Bionature, 36 (1), 2016 : 19-24

OBSERVATION ON PUPAL PERIOD OF *ENDAPHIS APHIDIMYZA* (SHIVPUJE & RAODEV) (*ZOOPHAGOUS CECIDOMYIIDS*) DIPTERA : CECIDOMYIIDAE

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ABSTRACT

Aphid sucks the vital nutrients of the plant sap from the different parts like lower surface of leaf, stem, tender branches, and inflorescence of the plant. This impairs the normal growth of the crop plants and thus reduces the crop production. The Midges (*Endaphis aphidimyza*) act on the Aphids and reduce their population and thus relieve the crop plants from the ill effects of aphids. This paper presents results of a study on the effects of seasonal factors on different stages of the life cycle of Midges and their population. The climatic factors have been assessed on the aphid population. Statistical analysis has revealed that the partial regression coefficient of temp (x_1 ^{0}C) and pupal period (y) has negative and significant effect i.e. (b_1 = -0.295), on 1^0 change in temperature decreases this period by -0.295. Similarly humidity (x_2) has positive but highly significant result (b_2 =0.104). The resultant effect of rainfall (b_3 = 0.025) though positive but non-significant and the wind velocity adversely affects the pupal period (b_4 = -0.00104). The total variation explained by all the independent variables x_1, x_2, x_3 and x_4 came out to be 71.2 per cent. Obviously, *Zoophagous* appears to be ecofriendly organism.

Keywords : *Endaphis aphidimyza*, Ecofriendly gallmidge, Pupal period of Cecidomyiids, *Zoophagous,* Cecidomyiids,

साराँश

एफिड पौधों के आवश्यक तत्वों को फसल वाले पौधों की पत्ती, कोमल शाखा, तना तथा पुष्पक्रम से चूस लेते हैं। इनके कारण फसल की पैदावार कम हो जाती है। मिजेज (*एन्डाफिस एफीडाइमिजा*) एफिड पर भारी पड़कर उनकी जनसंख्या को कम करने में कारगर हैं। इस शोध पत्र में मिजेज के जीवनचक्र में मौसमी कारकों के प्रभाव संबंधी परिणामों का अध्ययन कर उनका सांख्यिकीय विश्लेषण किया गया है।

Introduction

The Cecidomyiids are fragile and delicate small flies (0.5 - 3.0 mm), rarely 8.0 mm in length. They have long moniliform antennae and a pair of wings with a few veins. Their larvae considerably damage different parts of plant tissue and encourage the development of mal formation that is known as “gall”, that’s why they are also known as gall midges. There are four instars in the larval stage of Cecidomyiids (Metcalfe, 1933., Abbas,1965., and Prasad and Grover,1966).The fourth instar larvae that fall on the ground, make their way into the soil and usually spun cocoons, as protective sheaths, within which they pupate. Grover and Kashyap (1984). Cecidomyiidae is the youngest and largest family of the order Diptera, comprises approximately 6000 species (Bayrams and Sukhrava, 2004). The family presently contains 6203 known species and 736 genera (Gagne & Jaschhof, 2014). *Zoophagous gall midges* comprise more than 20 genera and 300 species in the world (Abe

and Yukawa, 2006). Many larvae of gall midges have been occurring for a long time as enemies of aphid. In India 787 species of aphids are reported. Among them 250 aphid species are major insect pest of different crops. There are about 4000 species of aphid worldwide (Dixon, 1998).

In the present work effects of abiotic and biotic factors on different life processes of the aphids and the midges have been observed. The different stages of life cycle of the Midges under study are, emergence of adults from the cocoons, egg laying, incubation period, larval period, pupal period , fecundity and longevity. The structure of egg, larva, pupa and adult of *Zoophagous cecidomyiids* was also studied to confirm the identification of *Endaphis aphidimyza*. Experimental data on the population dynamics of Safflower Aphid and its endoparasitoid *Endaphis aphidimyza* were also recorded. The influence of substrate on fecundity and longevity was assessed.. The larvae of this endo-parasitoid, Cecidomyiids feed the contents of body of the aphids internally and ultimately kill the aphids. At the time of 4th instar larvae, puncture the abdomen of Aphid and drop on the soil. The larvae spin a fibrous cocoon, get confined inside and it pupation takes place. The adults emerge from the pupa. But due to unfavorable climatic condition the fourth instar larva enter into diapauses.

Materials and methods

The experiment was conducted during the year 2007 to 2010 at agriculture farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalay Chitrakoot Satna (M.P.) India by Tripathi (2012). Safflower aphids Uroleucon gobonis were collected from safflower plant (*Carthamus tinctorius*) in the winter (rabi) season. For the present study 60 plants of safflower (*Carthamus tinctorius*) were planted in the field. Out of these 20 plants were randomly selected and caged by muslin-polythene bag to observe development attributes and behavior of the midges. The effect of climatic factors like temperature, humidity, rainfall and wind velocity were recorded at regional metrological laboratory Nagpur Maharashtra. This was to observe their effects on the life cycle of *Zoophagous gallmidges* (*Endaphis aphidimyiiza*).

Results and Discussion

The observations on pupal period recorded from 2007 to 2010 for 20 periods each. The difference between date of pupation and date of emergence is known as pupal period. Average pupal period of Endaphis aphidimyza was recorded 10 to 12.3 days during 2007-2010. The statistical tools like, coefficient of dispersion, student t- test along with their averages were worked out. The pupal periods are given in the following table

Table 1: Pupal period of *Endaphis aphidimyza* during 2007-08

S. No.	No. of larvae	Date of pupation	Date of emergence	Pupal period in days
1	10	25.12.2007	7.1.2008	13
2	11	26.12.2007	7.1.2008	12
3	14	27.12.2007	7.1.2008	11
4	15	28.12.2007	7.1.2008	10
5	21	29.12.2007	8.1.2008	10
6	25	30.12.2007	10.1.2008	11
7	41	31.12.2007	10.1.2008	10
8	22	1.01.2008	11.1.2008	11
9	26	2.01.2008	12.1.2008	10
10	30	3.01.2008	13.1.2008	11
11	94	4.01.2008	15.1.2008	11
12	100	5.01.2008	15.1.2008	10
13	110	6.01.2008	16.1.2008	10
14	50	7.01.2008	17.1.2008	10
15	36	8.01.2008	18.1.2008	10
16	15	7.02.2008	17.2.2008	10
17	10	8.02.2008	17.2.2008	9
18	7	9.02.2008	16.2.2008	7
19	5	1.03.2008	8.3.2008	7
20	2	2.03.2008	9.3.2008	7

Table 2: Pupal period of *Endaphis aphidimyza* in 2008-09

S. No.	No. of larvae	Date of pupation	Date of emergence	Pupal period in days
1	10	25.12.2008	8.01.2009	14
2	11	26.12.2008	7.01.2009	12
3	15	28.12.2008	10.01.2009	13
4	21	29.12.2008	12.01.2009	14
5	25	30.12.2008	13.01.2009	13
6	41	31.12.2008	14.01.2009	14
7	130	3.1.2009	15.01.2009	12
8	94	4.01.2009	16.01.2009	12
9	100	5.01.2009	18.01.2009	13
10	110	6.01.2009	19.01.2009	13
11	50	7.01.2009	20.01.2009	13
12	36	8.01.2009	21.01.2009	13
13	42	9.01.2009	22.01.2009	13
14	22	10.01.2009	22.01.2009	12
15	24	11.01.2009	23.01.2009	12
16	17	13.01.2009	24.01.2009	11
17	21	15.01.2009	25.01.2009	10
18	22	16.01.2009	25.01.2009	9
19	5	22.01.2009	30.01.2009	8
20	2	23.01.2009	30.01.2009	7

Table 3: Pupal period of *Endaphis aphidimyza* in 2009-10

S. No.	No. of larvae	Date of pupation	Date of emergence	Pupal period in days
1	30	28.12.2009	11.01.2010	14
2	42	29.12.2009	11.01.2010	13
3	51	30.12.2009	13.01.2010	14
4	29	31.12.2009	14.01.2010	14
5	32	1.01.2010	13.01.2010	12
6	42	2.01.2010	15.01.2010	13
7	44	3.01.2010	16.01.2010	13
8	46	4.01.2010	17.01.2010	13
9	45	5.01.2010	18.01.2010	13
10	47	6.01.2010	20.01.2010	14
11	700	4.02.2010	12.02.2010	8
12	375	5.02.2010	16.02.2010	11
13	125	6.02.2010	16.02.2010	10
14	140	6.02.2010	17.02.2010	11
15	110	6.02.2010	18.02.2010	12
16	200	7.02.2010	18.02.2010	11
17	215	7.02.2010	19.02.2010	12
18	150	9.02.2010	22.02.2010	13
19	57	9.02.2010	22.02.2010	13
20	35	11.02.2010	23.02.2010	12

Regression analysis of pupal period versus temp (x_1), humidity (x_2), rainfall (x_3) and wind velocity (x_4)

As regards the pupal period, the regression analysis revealed that the rate of increase in *Zoophagous cecidomyiids* with respect unit change in wind velocity (Km/hr) remained 87.2. This regression coefficient remained significant at 1 per cent level of probability. Wind velocity alone contributed 43.5 per cent variation in the formation of *Zoophagous cecidomyiids*.

Pupal period (y) versus x_4

* *** (ins)

$Y = 105 + 87.2\ x_4$

SE = (23.45)

t = 3.72

r^2 = 43.5 per cent

From this model of pupal period keeping x_2 (Humidity) constant the rate *Zoophagous cecidomyiids* with temperature remained -10.5 and while keeping x_1(temp) constant its value with respect to x_2 (humidity) came out -1.75. Both the regression coefficients were observed to be non significant. The variation explained by both the independent variables x1 and x2 was 7.7 per cent.

Pupal period (y) versus x_1 and x_2

* *** (ins)

$Y = 366 - 10.5\ x_1 - 1.75\ x_2$

SE = (11.74) (1.499)

t = - 0.89 1.17

r^2 = 7.7 per cent

During the pupal period of *Zoophagous cecidomyiids* with respect to humidity was negative (-1.77) and non significant, whereas in case of rainfall its value remained positive (+ 103) and significant at 5 per cent level of significant.

The variation with respect to humidity (x_2) and rainfall (x_3) was 24.9 per cent.

Pupal period (y) versus x_2, x_3

(ns) *

$$Y = 80.5 - 1.77\ x_2 + 103\ x_3$$
$$SE = \quad (1.132) \quad (46.76)$$
$$t = \quad -1.56 \quad 2.21$$
$$r^2 = 24.9 \text{ per cent}$$

In this period, regression coefficient of *Zoophagous cecidomyiids* with respect to rainfall was (73.7) remained significant at 5 per cent level of significance whereas with respect to wind velocity came out (85.5) and highly significant. The variation explained by wind velocity and rainfall during the pupal period remained 55.8 per cent for *Zoophagous cecidomyiids* formation.

Pupal period (y) versus x3, x4

$$\qquad\qquad * \quad *** \quad \text{(ins)}$$
$$Y = -166 + 73.7\ x_3 + 85.5\ x_4$$
$$SE = \quad (33.82) \quad (21.35)$$
$$t = \quad 2.18 \quad 4.00$$
$$r^2 = 55.8 \text{ per cent}$$

The analysis of pupal period revealed that rate *Zoophagous cecidomyiids* with respect to temperature came out -11.7 where as with respect to wind velocity was observed 99.8 which were non - significant and highly significant respectively. The above model explained 51.2 per cent variation in *Zoophagous cecidomyiids* (pupal period) (Fig. : 20).

Pupal period (y) versus x1, x4

$$\qquad\qquad \text{(ns)} \quad ***$$
$$Y = 90 - 11.7\ x_1 + 99.8\ x_4$$
$$SE = \quad (7.108) \quad (23.68)$$
$$t = \quad -1.64 \quad 4.21$$
$$r^2 = 51.2 \text{ per cent}$$

In pupal period the regression coefficient of *Zoophagous cecidomyiids* with respect to temp (-16.9) remained non significant whereas regression coefficient with respect to humidity (-3.24) and rainfall (121) were observed to be significant at 5 per cent level of significance. The variation explained by temperature, humidity and rainfall was observed 35.6per cent.

Pupal period (y) versus x_1, x_2, x_3

$$\qquad\qquad \text{(ns)} \quad * \quad *$$
$$Y = 470 - 16.9\ x_1 - 3.24\ x_2 + 121\ x_3$$
$$SE = \quad (10.40) \quad (1.409) \quad (45.94)$$
$$t = \quad -1.63 \quad -2.30 \quad 2.64$$
$$r^2 = 35.6 \text{ per cent}$$

In this period, the regression coefficient with respect to humidity and rainfall were 0.40 and 67.9 respectively. They were non significant whereas with respect to wind velocity (91.2) remained significant at 5per cent level of significant.

The variation explained by humidity, rainfall and wind velocity were observed to be 56.24 percent during the pupal period.

Pupal period (y) versus x_2, x_3, x_4

$$\qquad\qquad \text{(ns)} \quad \text{(ns)} \quad *$$
$$Y = -195 + 0.40\ x_2 + 67.9\ x_3 + 91.2\ x_4$$
$$SE = \quad (1.098) \quad (38.30) \quad (27.00)$$
$$t = \quad 0.36 \quad 1.77 \quad 3.38$$
$$r^2 = 56.2 \text{ per cent}$$

During this period, regression coefficient of temperature (-11.0) was non-significant whereas their value in case of rainfall (71.2) significant at 5 per cent level of significance and wind velocity (97.4) highly significant. Variation explained by x_3, x_4 and x_1 was observed 62.7 per cent in this period.

Pupal period (y) versus x_3, x_4, x_1

$$\qquad\qquad * \quad *** \quad \text{(ins)}$$
$$Y = 21 + 71.2\ x_3 + 97.4\ x_4 - 11.0\ x_1$$
$$SE = \quad (32.05) \quad (21.37) \quad (6.411)$$
$$t = \quad 2.22 \quad 4.56 \quad -1.72$$
$$r^2 = 62.7 \text{ per cent}$$

The multivariate model consisting temp (x_1), humidity (x_2), rainfall (x_3), wind velocity (x_4) during the pupal period were regressed pertaining *Zoophagous cecidomyiids* formation.

The regression coefficient with respect to temperature (-14.7) came out non – significant and in case humidity (x_2) it was (-0.97) and also it was non significant. The

respective value for rainfall and wind velocity was observed 84.7 and 87.4 respectively. These values were significant at 5 percent and 1 per cent respectively. The total variation explained by the four independent variables namely temp, humidity, rainfall and wind velocity was 64.1 per cent.

Pupal period (y) versus x_1, x_2, x_3, x_4

		(ns)	(ns)	*	**
$Y = 154 - 14.7\ x_1 - 0.97\ x_2 + 84.7\ x_3 + 87.4\ x_4$					
SE =	(8.044)	(1.270)	(36.95)	(25.31)	
t =	- 1.82	-0.76	2.29	3.45	

r^2 = 64.1 per cent

Correlation: y, x_1, x_2, x_3, x_4

	Y	x_1	x_2	x_3
x_1	-0.051			
x_2	-0.183	-0.615		
x_3	0.376	-0.031	0.336	
x_4	0.659	0.323	-0.537	0.037

In this period the regression coefficient of *Zoophagous cecidomyiids* with respect to humidity was observed (- 0.93) and it was non significant.

The variation with respect to humidity remained 3.4 per cent during the pupal period.

pupal period: y versus x2

	(ns)
$y = 121 - 0.93\ x_2$	
SE =	(1.175)
t =	-0.79

r^2 = 3.4 per cent

During this period the regression coefficient of *Zoophagous cecidomyiids* with respect to rainfall was observed (78.8) which were non – significant.

The rainfall contribution on *Zoophagous cecidomyiids* formation during the pupal period was observed 14.1 per cent.

pupal period: y versus x3

	(ns)
$Y = - 2.2 + 78.8\ x_3$	
SE =	(45.79)
t =	1.72

r^2 = 14.1 per cent

During the pupal period the regression coefficient of *Zoophagous cecidomyiids* with respect came out (-2.03) and it was non – significant. The contribution of temperature during the larval period was only 0.3 per cent.

pupal period : y versus x_1

	(ns)
$Y = 104 - 2.03\ x_1$	
SE =	(9.350)
t =	-0.22

r^2 = 0.3 per cent

Pupal period Y = 10.9-0.295 temp (x_1) + 0.104 humidity (x_2) + 0.025 rainfall (x_3) -

SE =	(0.1434)	(0.02477)	(0.1226)
t =	- 2.05	4.19	0.21

-0.00104 wind velocity (x_4)
(0.005206
-0.20

r^2 = 71.2 per cent

The statistical analysis had revealed that the partial regression coefficient of temp (x_1 ^{0}C) and pupal period (y) has negative and significant effect i.e. (b_1 = -0.295), on 1^0 change in temperature decreases this period by -0.295. Similarly humidity (x_2) has positive but highly significant result ($b_{2=}$0.104). The resultant effect of rainfall ($b_{3=}$ 0.025) though positive but non-significant and the wind velocity adversely effects the pupal period ($b_{4=}$ -0.00104). The total variation explained by all the independent variables x_1, x_2, x_3 and x_4 came out to be 71.2 per cent.

Correlation

Pupal period	(y)			
temperature (x_1),	-0.051			
humidity (x_2)	0.000	0.353		
rainfall (x_3)	0.23	0.303	0.047	
Wind velocity(x_4)	0.735	0.588	0.676	
		rainfall (x_3)		
Wind velocity (x_5)		0.782		

Diapause

After completion of their feeding phase,the of larvae drop on the soil. The larvae spin a

fibrous cocoon and pupation takes place inside it. The adults emerge from the pupa. But due to unfavorable climatic condition the fourth instar larva enter in to diapause. This state of dormancy was maintained until favorable conditions for morphogenesis. This stage is called as diapause (Lees, 1955).

Conclusion

Statistical treatment of the data analysis has revealed that the partial regression coefficient of temp ($x_1{}^0C$) and pupal period (y) has negative and significant effect i.e. (b_1 = -0.295), on 1^0 change in temperature, decreases this period by -0.295. Similarly humidity (x_2) has positive but highly significant result (b_2 =0.104). The resultant effect of rainfall (b_3 = 0.025) though positive but non-significant and the wind velocity adversely effects the pupal period (b_4 = -0.00104). The total variation explained by all the independent variables x_1, x_2, x_3 and x_4 came out to be 71.2 per cent. This creates a balance between environment and safe guard the ecological factors for good harvesting practices. In the light of this fact *Zoophagous cecidomyiids* is eco-friendly and crop protected insect.

Acknowledgement

We thank Dr. O. P. Khanna (Prof. of statistics C.S.A University Kanpur) for their valuable advice and help with statistical analysis during this study.

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