

BIOLOGY OF EPILACHNA BEETLE,  
Henosepilachna vigintioctopunctata  
(Fabricius) (Coccinellidae : Coleoptera)  
AND EVALUATION OF INDIGENOUS BOTANICAL  
MATERIALS FOR IT'S CONTROL

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BY  
KAUSHIK NANUBHAI PATEL  
B. Sc. ( Agri. )

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY  
N. M. COLLEGE OF AGRICULTURE  
**Gujarat Agricultural University**  
NAVSARI CAMPUS, NAVSARI - 396 450  
GUJARAT STATE  
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# **ABSTRACT**

**BIOLOGY OF EPILACHNA BEETLE, Henosepilachna  
vigintioctopunctata (Fabricius) (Coccinellidae : Coleoptera) AND  
EVALUATION OF INDIGENOUS BOTANICAL MATERIALS FOR  
IT'S CONTROL**

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Student :  
Shri K.N. Patel

Major Advisor:  
Dr. M.S. Purohit

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DEPARTMENT OF ENTOMOLOGY,  
N.M. COLLEGE OF AGRICULTURE,  
GUJARAT AGRICULTURAL UNIVERSITY,  
NAVSARI CAMPUS, NAVSARI - 396450

**ABSTRACT**

Investigations on host range, biology and host preference of epilachna beetle, Henosepilachna vigintioctopunctata (F.) as well as the bioefficacy of indigenous botanical materials against larvae and adults of H.vigintioctopunctata were carried out under laboratory conditions, at N.M. College of Agriculture, GAU, Navsari, during 1995-96.

The main host plants recorded in the survey area were brinjal, tomato and bitter gourd. The pest was active during post monsoon season only i.e from September-November.

The study on biology indicated that the female laid on an average  $354.40 \pm 160.040$  eggs in batches of 5 to 75 each, mainly on lower and upper surface of the leaf.

The freshly laid eggs were lemon chrome in colour and change to buff yellow as the time passed. The eggs were cylindrical in shape and slightly tapering towards apex, measured on an average  $1.292 \pm 0.012$  mm in length and  $0.410 \pm 0.019$  mm in breadth. The average incubation period was  $3.40 \pm 0.498$  days. The larval stage passed through 4 instars. The larva was yellow in colour and bears scoli on dorsal and subdorsal side. Average developmental period of first, second, third and fourth larval instar was  $3.40 \pm 0.563$ ,  $2.77 \pm 0.678$ ,  $2.20 \pm 0.406$  and  $3.23 \pm 0.504$  days, respectively. The total larval development period was  $15.00 \pm 1.144$  days. The duration of pupal stage was  $3.33 \pm 0.475$  days. The adult beetles were hemispherical in shape and reddish brown in colour with 28 characteristically arranged black spots on the pronotum and forewings or elytra. The male and female measured on an average  $5.690 \pm 0.184$  and  $5.830 \pm 0.082$  mm in length and  $4.560 \pm 0.139$  and  $5.510 \pm 0.109$  mm in breadth, respectively. The average pre-oviposition, oviposition and post-oviposition period was  $7.00 \pm 1.414$ ,  $29.60 \pm 1.949$  and  $8.60 \pm 1.516$  days, respectively. The average longevity of male and female was  $33.40 \pm 0.894$  and  $45.20 \pm 1.643$  days, respectively. The total life cycle occupied 50 to 54 days (Ag.  $52.00 \pm 1.527$  days) in case of male and 63 to 67 days (Ag.  $65.00 \pm 1.632$  days) in case of female.

The bioefficacy of various botanical materials and formulations viz., garlic bulb extract (3 % suspension), mint leaves extract (3 % suspension), neem seed kernel

extract (3 % suspension), ardusa leaves extract (3 % suspension), L.camara leaves extract (3 % suspension), neemark (0.5%), fieldguard (1.0%) alongwith the chemical insecticides viz., DDVP (0.03%) and endosulfan (0.075 %) were tested under laboratory condition. The treatment of DDVP was found superior in effectiveness followed by endosulfan against both the larvae and adults. Though the per cent mortality obtained in the treatments of various botanical materials was less than that of chemical insecticides, the neem based insecticides viz., fieldguard 1.0 per cent, neemark 0.5 per cent and neem seed kernel extract 3% suspension, gave considerable per cent mortality of larvae and adult beetles. The azadirachtin based insecticides and neem seed kernel extract also showed remarkable antifeedant property both for larvae and adults.

The study on host preference indicated that the brinjal was the most preferred food plant than the tomato.

Dr.M.S. Purohit,  
Ph.D., Entomology,  
Training Associate (P.P.),  
Training and Visit Scheme,  
Gujarat Agricultural University,  
Navsari Campus, Navsari-396450

### CERTIFICATE

This is to certify that the thesis entitled "Biology of Epilachna beetle, Henosepilachna vigintioctopunctata (Fabricius) (Coccinellidae: Coleoptera) and Evaluation of Indigenous Botanical Materials for It's Control" submitted by SHRI KAUSHIK KUMAR NANUBHAI PATEL in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in the subject of **AGRICULTURAL ENTOMOLOGY** of the **GUJARAT AGRICULTURAL UNIVERSITY** is a record of bonafide research work carried out by him under my guidance and supervision and that the thesis has not previously formed the basis for the award of any degree, diploma or other similar titles.

Place : Navsari

Date : 28th October, 1996

  
(M. S. Purohit)

Major Advisor

## DECLARATION

This is to declare that the whole of the research work reported here in the thesis for the partial fulfilment of the requirements for the degree of Master of Science (Agriculture) in Agricultural Entomology by the undersigned is the result of investigation done by me under the direct guidance and supervision of Dr.M.S. Purohit, Training Associate (P.P), Training and Visit Schme, Gujarat Agricultural University, Navsari Campus, Navsari and no part of the work has been submitted for any other degree so far.

Place : Navsari

Date : 28th October, 1996

*K.N. Patel*  
(K. N. Patel)

## COUNTERSIGNED BY

*M.S. Purohit*  
*28/10*  
(M. S. Purohit)

Training Associate (P.P),  
Training and Visit Scheme,  
Gujarat Agricultural University,  
Navsari Campus, Navsari-396450

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K.N. Patel  
(K. N. Patel)

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# **INTRODUCTION**

## I INTRODUCTION

The vegetables form an essential component of the human diet specially in the case of India and some South-east Asian countries where sizeable population basically consists of vegetarians. So vegetables play an important role in balanced nutrition as these are valuable sources of carbohydrates, proteins, vitamins and minerals. Since both food security and nutritional security are important requirements, special efforts on intensification of production and supply of vegetable crops are necessary.

India's an estimated production of vegetable is 50 million tones in 1995 from an areas of 5.24 million hectares (Anonymous, 1995). It is targeted to increase production to 76 million tones by the end of the eighth plan (1996-97). India is the second largest producer of vegetables in the world next only to China. In spite of large production, per capita supply of vegetables is only about 140 gms per day as against 280 gms of dietary recommendation which is the result of increasing rate of population and poor purchasing power of consumer. We have, therefore, to go a long way and have to double our vegetable production to supply a balanced diet to our masses.

The major constraints in India for increasing vegetable production per unit area as compare to other advanced countries are low priority in developmental programmes, lack of widely adaptable high yielding

varieties, lack of short duration superior varieties to fit in different farming systems, non-availability of seed of improved high yielding varieties, limited extension service support, several diseases and insect-pests, unorganised marketing and lack of organisational set-up for research and development programmes. Among these the losses caused by the insect-pests is one of the major factors responsible for low productivity of vegetables. Insects cause losses to vegetable growers amounting to many millions of dollars annually, probably hundreds of millions (Thompson and Kelly, 1957). Srinivasan (1993) believed that more than 40 per cent of yield losses is caused due to pest attack in different vegetables in India.

Several species of insects are recorded from different vegetables. Of the recorded pests some of the important insect-pests which causes damage to vegetable crops in India are fruit borer, Heliothis armigera; cutworms, Agrotis ypsilon Rott.; spotted bollworm, Earias Spp.; leaf hopper, Empoasca devastans D.; aphid, Aphis Spp.; fruit fly, Dacus cucurbitae, Dacus diversus Coq.; epilachna beetle, Epilachna Spp; myllocerus weevil, Myllocerus blandus Fst.; red and black pumpkin beetle, Aulacophora Spp.

Amongst the beetle pests the important ones are a group of coccinellids, commonly known as hadda beetles/ epilachna beetles (Epilachna Spp.), Occurs widely in India and other parts of the world. These phytophagous and harmful species are often confused with beneficial predatory coccinellid beetles popularly known as lady bird beetles.

Both grubs and adults possess mandibulate type of mouth parts which are strongly developed and they eat the chlorophyll of the leaf in between the veins and cause characteristic skeletonized patches on leaves. The adults being strong fliers, infest wide area during their peak activity period.

The species reported damaging solanaceous and cucurbitaceous vegetable crops are, Henosepilachna vigintioctopunctata (Fabricius), Epilachna dodecastigma Mulsant, E. implicata Mulsant, E. ocellata Redtenbacher, E. septima Dieke and E. demurili. These have also been reported as quite serious pests of various other vegetable crops from different parts of the world. E. varivestis Mulsant the Mexican bean beetle is confined to southern Canada, USA., Mexico and Guatemala where it is a serious pest of beans (Phaseolus Spp.) and E. hirta (Thunberg), E. fulvosigmata Reiche and E. similis (Thunberg) are common in Africa on cucurbits. These species, however, have not yet been intercepted from South-east Asia. Of the species recorded in South-east Asia, H. vigintioctopunctata (F.) is the most common and destructive one specially to brinjal, bitter gourd, bottle gourd, snake gourd, potato and tomato. This is causing considerable damage to the vegetable crops. Kabissa and Fronk (1986) noted that the percentage of total yield loss of bean due to larvae of second, third, fourth instar and adult were determined as 2.0, 2.9, 8.3 and 54.9 per cent, respectively. Similarly Rao et al. (1989) reported the damage by the beetle goes beyond 30-40 per cent on leaves and also nearly 50 per cent on fruits. Potato yield is

reduced drastically and loss up to 75 per cent has been recorded (Misra, 1986). Though the literature on losses due to Epilachna Spp. in Gujarat is lacking, Thakor (1972) found that the pest is attacking solanaceous, cucurbitaceous and other vegetable crops viz., tomato, potato, brinjal, bitter gourd, cucumber, pumpkins, lady's finger, cabbage etc.

Introduction of high yielding varieties of vegetable crops and change in cropping pattern i.e continuous cropping of sole vegetable crops twice or thrice in a year, has aggravated the insect pest problem including epilachna beetle in South Gujarat. To combat these pest problem, insecticidal application are found to be economical and it has become most popular control measures amongst the vegetable growers. However, because of over enthusiasm farmers use excessive application of pesticides in inappropriate proportion to get monitory return. This has resulted into several serious problems such as destruction of natural enemies of pest, resurgence and insecticidal resistance to insects etc. As described earlier, epilachna beetle H. vigintioctopunctata has enough potential to cause severe damage to the vegetable crops. Hence, it is necessary to develop suitable pest management strategy to combat menace of this pest.

To develop such strategy there is prime need to study the biology of epilachna beetle H. vigintioctopunctata, to find out the weak links in it's life history. Few workers have reported its biology in India (Kapur, 1950; Pawar, 1964; and Atwal, 1976). In Gujarat only Thakor (1972) reported the

bionomics of epilachna beetle, H.vigintioctopunctata in Saurashtra region. However, no work has been done on it's biology and control under South Gujarat heavy rainfall agroclimatic zone.

Now a days farmers are using chemical insecticides like malathion, parathion, endosulfan, methyl demeton, carbaryl, DDVP etc. for controlling epilachna beetle. It is likely that frequent and unjudicious use of chemical insecticides may pose severe threat to natural enemies of epilachna beetle and also increase the residue problems in the vegetable fruits. To get rid of the problems, it is necessary to restrict the use of chemical and replace it by safer and bio-degradable products like botanical materials as pesticides. So an attempt has been made to study the effect of certain plant material extracts against epilachna beetle along with two conventional insecticides under laboratory conditions during the course of this investigation.

In view<sup>of</sup> the above facts and relative scarcity of information, the present investigation was undertaken with following aspects.

1. Host plants survey.
2. Biology of epilachna beetle, H.vigintioctopunctata (F.).
3. Bio-efficacy of some indigenous botanical materials against larvae and adults of epilachna beetle, H.vigintioctopunctata (F.) under laboratory conditions.
4. Studies on the host preference of H.vigintioctopunctata (F.).

**REVIEW  
OF  
LITERATURE**

## II REVIEW OF LITERATURE

The epilachna beetle Henosepilachna vigintioctopunctata (F.) belongs to the family coccinellidae of the order coleoptera. It is one of the important pest of vegetable crops like brinjal, tomato, potato, bitter gourd etc. The literature pertaining to epilachna beetle particularly in relation to the present investigation has been reviewed.

### 2.1 Systematic Position of Epilachna Beetle :

In the earlier literature several workers (Sengupta and Panda, 1958 ; Mathur and Srivastava, 1964; Krishna and Sinha, 1969; Rai and Gopal, 1975; Sinha, et al., 1977; Iftekhhar, 1985; Dhamdhere et al., 1990) have reported the scientific name of epilachna beetle as Epilachna vigintioctopunctata which is the most common Spp. Prevailing in India. Richards (1983) mentioned that genus Epilachna and Henosepilachna are synonyms. Thereafter, most of the workers (Butani and Jotwani, 1983; Narang and Ramzan, 1984; Borah and Saharia, 1985; Tewari and Krishnamoorthy, 1985; Hirano, 1985; Chen et al., 1990; Zhang and Liu, 1994) have given it's scientific name as Henosepilachna vigintioctopunctata (Fabricious). Thus it seems that genus Epilachna and Henosepilachna are synonyms.

## 2.2 Distribution and Host Range of Epilachna Beetle :

Epilachna beetle, Epilachna Spp. are known as the pest of solanaceous and cucurbitaceous crop throughout the world including India. The host plants and distribution of this pest are presented in tabular form (Table 1).

## 2.3 Nature of Damage of Epilachna Beetle :

The epilachna beetle, Epilachna Spp. are one of the important species of phytophagous coccinellids. Their damage occurs right from <sup>e</sup> seedling stage to crop maturity stage.

E. vigintioctopunctata causing severe damage to brinjal seedlings especially during the month of July and August and in the later stage in most cases withstand the feeding of the larvae without being killed but stunting the growth is evident in young plants (Sengupta and Panda, 1958). However, young plants when heavily attacked start withering and soon die out (Mathur and Srivastava, 1964).

Both adult and grub feed on leaf tissue in a very peculiar manner and cause considerable damage to the crops. According to Mathur and Srivastava (1964) both the adults and grubs of E. vigintioctopunctata feed on the under surface of leaves by scrapping the epidermal layer in a very characteristic manner. They normally consumed the chlorophyll bearing tissues in concentric curves (Rai and Gopal, 1975). Similar nature of damage was reported by Atwal (1976). The damaged leaves get skeletonized and gradually

Table: 1 Hosts and distribution of Epilachna Spp.

Hosts	Distribution	Author (s)
1	2	3
Banana	Wallis Island	Cohic, 1954
Bitter gourd	Ceylon	Hutson, 1924; Austin, 1925
	India (West Bengal; Kerala)	Rebeiro, 1934; Thomas and Jacob, 1991
Black night shade ( <u>Solanum nigrum</u> )	Australia	Temperley, 1928
	Kwangtung Province	Chue, 1930
	South China	Hoffmann, 1932
	Japan	Koyana, 1960
Cabbage	Indonesia	Dresner, 1955
Cucumber	Samea, Tongo and Ellice Islands	Hopkins, 1928
	Australia	Temperley, 1928
	Japan	Koyana, 1960
	Turkey	Giray, 1971
	India (Punjab)	Narang and Ramzan, 1984
Cucurbits	Southern Queensland	Jarvis, 1914
	Sydney	Gurney, 1925
	Malaya	Gater, 1925
	Ceylon	Austin, 1926
	Melbourne	Helson, 1948
	Argentina	Migliardi, 1983
	India (Mysore; New Delhi)	Krishnamurti, 1933; Pruthi, 1949; Puttarudriah and Krishnamurti, 1956; Choudhuri, <u>et al.</u> , 1983



Table:1 ... (contd.2)

1	2	3
Cotton	Australia	Temperley, 1928
Cowpea	India (U.P)	Srivastava and Katiyar, 1972
Egg-plant	Ceylon	Hutson, 1922; Austin, 1925
	Malaya	Gater, 1925
	Samea, Tongo and Ellice Islands	Hopkins, 1928
	Kwangtung Province	Chue, 1930
	South china	Hoffmann, 1932
	Wallis Island	Cohic, 1954
	Japan	Koyana, 1960; Hirano, 1993
	India (Punjab; Mysore; Tamilnadu)	Chopra, 1928; Krishna murti, 1933; Puttarudriah and Krishnamurti, 1956; Srivastava, 1957; Thomas <u>et al.</u> , 1969; Uthamasamy <u>et al.</u> , 1973; Singh and Garg, 1978; Narang and Ramzan, 1984; Grewal, 1988
Elephant grass	Ghana	Scheibelreiter and Inyang, 1974
French beans	Malaya	Gater, 1925
Lady's finger	Malaya	Gater, 1925

Table:1... (contd.3)

1	2	3
Maize	Ghana	Scheibelreiter and Inyang, 1974
Melon	Turkey	Giray, 1971
	USSR	Tilavov, 1980
	India (Punjab; Rajasthan)	Narang and Ramzan, 1984; Pareek and Kavadia, 1987
Potato	Fiji	Knowles, 1919; Lever, 1939
	Australia	Froggatt, 1921; Temperley, 1928
	Java	Van Der Goot, 1924
	Ceylon	Hutson, 1924
	Siberia	Engelhardt and Ehvenbrapat, 1928
	Melbourne	Pescott, 1928
	Queensland	May, 1947
	Indonesia	Dresner, 1955
	Japan	Koyana, 1960; Inoue, 1970; Hirano, 1985; Hirano, 1993
	India (Mysore; Punjab; West Bengal)	Krishnamurti, 1933 Subramanian, 1933; Puttarudriah and Krishna murti, 1956; Singh and Garg, 1978; Narang and Ramzan, 1984; Mohasin, 1994

Table:1... (contd.4)

1	2	3
pumpkins	Ghana	Temperley, 1928
	Japan	Koyana, 1960
Rice	Ghana	Scheibelreiter and Inyang, 1974
Ridge gourd	India (Assam)	Borah and Saharia, 1985
sorghum	Ghana	Scheibelreiter and Inyang, 1974
Thorn-apple	Australia	Temperley, 1928
<u>(Datura stramonium)</u>	Japan	Koyana, 1960
	India	Thomas <u>et al.</u> , 1969
Tobacco	Fiji	Lever, 1939
Tomato	Philippines	Jowes, 1913
	Australia	Temperley, 1928
	Melbourne	Pescott, 1937
	Fiji	Lever, 1939
	Wallis Island	Cohic, 1954
	Japan	Koyana, 1960
	India (Mysore; Punjab)	Puttarudriah and Krishna murti, 1956; Thomas <u>et</u> <u>al.</u> , 1969; Narang and Ramzan, 1984
Wheat	Ghana	Scheibelreiter and Inyang, 1974

turn brown, dry-up and fall-off, completely defoliating the plants (Shinde et al., 1970; Butani and Jotwani, 1983; Misra, (1986). According to Lal (1990) both adults and larvae of E. ocellata Redt. are voracious feeders and cause almost the same type of damage to different food plants. They preferably attack the leaves and heavily attacked leaves are skeletonized, shrivelled and ultimately get dried-up.

Rai and Gopal (1975) reported that the beetles not only fed on the leaves of brinjal plants but also attacked fruits by causing the characteristic ladder like concentric injury and reduced their economic value. Earlier, Krishna and Sinha (1969) noted that the beetles of E. vigintioctopunctata preferred to feed on the flowers of Luffa aegypticeae Mil. than any other parts of the plant.

Pawar (1964) reported that the extent of loss in yield in solanaceous crops due to this pest is 50 per cent or even more. Kabissa and Fronk (1986) noted that the percentage of total yield losses in bean crop due to larvae of second, third, fourth instar and adults were determined as 2.0, 2.9, 8.3 and 54.9 per cent, respectively. Whereas Misra (1986) reported yield loss up to 75 per cent in potato. Rao et al., (1989) observed that the damage by the beetle goes beyond 30-40 per cent on leaves and also nearly 50 per cent on fruits.

## 2.4 Biology of Epilachna Beetle:

### 2.4.1 Egg

#### 2.4.1.1 Site of egg laying

Pawar (1964) found that the female adult laid eggs singly and in batches on the underside of the leaves of the host plants. Similar observation was made by Atwal (1976), Tilavov (1980), Butani and Jotwani (1983) and Iftekhar (1985).

#### 2.4.1.2 Colour, shape and size

According to Pawar (1964) the freshly laid eggs of H.vigintioctopunctata were silver yellow in colour, as maturity advances the colour turns to dull yellow. The eggs were bomb shaped, pointed at the apex and flat at the base; the side which is glued to the leaf is flat. Atwal (1976) reported that eggs of H.vigintioctopunctata were yellow, cigar shaped and laid in batches of 5-40 each. Whereas, Iftekhar (1985) reported that the eggs are bright yellow in colour and elliptical in shape.

Pawar (1964) reported that the eggs of H.vigintioctopunctata were about 0.75 mm in length and 0.5 mm in width. However, Iftekhar (1985) recorded it 1.1178 to 1.2204 mm in length and 0.4407 to 0.5085 mm in width.

### 2.4.1.3 Incubation period

According to Mathur and Srivastava (1964) the incubation period was 3-8 days while, Pawar (1964) reported it as 3-4 days.

Atwal (1976) observed that the duration of egg stage was 5, 3.3 and 2.9 days at 25, 30 and 35°C temperature, respectively. Whereas, Abdin and Siragelnour (1991) reported that the egg period was  $5.0 \pm 0.45$  at  $25 \pm 1^\circ\text{C}$  temperature and  $42.0 \pm 5.0$  per cent RH in the laboratory.

## 2.4.2 Larva

### 2.4.2.1 Number of instars

The newly hatched larva moults three times to reach its advanced stage and prepare itself for pupation (Pawar, 1964). Later on similar number of larval instars were reported by several workers (Thakor, 1972; Tilavov, 1980; Iftekhar, 1985).

### 2.4.2.2 First instar larva

Thakor (1972) reported that the body colour of newly hatched larva of H.vigintioctopunctata was bright yellow with mandibles, ocelli and claws dark red in colour. He further reported that head was relatively large, triangular with setae separately distributed on the dorsal surface. The epicranial suture is distinct with its arms extending upto the bases of the antennae and the dorsal and subdorsal scoli are similarly branched as those on the

thorax. Iftekhhar (1985) observed that first instar larva has two segmented antennae and the large subrounded head bears characteristic spines all along it's thorax and abdomen. Prothorax, which is as wide and half as long as head, possess on it's dorsal surface a transverse row of four equally placed dorsal and sub dorsal scoli. The abdomen, which is nine segmented with one small additional somewhat indistinct segment has a similar pattern of scoli. Earlier, similar morphological character was also observed by Kapur (1950).

According to Thakor (1972), the first instar larva of H. vigintioctopunctata was measured on an average  $1.310 \pm 0.08$  mm in length and  $0.44 \pm 0.02$  mm in breadth. However, Iftekhhar (1985) measured it 1.1595 to 1.2543 mm in length and 0.4238 to 0.5254 mm in width.

From the study on the influence of temperature on the duration of larval instars Iftekhhar (1985) found that the duration of first instar larva was 3 to 4 days at an average lab temperature of  $27 \pm 1^{\circ}\text{c}$  and 60-70 per cent RH. Earlier, Thakor (1972) reported that duration of first instar larva was 3 to 5 days.

#### **2.4.2.3 Second instar larva**

Kapur (1950) observed that the second instar larva of H. vigintioctopunctata was similar to first instar in general structure and antennae but easily distinguished from it by the structure of the scoli, the dorsal and dorsolateral scoli on thorax having nine branches and on

abdomen seven or eight on the ventral surface each group comprises three or four setae. Similarly, Thakor (1972) reported that the second instar larva was similar in shape to first instar larva. He further reported that larval body was oblong and oval with many branched scoli distributed all over the dorsal surface of the body. Iftexhar (1985) also noted that it resembles the first instar larva except for it's large size and hump back appearance.

Studies on the measurement of larva by Thakor (1972) revealed the second instar larva was  $2.58 \pm 0.32$  mm in length and  $0.94 \pm 0.10$  mm in breadth. While, Iftexhar (1985) measured it 2.3053 to 2.4800 mm in length and 0.7799 to 0.8644 mm in width.

Thakor (1972) reported that an average duration of second instar larva was  $2.13 \pm 0.43$  days. However, Iftexhar (1985) reported it about 2 to 3 days.

#### 2.4.2.4 Third instar larva

Kapur (1950) observed that pronotum and parts of the thoracic tergites of the third instar larva of H.vigintioctopunctata was more conspicuously sclerotised than in the earlier instar. Thoracic scoli usually with about twelve relatively long branches, abdominal scoli on the first few segment each with about twelve branches with relatively short setae. Whereas, Thakor (1972) reported that the body of third instar larva was more spiny due to well developed branches of various scoli. Iftexhar (1985) found that the third instar larva resembling the second instar

ones except distinct dark stripes on either side of the mid dorsal line of the thorax.

Thakor (1972) reported that third instar larva was  $3.98 \pm 0.28$  mm in length and  $1.52 \pm 0.13$  mm in breadth. Whereas, Iftekhhar (1985) noted that it was 3.0849 to 3.2713 mm long and 0.8475 to 1.0509 mm wide.

The duration of third instar larva recorded by Thakor (1972) was 2 to 4 days. While, Iftekhhar (1985) recorded it 3 to 4 days at  $27 \pm 1^{\circ}\text{C}$  room temperature.

#### 2.4.2.5 Fourth instar larva

The fourth instar larva of H.vigintioctopunctata was similar to third instar in general structure (Kapur, 1950). According to Pawar (1964) full grown larva was cream yellow in colour and except the head region all the segments bears six scoli symmetrically placed, three on each side with a black mid dorsal line running from front to back. Thakor (1972) also observed that the colour of the fourth instar larva was yellow having abdominal scoli. The fourth instar larva can be easily distinguished by it's large size (Iftekhhar, 1985).

Thakor (1972) found that the fourth instar larva was  $6.17 \pm 0.49$  mm in length and  $2.24 \pm 0.89$  mm in breadth. However, Iftekhhar (1985), measured it from 4.7799 to 5.0173 mm in length and 1.4238 to 1.7119 mm in width.

Thakor (1972) reported that an average duration of fourth instar larva was  $4.70 \pm 0.87$  days. Whereas, Iftekhhar

(1985) reported that the duration of fourth instar was 4 to 5 days.

#### **2.4.2.6 Larval period**

There is a large variation in duration of larval period reported by various workers. Pawar (1964) reported that the larval stages lasted for 20 to 25 days. While, Mathur and Srivastava (1964) recorded it to be 15 to 22 days. On the other hand Thakor (1972) reported that the larval period varied from 10 to 19 days and Nagia et al. (1992) reported it to be  $14.20 \pm 0.65$  days. The larval period was influenced by the different seasons as reported by Scheibelreiter and Inyang (1974), They stated that the larval period was shorter (9 to 17 days) in the dry season as compared to rainy season (17 to 23 days). The duration of larval period at different temperature was studied by Atwal (1976). The study revealed that the larva was full grown in 17.8, 8.7 and 7.1 days at 25, 30 and 35°C temperature, respectively.

#### **2.4.3 Pupa**

##### **2.4.3.1 Prepupal stage**

According to Pawar (1964) in the prepupal stage the full grown larva ceased its feeding activity, starts shrinking and the body starts taking a convex shape. However, Thakor (1972) observed that the shortening of larva in length and slight swelling in thoracic region.

According to Pawar (1964) prepupal stage lasted about a day. Whereas, Thakor (1972) reported that the average duration of prepupal stage was  $1.76 \pm 0.4$  days while Gupta and Kumar (1983) observed it as 2 days.

#### **2.4.3.2 Pupal stage**

According to Pawar (1964) the exuviae of the last larval stage along with scoli forms as sort of covering on the pupa except the freely suspended anterior end. The freshly formed pupa was hemispherical in shape and pale yellow in colour but later on developed dark natural grey patterns dorsally and buff yellow ventrally (Thakor, 1972). Iftekhar (1985) also observed yellow colour and oval shape pupa covered with bristles and later on the brown markings start appearing on the dorsal surface and the colour change to yellowish white.

Thakor (1972) reported that the pupa was 6.78 mm in length and 4.20 mm in breadth. Whereas, Iftekhar (1985) noted that it was 3.833 to 4.277 mm in length and 1.705 to 2.058 mm in width.

Pawar (1964) reported that the pupal stage lasted for about 5 to 6 days. While, Thakor (1972) recorded it to be 3 to 5 days. Iftekhar (1985) also reported it to be 4 to 5 days.

## 2.4.4 Adult

### 2.4.4.1 Colour, shape and size

Thakor (1972) reported that the adult of H.vigintioctopunctata was hemispherical in shape but slightly elongated towards the hinder region. The head was deeply inserted in the anterior concave margin of the pronotum. Butani and Jotwani (1983) noted that adult was hemispherical, pale brown and mottled with black spots; with 14 spots on each elytron. Iftekhar (1985) observed that the newly emerged adult was light yellow, faintly spotted and oval in shape. Within the next three hours the colour changed to reddish brown with 28 characteristically arranged black spots of variable size.

Thakor (1972) recorded average length of female and male was  $6.65 \pm 0.29$  mm and  $6.08 \pm 0.34$  mm, respectively. While, the average breadth of abdomen of female and male was  $5.92 \pm 0.29$  mm and  $4.94 \pm 0.39$  mm, respectively. Iftekhar (1985) reported the size of the adult beetle in general. He noted that the adult beetle was 4.28 to 6.54 mm in length and 2.86 to 4.12 mm in width.

### 2.4.4.2 Sex ratio

Pandey and Umashankar (1975) reported that the sex ratio of Male : Female was 1:2 in the laboratory condition. Whereas, Iraqi and Farag (1986) recorded it was about 1:1.

#### 2.4.4.3 Copulation

Iftekhar (1985) observed that the freshly emerged males and females of H.vigintioctopunctata started copulating in the laboratory after 6-8 days of emergence. He further reported that the process was generally completed within an hour.

#### 2.4.4.4 Pre - oviposition period

Thakor (1972) reported that the pre-oviposition period of H.vigintioctopunctata was about 8 to 11 days. Similarly Scheibelreiter and Inyang (1974) also observed it as 7 days. Whereas, Abbas and Nakamura (1985) recorded it to be 11 days. Whereas, Iftekhar (1985) recorded pre-oviposition period as 16 to 19 days at  $27 \pm 1^{\circ}\text{C}$  temperature and 60-70 per cent RH.

#### 2.4.4.5 Oviposition period

According to Thakor (1972), the oviposition period was 15-21 days. On the other hand Giray (1971) observed it as 19 to 67 days. However, Iraqi and Farag (1986) recorded wide range (1 to 91 days) in oviposition period. Iftekhar (1985) recorded that the oviposition period was 22 to 36 days at  $27 \pm 1^{\circ}\text{C}$  temperature and 60-70 per cent RH.

#### 2.4.4.6 Post - oviposition period

Thakor (1972) observed that the post-oviposition period of H. vigintioctopunctata varied from 2 to 8 days. While, Abbas and Nakamura recorded it 2.3 days.

#### 2.4.4.7 Fecundity

According to Mathur and Srivastava (1964), the female laid 500 to 700 eggs during its lifetime. Later on almost similar egg laying capacity was reported by other workers (Pawar, 1964; Atwal, 1976; Dhamdhere <sup>et al.</sup> 1990). Whereas, Iftexhar (1985) noted that number of eggs deposited by a female during oviposition period varied from 107 to 238.

#### 2.4.4.8 Longevity

According to Thakor (1972) the average life duration of female and male was 31.50 and 27.25 days, respectively. However, Pandey and Umashankar (1975) reported that the average longevity of female was 44 days and that of male was 37 days. Similarly, Dhamdhere et al., (1990) recorded that the longevity of female and male was 46 and 34 days, respectively.

#### 2.4.4.9 Total life cycle

Rao and Azam (1973) recorded total life cycle of E.vigintioctopuctata was 21.5 days. Whereas, Butani and Jotwani (1983) reported that the life cycle of H.vigintioctopuctata was completed in 18 to 25 days during summer and may extend up to 50 days during winter. However, Dhamdhere <sup>et al.</sup> (1990) recorded that the average life cycle period of H. vigintioctopuctata was 21.06 days.

## .5 Control Measures :

### 2.5.1 Chemical Insecticide

Jayakumari and Nair (1969) studied the relative susceptibility of larvae in each of the three instars of H. vigintioctopunctata to five insecticides under laboratory condition. He found that carbaryl was the most toxic to all three instars collectively, followed by parathion, malathion, BHC and DDT.

Shinde et al. (1970) found that out of ten insecticides tested against the adults of Epilachna dodecastigma w., only nine insecticides viz., mevinphos, dicrotophos, diazinon, dichlorvos, phosphamidon, methyl-parathion and ethyl-parathion were found to be more toxic than dimethoate.

Thakor (1972) evaluated eleven different insecticides against the adults of epilachna beetle under laboratory condition. He concluded that parathion 0.03 per cent gave a 100 per cent mortality in just over 48 hr whereas, all other insecticides were found to be slow acting in getting even 80 per cent mortality.

McClanahan (1981) tested the contact action of 21 insecticides against first instars of Epilachna varivestis M. He found that the most toxic materials were the synthetic pyrethroids, carbofuran, methomyl and carbaryl, and the least toxic were malathion, endosulfan and phosmet.



Nagia et al. (1992) evaluated nine insecticides in the laboratory against larvae and adults of H. vigintioctopunctata and found that carbaryl, quinalphos, endosulfan, cypermethrin, deltamethrin, and fenvalerate were effective against larvae and adults.

### 2.5.2 Botanical materials

Ascher and Gsell (1981) found that methanolic seed kernel extract of neem treatment at 15 mg/lit resulted in the development of a high percentage of abnormal adults and 20-30 mg/lit marked larval mortality.

The effects of crude extracts of garlic (Allium sativum L.) on the feeding activity and metamorphosis of E. varivestis were tested by Nasseh (1981) under laboratory conditions. He found that the application of 3 concentrations of the extract (1.25, 2.5 and 5.0 %) to the larval food had a strong antifeedant effect on the insect. In addition, high larval and pupal mortality occurred.

Dhandapani et al. (1985) reported that neem seed kernel extract at 3 per cent reduced feeding activity of chewing insects. They further studied the efficacy of the emulsion concentrates of five different plant extracts, neem oil and leaf extracts of neem, parthenium, Vinca rosea and Solanum xanthocarpum on H. vigintioctopunctata. Their study indicated that the neem oil was found superior in reducing the pest population.

Tewari and Krishnamoorthy (1985) found that all concentrations ranging from 0.05 to 0.5 per cent petroleum ether extract of the drupes of Melia azedarach Linn., rhizomes of Acorus calamus Linn. and seed oil of Azadirachta indica A. Juss., showed varying degrees of antifeeding effect both against grubs and adults of H. vigintioctopunctata. They noted that concentration of 0.5 and 0.1 per cent of all the plant substances gave 100 per cent protection to the leaf.

The effectiveness of extracts of nine plants against the E.vigintioctopunctata was studied by Chandel et al. (1988). They found that the seed extract of Gynandropsis gynandra was the most toxic followed by the rhizome extract of Acorus calamus and the extracts of shade dried stems of Cyperus rotundus.

The antifeedant properties of petroleum ether and aqueous extracts of the leaves of 15 plant species were evaluated against second instar larvae of H. vigintioctopunctata by Rao et al. (1990). They found that the most potent antifeedants were those extracted from Annona squamosa, Argemone mexicana, Cacopris gigantea and Ricinus communis. Whereas, Jeyanarajan and Babu (1990) found that NEM-75 at 1000 ppm was the best antifeedant for fourth instar E.vigintioctopunctata larvae followed by NK-100 and Nemidin. NK-100 had the greatest antifeedant activity against adults.

Rao et al. (1992) tested petroleum ether extracts of leaves of four selected plants in the laboratory for their antifeedant and insecticidal properties against H. vigintioctopunctata. They found that 0.2 and 0.5 per cent of Bougainvillea spectabilis, Parthenium hysterophorus and 0.5 per cent concentration of Azadirachta indica leaves extract gave 100 per cent mortality. Extracts from Croton sparsiflorus was the least effective whereas there was no mortality when insects were treated with 0.2 per cent C. sparsiflorus.

Reddy et al. (1990) reported that the 1 per cent petroleum ether extracts of A. indica, A. squamosa were the most effective in reducing the H. vigintioctopunctata larvae population by 92.99 and 91.02 per cent, respectively. Later on Reddy et al., (1990) reported similar results of these two extracts on larval population on brinjal plants.

Chitra et al. (1992) reported that the plant extract of A. squamosa, A. mexicana, C. gigantea and R. communis at 0.5 and 1.0 per cent gave effective protection to plants against first and third instar larvae of H. vigintioctopunctata. They also noted more than 20 per cent reduction in the larval weight.

Sreedevi et al. (1993) studied the efficacy of certain plant extracts against H. vigintioctopunctata grubs. They observed that the plant extracts of RD 9 repellin had higher efficacy and it was followed by neemicide, vapenik, neknool and wellgro.

## 2.6 Host Preference :

Thomas et al. (1969) compared five solanaceous plants in the laboratory for their suitability as food plants for larvae of H.vigintioctopunctata and found that the percentage survival and the growth rate index were highest on Physalis maxima and lowest on tomato.

Giray (1971) studied on the host preference of E.chrysomelina in the laboratory and found the order of decreasing preference was cucumber, squash, melon, Ecballium elaterium and water melon when choice was provided.

Pandey and Umashankar (1975) studied on the host preference of H.vigintioctopunctata. The study revealed that the larval period, larval weight, average longevity, fecundity and percentage of adult emergence was highest in case of brinjal and lowest on pumpkin. The other host preferred in descending order were potato, tomato, toroi and lauki.

Borah and Saharia (1981) studied the development of H.vigintioctopunctata on 10 species of cucurbitaceous plants and found that on the basis of leaf area consumed, both larvae and adults preferred Momordica cochinchinensis, to be the most suitable food plant.

Choudhuri (1983) studied the duration and body development of different stages of E.dodecastigma on the two

different food plants, cucurbits uchche (M.charantia) and korola (M.charantia Cv.korola) and noted that the korola was the preferred food plant on which population increased faster.

From the results of the studies on the preference of third and fourth instar larvae of H. vigintioctopunctata for the leaves of solanaceous plants. Vasantha et al. (1986) reported that the Solanum melongena was the most preferred food plant followed by tomato, Datura fastuosa, Physalis maxima and Solanum nigrum.

Dhamdhare et al. (1990) studied the effect of six host plants on the larval and post larval development of E.vigintioctopunctata and found that on the basis of development and survival of the pest, brinjal and tomato were the most preferred and datura was the least preferred food plants.

Nagia et al. (1992) reported that first and second instar larvae of H.vigintioctopunctata survived better on leaves of the weed (Physalis minima) than on leaves of brinjal whereas, older larvae survived comparably on either plant in the laboratory.

**MATERIALS  
AND  
METHODS**

### III MATERIALS AND METHODS

The materials and methods used for the present investigation on various aspects of epilachna beetle, Henosepilachna vigintioctopunctata (Fabricius) are presented below.

#### 3.1 Host Range :

To record the host of H. vigintioctopunctata (F.), surveys were carried out on the Farm of Gujarat Agricultural University, Navsari and its surrounding area. For this purpose, various crops viz; brinjal, tomato, bitter gourd, bottle gourd, spine gourd, ridge gourd, beans, cowpea, lady's finger and cabbage, were observed from 2nd week of June' 95 to 1st week of June' 96. The total number of larvae and adults on five randomly selected spots of each crop were recorded at weekly interval.

#### 3.2 Nature of Damage :

The epilachna beetle infested brinjal plants were observed critically in the field as well as in the laboratory for studying the nature of damage.

#### 3.3 Biology :

Studies on biology of H. vigintioctopunctata (F.) was carried out under laboratory condition at Department of Entomology, N.M. College of Agriculture, Gujarat Agricultural University, Navsari during October to December - 1995.

The average minimum and maximum room temperature during the study period was  $25.00 \pm 3.05^{\circ}\text{c}$  and  $29.85 \pm 2.31^{\circ}\text{c}$ , respectively, while, relative humidity was  $82.94 \pm 10.57$  per cent.

### 3.3.1 Rearing technique

Initial culture was raised from the eggs, larvae and adults of H. vigintioctopunctata, collected from the brinjal crop grown on the Farm of Gujarat Agricultural University, Navsari. The collected eggs, larvae and adults were reared on brinjal leaves in the laboratory of Department of Entmology, N.M.College of Agriculture, Navsari. For this purpose, brinjal leaves were washed thoroughly with water to clean dust and other particles. The petiole of the leaf was wrapped with cotton wool and soaked in water, so as to keep the brinjal leaf fresh and turgid for longer period of time. Such individual leaf of brinjal was kept in glass petri dish (5 x 1.7 cm). Then the petri dish was placed on the bottom of cylindrical glass jar (20 x 15 cm). The field collected larvae and adults were released in the glass jar. The top of the jar was covered by white muslin cloth to prevent the escape of insects. The jars prepared thus were placed in wooden cage (60 x 60 x 75 cm) [Plate I]. Fresh food was supplied to beetles daily in the morning.

The eggs laid on leaves and inner wall of glass jar were collected with the help of fine camel hair brush (No.1) The eggs were transferred to clean glass petri dish (8 x 1.7 cm). The wet cotton was provided in the bottom.



PLATE I. Glass jars and petridishes  
placed in wooden cage for  
laboratory rearing of  
H. vigintioctopunctata

The eggs placed on brinjal leaf were observed twice in a day for hatching. The newly hatched larvae were reared individually on brinjal leaves. A single larva was placed in each petri dish (10 x 1.7 cm) with fresh food. The larvae were transferred to clean container with fresh food everyday until they attained adult stage.

The adults were separated as male and female, on the basis of difference in size and were paired separately in a petri dish (10 x 1.7 cm). The eggs laid by individual female on the leaves and inner wall of petri dish were removed with the help of camel hair brush and kept in the petri dish (10 x 1.7 cm) for hatching.

### **3.3.2 Egg**

The colour, shape and size of the eggs were studied. For the purpose, the fresh eggs were transferred on the glass slide (7.5 x 2.5 cm) with fine camel hair brush. The colour and shape were observed and recorded. The size was measured under student microscope with the help of ocular micrometer after calibrating with stage micrometer. In all 30 eggs were examined.

For the study of incubation period counted number of freshly laid eggs were observed daily till hatching. The eggs were considered as hatched when tiny larvae came out from the eggs. Average incubation period was then calculated. Hatching percentage was calculated from the number of eggs hatched, out of total number of eggs kept under observation.

To study the site and pattern of egg laying, the eggs laid on leaves and different places inside the rearing jar were observed.

### **3.3.3 Larva**

To study the number and duration of different instars, the newly hatched larvae were transferred individually on the fresh brinjal leaves with camel hair brush. Such leaves with the larvae on them, were placed in glass petri dish (10 x 1.7 cm) [Plate I]. Larvae were transferred to clean petri dish and supplied with fresh food everyday. They were observed daily to study their appearance. The moulting was confirmed by presence of exuvium on the leaf or innerside of petri dish. The colour and shape of each larval instar was observed. The size of each larval instar was also measured under microscope as described earlier. The individual larval instar period and total larval period was then calculated from the period of egg hatching to the pupal formation.

### **3.3.4 Prepupa**

To record the prepupal period, the larva was observed from the time, when it stopped feeding and became sluggish to the time when it turned to pupa.

### **3.3.5 Pupa**

Freshly formed pupae were collected and kept individually in plastic tubes (2.5 x 7.5 cm). Observations on colour, shape, size and pupal duration were recorded.

### **3.3.6 Adult**

Newly formed adults were anaesthetized with chloroform and observed under the microscope to study their colour, shape and sex differences. The size of the adult was also measured and recorded.

#### **3.3.6.1 Sex ratio**

For determining the sex ratio, the adults were collected from the brinjal fields. The male and female were separated on the basis of size. The sex ratio under laboratory conditions was also determined in the same way from the culture raised in the laboratory.

#### **3.3.6.2 Pre - oviposition, oviposition and post - oviposition period**

The period between the emergence of adult female and commencing the egg laying was recorded as the pre-oviposition period. Period between commencing of egg laying and ceasing of egg laying by individual female was noted as oviposition period. While, period between ceasing of egg laying to death of female was considered as post-oviposition period.

#### **3.3.6.3 Fecundity**

In order to determine fecundity a pair was kept separately in glass petri dish (10 x 1.7 cm). In all 25 pairs were observed for the purpose. Fresh brinjal leaves were provided everyday as food. The number of eggs laid by

individual female was recorded daily till the death. Average fecundity was calculated from the data.

#### **3.3.6.4 Longevity**

Longevity of male and female was calculated separately from the date of emergence to the date of death of adult. In all longevity of 30 adults were observed for this purpose.

### **3.4 Bio - efficacy of Plant Material :**

Though the epilachna beetle is causing severe damage to the vegetable crops, it's distribution in the field condition is generally not uniform. Therefore, it was decided to conduct laboratory experiment to find out the precise efficacy of plant material against epilachna beetle. To evaluate the bio-efficacy of different plant material extracts and botanical formulations in comparison with the conventional insecticides against larvae and adults of H.vigintioctopunctata (F.) an experiment was conducted at Department of Entomology, N.M. College of Agriculture, Navsari during November - December, 1995 by using Completely Randomized Design (CRD) with 10 treatments replicated thrice. Details of the treatments are given in Table 2.

#### **3.4.1 Insect culture**

The culture of H. vigintioctopunctata was maintained on brinjal leaves as per the rearing method mentioned in para 3.3.1

Sr. No.	Treatments	Concentration (%)	Commercial Name	Formulation	Source
1	Garlic bulb extract	3% Suspension	Garlic bulb	-	Prepared in the laboratory.
2	Ardusa leaves extract	3% Suspension	Ardusa leaves	-	Prepared in the laboratory.
3	Neem seed kernel	3% Suspension	Neem seed kernel	-	Prepared in the laboratory.
4	Mint leaves extract	3% Suspension	Mint leaves	-	Prepared in the laboratory.
5	<u>Lantana camara</u> leaves extract	3% Suspension	<u>Lantana camara</u> leaves	-	Prepared in the laboratory.
6	Active azadirachtin	0.5%	Neemark	100 EC	M/s. West coast Herbochem. Pvt. Ltd., Bombay
7	Active azadirachtin	1.0%	Field guard	100 EC	M/S. Shri Chamunda Agro Processing Industries, Vichhiya (Guj.)
8	DDVP	0.03%	Nuvan	76 EC	M/C. Ciba India Ltd., Bombay
9	Endosulfan	0.075%	Thiodan	35 EC	M/S. Hoechst (India) Ltd., Bombay
10	Control	-	-	-	-

### 3.4.2 Test material

Botanical material used in the experiment viz; garlic bulb, ardua leaves, neem seed kernel, Lantana camara leaves and mint leaves were collected locally. The active azadirachtin used in test was 100 per cent emulsifiable concentrates (EC). Two separate brand, namely neemark and fieldguard provided by M/S West coast Herbochem Pvt. Ltd. and shri Chamunda Agro Processing Industries, respectively were used in the experiment.

#### 3.4.2.1 Preparation of plant material extracts

Thirty gram of each material was weighed using a top pan balance and ground in an electrical grinder with 100 ml water for two minutes at high (18000 RPM) speed. It was then filtered with fine muslin cloth and remnent from the cloth was again ground with 100 ml water and finally 1 litre volume was made to have 3 per cent suspension of the plant material by adding 800 ml water.

#### 3.4.2.2 Treatment application and mortality counts

Fresh brinjal leaves collected from the unsprayed crop were washed properly with clean water and air dried. Area of each brinjal leaf used in the experiment was measured separately by leaf area meter. Two ml solution of each treatment was applied on brinjal leaves separately with the help of Potter's Tower at 10 lbs/sq. inch pressure. Treated leaves were transferred to the petri dish (15 x 2.0 cm). Necessary care was taken to maintain turgidity of

leaves as described earlier. Ten starved third instar epilachna larvae were released on treated food material and allowed to feed for 24 hr. Fresh brinjal leaves were supplied 24 hr after treatment and thereafter, brinjal leaves were changed everyday as fresh food. The leaf area consumed by the larva within 24 hr of being put on the treated leaves was measured by leaf area meter, separately for each treatment. The percentage of leaf area consumed in different treatment was worked out. Mortality counts were recorded 24, 48, 72 hr and 7 days after treatment. Cumulative mortality was also worked out. The data was statistically analysed using C.R.D.. A similar experiment was also conducted with 2 to 3 days old epilachna adults.

### 3.5 Host Preference :

Epilachna beetle, H.vigintioctopunctata survives on the several hosts. Among the various groups of vegetable crop solanaceous plant brinjal and tomato are the main host of this pest. Therefore, it was decided to compare these two host for preference of H.vigintioctopunctata. Initial culture of H.vigintioctopunctata was raised in the laboratory on brinjal leaves as per the rearing technique mentioned in para 3.3.1. The study was under taken in the laboratory of Department of Entomology, N.M. College of Agriculture, Navsari. The larvae were reared on leaves of tomato and brinjal taken from the unsprayed fields. Neonate larvae were carefully transferred in petri dishes (15 x 2.0 cm) containing fresh leaves of both food plants, separately. A single larva was released in each petri dish. For each

host 40 larvae were reared. The larvae were allowed to feed on food material. The larvae were transferred to clean petri dishes supplied with respective fresh food material until pupation. The adults after emergence were also fed on their respective food material. For comparing the effect of host plants on development period, larval and pupal period were computed. Food on which insect gain greater body weight is always better source of energy. Body weight of full grown larvae and pupae were obtained by weighing them by single pan balance. The adults longevity and weight in respect of both foods were also recorded. The statistical analysis was done by applying 't' test.

**RESULTS  
AND  
DISCUSSION**

## IV RESULTS AND DISCUSSION

The results of present investigation on epilachna beetle, Henosepilachna vigintioctopunctata (F.) are presented and discussed as below.

### 4.1 Host Range :

The general survey made for determining the host range of epilachna beetle, H.vigintioctopunctata indicated that the pest was mainly found on brinjal (Solanum melongena L.), tomato (Lycopersicum esculentum L.) and bitter gourd (Momordica charantia L.) wherein the activity of the pest was found during September to November only. The activity was almost nil for rest of the period. No activity of epilachna beetle was observed during the survey period on bottle gourd (Lagenaria siceraria st.), spine gourd (Momordica dioica Roxb.), ridge gourd (Luffa acutangula Roxb.), beans (Phaseolus vulgaris L.), cowpea (Vigna sinensis L.), lady's finger (Hibiscus esculentus M.) and cabbage (Brassica oleracea).

In past, brinjal (Hoffmann, 1932; Krishnamurti, 1933; Cohic, 1954; Srivastava, 1957; Koyana, 1960; Thomas et al., 1969; Uthamasamy et al., 1973; Singh and Garg, 1978; Narang and Ramzan, 1984; Suman et al., 1987.), tomato (Puttarudra and Krishnamurti, 1956; Mathur and Srivastava, 1964; Thomas et al., 1969; Narang and Ramzan, 1984), bitter gourd (Ribeiro, 1934; Thakor, 1972; Thomas and Jacob, 1991) have been recorded as host plants of H.vigintioctopunctata.

## 4.2 Nature of Damage :

The study on nature of damage showed that the H.vigintioctopunctata caused damage to brinjal leaves with characteristic feeding habits. The insects nibbled away strips of leaf tissues. The larvae and adults removed the epidermis entirely and in several cases the leaves were skeletonized like a sieve [Plate II]. This was confirmed in the laboratory by releasing many individuals on the leaf [Plate III]. This finding tallies with the observations made by Thakor (1972). The adults were noticed in the laboratory to nibble the eggs, which were laid in clusters. Similar observation have also been reported by Thakor (1972).

## 4.3 Biology :

Studies on the biology of epilachna beetle, H.vigintioctopunctata (F.) was carried out during October to December, 1995. The average minimum and maximum room temperature during the study was  $25.00 \pm 3.05^{\circ}\text{c}$  and  $29.85 \pm 2.31^{\circ}\text{c}$ , respectively. While, relative humidity was  $82.94 \pm 10.57$  per cent. The results obtained are presented and discussed as under.

### 4.3.1 Egg

#### 4.3.1.1 Site of egg laying

The study on site of egg laying clearly indicated that most of the eggs were laid on the lower as well as upper surface of the leaf. Sometimes the eggs were also laid



PLATE II. A, B. Leaves damaged by H. vigintioctopunctata  
under field condition.

C. Healthy leaf



PLATE III. Leaf damaged by H. vigintioctopunctata  
under laboratory condition.

on the inner wall of the petri dishes and glass jars that were used for studies in the laboratory. Earlier, Thakor (1972) had reported similar sites of egg laying under laboratory condition. The female laid eggs in batches of 5 to 75 each. This type of egg laying habit was also observed by Thakor (1972). Later on Atwal(1976) and Iftekhar(1985) also made similar observation for site of egg laying.

#### 4.3.1.2 Colour, shape and size

The eggs of H.vigintioctopunctata were cylindrical in shape and slightly tapering towards apex. The freshly laid eggs were lemon chrome in colour and change to buff yellow as the time passed [Plate IV]. It can be seen with naked eye. A freshly laid egg was shining and soft and became hardened within 12 hr. When the embryonic development was completed the chorion at this time was smooth and transparent.

The length of eggs ranged from 1.280 mm to 1.310 mm with an average of  $1.292 \pm 0.012$  mm while the breadth ranged from 0.400 mm to 0.430 mm with an average of  $0.410 \pm 0.019$  mm (Table 3). The present findings on length and breadth of eggs are almost in conformity with those of Iftekhar (1985), who reported that the eggs were 1.22 mm in length and 0.44 mm in breadth, respectively.



PLATE IV. Eggs of H. vigintioctopunctata  
on brinjal leaf.

Table:3 Measurement of different stage of *H.vigintioctopunctata* (F.).

Stages	No. observed	Length (mm)			Breadth (mm)		
		Min.	Max.	Average	Min.	Max.	Average
<b>Egg</b>	30	1.280	1.310	1.292 ± 0.012	0.400	0.432	0.410 ± 0.019
<b>Larva</b>							
I instar	30	1.161	1.247	1.191 ± 0.032	0.430	0.430	0.430
II instar	30	2.064	2.193	2.129 ± 0.045	0.900	1.030	0.977 ± 0.034
III instar	30	2.666	3.354	3.101 ± 0.234	1.505	1.720	1.570 ± 0.086
IV instar	30	4.750	5.610	5.048 ± 0.308	2.000	2.330	2.098 ± 0.121
<b>Pupa</b>	30	5.600	5.930	5.793 ± 0.106	3.800	4.000	3.913 ± 0.073
<b>Adult</b>							
Male	30	5.330	5.790	5.690 ± 0.184	4.400	4.800	4.564 ± 0.139
Female	30	5.790	5.990	5.830 ± 0.082	5.330	5.660	5.510 ± 0.109

#### 4.3.1.3 Incubation period

The data presented in Table 4 indicated that the incubation period of eggs varied from 3 to 4 days with an average of  $3.40 \pm 0.498$ . Earlier, the incubation period of egg was found to be 3 to 8 days (Mathur and Srivastva, 1964) and 3 to 4 days (Pawar, 1964) which is more or less in accordance with the present finding. However, Abdin and Siragelnour (1991) reported delayed incubation period ( $5.0 \pm 0.45$  days) which is not in concurrence with the present finding. This might be due to different environmental conditions.

#### 4.3.1.4 Hatching percentage

The data on egg hatching percentage are presented in Table 5. From the result it can be seen that the egg hatching varied from 81.08 to 100 per cent with an average of  $91.31 \pm 6.95$  per cent. In past Thakor (1972) reported that the egg hatching varied from 85.71 to 100 per cent which is in close agreement with the present finding.

### 4.3.2 Larva

#### 4.3.2.1 Number of instars

The present study showed that the H. vigintioctopunctata passed through four larval instars (Table 4). Similar number of larval instar of this pest were also reported by several workers (Pawar, 1964; Thakor, 1972; Tilavov, 1980; Iftekhar, 1985).

Tabel:4 Details of life cycle of H.vigintioctopunctata (F.)  
on brinjal.

Sr. No.	Particulars	Period (days)		
		Min.	Max.	Average
1.	Egg period	3	4	3.40 ± 0.498
2.	Larval period:			
	First instar	3	5	3.40 ± 0.563
	Second instar	2	4	2.77 ± 0.678
	Third instar	2	3	2.20 ± 0.406
	Fourth instar	3	5	3.23 ± 0.504
	Total	13	17	15.00 ± 1.144
3.	Pupal period:			
	Prepupal	1	1	1.00 ± 0.000
	Pupal	3	4	3.33 ± 0.479
4.	Adult period:			
	Pre-oviposition	5	9	7.00 ± 1.414
	Oviposition	27	32	29.60 ± 1.949
	Post-oviposition	7	11	8.60 ± 1.516
	Longevity:			
	Male	32	34	33.40 ± 0.894
	Female	43	47	45.20 ± 1.643
5.	Total life cycle:			
	Male	50	54	52.00 ± 1.527
	Female	63	67	65.00 ± 1.632
6.	Egg laying capacity (Number)	205	600	354.40 ± 160.040

Table:5 Egg hatching of H.vigintioctopunctata (F.).

Sr. No.	Study period	No. of eggs observed	No.of eggs hatched	Hatching percentage
1	30.9.95 to 02.10.95	37	36	97.30
2	08.10.95 to 11.10.95	37	30	81.08
3	08.10.95 to 11.10.95	30	28	93.33
4	08.10.95 to 11.10.95	29	26	89.86
5	08.10.95 to 11.10.95	45	40	88.89
6	14.10.95 to 18.10.95	46	46	100.00
7	14.10.95 to 18.10.95	46	40	86.96
8	14.10.95 to 18.10.95	30	30	100.00
9	11.01.96 to 15.01.96	32	26	81.25
10	11.01.96 to 15.01.96	37	35	94.59
	Min.			81.08
	Max.			100.00
	Average $\pm$ S.D.			91.31 $\pm$ 6.95

#### 4.3.2.2 First instar larva

The larva escaped out by breaking the egg shell and remained there for 24 hr. The larva was bright yellow with mandibles, ocelli and claws dark red in colour [Plate V A]. The colour of first instar larva found in present study is in confirmation with the findings of Thakor (1972). The scoli present on dorsal and subdorsal side were white and shrunk, but next day they looked yellow in colouration on account of the yellow body fluid forced into them. Later on the spines arising from the branches of the scoli turned black, while the other portion of the scoli remained yellow. The dorsal and subdorsal scoli were similarly branched as those on the thorax. First instar larva was moderately elongate to oval in shape. The head was relatively large, triangular with setae separately distributed on the dorsal surface. The epicranial suture was distinct with its arms extending upto the bases of the antennae. Similar observation in respect of colour and shape of first instar larva were also made by Thakor (1972). In present study antennae was two segmented and the abdomen was found nine segmented with one small additional indistinct segment. Earlier, Iftekhhar (1985) also reported similar counts of segments of antennae and abdomen which is in conformity with the present finding.

The length of first instar larva ranged from 1.161 to 1.247 mm with an average of  $1.191 \pm 0.032$  mm. While, the breadth was 0.430 mm (Table 3). Thakor (1972) reported that



PLATE V. Larvae of H. vigintioctopunctata

- A. First instar
- B. Second instar
- C. Third instar
- D. Fourth instar

the length and breadth of first instar larva were  $1.310 \pm 0.08$  mm and  $0.44 \pm 0.02$  mm, respectively. Whereas, Iftekhar (1985) reported it to be 1.1595 to 1.2543 mm and 0.4238 to 0.5254 mm, respectively. The above reports support the present findings.

The duration of first instar larva varied from 3 to 5 days with an average of  $3.40 \pm 0.563$  days (Table 4). Earlier, Thakor (1972), noted the duration to be about 3 to 5 days. Similarly Iftekhar (1985) recorded it as 3 to 4 days at an average laboratory temperature of  $27 \pm 1^{\circ}\text{C}$  and 60 to 70 per cent relative humidity. The present results are in concurrence with the above reports.

#### **4.3.2.3 Second instar larva**

The larva in this instar was similar in general appearance to the first instar larva except large size and hump back appearance. Larval body was oblong and oval with many branched scoli distributed all over the dorsal surface of the body [Plate V B]. It can be easily distinguished from first instar larva by the structure of the scoli. The dorsal and dorsolateral scoli on thorax having nine branches and on abdomen seven or eight. The larva during this instar caused considerable damage to the leaves. Thakor (1972) and Iftekhar (1985) recorded more or less similar observations which confirmed the present findings.

The length of second instar larva ranged from 2.064 to 2.193 mm with an average of  $2.129 \pm 0.045$  mm while, breadth ranged from 0.900 to 1.030 mm with an average

of  $0.977 \pm 0.034$  mm (Table 3). The present findings<sup>are</sup> almost in conformity with that of Thakor (1972), who reported length and breadth of second instar larva to be on an average  $2.58 \pm 0.32$  mm and  $0.94 \pm 0.10$  mm, respectively. Later on Iftekhhar (1985) reported that second instar larva was 2.3053 to 2.4800 mm in length and 0.7799 to 0.8644 mm in breadth, which also support the present findings.

The duration of second instar larva varied from 2 to 4 days with an average of  $2.77 \pm 0.678$  days (Table 4). Almost similar results were reported by Thakor (1972), who observed that the average duration of second instar larva  $2.13 \pm 0.43$  days.

#### 4.3.2.4 Third instar larva

The body of third instar larva appeared more spiny due to well developed branches of various scoli [Plate V C]. Larva had distinct dark stripes on either sides of the middorsal line of the thorax. Head pronotum and parts of the thoracic tergites<sup>were</sup> more conspicuously sclerotised than the earlier instars. Thoracic scoli<sup>were</sup> usually with about twelve relatively long branches, abdominal scoli on the first few segment each with about twelve branches with relatively short setae. Larva in this instar fed rather vigorously. The exuvae left on the leaves appeared whitish. The above description is more or less similar to the reports of Thakor (1972) and Iftekhhar (1985).

Data on measurement (Table 3) revealed that the third instar larva measured 2.666 to 3.354 mm with an

average of  $3.101 \pm 0.234$  mm in length and 1.505 to 1.720 mm with an average of  $1.570 \pm 0.086$  mm in breadth. Thakor (1972) also reported that an average length and breadth was  $3.98 \pm 0.28$  mm and  $1.52 \pm 0.12$  mm, respectively. However, Iftekhar (1985) reported that it was 3.0849 to 3.2713 mm long and 0.8475 to 1.0509 mm wide, which is more or less in conformity with the present findings.

The duration of third instar larva varied from 2 to 3 days with an average of  $2.20 \pm 0.406$  days (Table 4). The present finding is in close agreement with the finding of Thakor(1972), who reported duration of third instar was 2 to 4 days. Similarly, Iftekhar (1985) recorded it was 3 to 4 days at  $27 \pm 1^{\circ}\text{C}$  room temperature.

#### **4.3.2.5 Fourth instar larva**

The fourth instar larva can be easily distinguished by its large size. The colour of the larva in this instar was yellow having six rows of long branched spines symmetrically placed on dorsal surface of body except the head region [Plate V D]. The larva fed voraciously during this instar. Almost similar morphological characters of fourth instar larva were described by Thakor(1972) and Iftekhar (1985).

The length of fourth instar larva ranged from 4.750 to 5.610 mm with an average of  $5.048 \pm 0.308$  mm, while the breadth ranged from 2.000 to 2.330 mm with an average of  $2.098 \pm 0.121$  mm (Table 3). According to Thakor (1972) an average length and breadth of fourth instar

was  $6.17 \pm 0.49$  mm and  $2.24 \pm 0.89$  mm, respectively. Whereas, Iftexhar (1985) recorded it was ranged from 4.7799 to 5.0173 mm in length and 1.4238 to 1.7119 mm in breadth, which is more or less in conformity with the present findings.

The duration of fourth instar larva varied from 3 to 5 days with an average of  $3.23 \pm 0.504$  days (Table 4). Thakor (1972) observed an average duration  $4.70 \pm 0.87$  days. Similarly, Iftexhar (1985) reported that it was varied from 4 to 5 days.

#### **4.3.2.6 Total larval period**

The total larval period varied from 13 to 17 days with an average of  $15.00 \pm 1.144$  days (Table 4). The total larval period found by Pawar (1964) was 20 to 25 days which is not in concurrence with the present finding. Other workers reported it to be 15 to 22 days (Mathur and Srivastava, 1964); 10 to 19 days (Thakor, 1972); 9 to 17 days (Scheibelreiter and Inyang, 1974); 17.8 days at 25°C temperature (Atwal, 1976) and  $14.20 \pm 0.65$  days (Nagia et al., 1992) which is more or less in conformity with the present finding. However variation in total larval period reported by above worker might be due to the different climatic conditions during study period and different host plants used as a food material.

### **4.3.3 Pupa**

#### **4.3.3.1 Prepupal stage**

When fourth instar larva completed their development, they ceased feeding. Prepupal stage was characterised by the shortening of larva in length and slight swelling in thoracic region. Body showed convex shape and attached its last abdominal segment to some substratum by means of viscous substance. Pawar (1964) and Thakor (1972) recorded similar observations which confirmed the present findings.

The duration of prepupal period was 1 day (Table 4). Pawar (1964) also reported that the duration of prepupal stage was one day.

#### **4.3.3.2 Pupal stage**

The freshly formed pupa was pale yellow in colour but later on developed dark natural grey patterns dorsally and buff yellow ventrally [Plate VI]. The pupa was more or less triangular with a bended head on ventral side. The elytra covering greater part of ventral body run postventral and was surrounded with a large number of setae. The legs were contracted and situated between wing pads. The abdominal terga are distinct each with a pair of the tubular spiracles. Almost similar characters of pupa were described by Thakor (1972).



PLATE VI. Pupae of H. vigintioctopunctata

The length of pupa ranged from 5.600 to 5.930 mm with an average of  $5.793 \pm 0.106$  mm while, the breadth varied from 3.800 to 4.000 mm with an average  $3.913 \pm 0.073$  mm (Table 3). Thakor (1972) also reported that an average length and breadth was  $6.78 \pm 1.30$  mm and  $4.20 \pm 1.91$  mm, respectively. However, Iftekhhar (1985) reported that it was 3.833 to 4.277 mm in length and 1.705 to 2.058 mm in breadth, which is not in conformity with the present findings. This variation in measurement might be due to difference in host used for study.

The duration of pupal stage varied from 3 to 4 days with an average of  $3.33 \pm 0.479$  days (Table 4). The present finding is in close agreement with the finding of Thakor (1972), who reported an average duration of pupal stage as  $3.83 \pm 0.28$  days. Similarly, Iftekhhar (1985) recorded it to be 4 to 5 days.

#### **4.3.4 Adult**

##### **4.3.4.1 Colour, shape and size**

Adult emerged out by breaking pupal covering. Freshly emerged adults were light yellow and faintly spotted. Within the next three hours the colour changes to reddish brown with 28 characteristically arranged black spots of variable size [Plate VII]. These black spots are symmetrically placed in a crescent manner on the pronotum and forewing or the elytra which covered the whole body from the dorsal side, excepting the last one or two abdominal segments when the beetle is at rest.



PLATE VII. Adults of H. vigintioctopunctata

A. Male

B. Female

The adult beetles were hemispherical in shape but slightly elongated towards the hinder region. The head was deeply inserted in the anterior concave margin of the pronotum. The hind wings are transparent and covered by elytra when at rest. The antennal segment of beetle were found gradually increased in diameter distally i.e Clavate type. Generally females were slightly bigger than the males. The morphological characters described above, are in concurrence with the reports of Pawar (1964), Thakor (1972) and Iftekhar (1985).

Measurement of males revealed that the length varied from 5.330 to 5.790 mm with an average of  $5.690 \pm 0.184$  mm, while breadth varied from 4.400 to 4.800 mm with an average of  $4.564 \pm 0.139$  mm. In case of females, the length varied from 5.790 to 5.990 mm with an average of  $5.830 \pm 0.082$  mm, while the breadth varied from 5.330 to 5.660 mm with an average of  $5.510 \pm 0.109$  mm (Table 3). Thus the male was smaller than the female. Similar observations were recorded by Thakor (1972) and Iftekhar (1985).

#### 4.3.4.2 Sex ratio

To determine the sex ratio of H.vigintioctopunctata field collected and laboratory reared adults were examined separately. The adults were separated on the basis of size. The data obtained are presented in Table 6. The data revealed that out of 137 adults reared in the laboratory, 53 were males and 84 were females. Thus the sex ratio of male to female was 1:1.63. The data further revealed that

Table:6 Sex ratio of H.vigintioctopunctata under laboratory and field conditions.

Date of observation	No. of adults observed	Sex		Sex ratio
		Number of		
		Male	Female	Male : Female
<b>Laboratory condition :</b>				
25.10.95	05	02	03	1 : 1.50
25.10.95	10	04	06	1 : 1.50
01.11.95	30	11	19	1 : 1.73
06.12.95	16	07	09	1 : 1.29
07.12.95	15	06	09	1 : 1.50
08.12.95	10	03	07	1 : 2.33
10.12.95	13	05	08	1 : 1.60
12.12.95	19	07	12	1 : 1.71
13.12.95	13	06	07	1 : 1.17
20.12.95	06	02	04	1 : 2.00
<b>Total</b>	<b>137</b>	<b>53</b>	<b>84</b>	<b>1 : 1.63</b>
<b>Field condition :</b>				
20.09.95	09	04	05	1 : 1.25
30.09.95	04	02	02	1 : 1.00
02.10.95	09	03	06	1 : 2.00
07.10.95	08	03	05	1 : 1.67
08.10.95	12	05	07	1 : 1.40
10.10.95	06	03	03	1 : 1.00
11.10.95	12	04	08	1 : 2.00
<b>Total</b>	<b>60</b>	<b>24</b>	<b>36</b>	<b>1 : 1.50</b>

the male: female ratio was 1:1.50 for field collected adults. These results indicated that the proportion of males and females were almost same both under laboratory condition and in the nature. The above findings are more or less in agreement with the findings of Pandey and Umashankar (1975), who reported that the sex ratio of male: female as 1:1.8 in laboratory condition. Whereas, Iraqi and Farag (1986) recorded it was about 1:1.

#### 4.3.4.3 Copulation

Mating behaviour of the epilachna beetle, H.vigintioctopunctata was observed in the laboratory condition. For the purpose, freshly emerged male and female were paired individually in glass petri dishes (10 x 1.7 cm) and observed continuously for its copulation process. In present observation adult started mating after emergence of 3 to 6 days and it continued upto 20 to 25 days. The pair remained in mating condition for about 15 to 30 minutes at a time [Plate VIII]. Earlier, Iftekhar (1985) observed that the freshly emerged males and females of H.vigintioctopunctata started copulating after 6-8 days of emergence. In present observation the pairs remained in coitus for 15 to 30 minutes at a time. The above findings are in accordance with the report made by Iftekhar (1985), who stated that the copulation process was generally completed within an hour.



PLATE VIII. Copulation of H. vigintioctopunctata

#### 4.3.4.4 Pre - oviposition period

Pre-oviposition period varied from 5 to 9 days with an average of  $7.00 \pm 1.414$  days (Table 4). The pre-oviposition period of epilachna beetle observed by Thakor (1972) was about 8 to 11 days whereas, Scheibelreiter and Inyang (1974) noted it to be about 7 days which is more or less in conformity with present findings.

#### 4.3.4.5 Oviposition period

The oviposition period varied from 27 to 32 days with an average of  $29.60 \pm 1.949$  days (Table 4). According to Iftekhar (1985), the oviposition period was 22 to 36 days at  $27 \pm 1^{\circ}\text{C}$  temperature and 60 to 70 per cent relative humidity which is closely tallies with the present result.

#### 4.3.4.6 Post - oviposition period

The post-oviposition period was found to be 7 to 11 days with an average of  $8.60 \pm 1.516$  days (Table 4). Thakor (1972) reported that the post-oviposition period varied from 2 to 8 days.

#### 4.3.4.7 Fecundity

The total number of eggs laid by an individual female varied from 205 to 600 with an average of  $354.40 \pm 160.040$  (Table 4). The fecundity of H.vigintioctopunctata reported by various workers was 500 to 700 (Mathur and Srivastava, 1964), 350 to 700 (Pawar, 1964), 400 (Atwal, 1976), 107 to 238 (Iftekhar, 1985) and 186 eggs (Dhamdhare et al., 1990).

#### 4.3.4.8 Longevity

The data presented in Table 4 showed that the longevity of male varied from 32 to 34 days with an average of  $33.40 \pm 0.894$  days, while longevity of females varied from 43 to 47 days with an average of  $45.20 \pm 1.643$  days. Thus, the males lived shorter than the females. Earlier, Pandey and Umashankar (1975) reported that the average longevity of male was 37 days and that of female was 44 days. Similarly, Dhamdhere et al. (1990) recorded that the longevity of male and female was 34 and 46 days, respectively, which is closely tallies with the present result.

#### 4.3.4.9 Total life cycle

Total life cycle occupied 50 to 54 days with an average of  $52.00 \pm 1.527$  days in case of male, while it occupied 63 to 67 days with an average of  $65.00 \pm 1.632$  days in case of female (Table 4). According to Butani and Jotwani (1983), the total life cycle was completed in 18 to 25 days during summer and may extend upto 50 days during winter. This is nearly accordance with the present findings. However, the finding of Dhamdhere et al., 1990 (21.06 days) are not in conformity with the present findings.

#### 4.4 Evaluation of Various Botanical Materials and Formulations :

##### 4.4.1 Evaluation of various botanical materials and formulations against H. vigintioctopunctata larvae

The bioefficacy of various botanical materials and formulations against larvae of H. vigintioctopunctata was evaluated under laboratory condition. The per cent mortality recorded at 24 hr, 48 hr, 72 hr and 7 days after treatments are presented in Table 7.

The results revealed that there was significant difference in per cent mortality at all the intervals of observations. At 24 hr of the post treatment the per cent mortality ranged from 0.90 to 61.19. All the treatments under tests found superior over control. The treatment of DDVP gave 61.19 per cent mortality and it was at par with endosulfan (59.18 %) and fieldguard (54.76%). Further, the treatment of neemark 0.5 per cent gave 46.90 per cent mortality of larva which was comparable with fieldguard 1.0 per cent (54.76%). Amongst the other botanical material neem seed kernel extract and L. camara leaves extract gave equal per cent of mortality (37.21 %) and it was at par with garlic bulb extract (35.20%) and mint leaves extract (34.99%). Ardusa leaves extract was least effective as compared to all the treatments.

At 48 hr of post treatment per cent mortality ranged from 0.90 to 89.05. The treatment of DDVP recorded

Sr. No.	Treatment	Concentration (%)	Cumulative mean per cent mortality after indicated period			
			24 hr	48 hr	72 hr	7 days
1	Garlic bulb extract	3 % Suspension	35.20*(33.23)**	58.98 (73.44)	63.40 (79.96)	63.40 (79.96)
2	Ardusa leaves extract	3 % Suspension	26.55 (19.98)	41.13 (43.27)	44.98 (49.96)	44.98 (49.96)
3	Neem seed kernel extract	3 % Suspension	37.21 (36.57)	43.06 (46.61)	52.75 (63.36)	52.75 (63.36)
4	Mint leaves extract	3 % Suspension	34.99 (32.89)	41.13 (43.27)	46.90 (53.32)	46.90 (53.32)
5	<u>Lantana camara</u> leaves extract	3 % Suspension	37.21 (36.57)	48.82 (56.65)	63.40 (79.96)	63.40 (79.96)
6	Neemark	0.5%	46.90 (53.32)	66.11 (83.60)	77.37 (95.22)	77.37 (95.22)
7	Fieldguard	1.0%	54.76 (66.70)	68.82 (86.95)	71.53 (89.96)	71.53 (89.96)
8	DDVP	0.03%	61.19 (76.78)	89.05 (99.97)	89.05 (99.97)	89.05 (99.97)
9	Endosulfan	0.075%	59.18 (73.76)	83.21 (98.60)	83.21 (98.60)	83.21 (98.60)
10	Control	-	0.90 (0.02)	0.90 (0.02)	0.90 (0.02)	0.90 (0.02)
	S.Em. ±		2.67	2.61	2.75	2.75
	C.D. at 5%		7.88	7.72	8.13	8.13
	C.V. %		11.74	8.37	8.04	8.04

\* Figures outside the parentheses are arcsin transformed values.

\*\* Figures in the parentheses are retransformed values.

higher mortality (89.05%) and it was at par with endosulfan (83.21%). It was followed by fieldguard (68.82%), neemark (66.11%) and garlic bulb extract (58.98%). Former two treatments were at par. The rest of the botanical materials viz., L.camara leaves extract (48.82%), neem seed kernel extract (43.06%), mint leaves extract (41.13%) and ardusa leaves extract (41.13%) gave less than 50 per cent mortality and they were at par with each other.

At 72 hr of post treatment no further increase in mortality was observed in the treatments of chemical insecticides. Here also DDVP gave higher per cent mortality (89.03%) and it was at par with endosulfan (83.21%). The per cent mortality was increased considerably in the treatment of neemark (77.37%) at 72 hr of post treatment and it was at par with endosulfan (83.21%). The treatment of fieldguard gave 71.53 per cent mortality which was comparable on one hand with neemark (77.37%) and other hand with L.camara leaves extract (63.40%) and garlic bulb extract (63.40%). The other treatment in which more than 50 per cent mortality obtained was the treatment of neem seed kernel extract (52.75%). However, it was at par with least effective treatments of mint leaves extract (46.90%) and ardusa leaves extract (44.98%). After 72 hr of post treatment no further increase in mortality was observed in any of the treatment. The per cent mortality observed 7 days after treatment was similar to that observed at 72 hr of post treatment. The descending chronological order of effectiveness of treatments based on per cent mortality of

larva was: DDVP > endosulfan > neemark > fieldguard > L.camara leaves extract > garlic bulb extract > neem seed kernel extract > mint leaves extract > ardusa leaves extract.

Thus from the above results it can be seen that the treatment of chemical insecticides viz., DDVP 0.03 per cent and endosulfan 0.075 per cent proved to be more effective in giving higher mortality of H.vigintioctopunctata larvae than the treatments of botanical materials included in the test. These results are supported by the finding of Sreedevi et al., (1993) who also observed that the endosulfan 0.075 per cent gave higher mortality than the treatment of repellin 1.0 per cent and neemicide 0.5 per cent after 7 days of treatment. The treatment of botanical formulations viz., neemark 0.5 per cent and fieldguard 1.0 per cent exhibited considerable per cent mortality of larvae. The per cent mortality ranged from 44.98 to 63.40 due to the treatment of various plant material extracts viz., ardusa leaves extract, mint leaves extract, neem seed kernel extract, garlic bulb extract and L.camara leaves extract. Earlier, Reddy et al. (1990) also reported the similar effectiveness of neem leaves extract and L.camara leaves extract against H.vigintioctopunctata larvae. Although not comparable due to different plant material extract used in present investigation Nasseh (1981) obtained higher per cent mortality of larva in the treatment of crude extract of Allium sativum L.

#### 4.4.2 Evaluation of various botanical materials and formulations against adults of H.vigintioctopunctata

The bioefficacy of various botanical materials and formulations against adults of H.vigintioctopunctata was evaluated under laboratory condition. The per cent mortality recorded at 24 hr, 48 hr, 72 hr and 7 days after treatments are presented in Table 8.

The results revealed that there was significant difference in per cent mortality at all the intervals of observations. After 24 hr all the treatments under test were found to be significantly superior for having higher per cent mortality of adults than the control. However, none of the treatment gave 50 per cent or more mortality except the treatment of DDVP (52.75%) at 24 hr of post treatment. It was significantly superior over rest of the treatments. Endosulfan 0.075 per cent ranked second in effectiveness (39.21%) and was at par with fieldguard (37.21%), neemark (35.20%) and neem seed kernel (33.19%). The treatment of L.camara leaves gave 26.55 per cent mortality and it was at par with neem seed kernel (33.19%). The treatment of ardusa leaves extract (23.84%), garlic bulb extract (21.13 %) and mint leaves extract (15.29%) were least effective and at par with each other. However, former two treatments were comparable with the treatment of L.camara leaves extract.

At 48 hr of post treatment no further increase in per cent mortality was observed in all the treatments of botanical pesticides and plant material extracts.

Sr. No.	Treatment	Concentration (%)	Cumulative mean per cent mortality after indicated period			
			24 hr	48 hr	72 hr	7 days
1	Garlic bulb extract	3 % Suspension	21.13*(13.00)**	21.13(13.00)	26.55(19.98)	26.55(19.98)
2	Ardusa leaves extract	3 % Suspension	23.84(16.34)	23.84(16.34)	23.84(16.34)	23.84(16.34)
3	Neem seed kernel extract	3 % Suspension	33.19(29.97)	33.19(29.97)	35.20(33.23)	35.20(33.23)
4	Mint leaves extract	3 % Suspension	15.29(6.95)	15.29(6.95)	21.13(13.00)	21.13(13.00)
5	<u>Lantana camara</u> leaves extract	3 % Suspension	26.55(19.98)	26.55(19.98)	30.98(26.50)	30.98(26.50)
6	Neemark	0.5%	35.20(33.23)	35.20(33.23)	37.21(36.57)	37.21(36.57)
7	Fieldguard	1.0%	37.21(36.57)	37.21(36.57)	41.13(43.27)	41.13(43.27)
8	DDVP	0.03%	52.75(63.36)	66.11(83.60)	66.11(83.60)	66.11(83.60)
9	Endosulfan	0.075%	39.21(39.97)	44.98(49.96)	46.90(53.32)	46.90(53.32)
10	Control	-	0.90(0.02)	0.90(0.02)	0.90(0.02)	0.90(0.02)
	S.Em. ±		2.89	3.13	2.05	2.05
	C.D. at 5%		8.55	9.25	6.07	6.07
	C.V. %		17.59	17.84	10.80	10.80

\* Figures outside the parentheses are arcsin transformed values.  
 \*\* Figures in the parentheses are retransformed values.

Mortality per cent was similar to that of recorded at 24 hr of post treatment. However, there was considerable increase in per cent mortality in the treatment of chemical insecticides. The treatment of DDVP gave higher per cent mortality (66.11%) and it was significantly superior over rest of the treatments. It was followed by endosulfan (44.98%) and it was at par with fieldguard (37.21%).

All the treatments were found to be significantly superior over control at 72 hr of post treatment. Though the per cent mortality remained unchanged (66.11) in the treatment of DDVP, it was significantly superior over rest of the treatments at 72 hr of post treatment. Next in order of effectiveness was endosulfan (46.90%) which was at par with fieldguard (41.13%). The other treatments in which more than 30 per cent mortality obtained were the treatment of neemark (37.21%), neem seed kernel extract (35.20%) and L.camara leaves extract (30.98%). Former two treatments were at par with each other and also comparable with the treatment of fieldguard. The treatment of L. camara leaves extract was at par one side with neem seed kernel extract and on other side with garlic bulb extract (26.55%). The results further revealed that the treatments of mint leaves extract was significantly inferior (21.13%) to all the treatments except ardusa leaves (23.84%) and garlic bulb extract (26.55%). After 72 hr of post treatments no further increase in mortality was observed. Thus the descending

chronological order of effectiveness of treatments was: DDVP > endosulfan > fieldguard > neemark > neem seed kernel extract > L.camara leaves extract > garlic bulb extract > ardusa leaves extract > mint leaves extract.

The above results clearly indicated that the treatment of DDVP 0.03 per cent remained top in effectiveness as it has given higher per cent mortality of adults. The other chemical insecticide i.e. endosulfan proved less effective as compared to DDVP. Thus both the chemical insecticides proved better in effectiveness as compared to botanical formulations and botanical materials included in the experiment. This would support the finding of Shinde et al. (1970) that the DDVP was found to be more toxic against adults of E. dodecastigma. The present result was further supported by Nagia et al. (1992) who reported the effectiveness of endosulfan against adults of H.vigintioctopunctata. Though the per cent mortality obtained in the treatment of various botanical materials was less than that of chemical insecticides, the neem based insecticides viz., fieldguard, neemark and neem seed kernel extract gave considerable per cent of mortality of adults. Earlier, Dhandapani et al. (1985) reported that the neem oil was effective in reducing the population of H.vigintioctopunctata adults.

#### 4.4.3 Evaluation of antifeedant properties of various botanical materials and formulations against larvae and adults of H.vigintioctopunctata

The antifeedant properties of various botanical materials and formulations against larvae and adults of H.vigintioctopunctata were evaluated under laboratory condition. The per cent leaf area consumed at 24 hr after treatments by both the stages are presented in Table 9.

The results revealed that there was significant variation in the per cent leaf area consumed by larvae of H.vigintioctopunctata due to treatments tested. At 24 hr of post treatment all the treatments under test were found to be significantly superior for having lower per cent leaf area consumed than the control. The treatment of DDVP showed 1.18 per cent leaf area consumption and it was at par with neemark (1.57%) which in turn was at par with fieldguard (2.05%). The treatment of neem seed kernel extract showed 3.12 per cent consumption. The maximum leaf area was consumed in the treatment of ardusa leaves extract and it was significantly inferior (11.64%) to all the treatments. The leaf area consumption was in the range of 5.27 to 8.88 per cent in rest of the treatments. The ascending chronological order of leaf area consumption of treatments was : DDVP > neemark > fieldguard > neem seed kernel extract > endosulfan > L.camara leaves extract > mint leaves extract > garlic bulb extract > ardusa leaves extract > control. The per cent leaf area consumed by adults was also significantly differing amongst treatments (Table 9). Trend of per cent

Table:9 Antifeedant properties of some plant extracts and formulation against larvae and adults of H.vigintioctopunctata (F.)

Sr. No.	Treatment	Concentration (%)	Mean per cent leaf area consumed	
			Larvae	Adults
1	Garlic bulb extract	3% suspension	8.88	10.05
2	Ardusa leaves extract	3% suspension	11.64	12.46
3	Neem seed kernel extract	3% suspension	3.12	4.34
4	Mint leaves extract	3% suspension	7.44	9.73
5	<u>Lantana camara</u> leaves extract	3% suspension	6.25	6.80
6	Neemark	0.5 %	1.57	3.61
7	Fieldguard	1.0 %	2.05	3.90
8	DDVP	0.03 %	1.18	3.01
9	Endosulfan	0.075 %	5.27	6.34
10	Control	-	18.79	18.41
	S.Em. $\pm$		0.27	0.29
	C.D. at 5%		0.82	0.88
	C.V.%		7.26	6.54

leaf area consumption was similar to that of observed in case of larvae. However, the per cent leaf area consumed by adults was higher than that was consumed by larvae, in all the treatments. The per cent leaf area consumption was ranged from 3.01 to 12.46.

From the above results it is evident that the per cent leaf area consumption was minimum when DDVP 0.03 per cent applied. However, this minimum leaf damage was not due to it's antifeedant property. This might be due to it's knock down effect and toxic effect thereafter. This is evident from the higher per cent mortality of both larvae and adults obtained at 24 hr of post treatment of DDVP. The azadirachtin based insecticides and neem seed kernel extract exhibited remarkable antifeedant property as compared to remaining plant material extract. This would support the findings of Tewari and Krishnamoorthy (1985) that the seed oil of Azadirachta indica (0.5 and 0.1 %) showed antifeedant property against both grubs and adults of H.vigintioctopunctata. Further, Rao et al. (1990) reported that aqueous extracts of A.indica and L.camara showed antifeedant activity at 5 per cent concentration against the larva of H.vigintioctopunctata.

#### **4.5 Studies on the Host Preference of H.vigintioctopunctata (F.):**

##### **4.5.1 Effect of food on larval and post larval period**

The effect of food plants on the larval period and post larval period was studied in the laboratory condition.

Table:10 Effect of food plants on larval and post larval period of H.vigintioctopunctata.

Host Plant	Duration (days)		Logevity (Days)	
	Larval	Pupal	Male adult	Female adult
Brinjal	15.60 ± 0.73	4.10 ± 0.30	34.00 ± 1.51	46.15 ± 1.46
Tomato	15.95 ± 0.86	4.30 ± 0.46	37.00 ± 1.15	48.00 ± 0.65
't' Value	1.35	1.54	2.20*	2.06*
	NS	NS	Sig	Sig

\* 't' value significant at 5% level of significance  
NS = Non significant.

Table:11 Effect of food plants on weight of full grown larva, pupa and adult of H.vigintioctopunctata.

Host Plant	Mean weight (mg.)		
	Larva	Pupa	Adult
Brinjal	27.55 ± 0.51	28.65 ± 0.52	29.72 ± 0.52
Tomato	23.40 ± 0.57	25.19 ± 0.66	26.31 ± 0.74
't' value	23.06*	18.21*	16.24*
	Sig.	Sig.	Sig.

\* 't' value significant at 5% level of significance.

Data are presented in Table 10. From the table it could be seen that the larval period was not significantly affected by the food plant. However, the average number of days required to complete entire larval stage was slightly longer ( $15.95 \pm 0.86$  days) on tomato leaves as compared to brinjal leaves ( $15.60 \pm 0.73$  days). The pupal period was also not significantly affected by the food plants. However, the pupal period was slightly prolonged on tomato leaves ( $4.30 \pm 0.46$  days) than on the brinjal leaves ( $4.10 \pm 0.30$  days). The adults longevity differed significantly amongst the food plants. Average longevity of male was higher ( $37.00 \pm 1.15$  days) on tomato leaves as compared to brinjal leaves ( $34.00 \pm 1.51$  days). Female longevity was also significantly higher on tomato ( $48.00 \pm 0.65$  days), as compared to brinjal ( $46.15 \pm 1.46$  days).

#### **4.5.2 Effect of food on weight of full grown larva, pupa and adult.**

Weight of full grown larva, pupa and adult on both the food plants are given Table 11.

From the data of the table it is evident that the significantly higher weight was gained by larva when reared on brinjal leaves. The mean weight of larva was  $27.55 \pm 0.51$  mg and  $23.40 \pm 0.57$  mg on brinjal and tomato, respectively. The pupal weight was also significantly affected by the food plants. The mean weight of pupa was  $28.65 \pm 0.52$  mg and  $25.19 \pm 0.66$  mg when larva was reared on brinjal and tomato leaves, respectively. Similar trend of

weight was also observed in case of adults wherein the weight of adults was more ( $29.72 \pm 0.52\text{mg}$ ) on brinjal leaves than on the tomato leaves ( $26.31 \pm 0.74 \text{ mg}$ ).

From the overall results it is evident that the larvae grow faster and attained heavier weight, when grown on brinjal leaves. This in turn reflected in weight of pupae. Such effect of brinjal leaves when used as food was found to have enhanced the development and body weight of adults. These results clearly indicate that the brinjal leaves was more preferred by larvae and adults which in turn supported the development in shorter period and also helped in gaining heavier weight of both the damaging stage. The present results are supported by the findings of Rao and Azam (1973) who observed that the brinjal was the most preferred food for H.vigintioctopunctata as compared to tomato food plant.

**SUMMARY  
AND  
CONCLUSION**

## V SUMMARY AND CONCLUSION

Investigations on host range, biology and host preference of epilachna beetle, H.vigintioctopunctata (F.) were undertaken under laboratory condition. The bioefficacy of various botanical materials and formulations alongwith their antifeedant properties against larvae and adults of H.vigintioctopunctata (F.) were also evaluated under laboratory condition. The important findings derived from these investigations are summarised and concluded below.

### 5.1 Host Range :

The survey on the host range of epilachna beetle, H.vigintioctopunctata in the Farm of Gujarat Agricultural University, Navsari and it's surrounding area showed that the pest has very narrow host range. The activity of the pest was found only on brinjal, tomato and bitter gourd for a limited period of time i.e from September to November.

### 5.2 Nature of Damage :

The study on nature of damage showed that the epilachna beetle caused damage to brinjal leaves with characteristic feeding habits. The insects nibble away strips of leaf tissues. The larvae and adults remove the epidermis entirely and in several cases the leaves are skeletonized like a sieve. The adults were also noticed in the laboratory to nibble the eggs which were laid in clusters.

### 5.3 Biology :

Study on biology of H.vigintioctopunctata was undertaken in the Department of Entomology, N.M. College of Agriculture, Navsari during the year 1995. The average minimum and maximum room temperature during the study was  $25.00 \pm 3.05^{\circ}\text{c}$  and  $29.85 \pm 2.31^{\circ}\text{c}$ , respectively while, relative humidity was  $82.97 \pm 10.57$  per cent.

It was found that the female of H.vigintioctopunctata laid eggs in batches of 5 to 75 each, mainly on the lower as well as upper surface of the leaf. The freshly laid eggs were cylindrical in shape, lemon chrome in colour and change to buff yellow as the time passes. It can be seen with naked eye. An average length and breadth of egg was  $1.292 \pm 0.012$  mm and  $0.410 \pm 0.019$  mm, respectively. The average incubation period was recorded as  $3.40 \pm 0.498$  days. Whereas, average egg hatching was  $91.31 \pm 6.95$  per cent.

The larval stage passed through four instars. The newly hatched larva was bright yellow in colour. Head was relatively large, triangular with setae separately distributed on the dorsal surface. The antenna was two segmented and the abdomen was found to be nine segmented with one small additional somewhat indistinct segment. The second instar larva was similar to the first instar larva except large size and hump back appearance. The body of third instar larva appeared more spiny due to well developed branches of various scoli. Larva have distinct dark stripes

on either side of the mid dorsal line of the thorax. Head pronotum and parts of the thoracic tergites<sup>4,5</sup> more conspicuously sclerotised than in the earlier instars. The colour of the fourth instar larva was yellow having six rows of long branched spines symmetrically placed on dorsal surface of body except the head region and can be easily distinguished by it's large size. The larva fed voraciously during this instar. The average length of first, second, third and fourth instar larva was  $1.191 \pm 0.032$  mm,  $2.129 \pm 0.045$  mm,  $3.101 \pm 0.234$  mm and  $5.048 \pm 0.398$  mm. While, the breadth was  $0.430 \pm 0.000$  mm,  $0.977 \pm 0.034$  mm,  $1.570 \pm 0.086$  mm and  $2.098 \pm 0.121$  mm, respectively. The developmental period of first, second, third and fourth instar larva was  $3.40 \pm 0.563$ ,  $2.77 \pm 0.678$ ,  $2.20 \pm 0.406$  and  $3.23 \pm 0.504$  days, respectively, with a total larval period of  $15.00 \pm 1.144$  days.

Prepupal stage<sup>6</sup> was characterised by the shortening of larva in length and slight swelling in thoracic region. Body showed convex shape and attached it's last abdominal segment to some substratum by means of a viscous substance. The freshly formed pupa was pale yellow in colour but later on developed dark natural grey patterns dorsally and buff yellow ventrally. The pupa was more or less triangular with a bended head on ventral side. The average length and breadth of pupa was  $5.793 \pm 0.106$  mm and  $3.913 \pm 0.073$  mm, respectively. The duration of pupal period was  $3.33 \pm 0.479$  days.

The adults of H.vigintioctopunctata were light yellow and faintly spotted when emerged out from pupa. Within the next three hours the colour changed to reddish brown with 28 characteristically arranged black spots of variable size. The adult beetles were hemispherical in shape but slightly elongated towards the hinder region. The hind wing was transparent and covered by elytra when it rest. Females were slightly bigger than the males. The male adults measured on an average  $5.690 \pm 0.184$  mm in length and  $4.564 \pm 0.139$  mm in breadth. Whereas, females measured  $5.830 \pm 0.082$  mm in length and  $5.510 \pm 0.109$  mm in breadth. The sex ratio of male to female was found to be 1:1.50 and 1:1.63 for <sup>n</sup> field collected and laboratory reared adults, respectively.

Mating <sup>took</sup> place 3 to 6 days after emergence and it continued upto 20 to 25 days. The pair remained in mating condition for about 15 to 30 minutes at a time. The average pre-oviposition, oviposition and post-oviposition period was  $7.00 \pm 1.414$ ,  $29.60 \pm 1.949$  and  $8.60 \pm 1.516$  days, respectively. The egg laying capacity of the female was  $354.40 \pm 160.040$  eggs. The longevity of male and female was  $33.40 \pm 0.894$  and  $45.20 \pm 1.643$  days, respectively. The total duration of life cycle was 50 to 54 days (Av.  $52.00 \pm 1.527$  days) in case of male, while it was 63 to 67 days (Av.  $65.00 \pm 1.632$  days) in case of female.

#### 5.4 Evaluation of Various Botanical Materials and Formulations :

The bioefficacy of various botanical materials and formulations viz., garlic bulb extract (3 % suspension), mint leaves extract (3 % suspension), neem seed kernel extract (3 % suspension), ardua leaves extract (3 % suspension), L.camara leaves extract (3 % suspension), fieldguard (1.0%), neemark (0.5%) alongwith the DDVP (0.03%) and endosulfan (0.075 %) was tested under laboratory condition. The effectiveness of treatments was concluded on the basis of per cent mortality of larvae and adults of H.vigintioctopunctata after 24 hr, 48 hr, 72 hr and 7 days of application.

The results showed that the treatment of chemical insecticides viz., DDVP 0.03 per cent and endosulfan 0.075 per cent proved to be more effective in giving higher mortality of H.vigintioctopunctata larvae than the treatments of botanical materials included in the test. The treatments of botanical formulations viz., neemark 0.5 per cent and fieldguard 1.0 per cent showed considerable per cent mortality of larvae. Rest of the treatments of various plant material extracts viz., ardua leaves extract, mint leaves extract, neem seed kernel extract, garlic bulb extract and L.camara leaves extract, proved less effective against the larvae.

The chemical insecticides also proved better in effectiveness against adults as compared to botanical formulations and botanical materials.

The treatment of DDVP 0.03 per cent remained top in giving higher per cent mortality of adults. The neem based insecticides viz., fieldguard, neemark and neem seed kernel extract proved effective to some extent.

The antifeedant property of various botanical materials and formulations included in the experiment was also evaluated on the basis of leaf area consumed by larvae and adults at 24 hr after treatments. The per cent leaf area consumption was minimum by the larvae and adults when DDVP 0.03 per cent was applied. However, this minimum leaf damage was not due to its antifeedant property. This might be due to its knock down effect and toxic effect thereafter. The azadirachtin based insecticides and neem seed kernel extract exhibited remarkable antifeedant property as compared to remaining plant material extract.

#### 5.5 Host Preference :

In order to study the host preference of H.vigintioctopunctata two solanaceous crops viz., brinjal and tomato were chosen as host plants. The larvae were reared on both these host plants, separately. The host preference was determined by observing larval and post larval development period and weight gained by larval and post larval stages. The results clearly indicated that the brinjal leaves were more preferred by larvae and adults which in turn supported the development in shorter period and also helped in gaining heavier weight of both the damaging stage.

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\* Original not seen.

## CERTIFICATE

This is to certify that I have no objection for supplying to any Scientist only one copy or any part of this thesis for rendering reference service in a library or documentation centre.

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*K. N. Patel*

(K. N. Patel)