

Sex ratio

In field, the females preponderated to males. The female population was more than double to males during the months of October, November and December (2.00 - 3.64:1) and afterwards it declined but remained almost constant (1.12 - 1.28:1). However, in laboratory bred parasitoid progeny the sex ratio was observed to be 1 female : 1.25 males (Table 2).

Extent of parasitism

A. punctulatus, a gregarious parasitoid, parasitized almost late instar mealybugs. As many as 14 adults emerged from a single mealybug mummy. However, the number was dependent upon the host size. Each adult emerged from the host by making an individual hole.

TABLE 4

Parasitism by *A. punctulatus* in different months of the year 1990-91.

Month	*Total mealybugs observed*	*Parasitism (%)*
March	250	20.8
April	400	20.5
May	400	22.5
June	200	26.5
July	250	31.2
August	100	00.0
September	100	00.0
October	300	30.0
November	450	17.8
December	800	17.9
January	450	38.2
February	250	38.8

TABLE 5

Relative toxicity of different insecticides to *A. punctulatus* adults.

Insecticide	*Conc. (%)*	**Corrected per cent mortality at different intervals (days)*								
		1	*3*	*7*	*14*	*21*	*P*	*T*	*PT*	*RE*
Fenvalerate	0.02	46.67	20.00	3.33	00.00	00.00	7	41.67	291.69	1.00
Dimethoate	0.03	93.33	76.67	6.67	00.00	00.00	7	58.89	412.23	1.41
Endosulfan	0.07	73.33	66.67	30.00	00.00	00.00	7	67.50	472.50	1.62
Formothion	0.05	100.00	100.00	6.67	00.00	00.00	7	76.67	536.69	1.84
Monocrotophos	0.04	53.33	50.00	23.33	6.67	00.00	14	44.00	616.00	2.11
Phosphamidon	0.03	100.00	100.00	53.33	33.33	00.00	14	77.33	1082.62	3.71
Chlorpyriphos	0.05	100.00	100.00	50.00	43.33	10.00	21	67.33	1413.93	4.85
Quinalphos	0.05	100.00	100.00	96.67	73.33	20.00	21	81.67	1715.07	5.88
Malathion	0.05	100.00	100.00	100.00	70.00	23.33	21	82.22	1726.62	5.92

* Average of three replications

P = Period

T = Residual toxicity

PT = Production of P X T

RE = Relative efficacy

The data presented in Table 4 revealed that the percentage parasitism by *A. punctulatus* ranged from 20.8 to 38.8 during the months of March 1990 to February 1991. The level of parasitism increased from March (20.8%) to July (31.2%). The activity of the parasitoid ceased in August and September probably due to heavy rainfall. The activity reached the peak (38%) in January and Fubruary. Parasitism of mealybug was observed maximum (35.5%) on the upper portion of the cane as compared to middle (25.5%) and lower (15.3%) portions. Barro (1990) reported that the abundance of *A. saccharicola* appeared to be correlated to rainfall and accounted for 10.1 - 19.8 per cent parasitism in dry season and 0 - 1.3 per cent parasitism in wet season.

Residual toxicity of insecticides

The data (Table 5) indicated that dimethoate, fenvalerate, endosulfan and formothion were less toxic on the 7th day of application. Phosphamidon and monocrotophos were harmless on 14th day of application, while quinalphos, malathion and chlorpyriphos were toxic up to 21st day of application. On the basis of PT values, the highest PT value was recorded in malathion (1726.62), followed by quinalphos (1715.07), chlorpyriphos (1413.93) and phosphamidon (1082.62). The lowest PT value was recorded in fenvalerate (291.69), followed by dimethoate (412.23), endosulfan (472.50), formothion (536.69) and monocrotophos (616.00). These results showed that fenvalerate was the least persistent insecticide against *A. punctulatus* adults as compared to the other tested insecticides.

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