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Biology of *Zygogramma bicolorata* Pallister on different parts of *Parthenium hysterophorus* Linn. under laboratory conditions

SS Dhurgude, DD Patait, GS Kharat, PS Neharkar and AG Badgujar

Abstract
The mean incubation period of *Z. bicolorata* varied from 4.48 to 6.7 days on plant parts of *P. hysterophorus*. The significantly shortest larval duration (9.4 days), the higest growth index (8.75), the highest% pupation (82.00) and shortest pupal period to the tune of 9.80 days was observed in those larvae which fed on tender leaves of *P. hysterophorus*. The significantly highest pupal duration (15.80 days) and lowest adult emergence (64.60%) was observed on flowers of *P. hysterophorus*. The life cycle duration of male and female beetles of *Z. bicolorata* was found to be lowest on flowers of *P. hysterophorus* to the extent of 46.80 and 49.60 days respectively.

Keywords: Mexican beetle, parthenium, biology, life cycle

Introduction
Parthenium hysterophorus L. (Asteraceae; Heliantheae), commonly known as parthenium, is an annual or short-lived perennial, herbaceous plant. Parthenium is a noxious, invasive weed of both agricultural and natural ecosystem (Shrestha *et al*. 2019) [14]. It is a native of Mexico and neighboring USA. This weed got accidentally introduced into in early 1950's along with imported food grains (Vartak, 1968) [17]. Now it has attained a status of worst weed in India and spread at alarming rate throughout the country infesting 5 million hectares of land. In Indian it was recorded from Pune in 1995. It has spread all over India covering most of the vacant and marginal lands.
The beetles, *Z. bicolorata*, is commonly known as the Mexican beetle, but also called as parthenium beetle (CABI 2020b) [2]. Larval and adult feeding on parthenium result in skeletonization, defoliation and reduction in flowers and seed production. *Z. bicolorata* can cause 100% defoliation of parthenium, resulting in reduced weed density, plant height, plant biomass, flower production and soil seed bank (Dhileepan *et al*. 2000) [3]. Augumentative release of *Z. bicolarata* is one of the sustainable management approach of pernicious weed *P. hysterophorus.* However, several augmentative release may be required to ensure the establishment and effective control of parthenium (Sushilkumar & Ray 2011) [16]. Successful mass rearing technology is needed for an effective augmentative release program of *Z. bicolorata* against parthenium weed. Knowledge of the life cycle and biology of *Z. bicolorata* is indispensable to initiate any mass rearing and augmentative release program. Hence, the present study was undertaken to understand the life cycle and biology of *Z. bicolorata* under lab condition.

Material and Methods
The studies on biology of *Z. bicolorata* on *Parthenium hysterophorus* we carried out under room temperature in a completely randomized design replicated five times. There were three types of leaves *viz*, tender, older and tender +older leaves and flowers of *Parthenium hysterophorus* were fed to grub and beetles of *Z. bicolorata* on alternate day i. e tender leaves followed by older leaves.
One hundred freshly laid eggs of *Z. bicolorata* for each type of food substrate were kept in plastic box individually. Each replication comprised of 20 eggs. The observation were recorded in respect of incubation period and% egg hatch. The newly hatched grub were reared on respective food substract. The food substrates were changed daily. The observations on Mean incubation peririod (day), % egg hatch, Mean larval duration (day), % larva pupated, Growth index, Larval instar duration (day), Pupal duration (day), Adult emergence, adult

longevity and life cycle duration were recorded on respective food substrate. The male and female beetle were identified on the basis of their body size. The size of female adult is larger than the male beetle. The data obtained were subjected to statistical analysis. The growth index was calculated by using Howe's (1953) [5] formula.

Growth index = % larva pupated /Mean larval duration (day)

Result and Discussion

Table 1: The incubation period, egg hatch, larval duration, pupation and growth index of *Z. bicolorata* on different plant parts of *P. hysterophorus*

Plant parts of *Parthenium hysterophorus*	Mean Incubation period (day)	% egg hatch	Mean larval duration (day)	% larva pupated	Growth index
Tender leaves	4.48	82.00	9.4	82.00	8.75
Older leaves	6.7	77.00	12.60	77.00	6.11
Tender leaves + older leaves	4.67	79.00	11.80	79.80	6.77
Flowers	5.27	67.00	17.40	44.20	2.54
S. E +_	0.03	0.45	0.2	0.35	0.14
C. D at 5%	0.09	1.34	0.60	1.04	0.41
C. V (%)	1.24	1.31	3.49	1.09	5.05

It is evident from Table. 1 that significantly minimum incubation period of *Z. bicolorata* to the extent of 4.48 days was recorded when feed on tender leaves of *P. hysterophorus* followed by Tender leaves + older leavea of *P. hysterophorus* (4.67 days), Flowers (5.27 days) of *P. hysterophorus* and Older leaves of *P. hysterophorus* (6.7 days), respectively. According to Rathod *et al*. (2012) [11], Parise (2010) [10], Jayanth (1987) [6] and Sharma and Shajauddin (2006) [12], the incubation period of *Z. bicolorata* was 4 to 6 days. Ajaya Shree Ratna Bajracharya *et al*. (2020) [1] reported the average incubation period of an egg was found 4.33 days ranging from 4-5 days.

The higest egg hatching of *Z. bicolorata* to the tune of 82.00% was observed when fed on tender leaves of *P. hysterophorus* followed by Tender leaves +older leavea of *P. hysterophorus* (79.00%), older leaves of *P. hysterophorus* (77.00%) and Flowers of *P. hysterophorus* (67.00%). Dhiman and Bhargawa (2005a) [4] reported egg viability of *Z. bicolorata* to the tune of 70% when fed on *P. hysterophorus*. The hatching percentage of 66.82 to 78.72 in laboratory was reported by previous workers (Rathod *et al*. 2012; Sidhhapara *et al*. 2012; Mehta & Raghuraman 2019) [9, 11].

The shorter mean larval duration of *Z. bicolorata* to the extent of 9.4 days was observed when feed on tender leaves of *P. hysterophorus* followed by tender + older leaves (11.80), older leaves (12.60) and flowers (17.40) of *P. hysterophorus*. According to Jayanth (1987) [6] and Shinde (1990) [13], the larval period of *Z. bicolorata* was observed to be 14 to 16 and 8 to 10 days, respectively when fed on *P. hysterophorus*. The mean larval period was 12.20 days ranging from 11-14 days. (Ajaya Shree Ratna Bajracharya *et al*. 2020) [1].

The significantly highest pupation of *Z. bicolorata* was recorded when fed on tender leaves of *P. hysterophorus* (82.00%) followed by tender +older leaves (79.80%), older leaves (77.00%) and flowers (44.20%) of *P. hysterophorus*. The significantly highest growth index was observed in the case of those larvae which fed on tender leaves of *P. hysterophorus* (8.75) over, tender +older leaves (6.77), older leaves (6.11) and flowers (2.54) of *P. hysterophorus*.

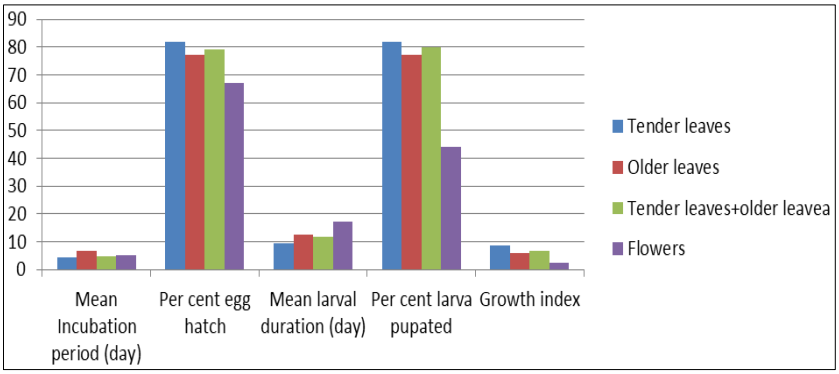

Fig 1: The incubation period, egg hatch, larval duration percent larva pupated and growth index of *Z. bicolorata* on different plant parts of *P. hysterophorus* title

Table 2: The mean larval instar duration of *Z. bicolorata* on different plants part of *P. hysterophorus*

Plant parts of *Parthenium hysterophorus*	Larval instar duration(day)				Total	Mean
	I	II	III	IV		
Tender leaves	2.15	2.25	2.17	2.83	9.4	2.35
Older leaves	3.34	2.54	2.34	4.38	12.6	3.15
Tender leaves + older leavea	3.03	2.44	2.30	4.03	11.08	2.77
Flowers	6.15	3.75	3.25	4.25	17.40	4.35
S. E +_	0.016	0.014	0.019	0.031		
C. D at 5%	0.049	0.042	0.056	0.093		
C. V (%)	1.02	1.17	1.67	1.79		

It is evident from Table-2 that the *Z. bicolorata* passed through four larval instars when fed on different plants parts of *P. hysterophorus*. The duration of I, II, III and IV larval instar ranged from 2.15 to 6.15, 2.25 to 3.75, 2.17 to 3.25 and 2.83 to 4.25 on tender leaves, older leaves, tender +older leaves, older leaves of *Z. bicolorata* and flowers of respectively. The significantly lowest larval instar duration were recorded when the grub of *Z. bicolorata* fed on tender leaves of *P. hysterophorus* (2.15, 2.25, 2.17, 2.83 and 2.83 days) followed by tender +older leaves (3.03, 2.44, 2.30 and 4.03 days). The higest I, II, III and IV instar duration was recorded when the grub fed on flowers of *P. hysterophorus* (6.15, 3.75, 3.25 and 4.25 days). The duration of I, II, III and IV larval instars of *Z. bicolorata* when fed on *P. hysterophorus* were also reported to 3.58, 2.27, 2.31, and 1.75 days (Jayanth and Bali, 1993) [7], 3 to 5, 3 to 3.5, 2 to 3 and 4 to 5 days (Dhiman, 2005a) [4], 2 to 4, 2 to 4 and 3 to 5 days (Parise, 2010) [10] and 2.9, 2.4, 2.4 and 3.0 days (Yadi *et al*., 2008) respectively.

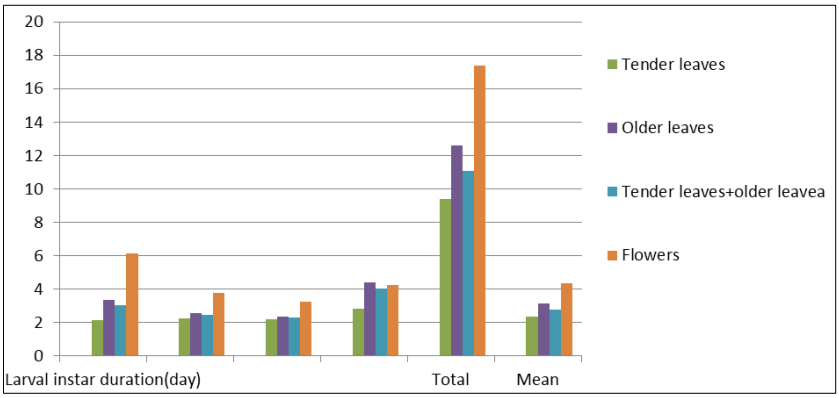

Fig 2: The mean larval instar duration of *Z. bicolorata* on different plants part of *P. hysterophorus*

Table 3: The pupal duration, % adult emergence and total developmental period of *Zygogramma bicolorata* on different plant parts of *Parthenium hysterophorus.*

Plant parts of *Parthenium hysterophorus*	Pupal duration(day)	% Adult emergence	Total developmental period(day)
Tender leaves	9.80	95.80	23.68
Older leaves	12.80	91.40	32.10
Tender leaves + older leaves	11.00	93.75	27.47
Flowers	15.80	64.60	38.47
S. E +_	0.26	0.50	0.59
C. D at 5%	0.79	1.49	1.76
C. V (%)	4.79	1.28	4.31

The significantly the lowest pupal duration was observed when fed on tender leaves of *P. hysterophorus* (9.80 days) followed by Tender leaves + older leavea (11.00 days), Older leaves (12.80 days) and flowers (15.80 days). Ajaya Shree Ratna Bajracharya *et al*. 2020 [1] reported that the pupal period was 11 days ranging from 10-12 days.

The significantly the higest adult emergence was observed in the case of grub which were fed on tender leaves of *P. hysterophorus* (95.80%) followed by tender leaves + older leavea of *P. hysterophorus* (93.75%), older leaves of *P. hysterophorus* (91.40%) and flowers of *P. hysterophorus* (64.60%).

The data presented in Table. 3 revealed that the mean total developmental period of *Zygogramma bicolorata* was observed to be significantly lowest whene fed on tender leaves of *P. hysterophorus* (23.68 days) followed by tender leaves + older leavea of *P. hysterophorus* (32.10 days), older leaves of *P. hysterophorus* (32.10 days) and flowers of *P. hysterophorus* (38.47 days). Ajaya Shree Ratna Bajracharya *et al*. 2020 [1] reported that the total developmental period of immature stage was found 27.53 days ranging from 25-30 days.

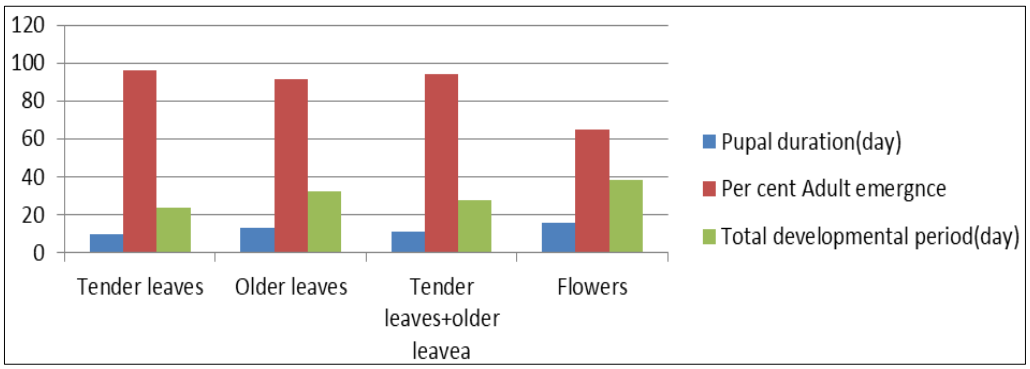

Fig 3: The mean pupal duration, percent adult emergence and total developmental period of *Zygogramma bicolorata* on different plant parts of *Parthenium hysterophorus*

Table 4: The mean longevity and life –cycle duration of *Zygogramma bicolorata* on different plant parts of *Parthenium hysterophorus*.

Plant parts of *Parthenium hysterophorus*	Longevity (day)		Life-cycle duration (day)	
	Male	Female	Male	Female
Tender leaves	55.00	56.80	79.80	80.40
Older leaves	50.80	51.80	80.20	82.00
Tender leaves + older leavea	52.00	52.60	76.80	79.20
Flowers	10.00	11.40	46.80	49.60
S. E +_	0.43	0.37	0.34	0.34
C. D at 5%	1.29	0.95	1.02	1.017
C. V (%)	2.29	1.64	1.07	1.04

The data presented in Table 4 revealed that statistically significant differences were observed in respect of longevity of male and female beetles of *Zygogramma bicolorata* on different plant parts of *P. hysterophorus*. The significantly highest longevity of male and female beetles of *Zygogramma bicolorata* was recorded on tender leaves of P. hysterophorus (55.00 and 56.80 days). It was followed by the longevity of male and female beetles of *Zygogramma bicolorata* on tender leaves +older leavea of *P. hysterophorus* (52.00 to 52.60 days), older leaves of *P. hysterophorus* (50.80 to 51.80 days) and flowers of *P. hysterophorus* (10.00 to 11.40 days).

Significantly the longest life -cycle duration of male and female beetles of *Zygogramma bicolorata* to the extent of 80. 20 to 82.00 days was observed when fed on older leaves of *P. hysterophorus* followed by tender leaves of *P. hysterophorus* (79.80 to 80.40 days), tender leaves + older leavea of *P. hysterophorus* (76.80 to79. 20days) and flowers of *P. hysterophorus* (46.80 to 49.60 days).

The results of the present investigation on longevity of female and male beetles of *Zygogramma bicolorata* are in good line with the result reported by Shinde (1990) [13], Kaur and Shenmar (2008) and Rathod *et al*., (2012) [11]. According to them, it was found to be 61 to 88 and 61 to 82 days, 64.93 and 74.33 days and 44 to 48 and 45 to 47 days, respectively.

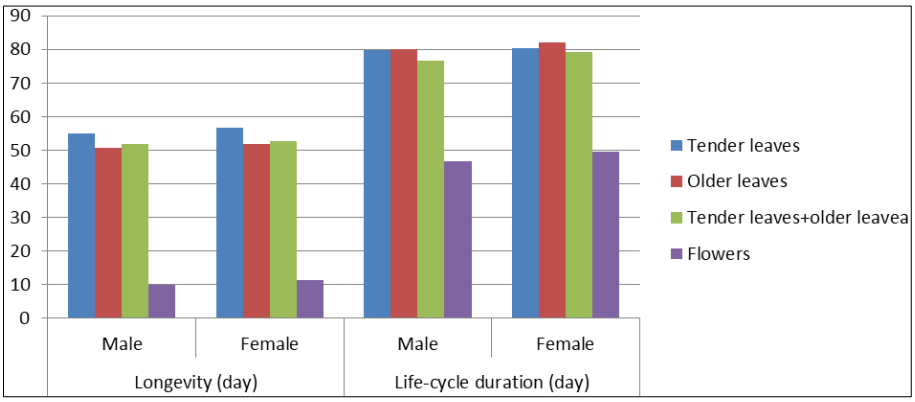

Fig 4: The mean longevity and life- cycle duration for *Zygogramma bicolorata* on different plant parts of *Parthenium hysterophorus*

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