



OCCURRENCE & DISTRIBUTION OF *ZYGOGRAMMA BICOLORATA* PALLISTER (COLEOPTERA: CHRYSOMELIDAE) THE BIOCONTROL AGENT OF *PARTHENIUM HYSTEROPHORUS* L. IN RAHURI TALUKA

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Abstract: *Parthenium hysterophorus* L. is a serious weed in India, covering about 5 million ha of land. *Zygogramma bicolorata* Pallister the leaf beetle, Mexican was considered a safe biocontrol agent. It causes extensive damage to *Parthenium* plants. Its occurrences & distribution was studied in villages from Rahuri Taluka in Ahmednagar District of Maharashtra State, India. It is mainly influenced by Agricultural practices performed by Mahatma Phule Agricultural University hence it will be interesting to study the occurrence and distribution of *Zygogramma* on *Parthenium*. The adult beetles were collected during the months of June to December 2012-13. It is found to be a promising, safe biocontrol agent. Its distribution among farmers can help to control the weed. Total number of insects (Mexican beetle) collected from 15 groups / localities from Rahuri taluka (*Zygogramma* was collected from about 64 villages out of 80) is 4979 from June 2012 to December 2012. And it was 4915 for the year 2013. The average of the two years was 4947. The highest collection and occurrence was observed in village Kondawad. It was found to be 734 insects. Maximum collection / occurrence of insects observed were 418 and 353 in the Month of October in villages Kendal and Kondwad, respectively. Insects were not observed from January onwards as they go in to hibernation in winter season. The data on preference of food by *Z. bicolorata* on crop plants along with carrot weed indicate that the adults moved within about 3-15 minutes from crop plants to *Parthenium hysterophorus*, indicating that they are not polyphagous except sunflower. Its life cycle and morphology was studied. Duration of different life stages recorded. Foraging activity on *Parthenium* by *Apis florae* and *Apis indica* observed.

Key words: Occurrence, distribution, Carrot weed; *Parthenium hysterophorus*; *Zygogramma bicolorata*; Rahuri taluka.

INTRODUCTION

Carrot weed *Parthenium hysterophorus* (family Asteraceae), (Fig.1), is one of the world's worst weeds. The fast-growing weed is a nuisance in public parks, residential colonies and orchards. It is harmful to health of man & domestic animals. In Queensland, Australia, losses to the cattle industry due to parthenium have been estimated to be Au\$ 16 million per year in terms of control costs and loss of pasture¹. Biocontrol of parthenium was first initiated in Australia in 1977. Australia & India have proved that biological control of parthenium is possible & effective². In India, this weed was first reported from Pune in 1955³, it has spread through the country occupying 5 million hectares of land. *Zygogramma bicolorata* Pallister was introduced from Mexico in 1983 and host-specificity tests were carried out under quarantine conditions with 40 plants belonging to 27 families. After much research, Mexican beetles *Zygogramma bicolorata* Pallister, (Fig.2) were considered a safe biocontrol agent. Field cage studies showed that *Z. bicolorata* is able to breed under Bangalore conditions and cause extensive damage to *Parthenium* plants. It is proved that this insect is capable of feeding and reproducing only on *Parthenium*. Both the adults and larvae are capable of feeding on the leaves thus checking the plant growth and flower production. Adults defoliate the plant. Immature flowers are cut by the beetles in an effort to chew the soft tissues beneath the flowers. Completely defoliated plants start to show die-back symptoms and gradually get killed.

As this Beetle is exotic in India, became abundant within three years after introduction, resulting in a significant reduction in *Parthenium* density in local areas⁴ & ⁵. It is now widely used in India to control *Parthenium*. It has spread to about 2 million ha in the country with different status of establishment and spread. In some places it is

reared in the laboratory & released for the control of the weed. In India, a single adult *Z. bicolorata* per plant caused 85-100% defoliation within six to eight weeks, depending on the stage of plant growth⁴. The present project deals with the observation and recording of *Zygogramma bicolorata* in study area on *Parthenium*, its biology & rearing. Its occurrence & distribution near and around Rahuri city, and villages from Rahuri taluka, district Ahmednagar (MS). It was also aimed to find out the extent of control of weed by it, its effective role as biocontrol agent for *Parthenium*, and feeding choice on crop plants other than *Parthenium* by leaf beetle.

About Rahuri taluka

Rahuri is a Taluka in Ahmednagar District of Maharashtra State, India. Rahuri Taluka Head Quarters is Rahuri Khurd town. It is located 37 KM towards North from District headquarters Ahmednagar. It is 225 KM from State capital Mumbai towards west. Its geographical coordinates are 19° 23' 0" North, 74° 39' 0" East and its original name (with diacritics) is Rāhuri.

Jambhulban is the smallest Village and Vambori is the biggest Village. It is in the 519m elevation (altitude). It is mainly influenced by Agricultural practices performed by Mahatma Phule Agricultural University hence it will be interesting to study the occurrence and distribution of *Zygogramma* on *Parthenium*.

MATERIALS AND METHODS

Collection of *Zygogramma*: The adult beetles were collected on *Parthenium* weed in its natural environmental conditions from villages in the range of 30 km around Rahuri city. The villages selected in 15 groups were Vambori, MPKV, Digrus, Mulanagar, Baragaon

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nandur, Taklimiya, Manori, Rahuri city (college campus), Guha (Table1) etc. The adult beetles were collected during the months of June, July, August, September, October, November and December (2012-13) during study period as the beetles were more active in these months. The beetles were collected in plastic containers of 1 liter capacity along with its natural food i.e. leaves of *Parthenium*. The five samples were collected from selected locality during day time from 10 am to 5 pm in 1 m² area. The collected samples counted & then again released in the same habitat.

Rearing in laboratory: The adult females were selected after mating were placed in plastic containers of 1 liter capacity along with fresh parthenium leaves for feeding & egg laying. Females deposited eggs on lower side of parthenium leaves. The leaves containing eggs of *Zygogramma* were placed in separate plastic containers of 1liter capacity till they hatch at room temperature and at 25^o±1^oC in BOD incubator (Fig.2) & 60%-70% humidity. The newly hatched larvae were provided fresh parthenium leaves. The rearing was done in mass culture for studying feeding preference of *Zygogramma* on various crop plants along with its host plant.

Choice & no-choice tests (Table 3): for studying preference/selection of plants for feeding & oviposition, choice tests & no-choice tests trays of 6''w x 9''l size were used. For choice tests about 25 leaves of each crop plant were placed in half part of trays & 25 leaves of carrot weed

in other half on opposite side in trays were placed. The distance kept between test crop plant & host plant was about 3''-4''. Five adults were placed on each test crop plant every time & its behaviour in terms of locomotion/attraction towards its natural food, the parthenium was observed (Table 2). In no choice test only crop plants were provided to adults for feeding & oviposition. Each test replicated five times consisting of five adults in each replica.

RESULTS AND DISCUSSION

Survey was conducted from June to December 2012, 2013 of 64 villages out of 80 from Rahuri taluka on occurrence and distribution of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) the Biocontrol agent of *Parthenium hysterophorus* L. in Rahuri taluka''. Insects collected & were reared in BOD incubator (Fig.3, 4 a, & b). Total number of insects (Mexican beetle) collected from 15 groups / localities from Rahuri taluka is 4979 from June 2012 to December 2012 and 4915 for the year 2013. The average of the two years was 4947 (Table 1 & 2). The highest collection and occurrence was observed in village Kondawad (Fig. 8a). It was found to be 734 insects. Maximum collection / occurrence of insects observed were 418 and 353 in the Month of October in villages Kendal and Kondwad (Fig.8a), respectively. Insects were not observed from January onwards as they go in to hibernation in winter season.

Table 1: Occurrence of *Zygogramma bicolorata* from June 2012 to December 2013 in Rahuri taluka.

S.no.	Name of Village/group	No. of Insect Collected 2012	No. of Insect Collected 2013	Average
1	Kondwad (Shilegaon, Karparwadi)	734	730	732
2	Musalwadi (Mahaduk centre, Malunje kh, Tandulwadi, Khursngaon)	618	624	621
3	Kendal (Aradagaon, Manori)	642	648	645
4	Takalimiya (Vaghacha akhada, Morwadi, Pathare)	617	647	632
5	Manjari (Walan,Wanjulpoi, Tilapur)	196	186	191
6	Deolali Pravara (Ambi, Jatap, Lakh, Karaigaon Davangaon, Brahmngaon, Bodhegaon, Chandegaon)	422	456	439
7	Deswandi, (Shilegaon)	225	205	215
8	Rahuri factory, (Guha, Songaon, Stral, Klohar kh.)	79	70	74.5
9	Rahuri College Road,(Jogeshweri akhada, Tambhere, Nimbhere)	389	399	394
10	Malharwadi, (Momin akhada, Ghorpadwadi, Sakuri, Chinchala)	91	105	98
11	MPKV, Digras, Vambori Khadamba, Mulanagr	285	265	275
12	Baragaon nandur, (Vavar, Jambhali)	354	374	364
13	Chichvihire, Taharabad, Dradgaon thadi, Mhaisgaon)	167	147	157
14	Kangar road, Ganegaon, Vadner)	100	119	219
15	Tamanarakhada, (Bramhni, Pimpari, Umbare, Gotumbe akhada)	60	87	73.5
	Total	4979	4915	4947



Fig.1: Carrot weeds *Parthenium hysterophorus*



Fig.2: Adult Mexican beetle, *Zygogramma bicolorata*



Fig.3: BOD incubator



Fig.4a: Culture of *Zygogramma* in BOD



Fig.4b: Culture of *Zygogramma* in BOD

Morphology and Life cycle (Fig.7 & 8)

The incubation period of eggs was found to be 4 to 5 days. Eggs- 1mm in size, yellowish in color, near hatching change in reddish color. Larvae- four larval instars, full grown larvae measure about 6mm in size, become dark yellow in color.

The larvae feeds for 10 to 15days on the leaves and on maturity enter the soil, larval period lasts for 9 to 7 days and pupate below up to 15 cm depth. The pupal period recorded was 8 to 11 days. The beetles emerged after eight to 12 days. Adult- female (Fig. 5 & 6) small in size about 5mm, male large in size about 6mm in size, adult are dull white or yellowish in color with black serpentine line on wings.

Total life cycle was completed in about 23 to 37 days⁶ (egg-adult approximately 6-8 weeks). Adults feed on leaves & flowers, females lays eggs on underside of leaves in cluster of two or three, eggs yellowish in color, 1mm in size, eggs become red near about to hatch. After 4-6 days from eggs hatches the larva, well grown larva measured about 6mm in length, larvae feed on leaves & buds, full grown larvae enter the soil & pupate in earth capsule, chamber.

The young adults emerged from pupae feed ferociously. Adult's feed on leaves & buds, after two –three days male & female mate in morning & early evening time, mating behavior simple, mating (Fig.5 & 6) last for five minutes to hour, a single female lays about 2000 eggs in her life time.



Fig.5: Mating in *Zygogramma*

Fig.6: Female *Zygogramma* depositing eggs



Fig.7: Larvae and adult of *Zygogramma* feeding on *Parthenium hysterophorus*.

High humidity & available moisture are essential to ensure continuous oviposition by *Z. bicolorata*, otherwise females stop ovipositing & adults go into the soil where they diapause. Continuous oviposition can be achieved by ensuring high humidity (70%).

The data collected is tabulated (Table 1) & shows occurrence, distribution of *Zygogramma bicolorata* around Rahuri on *Parthenium hysterophorus*.

The sample collected shows the variation in occurrence & distribution. In the month of June to November the adult beetles & larvae feed on leaves of host plant, the beetles also feed on seed of *Parthenium*. Further from December up to June these hibernate in soil and after first rain showers they come out of the soil and starts feeding on carrot grass. They are less in number at Guha & MPKV & higher at Rahuri college campus & Baragaon nandur (Fig.8a). However, this population is less, it is not sufficient to control the *Parthenium*. A total of 60.056 adults and 2, 17, 570 grubs of *Z. bicolorata* were released during 1987-1994 around Prawaranagar on *Parthenium*. Complete defoliation of the weed in released area was noticed from September onwards. Drying of weed started from October onwards. The population of *Z. bicolorata* underwent hibernation pupating below the soil. The recurrence of beetle occurs in July/ August ⁶. In our study we also observed recurrence of beetle in July/ August (Fig.8b) but we noticed its presence up to the December

rather than October. This may be due to the climatic variation of locality and year of study.

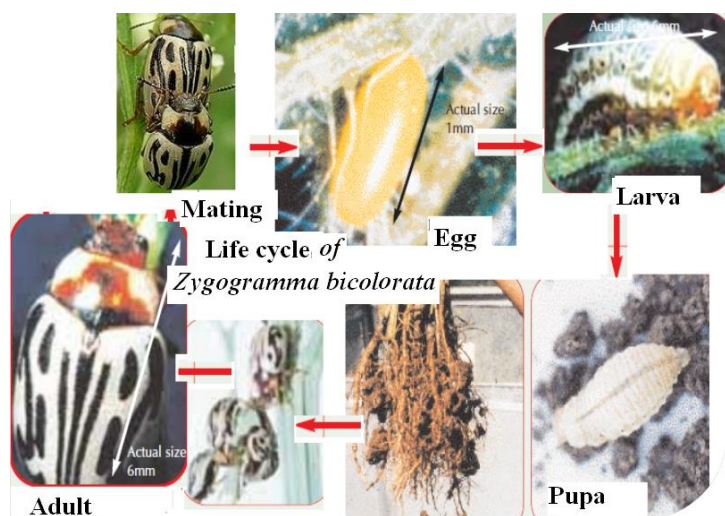


Fig.8: Complete life cycle of *Zygogramma bicolorata*

The data on preference of food by *Z. bicolorata* (Table3) on crop plants along with carrot weed indicate that the adults moved within about 3-15 minutes from crop plants to *Parthenium hysterophorus*, indicating that they are not polyphagous except sunflower. It was also found to feed on leaves of Sunflower when no choice of its host plant was provided. It can deposit the eggs on brinjal in no choice test.

Table 2: Occurrences & Distribution of *Zygogramma bicolorata* on *Parthenium hysterophorus* around Rahuri.

Sr. No	Location	Average no. of Adult Beetles collected/m ² area						Ave.
		June	July	August	Sept.	Octo.	Nov.	
1	Baragaon nandur	09	10	10	09	08	08	9.0
2	Digrus	06	06	07	06	07	07	6.5
3	Guha	06	07	07	04	03	03	5.0
4	Manori	05	06	07	07	06	05	6.0
5	MPKV	03	03	04	04	03	04	3.5
6	Mulanagar	06	07	08	07	08	07	7.16
7	Rahuri college campus	08	09	11	10	09	08	9.16
8	Vambori	04	06	05	06	05	05	5.16

Table 3: Preference of plant by adults of *Z. bicolorata* for feeding & oviposition in no-choice tests & choice test.

Sr. no.	Common name of plant	No-choice Tests		Choice Tests	
		feeding	oviposition	feeding	oviposition
1	Parthenium	++	++	++	++
2	Sunflower	+	0	0	0
3	Brinjal	0	+	0	0
4	Maize	0	0	0	0
5	Tomato	0	0	0	0
6	Potato	0	0	0	0
7	Spinach	0	0	0	0
8	Garlic	0	0	0	0
9	Onion	0	0	0	0
10	Sugarcane	0	0	0	0
11	Wheat	0	0	0	0
12	Ghass	0	0	0	0
13	Cabbage	0	0	0	0
14	Sorghum	0	0	0	0
15	Pigeon pea	0	0	0	0
16	Chickpea	0	0	0	0
17	Field peas	0	0	0	0
18	Baricot bean	0	0	0	0
19	Lentil	0	0	0	0
20	Green bean (shevaga)	0	0	0	0
21	Cotton	0	0	0	0
22	Methi	0	0	0	0
23	Radish	0	0	0	0
24	Coriander	0	0	0	0
25	Pumpkin	0	0	0	0
26	Ladies finger	0	0	0	0

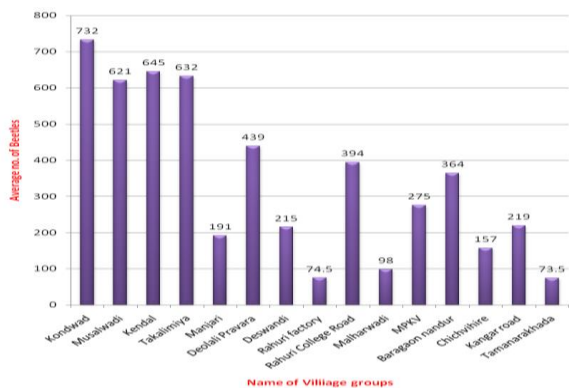


Fig.8a: Occurance and Distribution of *Zygogramma* in Rahuri taluka (June 2012 to Dec.2013)

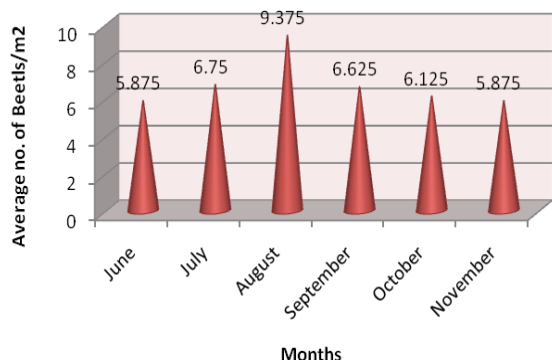


Fig.8b: Average number of Adult Beetles collected /m2 area (2012-2013)

***Parthenium hysterophorus* as a source of pollen for *Apis* sp. (Fig.9 & 10)**

During this survey study it has been observed that *Parthenium hysterophorus* flora serves as source of pollen. The two species of honey bees, *Apis florea* and *Apis indica* visit to flowers of *Parthenium hysterophorus* for nectars and pollen. The visit of these honey bees were trapped in photographs in Biroba nagar, Rahuri taluka and Holnantha Tal Shirpur Dist Dhulia. Singh, 2013 also reported foraging activity of *Apis mellifera* on *Parthenium hysterophorus*. *Apis mellifera* showed foraging activity on *Parthenium hysterophorus* which is considered worst weed for environment and human health. Average foraging activity was recorded 4.9 bees/m²/min⁷. It indicates that though the weed is spreading everywhere and causing hazards to man, domestic animals and environment its use as food by *Apis* cannot be ignored.



Fig.9: *Parthenium hysterophorus* as a source of pollen for *Apis florea*.



Fig.10: *Parthenium hysterophorus* as a source of pollen for *Apis indica* sp.

CONCLUSIONS

For controlling the weed, parthenium, the number of beetle should be increased in proper proportion. Hence there is need of rearing this insect in mass culture and its augmentative release on the host plant in large scale. It could be reared in laboratory & after sufficient amount can be released on its host plant. The Mexican beetle adult & larvae showed choice on *Parthenium hysterophorus* except sunflower as its preferred food. There is need of awareness & campaign⁵ & ⁶ about the Mexican beetle, *Zygogramma bicolorata* among farmers as a safe biocontrol agent for carrot weed.

Both adults and larvae of this chrysomelid feed on the foliage of parthenium weed. The insect over-winters as adults in the soil, although if fresh young parthenium weed foliage is available and climatic conditions are mild, some adults may spend all or part of the overwintering period on the host plant.

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