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Life Table of *Trilocha varians* (Lepidoptera: Bombycidae) on *Ficus benjamina* Under Laboratory Conditions

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Abstract **Original Research Article**

Ficus benjamina is an ornamental plant that planted alongside the road of Pakistan to increase the beauty of country. Several insect pests are attacking on this beautiful plant, responsible in reduction of aesthetic value of country. Among insect pests, *Trilocha varians* is serious and destructive pest whose larvae feed on leaves resulting 100% defoliation. The study was conducted to check the life table of this emerging pest on *F. benjamina* under controlled conditions. The study showed that total life period of *T. varians* from egg to adult was 33-35 days. The highest apparent mortality was recorded in early larval instars and rapidly reduced in later instars (3rd instars) which even reached to zero from 4th larval instars to pupal stage. Age-specific survivorship (lx) of the cohort was gradually reduce in later instars. Maximum mortality at early stage may exert significant negative effect on the insect population. The management practices could be more fruitful against early instars as compared to later instars larvae.

Keywords: Weeping fig, *Trilocha varians*, Silkworms, Life history, Net reproductive rate.

INTRODUCTION

Life table is analytical tool that becoming predictable in these days, used by many entomologists to study the population dynamic of insects. Life table is very important tabular device that give comprehensive information about insect population, expectancy, age, growth, development and survivorship of life (Yzdani and Samih 2012; Ali and Rizvi, 2007; Gabre et al., 2004). It is also used to study the inherent difference among different populations under different environmental conditions (Afrane et al., 2007; Atwal and Bain, 1974) and mortality effect on insect population (Harcourt, 1969; Bellows et al., 1992; Mohapatra, 2007). It can also provide better information about reproductive potential of insect under different climatic regimes (Atwal and Bain, 1974; Gabre et al, 2004). It can also use to determine quality and quantity of host plants (Ambegaonkar and Bilapate, 1981).

There are two types of life tables i.e. life tables for laboratory and ecological life table that used for natural populations of animals. These can be divided into further two categories on the basis of data like age-specific life tables and time-specific life tables (Southwood, 1966; Afrane et al., 2007).

Ficus, which belongs to family Moraceae is known as weeping fig. The Ficus spp. like Ficus benjamina is attacked by many insect pests like thrips, whitefly and mealybug (Walton and Pringle, 2004; Avery et al., 2011). Among them, Trilocha varians (Lepidoptera: Bombycidae) commonly known as leaf eating larvae caused severe losses in many countries (Navasero et al. 2013; Kedar et al. 2014; Singh and Brar 2016).

Insect has close relationship with silk worms (Bombyx mori), same family and nature but different diets. T. varians is serious pest of ornamental plants like F. microcarpa, F. benjamina, F. annulate and F. altissima. T.varians feeds on the moraceae family plants and causes 100% defoliation (Kedar et al., 2014; Basari et al., 2019). The severe attack of this pest destroys the leaves of plant (Zolotuhin and Witt, 9002), even death of plant occurs and has negative impact on the aesthetic value of the country (Daimon et al., 2012; Navasero et al., 2013).

In the current study, it was observed that the F. benjamina which planted alongside the roads as ornamental plants infested by this insect pest and caused negative impact on the beauty of country, Pakistan. Still no such type of research related to life table of T. varians has carried out in the globe. It is needed to learn about the mortality, survivorship, reproductive rate and life expectancy of Trilocha varians on natural food, F. benjamina. For this purpose, the rearing of this pest has been carried in Ecology Lab to provide all the optimum conditions like humidity and temperature.

MATERIAL AND METHODS

Collection and rearing of Trilocha varians

To determine the life table of this pest under laboratory conditions, immature stage like newly laid egg batches were searched out and collected from different location of District Multan. The collected batches were brought to Rearing Laboratory at Institute of Plant Protection, MNS-University of Agriculture, Multan for rearing purposes. Collected eggs placed into plastic cages for hatching. To perform the further study process, 100 petri dishes were purchased from market. After hatching, 100 newly emerged larvae were randomly selected and shifted individually into each petri dish with the help of camel hair brush. On daily basis, the flesh leaves of F. benjamina were placed into each petri dish till pupation. On the emergence of adults, male and female were separated and pairs of adult placed into separate adult rearing cage for obtaining egg and maintaining the culture. Nothing was provided to adults as food because adults have no proboscis. The culture was maintained till 4th generations by following the same procedure. Every stage such as egg, larva, pupa and adult was checked on daily basis. Molting, mating, mortality, fecundity and fertility of insect (male and female) was checked.

1. Construction of Life table

Stage Specific Life Table

Stage specific data regarding to survival and mortality of different insect stage were taken from the age specific life table. Stage specific life table was calculated by using the following biological parameters.

x = Insects age in days

l_x = Surviving number of tested insect at the beginning of each interval

d_x = Dying number of tested insects during the age interval

The different life table parameters were computed by using above assumption information as follows:

apparent mortality within a stage (qx) based on the number of insect alive at the beginning of a specific stage

Apparent Mortality (100q_x)

Apparent mortality can be calculated by the number of dying insect as a percent of insect number alive at the beginning of a specific stage like;

Apparent Mortality = $[d_x / l_x] \times 100$

Survival Fraction (Sx)

It can be obtained from the apparent mortality information by applying the following formula:

Survival Fraction of a particular stage = [l_x of a particular stage] / [l_x of subsequent stage]

Mortality Survival Ratio (MSR)

If mortality was not occurred during specific stage, then MSR provides information about population extension by applying the following equation:

Mortality Survival Ratio of a particular stage = [Mortality in a particular stage] / [l_x of subsequent stage]

Indispensable Mortality (IM)

It can be calculated by applying the following formula:

Indispensable Mortality = [No. of adults emerged] × [MSR of a particular stage]

K-values

It is used to determine the number of insect population from one generation to others. Difference between 'log l_x' of two successive insect stages reflects k-values, which can be used to obtain the total generation mortality (K) as under:

$K = k_{L1}+k_{L2}+k_{L3}+k_{L4}+k_{L5} +k_P$

Where, k_{L1}, k_{L2}. $k_{L3,}$ k_{L4}, k_{L5} and k_P are the k- values at first instar, second instar, third instar, fourth instar, fifth instar and pupal stage of insect.

Age Specific Life Table

The age specific life table was constructed by using the following parameter:

x = Insects age in days

l_x = Surviving number of tested insect at the beginning of each interval

d_x = Dying number of tested insects during the age interval

100q_x = Calculated by using formula

100q_x = $[d_x / l_x] \times 100$

Other two parameters such as L_x and T_x were also computed for the calculation of e_x

L_x = Number of individuals alive between age x and x+1

$L_x = l_x+1\ (x+1)/2$

Tx = Total number of individual of x age units beyond the age x

$T_x = l_x + (l_x+1) + (l_x+2)\ldots\ldots\ldots\ldots + l_w$

Here, l_w = Last age interval

e_x = Expectation of life for individuals of age x and calculated by applying following formula:
$e_x = T_x/l_x$

Cohort Life Table of Trilocha varians

The age specific life table was constructed by using the following parameter:
x = Insects age in days
l_x = Surviving number of tested insect at the beginning of each interval
d_x = Dying number of tested insects during the age interval
$100q_x$ = Calculated by using formula
$100q_x = [d_x / l_x] \times 100$

Other two parameters such as L_x and T_x were also computed for the calculation of e_x
L_x = Number of individuals alive between age x and x+1
$L_x = l_x+1 (x+1)/2$
Tx = Total number of individual of x age units beyond the age x
$T_x = l_x + (l_x+1) + (l_x+2) + l_w$
Here, l_w = Last age interval

e_x = Expectation of life for individuals of age x and calculated by applying following formula:
$e_x = T_x/l_x$

Average daily mortality = 1/ex
Fx = eggs produced at each stage
mx = eggs produced per surviving individual at each stage
lxmx = eggs produced per original individual at each stage

RESULTS

Age-specific Life Table of T. virescence

Total life period of T. varians from egg to adult was 33-35 days under controlled conditions. At early stage, age-specific survivorship (lx) of the cohort was gradually reduce in later instars and remained constant at 26th day. The irregular pattern was showed by mortality curve with high climax on 28, 5 and 2 days. Life expectancy (ex) was increased in early days (2nd-3rd days) while decreased in later days (up to 5th days). In the whole study, no mortality was observed on 13 to 25 and 6 to 11 days (**Fig. 1**).

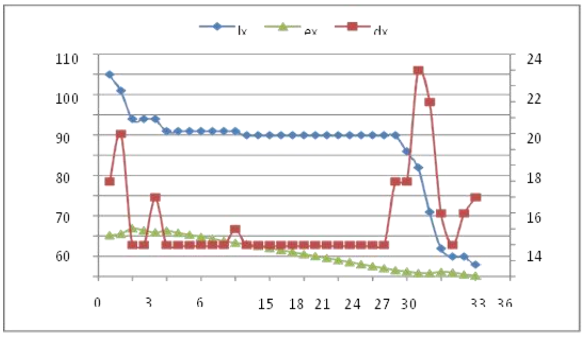

Fig-1: Age Specific Suvivorship (lx), Death (dx) and Life Expectancy (ex) of Trilocha varians on Ficus benjamina

Stage specific life table of T. varians

The highest apparent mortality was recorded in early larval instars and rapidly reduced in later instars (3rd instars) which even reached to zero from 4th larval instars to pupal stage. In the study, the survival fraction was found lowest in early instars while highest in the later instars. Lowest survival fraction was recorded in first larval instars and highest in fourth instars while maximum K- values were recorded in early instars (1st) which started to decrease from second larval instars to onward even become zero at 4th instars (Table 1).

Table-1: Stage specific life table of T. varians on leaves of F. benjamina

Stage X	No surviving at beginning of stage, lx	No. dying in each stage, dx	Apparent Mortality, 100qx	Survival Fraction, Sx	Mortalit/ Survival Ratio, MSR	Indespan sible mortality, IM	Log lx	K-values
1st Instar	100	20	20.00	0.70	0.40	23.39	2	0.13
2nd Instar	100	5	6.28	0.89	0.09	4.23	1.90	0.04
3rd Instar	93	4	2.80	1.00	0.06	2.16	1.89	0.02
4th Instar	87	0	0.00	1.00	0.01	0.01	1.76	0.00
5th Instar	72	0	0.00	1.00	0.00	0.00	1.75	0.00
Pupa	70	0	0.00	1.00	0.00	0.00	1.75	0.00
Adult	70	70	100	0.00	---	---	1.75	---
								K = 0.19

Cohort Life Table of T. varians

The maximum number (nx) of 1st and 2nd larval instars was found live which reduced from 100-93 at third instars. After 3rd instars, number of live instar was 87 and 72, respectively at 4th and 5th instars. It was remained constant in pupal and adult stage. The apparent mortality (qx) was recorded maximum at 1st larval instars (20.00) then reduced to 6.28 and 2.80 at 2nd and 3rd larval instars respectively. No mortality stages were recorded in the subsequent stages (4th, 5th larval instars, pupal and adult stages) (Table 2).

Table-2: Cohort life table of T. varians on F. benjamina

Stages (larva to adult)	Number surviving at each stage, qx	Proportion of original cohort dying during each stage, dx	Proportion of original cohort surviving to each stage lx	Mortality rate	Eggs produced at each stage Fx	Eggs produced per surviving individual at each stage mx	Eggs produced per original individual at each stage lxmx
1st	100	0.33	1.00	0.22	0.0	0.0	0.0
2nd	100	0.39	0.79	0.04	0.0	0.0	0.0
3rd	93	0.3	0.70	0.04	0.0	0.0	0.0
4th	87	0.1	0.69	0.00	0.0	0.0	0.0
5th	72	0.0	0.71	0.00	0.0	0.0	0.0
Pupa	70	0.0	0.70	0.00	0.0	0.0	0.0
Adult	70	0.70	0.70	-	4000	60.77	47.00

Reproductive parameters of T. varians

Total 4000 number of eggs were produced (Fx,) at adult stage and a single female laid (mx) 60.77 while 47.00 was net reproductive rate. Intrinsic rate of natural increase ® per insect or individual per day was 0.135 (Table 3).

Table-3: Reproductive parameters of T. varians feed on F. benjamina

Parameter name	Notation	Formula	Values
Net reproductive rate	Ro	∑ lx.mx	47.00
Mean length of generation	Tc	∑x(lx.mx)/∑(lx.mx)	27.08
Intrinsic rate of natural increase	R	LnRo/Tc	0.135
Finite rate of increase	Λ	Er	1.23
Gross reproduction rate	GRR	∑mx	60.77

DISCUSSION

The current study was conducted to develop the life table of serious and emerging pest, T. varians of Ficus species especially F. benjamina. The survivorship of larval population was affected by their age. The study findings are in agreement of earlier researchers who reported the similar results about life table of insect pests (Rizvi, 2007; Padmalaictha et al., 2003).

Highest mortality was recorded at early instars as compared to older which reduced the survivorship. The reproduction of adult stages can also affect through the mortality of early stages. The similar results have been reported by many scientists (Nath and Rai, 2010). During this study, no mortality of 4th and 5th larval instars was observed, so an effective and best management strategy should be recommended to control such stages. The similar findings had been discussed by Jia and Jinxin (1997).

A single female can lay 160-280 eggs in her whole life period. Chuenban et al. (2017) had reported that a single female can lay 160-278 eggs in her whole life cycle.Eggs are laid in the layers forms. The five larval instars had been reported by early scientists and our findings are in line with them. The mating was continued within 12 hours of adult emergence which lasted for long period of time approximately 10-15 hours.The transliteration

The population dynamic is calculated by using cohort life table. The net reproductive rate (Ro) of pest was high and study suggests that F. benjamina has proved a suitable larval food for their growth and development. The management strategy should be adopted against this pest within three days.

The environmental conditions are play key role in the development and growth of insect pests especially T. varians. The life period of T. varians can increase with decrease in temperature (Basari et al., 2019). Many other researchers had reported the similar findings about temperature (Daimon et al., 2012; Sibly et al., 2016; Lu et al., 2016).Navasero and Navasero (2014) had reported that time duration of each stage under controlled and uncontrolled conditions are similar to each other. The development of pest can also affect by the host plants phenology. The various studies were conducted to check the most important host plant of T. varians under laboratory conditions. The study investigated that F. benjamina is the most suitable host for larval growth and development. The different management strategies against insect pests are applied in crops. The cultural, biological, physical, mechanical and chemical (insecticides) can use against insect pests (Ramzan et al., 2019). The monitoring of pest is very important before any application of strategies against that pest (Murtaza et al., 2019).

CONCLUSION

The basic knowledge about biology and morphology of insect pests is play key role in controlling that pest. The current study findings showed that T. varians has high potential to develop and reproduce on F. benjamina which commonly known as weeping fig. The current study findings are fruitful in adopting control strategies against this pest especially in Pakistan.

Conflict of interest

Authors declare no conflict of interest.

Author contributions

All authors have equal contribution in writing this review.

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