SURVEY AND CHEMICAL CONTROL OF (Indarbela spp.)

BY

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AFFECTIONATELY DEDICATED

TO

MY BELOVED PARENTS

CANDIDATE'S DECLARATION

I hereby declare that the dissertation or part thereof has not been previously submitted by me for a degree of any University.

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C E R T I F I C A T E – I

This is to certify that Shri. Sunil Ramrao Gaikwad has satisfactorily prosecuted his course of research for a period of not l ss than four semesters and that the dissertation entitled "SURVEY AND CHEMCICAL CONTROL OF Indarbela spp submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the e amination.

I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any university.

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C E R T I F I C A T E - I I

This is to certify that the dissertation entitled "SURVEY AND CHEMCICAL CONTROL OF Indarbela spp submitted by Shri. Sunil Ramrao Gaikwad to the Marathwada Agricultural University, Parbhani in partial fulfilment of the requirement of the degree of MASTER OF SCIENCE in the subject of AGRICULTURAL ENTOMOLOGY has been approved by the student's advisory committee after oral examination in collaboration with the external examiner.

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Introduction

I. INTRODUCTION

The bark eating caterpillar, Indarbela spp (Metarbelidae; Lepidoptera) is a nocturnal pest. It causes severe damage to number of host plants. It feeds on the bark under the cover of the web and bores in to the trunk or the branches. The severe damage is observed in older and neglected orchards. This is a polyphagous pest widely distributed throughout the Indian subcontinent, including Bangladesh , Burma, Srilanka and Pakistan (Sharma and Kumar, 1986).

Earlier, host records of Indarbela spp included mango, citrus, guava, ber (Lefroy, 1909) ; forest trees (Australian babul. mahagani, bauhinia trees, pangara, ranbhendi, rudraksha, sausage tree , sisso etc) Verma et al. (1972) ; avenue trees (Banyan tree , Ashoka , Goldmohar , Peltophorum , Cork tree etc.) Patel et al. (1964).

In case of severe infestation normal growth of the plant and bearing capacity of the tree was reduced. It resulted drying of branches or even the whole tree. The extensive feeding affects the vitality of the plant. Breakage of stem and branches under the weight of heavy fruiting or breakage due to cyclonic winds was also noticed (Sandhu and Khangura, 1979)

This pest is active from Sept.- Nov. The scarcity of rainfall, uncleanliness of orchards and older neglected orchards are the favourable conditions for the activity of this pest.

The maximum incidence of this pest occured in the month of Oct-Nov. Peak period of pest activity every year due to minimum rainfall and favourable climatic conditions for the pest activity (Lal and Singh , 1982).

The larva remains inside the web and bore into the bark . It lives concealed life, forming a loose brownish web of silken strands in which excretal pallets and pieces of bark are entrapped .

David (1963) reported that the caterpillar has the special feeding habit at the same site or portion of the bark which was left after feeding during the last day. It hides in to the tunnel during the day time and continues to bore for 15 to 25 cm. in length .

Several insecticidal treatments were tested for the control of Indarbela spp out of which napthalene were used earlier but use of only kerosene was effective treatment (Patel, 1965).

Later, painting the bark with bordopaste solution has been recommended.

A field experiment was conducted in a guava orchard in India during April and May 1988 to test the effect of dichlorvos and petrol on Indarbela spp. infesting guava trees. The use of 10 ml of dichlorvos and 10 ml of Petrol gave 100 per cent and 96.7 per cent control, respectively after seven days of application (Patil, et al., 1990). Spraying with chlorinated hydrocarbons and organophosphates has also been recommended by different workers (David et al., 1963; Srivastava, 1972 ; Noor and Kushwaha, 1976). The use of wash bottle with insecticidal solutions proved to be a convenient tool for the treatment of larval burrows (Sandhu and Khangura, 1976).

Now a days envirnomental protection is became essential so to boost the fruit production and to prevent environmental pollution, Government Of India is launching a special drive for the tree plantation and social forestry. Considering these aspects it was essential to protect these trees from this polyphagous pest for this it was important to generate the information on the incidence and extent of damage caused by the bark eating caterpillar. It is also essential to adopt efficient method for the control of bark eating caterpillar.

Taking into consideration the above intention the present study was conducted in with objectives.

1. To survey the extent of infestation caused by Indarbela quadrinotata Walker on various trees.
2. To study the nature of damage caused by Indarbela quadrinotata.
3. Chemical control of Indarbela quadrinotata on guava and sweet orange by using various chemicals by adopting different methods of application.

Review of Literature

II. REVIEW OF LITERATURE

Indarbela spp. of which the larvae damage the bark is notorious pest found all over India on number of host trees. There are two species of Indarbela viz. Indarbela quadrinotata Walker and Indarbela tetraonis Moore.

The damage caused by these species was more in neglected and uncleaned orchards. This pest is polyphagous which infest the many hosts viz. avenue trees, forest trees, fruit trees, ornamental bushes and medicinal trees.

In this chapter, the relevent literature is reviewed and presented under the following sub heads

2.1 Survey on incidence of Indarbela spp

Lefroy and Hawlett (1909) recorded Mango, Citrus, Guava and Ber as the host of this insect

Moringa, Rose, Orange, Citrus, zizyphus jujuba, Eugena jambolana, Phyllanthus embilica, Litchi (Fletcher, 1921), Mango and Guava (Issac, 1931).

Ayyar, (1940) recorded Casuarina, Raintree, Peltophorum, Poinciana, Ashoka etc. as the additional hosts of this insect.

Other hosts of this insect pest recorded were Teak (Braithwaite, 1941); Tea (Ray, 1943);

Pomegranate, Anjan, Kanchan, Karanj and Mulberry (Sontakay, 1945); Citrus, Mango, Litchi, Guava, Ber, Pomegranate, Jamun, Rose etc. (Bindra, 1957); Curry leaf tree (Murraya Koengii Spr.) Moringa oleifera Lam. and Thespesia populnea Cav. (David, et al., 1963); Jack fruit (Wadhi and Batra, 1964); Cassia spp Gold mohar (Patel et al., 1964).

Singh, J.P. (1970) reported that the Guava was most prefered host of Indarbela tetraonis Moore, in India.

Verma, et al. (1972) undertaken survey of this pest that Illaichi, variety of ber was the most susceptible host than Deshi alwar, which was the resistant to the attack of Indarbela spp.

Verma and Khurana (1974) reported new hosts of Indarbela spp viz. Plum, Pear, Ficus glomerata, Madhuca longifolia, Meringa oleifera, Eleanthus excellsa, Cassia fistula, Dalbergia sisso, Acacia arebica, Pithecolobium dulce and Prosopis julifera in survey undertaken in Haryana.

Verma, et al. (1976) found that seven new hosts of this pest viz. peach (Prunus persica L.), Kadam (Nuclea kodamba), Safeda (Eucalyptus ctriodora), Siris (Albezia leebek L.), Dhaincha (Sesbania cannabina Retz), Banyan (Ficus bengalensis L.) and Peepal (Ficus

religiosa L.) were recorded in the experiment conducted in March, 1971 at Hissar, Haryana.

Sandhu and Khangura (1976) reported that the bark eating caterpillar Indarbela quadrinotata Wlk. was a polyphagous pest of fruit trees, roadside trees, forest trees and ornamental bushes in Punjab.

Verma and Khurana (1977) reported that, 70 per cent of the infested trees were having 1 to 5 holes and 30 per cent having 6 to 8.5 holes each. They also observed that Aonla (Emblica officinalis) was the most prefered food followed by pear (Bagukosha), Jamun (Syzygium cumini) Pomegranate (Pyrus pyrifolia), Ber, Guava, Plum, Orange, Mango, Lichi and Peach.

Mann and Bindra (1977) they revealed that, Rohtaki gola, a jujube cultivar had the lowest number of live holes during March while Sanura-1 had highest number of holes in February and Illaichi had the highest number of live holes in March.

Mann and Bindra (1978) found that infestation of the pest increased with the age of the orchard. Seedless Guava had highest incidence and L-49 and Allahabad Safeda, the two cultivars recommonded in Punjab, had low incidence of the pest.

Sandhu, et al. (1979) recorded the field preferences of Indarbela spp on Citrus and Guava cultivars. Differential infestation had been observed in the plantation. Populations were counted during the peak period of infestation (Late October to early November).

Sandhu, et al. (1979) reported that the varieties of sweet orange had higher population Indarbela quadrinotata than varieties of Mandrin. They also stated that the seedless Guava varieties harboured the highest number of larvae and the infestation was more in old neglected orchard.

Lal and Singh (1982) reported that the least susceptible cultivar of Loquat tree was Thames pride and maximum infestation was found in improved pale yelow cultivars.

Verma (1985) stated that, the bark eating caterpillar was damaging to the bark of Mango, Loquate, Pomegranate, Citrus, Bauhinia variegata, Linn., Grewia optica, Drum mond and Plum (Prunus domestica Linn.) in Himachal Pradesh. He also revealed that 90 per cent of the 12 to 15 years old trees were severely infested with an average of 13 larval holes per tree and 4 to 6 years old trees were free of infestation at Solan, Himachal Pradesh.

Das, *et al.* (1985) revealed that the infestation of the pest on Tea and Shade tree in North Eastern India.

Remadevi, (1989) reported that *Indarbela quadrinotata* (Walker) attacks mulbery too. *Indarbela quadrinotata* was recorded on mulberies from 1985 to 1989 in Karnataka, India.

2.2 Chemical control of *Indarbela* spp

Ayyar, T.V.R. (1940) recommended hooking of the caterpillars from the holes with hooked wires or injection of a small quantity of mixture of petrol and napthalene into the holes by means of a syringe and in addition spraying the Paris green mixture on the bark of infested trees for controlling the bark borer.

Cherian, (1942) reported that, when the infestation is severe, application of kerosene or a mixture of equal parts of Cresote oil and Chloroform or Petrol, or a mixture of equal parts of carbon disulhide and Chloroform is an effective in controlling bark borer. Spraying of DDT 0.3 per cent emulsion or suspension to be effective in controlling the bark borer.

Ramchandran (1954) reported that pouring small quantity of Petrol into the bored hole by dropper and plugging with mud or applying BHC 0.5 per cent dust was effective for controlling the bark bore on citrus.

Anonymous (1955) revealed that for controlling of the bark eating caterpillar few drops of Kerosene was found to be effective, where as few drops of 0.1 per cent DDT emulsion proved to be effective.

Few drops of ED/CT or Carbon disulphide or Petrol or Kerosene oil emulsion and use of 5 per cent BHC dust is effective for contring Indarbela spp (Bindra, 1957).

Injection of Ethylene glycol and Kerosene (1 : 3) into the tunnels is useful for controlling Indarbela spp (Srivastava and Siddiqui, 1962).

Spraying the bark with Chlorinated hydrocarbon and organophosphates had also been suggested by different workers (David, et al., 1963; Srivastava, 1972; Noor and Kushwaha, 1976).

Patel, et al., (1964) suggested various treatments, they injected 5 cc. of Kerosene, Cs_2 or DDT 0.1 per cent in the hole and sealed the hole with cotton wool and mud; resulted in a satisfactory control and also suggested that, Kerosene application was the most effective treatment.

Verma, et al., (1972). Studies revealed that plugging of holes with cotton soaked in BHC or Toxophene or Carbaryl or Fenitrothion, reduced the pest infestation.

A number of insecticides and chemicals are useful in controlling the pest. However, Only Kerosene or Petrol were effective and economical. (Srivastava, 1972).

Verma, et al., (1974) carried out field tests in Haryana, India, In March 1971 to evaluate the effectiveness of injecting various insecticides into the bark of Pomegranate trees. Treatments giving 100 per cent kill within 4 days were considered effective. As judged by effectiveness and cost, the best treatments were injection per larval hole of 5 ml of 0.0125 per cent Dichlorvos, 0.0125 per cent Methyl parathion, 0.05 per cent Trichlorophon, 0.05 per cent Endosulfan, or 10 per cent Kerosene emulsion.

Verma and Singh, (1975) reported that painting the bark with insectide solution using paint brush had controlled the bark borers.

Sandhu and Khangura (1976) suggested the use of wash bottles with dilute insecticidal solutions was effective for the treatment of larval burrows to overcome the hazardous method of dipping swab in insecticidal solutions to introduce into the larval burrows.

Siddiqui and Pandey (1977) found that injecting the hole with 0.03 per cent Endrin was significantly superior to drenching the whole tree with 0.03 per cent Endrin or spraying only the affected parts with 0.05 per cent Fndrin or painting the affected parts with 0.1 per cent Endrin.

Butani, -- (1978) suggested that inserting cotton wool soaked in Carbon disulfide, Petrol or Kerosene oil into larval tunnels and sealing with mud or spraying with Dichlorvos, Trichlorofon, Endosulfan, BHC, Endrin or DDT is effective method to control the bark borerinfesting Pomegranate.

Sandhu, et al. (1978) eavaluate different methods for control of Indarbela quadrinotata walker on citrus in the Punjab. Application of 0.05 per cent Permethrin or 0.05 percent Monocrotophos by wash bottles, high volume spot sprays of 0.05 per cent Monocrotophos and Monocrotophos at a high concentration to feeding sites by a cotton swab tied to a spoke gave effective control.

Sandhu, et al. (1978) found out the two new techniques in controlling the bark borers, viz. application of concentrated insecticides around the fresh feeding sites to kill the larvae and

application of stickers (adhesive) around the active holes to trap or disturb the caterpillar to be effective.

Sandhu and Khangura (1979) suggested that bark eating caterpillar infesting guava can easily controlled by any available insecticide or Kerosene oil 2-3 ml per hole during the active period of larval infestation (Oct to Nov.).

Ambekar, et al (1981) tested the effectiveness of different insecticides infesting guava. They also suggested that larval mortality was assessed 2-15 days after application, and the compound giving the maximum kill within 7 days were considered to be effective. On this basis, Monocrotophos as a 50 per cent E.C. was the most promising for the control of pest, followed by E.C. 50 per cent Fenitrothion, 100 per cent dichlorvos and 35 per cent Bromophos.

Injection of larval tunnels with Fenitrothion 0.1 per cent, Monocrotophos 0.05 per cent, Lindane 0.1 per cent, Dichlorvos 0.05 per cent, and Aldrin 0.25 per rent gave the complete kill after 15 days of treatment. (Teli, et al. 1981).

Verma, — - (1985) reported that treating the live holes by 10 per cent Phorate

granules at 1 gm/ hole and 0.05 per cent DDT at 10 ml per hole were effective treatment giving 100 per cent mortality after 7 days.

Doharey and Butani (1985) reported that 1-2 sprays of 0.01 per cent Fenvalrate and clearing of holes and fumigation with Carbon disulfide, Chloroform or Petrol is effective.

Application of Quinalphos 2 E.C. @ 1:100 Endosulfan 35 E.C. @ 1:200 or Detametrhin 2.8 E.C. @ 1:200 gave good control of pest upto 4 weeks. A granular aplication of Phorate 10 G @ 2 gm per hole gave effective control up to 6 weeks after application (Das, et al. 1985).

Verma (1985) found that treatment of 10 per cent Phorate granules @ 1 gm/hole and 0.05 per cent DDT @ 10 ml per hole were most effective method of control after 7 days of application.

Sharma and Kumar (1986) revealed that the sprays of 0.05 per cent Endosulfan; 0.05 per rent Trichloroform or 0.05 per cent Dichlorvos killed the larva at nibbling stage from July onwards and a fumigant soaked in cotton wool and sealed with mud controlled the larvae at tunneling stage.

Sandhu, et al(1987) compared several insecticides and suggested that the spraying of Monocrotophos 0.05 per cent was the most effective control method on orange.

Singh, et al (1988) tested the efficacy of many insecticides and suggested that Petrol and Kerosene afforded 95.54 and 73.55 per cent control respectively, followed by 0.5 per cent Demeton methyl, Dichlorvos and Quinalphos gave 57.51, 63.03 and 50.87 per cent control, respectively.

Patil, et al (1990) tested the effect of Dichlorvos and Petrol and found that Dichlorvos gave hundred per cent control where as Petrol gave 96.7 per cent control after 7 days of application.

Shewale, (1991) tested the efficasy of many insecticide and found that Dichlorvos at 0.08 per cent was the most effective closely followed by Monocrotophos at 0.08 per cent, Fenvalrate at 0.04 per cent and Carbaryl at 1 per cent.

Materials and Methods

III MATERIALS AND METHODS

The present investigations were carried out to study the relative incidence of Indarbela spp on different host plants. The infestation was observed from Sep. 1992 to Jan. 1993. Similarly efforts were done to find out a suitable and effective method for control of pest. The materials and methods followed during the present investigation are described as below.

3.1 Survey on the incidence of Indarbela spp.

The materials and methods followed are as follows.

3.1.1 Experimental site.

The survey was undertaken on the incidence and extent of infestation caused by Indarbela spp at Marathwada Agricultural University Campus, Parbhani, during Sep and Nov. 1992 and at Dnyaneshwar garden, Paithan during Dec. 1992.

3.1.1.1 Survey at Marathwada Agricultura University Campus, Parbhani.

In this area the survey was undertaken on ten different host species viz. Guava Psidium guajava, Sweet orange, citrus sinensis, Mango Mangifera indica and Aonla, Embilica officinalis at Horticultural farm, college of Horticulture, Parbhani; Nilgiri, Eucalyptus globulus; Ashoka,

Palyalthia longifolia on road side; Casuarina, Casuarina equisetifolia trees in the garden of College of Agriculture, Parbhani; Tassar, Terminalia spp i.e. Terminalia arjuna and Terminalia tomentosa trees at the field of Entomology, college of Agriculture, Parbhani and Siris, Albezia leebak; Sisso Dalbergia sisso at the Agroforestry farm, Parbhani.

3.1.1.2 Survey at Dnyeneshwar garden, Paithan

Survey was conducted on twenty different host trees viz. Neem, Azadirechta indica; Peltophorum, Peltophorum pterocarpum; Mahogany, Swietenia mahagoni; Australian babul, Acaria nilotica; Ranbhendi, Thespesia populnia; Sisso, Dalbergia sisso; Tamarind, Tamarindus indica, Jamun, Syzygium cumini, Sausage tree, Kigelia Pinnata; Vilayati imli, Pithecolobium dulce; Gold mohar, Delonix regia; Aonla, Embilica officinalis; Kanchan, Bauhinia purpurea and Bauhinia variegata; banayan tree, Ficus bengalensis; Pangara, Erythrina variegata; bottle brush, Callistemon lanceolatus; Pipri, Ficus spp; Ashoka, Polyalthia longifolia; Nilgiri, Eucalyptus globulus.

3.1.2 Methodology of survey.

Observations were recorded by using the eyeball technique and vernier callipar. The observations were recorded on the following particulars.

1. Name of the tree with botanical name and family.
2. Approximate height of the tree.
3. Type of bark.
4. Number of holes per tree.
5. Length of area fed (meter).
6. Height of the first hole from ground level (meter) .
7. Intensity of attack.
8. Thickness of the bark.
9. Condition of the plant at observation.

During the present investigations the observations were recorded on the intensity of attack by the pest, which is recognisable from total number of holes per tree and the total length of area fed by caterpillar per tree. Thus the observations were recorded on different host plants viz. Avenue trees, Forest trees, Fruit trees, Garden trees and Medicinal trees.

3.2 Chemical control of Indarbela spp on different host plants.

Food is the most important influencing factor for the distribution and abundance of pest. Chemical control of Indarbela spp has been undertaken on two different hosts viz. guava and sweet orange. The materials used during the present investigation are as shown in plate 1. The details are given below.

3.2.1 Chemical control of Indarbela spp infesting guava, Psidium guajava L.

3.2.1.1 Experimental site.

The field experiment was conducted in a severely infested guava plantation of Horticultural farm, College of Horticulture, Parbhani. The present experiment was conducted during 7 Mar to 6 Apr. 1993 on twenty five years old guava variety L-49, which planted in July-August 1968.

3.2.1.2 Methodology.

The frass from the suspected live borer holes was removed from all the infested trees two days before application of insecticides. The frass was removed with the help of an iron needle (old cycle spoke) to clean the infested holes. After two days these holes were again observed for confirmation. The holes were considered as live holes, if fresh frass was noticed around the holes. The fresh frass from each live holes was again

removed just before the application of treatments. The holes treated were marked by wrapping a piece of red cloth to infested twigs of the tree. Bore tunnels with two seperate openings, cracks and those facing downwards were discarded.

3.2.1.3 Experimental design.

The experimental design used was the randomised block design with eight treatments replicated four times. At least ten holes were treated with each treatment in each of the replications.

In the present experiment eight insecticidal treatments were evaluated The details of the insecticides used are given in Table 1.

Table 1. Details of treatments

Treatments	Insecticide	Trade name	Conc. of insecticide	quantity applied/ tunnel
T_1	Cypermethrin 25 E.C.	Basathrin	0.01 %	3 ml
T_2	Dichlorvos 100 E.C.	Nuvan	0.05 %	3 ml
T_3	Endosulfan 35 E.C.	Endosulfan	0.05 %	3 ml
T_4	Monocrotophos 36 E.C.	Nuvacron	0.05 %	3 ml
T_5	Choloroform	Chloroform(L.R.)	98 %	3 ml
T_6	Petrol	Petrol	100 %	3 ml
T_7	Phorate 10 G	Thimet	10 %	1.5 gm
T_8	Control	---	---	---

The recommended concentrations of the insecticides as shown in Table 1 were applied to the holes by inserting a cotton swab dipped in 3 ml insecticidal solution. Additional quantity of insecticidal solution was applied at feeding site as per area fed with the help of cotton wool tied to a stick. The fumigants were applied into the holes with recommended dosages and then sealed by mud + cowdung paste. (1:3 Proportion)

3.2.1.4 Observations.

The observations were recorded after 3,7, 15 and 30 days of application of treatments. During each observation if fresh frass was noticed, it was removed at the same time to facilitate the next observation. Thus by counting the number of reconstructed webs at each observation the subsequent population was assessed. The results were tabulated on the per cent mortality basis. The data were further transformed into angular values before statistical analysis. During observation each and every hole was observed and confirmed for infestation.

3.2.2 Chemical control of Indarbela spp infesting sweet orange (Citrus singnsis).

The bark eating caterpillar Indarbela spp is a polyphsgous pest infesting many fruit trees including Sweet orange, Guava, Pomegranate, Jamun etc. This is a nocturnal pest. It principally feeds on the bark of trees and spun a loose brownish web over the fed area. It also make deep tunnels into the trunk or branches in which the caterpillar remain hidden during the day time.

The experiments of chemical control of Indarbela spp were undertaken during 7 Mar - 6 Apr, 1993 on Sweet orange with same set of insecticides as that of Guava. Thus materials, methods and observations are same.

Results

IV. RESULTS

The incidence of Indarbela spp damaging the bark of various kinds of trees specially in neglected and uncleaned orchard was found to be severe. It remains hidden in the web and has nocturnal habit of feeding so it is difficult to control this pest. The feeding of the caterpillars causes interruption in translocation of cell sap due to which fruit setting capacity as well as growth of the plant is retarded. If the infestation is severe, the complete dryingup of the tree is observed.

The present studies were undertaken to survey the incidence on various hosts, locations and chemical control of bark eating caterpillar. Results are compiled and presented as follows.

4.1 Survey on the Incidence of Indarbela spp.

To evaluate the incidence of infestation and extent of damage caused by Indarbela spp. on different host trees, the survey was taken at two different places. The survey was conducted at Marathwada Agricultural University campus, Parbhani at various places and Dnyaneshwar Garden, Paithan Dist. Aurangabad.

The presence of the pest was indicated by the masses of dark frass generally near the forks or angles on the stem and branches. The larvae remains inside the gallaries of frass during feeding and use tunnels as a shelter when it rest.

The observations were recorded on different host plants, which are grouped under following categories.

4.1.1 Survey for infestation of Indarbela spp. on avenue trees.

Field survey for six major types of avenue trees were done for the infestation of bark eating caterpillar. The data presented in Table 2 give an indication of incidence and extent of damage caused by the Indarbela spp. on the following trees.

4.1.1.1 Banyan tree (Ficus bengalensis; moraceae)

For the evaluation of infestation of bark eating caterpillar, ten banyan trees were observed. Not a single tree was found to be infested by the pest. At the time of observation the condition of the tree was healthy and the bark was hard. The thickness of bark was 0.6 cm.

Table 2 : Details of infestation of Indarbela spp. on avenue trees

Sr No.	Family	Common name	Botanical name	No.of trees Obse-rved	% of trees infe-sted	Approximate height of plant (m) Avg.	S.D.	Height of first hole from ground level (m) Max.	Min	Avg.	S.D.	No. of holes per tree Max.	Min	Avg.	S.D.	Length of area fed (m) Max.	Min	Avg.	S.D.	Type of bark	Thick-ness of bark (cm)	Inte-nsity of attack	Cond-ition of plant
1	moraceae	Banyan tree	Ficus bengalensis	10	0.0	7.25	1 18	-	-	-	-	-	-	-	-	-	-	-	-	Hard	0.60	-	Healthy
2	Leguminosae	Gold mohar	Delonex regia	10	0.0	4.35	0.49	-	-	-	-	-	-	-	-	-	-	-	-	Semi hard	0.50	-	Healthy
3	Bignoniaceae	Cork tree	Milliagtonia hortensis	10	0.0	4.62	0.71	-	-	-	-	-	-	-	-	-	-	-	-	Semi hard	0.40	-	Healthy
4	Leguminosae	Peltophorum	Peltophorum pterocarpum	10	0 0	4.22	0.71	2.0	0.90	1.26	0 56	7.0	1.0	3.30	2.26	1	0.08	0.9	0.36	Semi hard	0.30	severe to mild	Healthy
5	Annonareae	Ashoka	Polyalthia longifolia	10	0.0	8 09	0 56	-	-	-	-	-	-	-	-	-	-	-	-	Semi hard	0.40	-	Healthy
6	Miliaceae	Neem tree	Azadirechta indica	10	0.0	8.50	0.40	-	-	-	-	-	-	-	-	-	-	-	-	Hard	0.80	-	Healthy

4.1.1.2 Gold mohar (Delonix regia; caesalpiniaceae)

The ten gold mohar trees were observed , all the observed trees were free from the infestation of Indarbela spp. The bark of the observed trees was semi-hard with thickness of 0.5 cm. The trees were healthy at the time of obervations.

4.1.1.3 Cork tree (Millingtonis hortensis ; Bignoniaceae)

Ten cork trees were observed for the infestation of bark eating caterpillar. It was revealed from Table that the cork trees were free from infestation. The type of bark of observed trees were semi hard and the thickness of bark was 0.4 cm.

4.1.1.4 Peltophorum (Peltophorum pterocarpum ; Leguminosae)

For the evaluation of infestation of the pest, ten trees were observed for the incidence and extent of damage caused by the Indarbela spp . Sixty per cent of the trees were infested by the pest. The maximun height of the first hole from ground level was 2 meter and a minimum height was 0.9 M with an average of 1.26 meters; the maximum number of holes per tree was 7 and the minimum was 1 with an average of 3.3. The maximum length of area fed by caterpillar was

found to be 1 meter and minimum was 0.08 m, the average length was 0.9 m. The type of bark was semi-hard with thickness of 0.3 cm. Intensity of attack was severe to mild and the condition of the plant at observation was healthy.

4.1.1.5 Ashoka (Polyalthia longifolia; Anonnaceae)

Ten different trees of the Ashoka was observed, and it was found that trees were free from infestation. The type of bark was semi-hard with thickness of 0.4 cm and the condition of the plant was healthy.

4.1.1.6 Neem (Azadirechta indica; miliaceae)

Ten Neem trees were observed and it was found that there was no infestation on neem tree because the type of bark was hard with thickness of 0.8 cm and very rough, so it was difficult to feed for the caterpillar.

4.1.2 Survey for the infestation of Indarbela spp. on forest trees

Eleven types of forest trees were observed for the infestation of Indarbela spp. The data is presented in Table 3.

Table 3 : Details of infestation of Indarbela spp on forest trees

Sr No.	Family	Common name	Botanical name	No.of trees Observed	% of trees infested	Approximate height of plant (m) Avg.	S.D.	Height of first hole from ground level (m) Max.	Min	Avg.	S.D.	No. of holes per tree Max.	Min	Avg.	S.D.	Length of area fed (m) Max.	Min	Avg.	S.D.	Type of bark	Thickness of bark (cm)	Intensity of attack	Condition of plant
1	Miliaceae	Mahaguni	Swietenia mahagonia	10	30	8.40	1.07	3	2.5	2.62	0.21	2.0	1.0	1.3	0.48	0.30	0.12	0.18	0.06	Hard	0.20	mild	Healthy
2	Malvaceae	Ranbhendi	Thespesia populnea	10	25	5.17	0.70	2	1.5	1.77	0.27	4.0	1.0	2.4	1.07	0.40	0.09	0 23	0.10	Hard	0.30	mild	Healthy
3	Leguminosae	Australian Babul	Acacia nilotica	10	80	4.97	1.11	3	1.0	1.87	0.99	5.0	1.0	2.6	1.58	0.80	0.12	0.37	0.26	Hard	0.18	mild	Healthy
4	Leguminosae	Pangara	Erythrina variegata	10	0.0	4.90	0.66	-	-	-	-	-	-	-	-	-	-	-	-	Hard	0.55	-	Healthy
5	Utriceceae	Pipri	Ficus spp	10	0 0	3.37	0 50	-	-	-	-	-	-	-	-	-	-	-	-	Hard	0 43	-	Healthy
6	Tiliaceae	Rudraksha	Elaeocarpus ganitrus	10	7 0	2 07	0.39	1	0.50	0.85	0.17	4.0	1 0	2.9	1.10	0.45	0.11	0.28	0.10	Hard	0.28	mild	Healthy
7	Cesalpiniaceae	Bauhinia	Bauhinia purpurea	10	0.0	4.10	0.62	-	-	-	-	-		-	-	-	-	-	-	Hard	0.64	-	Healthy
8	Cesalpiniaceae	Bauhinia tree	Bauhinia variegata	10	50	4.10	0.70	2.0	0.50	1 34	0 59	3.0	1 0	1 7	1 06	0.50	0.09	0.03	0.16	Hard	0.24	mild	Healthy
9	Combretaceae	Tasar	Terminalia spp	10	90	5.00	0.33	2.0	0.44	1.59	0.42	6.0	1.0	3.5	1 43	1.40	0.10	0.67	0.36	Soft	0.10	Severe Unto mild	healthy
10	Leguminosae	Vilayati imli	Pethecolobium dulce	10	80	6.50	0.53	4.0	2.25	2.58	0.51	5.0	2.0	3.7	1.50	1.95	0.08	1.10	0.50	Hard	0 22	mild	Healthy
11	Papilionaceae	Sisso	Dalbergia sisso	10	60	4 94	0 59	3.1	0.90	1.65	0.74	4 0	2.0	2.5	0 84	2.78	0.18	1 13	0.83	Hard	0 36	mild	Healthy

4.1.2.1 Mahogany (Swietenia mahagonia; Miliaceae)

Ten trees of Mahagani was observed for the infestation of Indarbela spp, out of the ten trees only three trees were infested by bark eating caterpillar. The infestation was just around the hole ranging from 0.12 m to 0.30 m. The average height of the first hole from ground level was 2.62 m. The average number of holes per tree was 1.3. The type of bark observed was hard with 0.2 cm in thickness. The intensity of attack was mild and the condition of the plant at the time of observation was healthy.

4.1.2.2 Ranbhendi (Thespesia populnea; Malvaceae)

Ten trees were observed for infestation of bark eating caterpillar (Indarbela spp). The average length of the area fed was found to be 0.23 m. The maximum height of the first hole from ground level was 2 meter and minimum height of the first hole from ground level was 1.5 m with an average of 1.77 m from ground level. The average number of holes per plants were 2.4 with maximum number of 4 holes per tree and minimum of one hole of per tree. The type of bark was found to be hard with 0.3 cm thickness and the intensity of attack was found to be mild. The condition of the plants were healthy.

4.1.2.3 Australian babul (Acacia nilotica; Leguminosae)

It was found from observed trees that 8 trees were infested out of ten trees by Indarbela spp. The average height of plant was 4.97 m. The maximum height of the first hole from ground level was 3 m and minimum was 1 m with an average of 1.87 m per tree. The maximum number of holes per tree was 5 and minimum of 1 hole per tree with an average of 2.6 . The maximum length of area fed by the caterpillar per tree was 0.80 m while the minimum was 0.12 meter. The average length of area fed by caterpillar was 0.37 m per tree. The type of bark was hard with thickness of 0.18 cm. The condition of the plants at the time of observations were helathy.

4.1.2.4 Pangara (Erythrina variegata; Leguminosae)

Ten trees of pangara was observed for infestation of Indarbela spp and it was found that all the trees were free of infestation. The type of bark observed was hard with thickness of 0.55 cm. The condition of the plants at the time of observations were healthy.

4.1.2.5 Pipri (*ficus spp*; Utricaceae)

Ten trees of pipri were observed. All the trees were found to be free of infestation from *Indarbela* spp. The type of bark was found to be hard with thickness of 0.43 cm The condition of the plants were healthy.

4.1.2.6 Rudraksha (*Elaeocarpus ganitrus*;Tiliaceae)

Ten trees of rudraksha were observed for infestation of *Indarbela* spp. The average height of the first hole from ground level was 0.85 m with a maximum height of 1 m and a minimum height of 0.50 m . The maximum number of holes per tree was 1 with an average 2.9 holes per tree. The average length of area fed was 0.28 m with maximum 0.45 m and minimum 0.11 m per tree. The bark of the tree observed was hard with thickness 0.28 cm. The intensity of attack was mild and the condition of the plants were helathy.

4.1.2.7 Bauhinia tree (*Bauhinia purpurea*;Cesalpiniaceae)

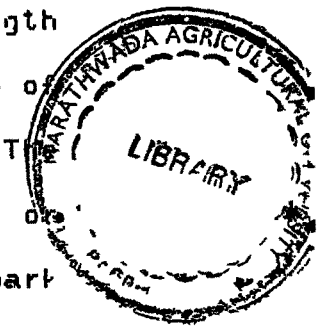
Ten trees of bauhinia were observed for the attack of pest. All the ten trees were found to be free from attack of pest. The type of the bark of observed trees were found to be hard. The average thickness of bark was 0.64 cm. The condition of the plants were healthy.

4.1.2.8 Bauhinia tree (Bauhinia variegata; Cesalpiniaceae)

Ten tress of Bauhinia variegata were observed for the infestation of bark borer. It was found that 50 per cent of the trees were attacked by the pest. The maximum height of first hole from ground level was 2 m and minimum 0.05 m with an average height of 1.34 m. The maximum number of holes per tree was 3 and minimum 1 with an average of 1.7 holes per tree. The maximum length of area fed was 0.50 m and the minimum length of 0.90 m. The average length of area fed by the pest per tree was 0.3m .The type of the bark observed was hard with thickness of 0.24 rm. The intensity of attack was mild and the condition of the plants were healthy.

4.1.2.9 Tasar (Terminalia spp; Combretaceae)

There are two spp of Tasar i.e. Terminalia arjuna and Terminalia tomentosa. Both the species were attacked by the pest. It was severely infested by the pest. The intensity of attack was so severe that the 90 per cent of the plants were found to be infested. The maximum height of the first hole from ground level was found to be 2 m and minimum height was 0.44 m with an average of 1.59 m from ground level. The maximum number of holes per treee was 6 and minimum was 1 with an



average of 3.5 holes per tree. The maximum length of area fed by caterpillar was 1.4 m and minimum of 0.10 m, with an average of 0.67m per tree. The infestation was mostly found near the forks or angles on the stem and branches. the type of bark of tree was found to be soft with thickness of 0.10 cm. The general condition of the tree was not found good.

4.1.2.10 Vilayati imli (Pithecolobium dulce; Leguminosae)

The observed ten trees of vilayati imli were severely attacked by the pest. The percentage of trees attarked were 80 per cent. The maximum height of first hole from ground level was 40 m and minimum was 2.25 m with an average of 2.58 m per tree. The maximum number of holes per tree was 5 and minimum number was 2 with an average of 3.75 holes per tree. The average length of area fed by caterpillar was 0.58 m with maximum of 1.95 m and minimum of 0.08 m . The type of bark observed was hard with thickness of 0.22 cm. The condition of plant at the time of observation was healthy.

4.1.2.11 Sisso (Dalbergia sisso; Papilionaceae)

Sixty per cent of the sisso trees were found to be attacked by the pest out of ten which were observed for the infestation of Indarbela spp. The maximum height of first hole from ground level

was 3.1 m and minimum of 0.90 m with an average of 1.65 m. The average number of holes per tree was 2.5 with minimum of 2 and maximum of 4 holes per tree. The maximum length of area fed was 2.78 m and minimum was 0.18 m with an average of 0.83 m. The type of bark was hard with thickness of 0.36 cm. The intensity of attack was mild and general condition of the trees were healthy.

4.1.3 Survey for infestation of Indarbela spp on fruit trees

Seven different types of fruit trees were observed for the infestation of Indarbela spp. The data is presented in Table 4.

4.1.3.1 Guava (Psidium guajava; Myrtaceae)

Ten guava trees were observed for the attack of Indarbela spp. There was hundred per cent infestation on guava trees. All most all guava trees were infested severely. The maximum height of first hole from ground level was 1.6 m and minimum height was 0.20 m . The average height of first hole from ground level was 1.3 m. The average number of holes per tree was 4.2 with maximum 12 holes and minimum 2 holes per tree. The maximum length of area fed by caterpillar was 6.2 m.and minimum length was 0.90 m. The average length of area fed was 2.11 m. The type of bark observed was soft with thickness of 0.15 cm. The

Table 4 : Details of infestation of Indarbela spp on fruit trees

Sr No.	Family	Common name	Botanical name	No.of trees Observed	% of trees infested	Approximate height of plant (m)		Height of first hole from ground level (m)				No. of holes per tree				Length of area fed (m)				Type of bark	Thickness of bark (cm)	Intensity of attack	Condition of plant
						Avg.	S.D.	Max.	Min	Avg.	S D.	Max.	Min	Avg.	S.D.	Max.	Min	Avg.	S.D.				
1	Myrtaceae	Guava	Psidium guajava	10	100	4.00	0.53	1.6	0.2	1.3	0.42	12.0	2.0	7.2	2.61	6.20	0.90	2.11	1.91	Soft	0.15	Severe to mild	Poor to healthy
2	Rutaceae	Sweet Orange	Citrus sinensis	10	100	4.40	0.45	2.2	0.8	1.19	0.44	11.0	3.0	8.6	2.37	2.00	0.70	1.27	0.37	Soft	0.18	Severe to mild	Healthy
3	Caesalpiniaceae	Tamarind	Tamarindus indica	10	30	9.40	1.50	3.5	1.5	2.40	0.81	6.0	1.0	2.5	1.58	1.00	0.15	0.78	0.30	Hard	0.58	mild	Healthy
4	Myrtaceae	Jamun	Syzygium cumini	10	20	2.80	0.59	1.0	0.75	0.17	0.37	1.0	1.0	0.2	0.42	0.25	0.25	0.05	0.10	Soft	0.15	mild	Healthy
5	Annonaceae	Custard apple	Annona squaosa	10	30	2.60	0.39	1.25	1.0	0.32	0.53	1.0	1.0	0.3	0.48	0.75	0.25	0.15	0.27	Soft	0.20	mild	Healthy
6	Sapotaceae	Sapota	Achras zapota	10	0.0	3.07	0.29	-	-	-	-	-	-	-	-	-	-	-	-	Soft	0.22	mild	Healthy
7	Mangiferi	Mango	Mangifera indica	10	30	6.10	0.51	2.0	1.25	0.52	0.87	1.0	1.0	0.3	0.48	1.5	0.75	0.32	0.55	Hard	0.85	mild	Healthy

intensity of attack was very severe and the condition of the tree at observation was poor to healthy.

4.1.3.2 Sweet orange (Citrus sinensis; Rutaceae)

Ten sweet orange trees of Nucellar variety was observed for the infestation of caterpillar. It was seen that every tree was full of infestation. There was hundred per cent attack of Indarbela spp on sweet orange. The picularity of this infestation was observed that the pencil sized twigs are also attacked by the caterpillar. The maximum height of the first hole from ground level was found to be 2.2 m and minimum was 0.80 m with an average height of 1.19 m . The maximum number of holes per tree was 11 and minimum was 3 holes per tree with an average of 8.6 m. The maximum length of area fed by the pest was found to be 2.0 m and minimum of 0.7 m . The average length of area fed was 1.27 m. The type of bark was found to be soft and the thickness of the bark was 0.15 cm. The intensity of attack was severe to mild. It was also observed that the young twigs were severely attacked and the gallaries were found on the trunk which was made by the caterpillar. Inspite of severe infestation, the condition of the plant was found to be healthy.

4.1.3.3 Tamarind (*Tamarindus indica*; Cesalpiniaceae)

Ten tamarind trees were observed at the random places in field of M.A.U. campus. The percentage of infested trees was 30 per cent. The maximum height of first hole from ground level was 3.5 m and minimum height was 1.5 m from ground level with an average of 2.4 m. The maximum number of holes per tree was 6 and the minimum number was found to be 1 per tree. The average holes per tree was 2.5. The maximum length of area fed was 1 m. and minimum was 0.15 m. The average length of area fed was 0.78 m. The type of bark observed was hard with thickness of 0.58 cm. Intensity of attack was mild and the general condition of the trees observed were healthy.

4.1.3.4 Jamun (*Syzygium cumuni* ; Myrtaceae)

Ten trees of jamun were observed for the incidence of attack of *Indarbela* spp. out of which 20 per cent trees were infested by the attack of caterpillar. The maximum height of first hole from ground level observed was 1 m and minimum was 0.75 m with an average height of 0.37 m from ground level. The maximum number of holes per tree was 1 and minimum also 1 with average of 0.2 holes per tree. The maximum, minimum and average length of area fed was 0.25 m. The type of bark observed was

soft with 0.15 cm thickness. The general condition of the tree at observation was found to be healthy.

4.1.3.5 Custard apple (Annona squamosa ; Annonaceae)

Ten trees of custard apple were observed where 30 per cent trees were infested. The maximum height of the first hole from ground level was 1.25 m and minimum was 1 m with an average of 0.90 m. The maximum number of holes per tree was 4 while minimum was 1 hole per tree with an average of 2.3 m. The maximum length of area fed was 0.75 m while minimum length was 0.30 m with an average of 0.45 m. The type of bark observed was soft with 0.20 cm thickness . The intensity of attack was mild and the condition of the trees were healthy.

4.1.3.6 Sapota (Achras zapota ; Sapotaceae)

For the evaluation of infestation of bark eating caterpillar 10 trees of sapota were observed. Out of which none of the trees were infested by the caterpillar. The approximate height of the plant observed was 3.07 m. The type of bark observed was soft with thickness of 0.22 cm and the condition of the plants were healthy.

4.1.3.7 Mango (*Mangifera indica* ; Mangiferae)

Ten trees of mango were observed for the infestation of bark eating caterpillar. The percentage of infested trees was 30. The maximum height of first hole from ground level was 2 m while minimum height was 1.25 m and the average height was 0.52 m. The maximum and minimum number of holes per tree was 1 with an average of 0.30 holes per tree. The maximum area fed by the caterpillar was 1.5 m , minimum was 0.75 m and average area fed was 0.32 m. The type of bark observed was hard and the thickness of bark was 0.85 cm. The intensity of attack was mild and condition was healthy.

4.1.4 Survey for infestation *Inderbela* spp on garden trees

The number of categories of hosts observed for the incidence and extent of damage caused was 2. The data is presented in Table 5.

4.1.4.1 Casuarina tree (*Casuarina equisetifolia* ; Casuarineae)

Ten casuarina trees were observed for infestation of pest and infestation recorded was 80 per cent. The maximum height of first hole from ground level was 1.4 m while the minimum was 0.60

Table 5 : Details of infestation of Indarbela spp. on Garden trees

Sr No	Family	Common name	Botanical name	No.of trees Observed	% of trees infested	Approximate height of plant (m)		Height of first hole from ground level (m)				No. of holes per tree				Length of area fed (m)				Type of bark	Thickness of bark (cm)	Intensity of attack	Condition of plant
						Avg.	S.D.	Max.	Min	Avg.	S.D.	Max.	Min	Avg.	S.D.	Max.	Min	Avg.	S.D.				
1	Casuarineae	Casuarina tree	Casuarina equisetifolia	10	80	3.50	0.47	1.4	0.60	0.68	0.43	7	2	2.8	2.14	2.8	0.75	1.78	0.85	Hard	0.35	Severe	Healthy
2	Myrtaceae	Bottle brush	Callistemon lanceolatus	10	0.0	4.00	0.41	-	-	-	-	-	-	-	-	-	-	-	-	Hard	0.50	-	Healthy

m and the average height was 0.68 m. The number of holes per tree were also recorded and the maximum, minimum and average number of holes per tree was 7,2 and 2.8 respectively. The maximum length of area fed was 2.8 m. The minimum length of area fed was 0.75 m and average length of area fed was 1.78 m. The type of bark observed was hard with thickness of 0.35 cm. The intensity of attck was severe but the condition of plants at the time of observations were healthy.

4.1.4.2 Bottle brush (Callistemon lanceolatus ; Myrtaceae)

Ten bottle brush trees were examined for the incidence of damaged caused by Indarbela spp. The bottle brush trees were found to be free from attack of pest. The type of bark was hard with thickness of 0.50 cm. The condition of the plants were healthy.

4.1.5 Survey for infestation of Indarbela spp. on medicinal trees

The two different species of medicinal trees were observed for the incidence of the pest. The data is presented in Table 6.

Table 6 : Details of infestation of Indarbela spp on Medicinal trees

Sr No.	Family	Common name	Botanical name	No.of trees Observed	% of trees infested	Approximate height of plant (m)		Height of first hole from ground level (m)				No. of holes per tree				Length of area fed (m)				Type of bark	Thickness of bark (cm)	Intensity of attack	Condition of plant
						Avg.	S.D.	Max.	Min	Avg.	S.D	Max	Min	Avg.	S.D.	Max.	Min	Avg.	S.D.				
1	Euphorbiaceae	Aonla	Emblica officinalis	10	40	3.50	0.41	1.9	1.40	0.64	0.83	1	1	0.4	0.52	0.60	0.09	0.13	0.21	Hard	0.30	Mild	Healthy
2	Myrtaceae	Nilgiri	Eucalyptus globulus	10	80	6.20	0.54	3.0	0.80	1.14	0.89	5	1	1.4	1.42	2.50	0.40	0 75	0 72	Semi hard	0.25	Severe to mild	Healthy

4.1.5.1 Aonla (Emlica officinalis ; Euphorbiaceae)

Ten trees of aonla was observed for the incidence and extent of damage by Indarbela spp. Fourty per cent trees were found to be attacked by the pest . The maximum height of first hole from ground level was 1.9 m. The minimum height was 1.4 m with an average of 0.60 m. The maximum number of holes per tree was 1 and minimum was 1 with an average of 0.4 holes per tree. The maximum length of area fed by the caterpilar was 0.64 m, minimum was 0.09 m with an average of 0.13 m. The type of bark observed was hard with thickness of 0.30 cm. The intensity of attack was mild and general condition of plants were healthy.

4.1.5.2 Nilgiri (Eucalyptus globulus ; Myrtaceae)

Ten trees were observed for incidence of Indarbela spp on Nilgiri. Eighty per cent trees were attacked by pest. The maximum height of first hole from ground level was 3 m, minimum of 0.8 m and average height was 1.14 m. The maximum number of holes per tree was found to be 5 with minimum of 1 hole per tree. The average number of holes per tree was 1.42. The average length of area fed was 0.75 m with maximum of 2.5 m and minimum of 0.4 m. The type of bark was semi-hard with thickness of

0.25 cm. The intensity of attack was severe to mild and condition of plants at the time of observations were healthy.

4.2 Chemcal control of Indarbela spp .

To evaluate the efficacy of different insecticide, seven insecticides were tested for the control of Indarbela spp. on Guava and Sweet orange. Results are presented under following subheads.

4.2.1 Chemical control of Indarbela spp. infesting Guava

A field experiment was conducted in Guava orchard having 64 trees arranged in 8 X 8 manner. The experimental findings are as follows.

4.2.1.1 Percentage reduction in Indarbela spp. 3 days after insecticidal treatments on Guava trees

The data pertaining to the percentage reduction in Indarbela spp. after three days of insecticidal application are presented in Table 7.

It was evident from the Table that all the chemical treatments were significantly superior to control. The per cent reduction in Indarbela spp. after 3 days of application ranged from 79.51 to 100 per cent. The trees treated with

Table no 7.
Percentage reduction in Indarbela spp. 3 days after incecticidal treatments on guava.

Treatment No.	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	76.92 (61.27)	88.89 (70.54)	66.67 (54.76)	85.72 (67.78)	79.55 (63.58)
T2	Dichlorvos (0.05 %)	81.82 (64.75)	85.72 (67.78)	91.67 (73.26)	83.33 (65.88)	85.63 (65.88)
T3	Endosulfan (0 05 %)	88.89 (70.54)	84.68 (66.97)	85.72 (67.78)	85.72 (67.78)	86.25 (68.26)
T4	Monocrotophos (0.05 /)	76.03 (60.67)	71.43 (57.67)	88.24 (69.91)	82.36 (65.20)	79.51 (68.36)
T5	Chloroform (L.R.)	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T6	Petrol	93.33 (75.00)	100 (90)	100 (90)	95.63 (77.89)	97.24 (83.22)
T7	Phorate 10 G	91.01 (72.54)	100 (90)	92.31 (73.89)	100 (90)	95.83 (81.60)
T8	Control	0.0	0.0	0.0	0.0	0.0
						S.E.2.77 C.D.8.15

Figures in parantheses are transformed values.

Chlorofarm (L.R.) gave highest per cent reduction of Indarbela spp. (100 per cent) and was significantly superior over rest of the treatments except petrol treatment which was at par with Chlorofarm. However, trees treated with Phorate 10 G was equally good in controlling Indarbela spp. as compare to Cypermethrin 0.01 per cent, Dichlorvos 0.05 per cent, Endosulfan 0.05 per cent and Monochrotophos 0.05 per cent but these treatments were at par amongst each other.

4.2.1.2 Percentage reduction in Indarbela spp. 7 days after insecticidal treatments on Guava trees

The data on the percentage reduction in Indarbela spp after 7 days of insecticidal application are presented in Table 8.

It was observed from Table that all the insecticidal treatments were significantly superior over control. The percentage reduction in Indarbela spp. after 7 days of insecticidal application ranged from 85.46 to 100 per cent.

It was evident from the data that the treatment Chlorofarm (L.R.) recorded the highest per cent reduction of Indarbela spp. (100 per cent) followed by petrol (98.90 per cent) and Phorate 10 G (98.07 per cent). However, this

Table no. 8

Percentage reduction in Indarbela spp 7 days after treatment on guava

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	84.62 (66.89)	92.60 (74.21)	75.00 (60.00)	89.29 (70.81)	85.46 (67.97)
T2	Dichlorvos (0.05 %)	90.01 (71.52)	88.47 (70.09)	95.84 (78.17)	88.89 (70.54)	90.80 (72.59)
T3	Endosulfan (0.05 %)	92.31 (73.89)	90.48 (71.95)	89.29 (70.31)	93.75 (75.94)	91.35 (70.00)
T4	Monocrotophos (0.05 %)	84.62 (66.89)	78.58 (62.44)	94.12 (75.94)	88.34 (70.00)	86.41 (68.81)
T5	Chloroform (L.R.)	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T6	Petrol	100 (90)	100 (90)	100 (90)	95.63 (77.89)	98.90 (86.97)
T7	Phorate 10 G	100 (90)	100 (90)	92.31 (73.89)	100 (90)	98.07 (85.97)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.58
					C.D.	7.59

Figures in parantheses are transformed values.

treatments were at par with each other and significantly superior over rest of the insecticidal treatments. Similarly the trees treated with Endosulfan 0.05 per cent , Dichlorovos 0.05 per cent, Monochrotophos 0.05 per cent and Cypermethrin 0.01 per cent gave significant reduction in the infestation as compare to control.

4.2.1.3 percentage reduction in Indarbela spp 15 days after insecticidal treatments on guava trees

The data of the percentage reduction in Indarbela spp after 15 days of insecticidal application are presented in Table 9.

Results indicated that all the chemical treatments were significantly superior over control The percentage reduction in Indarbela spp after 15 days of application was found from 91.26 to 100 per cent. Cent per cent reduction in Indarbela spp was observed with application of Chloroform (I . R.) and Petrol. These treatments were found to be at par with Phorate 10 G and significantly superior over rest of the treatments. How ever, there were no significant differences amongst Phorate 10 G and Endosulfan 0.05 per cent treatments as for as per cent reduction of the pest is concerned.

Table no. 9
Percentage reduction in Indarbela spp 15 days after treatment on guava

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	92.31 (73.89)	96.56 (79.37)	83.74 (65.88)	92.86 (74.32)	91.26 (73.36)
T2	Dichlorvos (0.05 %)	95.46 (77.75)	92.31 (73.89)	95.84 (78.17)	94.45 (76.31)	94.51 (76.53)
T3	Endosulfan (0.05 %)	92.31 (73.89)	95.24 (77.34)	92.86 (74.32)	100 (90)	95.10 (78.88)
T4	Monocrotophos (0.05 %)	92.31 (73.89)	85.72 (67.78)	94.12 (75.94)	100 (90)	93.03 (76.90)
T5	Chloroform (L.R.)	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T6	Petrol	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T7	Phorate 10 G	100 (90)	100 (90)	92.31 (73.89)	100 (90)	98.07 (85.97)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.58
					C.D.	7.59

Figures in parantheses are transformed values.

4.2.1.4 Percentage reduction in Indarbela spp 30 days after insecticidal treatments on guava trees

The data on the percentage reduction in Indarbela spp after 30 days of inceticidal application are presented in Table 10.

It is evident from data that all the insecticidal treatments were significantly superior to control. It is also clear that all the insertıcıdal treatments gave good control of Indarbela spp even up to 30 days of applications.

The treatments with chloroform, Petrol and Phorate 10 G gave 100 per cent reduction of the pest and were at par with rest of the chemical treatments.

4.2.2 Chemical control of Indarbela spp infesting sweet orange

The severely infested sweet orange trees were selected for experimental purpose. The findings are given below.

Table no. 10

Percentage reduction in Indarhela spp 30 days after treatment on guava

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	100 (90)	96.56 (79.37)	91.66 (73.26)	94.45 (76.31)	95.66 (79.73)
T2	Dichlorvos (0.05 %)	100 (90)	96.16 (78.61)	100 (90)	94.45 (76.31)	97.65 (83.73)
T3	Endosulfan (0.05 %)	96.16 (73.89)	100 (90)	94.45 (76.31)	100 (90)	97.65 (83.73)
T4	Monocrotophos (0.05 %)	92.31 (73.89)	92.86 (74.32)	100 (90)	100 (90)	96.29 (82.05)
T5	Chloroform (L.R.)	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T6	Petrol	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T7	Phorate 10 G	100 (90)	100 (90)	100 (90)	100 (90)	100 (90)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.93
					C.D.	8.62

Figures in parantheses are transformed values.

4.2.2.1 percentage reduction in Indarbela spp 3 days after insecticidal treatments on sweet orange trees

The relevant data on percentage reduction on Indarbela spp after 3 days of insecticidal application are presented in Table 11.

The data showed that all the insecticidal treatments gave significant per cent reduction of pest as compered to control. The percentage reduction has ranged from 67.41 to 95.37 per cent. Significantly higher percentage reduction was observed with Petrol (95.37 per cent), Chloroform (L.R.) (95.13 per cent) and Phorate 10 G as compared to Cypermethrin 0.01 per cent, Dicholorvos 0.05 per cent and Endosulfan which gave 85.51, 82.42, 67.41 per cent reduction respectively. Least percentage reduction was observed with application of Endosulfon at 0.05 per cent (67.41 per cent) which was significantly inferior to all the insecticidal treatments.

4.2.2.2 Percentage reductin in Indarbela spp 7 days after insecticidal treatments on sweet orange

The data on the percentage reduction in Indarbela spp after 7 days of insecticidal application are presented in Table 12.

Table no. 11

Percentage reduction in Indarbela spp 3 days after treatment on sweet orange

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	76.48 (61.00)	81.25 (64.30)	95.84 (78.17)	89.48 (71.00)	85.51 (68.61)
T2	Dichlorvos (0.05 %)	85.72 (67.78)	77.78 (61.89)	84.00 (66.42)	82.36 (65.20)	82.46 (65.32)
T3	Endosulfan (0.05 %)	80.96 (64.16)	63.16 (52.65)	57.15 (49.08)	68.43 (55.80)	67.41 (55.42)
T4	Monocrotophos (0.05 %)	89.48 (71.09)	91.67 (73.26)	83.37 (65.96)	85.72 (67.78)	87.56 (69.52)
T5	Chloroform (L.R.)	94.12 (75.94)	91.67 (73.26)	94.74 (76.69)	100 (90)	95.13 (78.97)
T6	Petrol	92.31 (73.89)	94.45 (76.31)	94.74 (76.69)	100 (90)	95.37 (79.22)
T7	Phorate 10 G	88.24 (69.91)	95.00 (77.08)	100 (90)	88.34 (70.00)	92.89 (76.74)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.58
					C.D.	7.59

Figures in parantheses are transformed values.

Table no. 12

Percentage reduction in Indarbela spp 7 days after treatment on sweet orange

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	88.34 (61.00)	93.75 (64.30)	100 (90)	94.74 (76.69)	94.20 (78.03)
T2	Dichlorvos (0.05 %)	90.48 (72.05)	83.37 (65.96)	88.00 (69.73)	88.24 (69.91)	87.52 (69.41)
T3	Endosulfan (0.05 %)	85.72 (67.78)	73.69 (59.15)	73.64 (59.08)	77.78 (61.89)	77.70 (61.97)
T4	Monocrotophos (0.05 %)	94.74 (76.69)	95.84 (78.12)	87.50 (69.30)	90.48 (72.05)	92.14 (74.05)
T5	Chloroform (L.R.)	100 (90)	95.84 (78.17)	100 (90)	100 (90)	98.96 (87.04)
T6	Petrol	96.16 (78.61)	94.45 (76.31)	94.45 (76.31)	100 (90)	96.26 (80.30)
T7	Phorate 10 G	88.24 (69.91)	95.00 (77.08)	100 (90)	94.12 (75.94)	94.34 (78.23)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.58
					C.D.	8.50

Figures in parantheses are transformed values.

It is evident from the data that all the insecticidal treatments were equally effective even up to 7 days of application of insecticides as compered to control. The percentage reduction in Indarbela spp after 7 days of application was from 77.70 to 98.96 per cent. Amongst the insecticidal application of Chloform (L.R.) recorded highest per cent reduction of pest (98.96 per cent) which was significantly superior over rest of the insecticidal treatments. How evr the trees treated with Petrol, Phorate 10 G and Cypermethrin 0.01 per cent were also effective in controlling the pest as compare to Dichlorvos 0.05 per cent and Endosulfon 0.05 per cent. The treatment Endosulfon recorded the loest per cent reduction of the pest (77.70) thus it was inferior to all insectirial treatments.

4.2.2.3 Percentage reduction in Indarbela spp 15 days after insecticidal treatments on sweet orange

The data on the percentage reduction in Indarbela spp 15 days after insecticidal application are presented in Table 13.

Results indicated that all the insecticidal treatments were significantly superior to control as for as per cent reduction of host is concered. It ranged from 86.32 to 98.56 per cent. The trees treated with Choloroform (L.R.) recorded

Table no 13

Percentage reduction in Indarbela spp 7 days after treatment on sweet orange

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	94.18 (75.94)	93.75 (75.46)	100 (90)	94.74 (76.69)	95.66 (79 52)
T2	Dichlorvos (0.05 %)	95.24 (77.34)	88.89 (70.54)	92.00 (73.57)	94.12 (75.94)	92.56 (74 34)
T3	Endosulfan (0.05 %)	90.48 (72.05)	89.48 (71.09)	80.00 (63.43)	85.34 (67.46)	86 32 (68 50)
T4	Monocrotophos (0.05 %)	100 (90)	95.84 (78.17)	91.67 (90)	95.24 (77.34)	95.68 (79 69)
T5	Chloroform (L.R.)	100 (90)	95.85 (78.17)	100 (90)	100 (90)	98.96 (87 04)
T6	Petrol	96.16 (78.61)	94.45 (76.31)	94.45 (76.31)	100 (90)	96.26 (80.30)
T7	Phorate 10 G	94.12 (75.94)	95.00 (77.08)	100 (90)	94.12 (75.94)	95.81 (79.74)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.81
					C.D.	8.27

Figures in parantheses are transformed values.

highest percentage reduction of the pest (98.96 per cent)15 days after application followed by Petrol(96.26), Phorate 10 G (95.81 per cent), Monocrotophos (95.68 per cent), Cypermethrin (95.66). However, these treatments were found to be at par amongst each other the treatment Endosulfon 0.05 per cent recorded the lowest percentage reduction of the pest (86.32) thus it was least effective as compare to other insecticides.

4.2.2.4 Percentage reduction in Indarbelaspp 30 days after insecticidal treatments on sweet orange

The relevant data on the percentage reduction in Indarbela spp 30 days after insectiridal treatments are presented in Table 14.

It is evident from the data presented that all the insecticidal treartments were equally effective up to 30 days of application of insectirides as compared to control. The percentage reduction in Indarbela spp was observed from 91.38 to 98.96 per rent. How ever these insecticidal treatments did not differ signifirantly amongsts each other as for as present reduction of damage is concerned. The treatment endosulfon was least effective which recored lowest percentage (91.38 per cent) reduction of the pest.

Table no. 14
Percentage reduction in Indarbela spp 30 days after treatment on sweet orange

Treatment	Treatment	Replications RI	RII	RIII	RIV	Average
T1	Cypermethrin (0.01 %)	94.18 (75.94)	93.75 (75.46)	100 (90)	94.74 (76.69)	95.66 (79.52)
T2	Dichlorvos (0.05 %)	95.24 (77.34)	88.89 (70.54)	92.00 (73.57)	94.12 (75.94)	92.56 (74.34)
T3	Endosulfan (0.05 %)	90.48 (72.05)	89.48 (71.09)	80.00 (63.43)	85.34 (67.46)	86.32 (68.50)
T4	Monocrotophos (0.05 %)	100 (90)	95.84 (78.17)	91.67 (90)	95.24 (77.34)	95.68 (79.69)
T5	Chloroform (L.R.)	100 (90)	95.85 (78.17)	100 (90)	100 (90)	98.96 (87.04)
T6	Petrol	96.16 (78.61)	94.45 (76.31)	94.45 (76.31)	100 (90)	96.26 (80.30)
T7	Phorate 10 G	94.12 (75.94)	95.00 (77.08)	100 (90)	94.12 (75.94)	95.81 (79.74)
T8	Control	0.0	0.0	0.0	0.0	0.0
					S.E.	2.81
					C.D.	8.27

Figures in parantheses are transformed values.

Fig-1 PHOTOGRAPH SHOWING CHEMICALS USED.

Fig-1 PHOTOGRAPH SHOWING BARK EATING CATARPILLAR.

Fig 3 - INFECTION ON CITRUS

Fig-4

GUAVA TREES

SEVERELY INFESTED

Fig-5

Fig-6 INFESTATION CLEANED FOR CHEMICAL TREATMENT

Fig-7 CLEANING OF WEBS ON GUAVA.

Fig-8 PHOTOGRAPH SHOWING APPLICATION OF CHEMICAL.

Discussion

V DISCUSSION

The bark eating caterpillar, Indarbela spp is polyphagous pest infesting several trees. The infestation is generally observed in unrleaned and older orchards. The Peculiarity of this pest is that it feeds on the bark of the tree living consealed life in webs. So the trees having thin bark is more suseptible to the attack of caterpillar than hard bark. Its extensive feeding affects the vitality of the plants. It also reduses the bearing capasity. In case of severe infestation the cell sap flow may disturbed resulting into dryingup of branches even the whole tree may die.

Many scientist worked for the chemical contral of Indarbela spp by using various chemicals and also studied the efficacy of the different insecticides. They also suggested the most effective, economical and easily available insecticides for conrolling the pest. In this chapter the results obtained in the present investigation are discussed under following sub heads.

5.1 Survey on the incidence of Indarbela spp

In present investigations the five catagaries of host trees are surveyed at two different places viz, survey for avenue trees, forest trees, fruit trees, garden trees and medicinal trees.

The survey was taken at Marathwada Agricultural University campus, Parbhani and Dnyaneshwar garden, Paithan.The observations were recorded on the height of the plant, no. of holes per tree, area fed by the caterpillar, intensity of attak, type and thickness of the bark and general condition of the plant at the time of obervations.

The results obtained in the persent investigation are discussed under the following sub heads.

5.1.1 Survey for infestation of Indarbela spp on avenue trees.

5.1.2 Survey for infestation of Indarbela spp on forest trees.

5.1.3 Survey for infestation of Indarbela spp on fruit trees.

5.1.4 Survey for infestation of Indarbela spp on garden trees.

5.1.5 Survey for infestation of Indarbela spp on Medicinal trees.

The experimental findings are further discussed under following subheads.

5.1.1 Survey for infestation of *Indarbela* spp on avenue trees.

In this category six species of avenue trees were surveyed for the infestation of bark cating caterpillar. Out of these six trees only peltophorum was found to be severely attacked by the pest. Sixty per cent of peltophorum trees were observed under the infestation of the pest. The infestation has ranged from severe to mild with an average 3.30 number of holes per tree. The average length of area fed by the caterpillar was 0.9 m. The thickness of the bark was 0.3 cm.(table 2).

Though various workers have reported different avenue trees as the host for this pest, Gold mohar, *Delonix regia* (Patel *et al.*,1964, Verma *et al.*, 1974); Banyan tree, *Ficus bengalensis* (Verma *et al.*,1974); Ashoka *Polyalthia longifolia* (Ayyar, 1940 ; Verma and Khurana, 1974), however, in present survey the above trees were found to be free from infestation of bark eating caterpillar.

The Neem trees and Cork trees were also found to be free of infectation as the bark of these trees were hard and these trees were not

the host of the pest. Earliar workers also not reported these trees as a host of bark eating catepillar.

5.1.2 Survey for infestation of Indarbela spp on forest trees

Eleven types of forest trees were surveyed for the infestation of bark eating caterpillar. (Table 3) Out of these trees eight types of trees were found to be attacked by the pest. The percentage of infestation of these trees are given as follows.

Mahogany, Swietenia Mahagonia (30%);
Ranbhendi, Thespesia Populnea (25%);
Australian babul, Acacia nilotica (80%);
Rudraksha, Elaeocarpus ganitrus (70%);
Bauhinia tree, Bauhinia Variegata (50%);
Tasar, Terminalia spp (90%);
Vilayati imli, pithecolobium dulce (80%);
Sisso, Dalbergia Sisso (60%).

The infestation was not found on Pipri, Ficus spp; Pangara, Erythrina variegata and Bauhinia purpurea i.e. Bauhinia tree.

The infestation on Mahogany, Swietenia Mahagonia tree was mild . The average number of holes found per tree was 1.3. The average length of area fed by pest was 0.18 m. The thickness of bark was 0.2 cm.

The infestation found on Ranbhendi, Thespesia populnea tree was also mild. The average number of holes pe tree was 2.4 and the average length of area fed by caterpillar was 0.23 m. The thickness of bark was 0.3 cm.

The infestation on the Asutralian babul, Acacia nilotica was mild. The average number of holes per tree was 2.6 . The average length of area fed by caterpillar was 0.37 m. and the thickness of bark was 0.18 cm. Verma and Khurana (1974) reported that Australian babul as the host plant of Indarbela spp.

The infestation on Rudraxha tree, Elaeocarpus ganitrus was mild. The average number of holes per tree was 2.9. The average length of area fed by caterpillar was 0.28 m and the thickness of bark was 0.28 cm.

Bauhinia tree, Bauhinia variegata was also infested by the caterpillar . The intensity of attak was mild with an average holes per tree was 1.7 and the average length of area fed by caterpillar was 0.09m. The thickness of bark was 0.24 cm. Verma (1985)found that the Bauhinia variegata Linn. trees was severy infested by the caterpillar.

Sontaky (1945) reported that Terminalia arjuna as the host of Indarbela spp. the

infestation was severe to mild and the condition of the plant was unlealthy . The average number of holes per tree was 3.5 with an average length of area fed was 0.67 m. The type of bark was soft with 0.10 cm.of thickness of bark.

The infestation found on vilayati imli, Pithecolobium dulce was mild . The average number of holes per tree was 3.7. The average length of area fed by catespillar was 1.10m . The type of bark was hard with 0.22 cm. thickness.

Verma and Khurana (1974) found that Indarbela quadrinatata Wlk.on Sisso tree. The infestation on the Sisso trees, Dalbergia Sisso was found to he mild. The average number of holes per tree was 1.65 . The average length of area fed by caterpillar was 1.13 m. The bark was hard with thickness of 0.36 cm.

5.1.3 Survey for infestation of Indarbela spp on fruit trees.

In this category , seven types of fruit trees were surveyed for the infestation of bark eating caterpillar. All the fruit trees selected for the survey were found to be attacked by the pest.

The infestation on Guava, Psidium guajava was severe to mild. Lefroy and Hawlett (1909); and Issac (1931) reported that the Guava

was a host of the Indarbela spp. The aaverage holes of these Guava trees were observed as 7.2 and the avrage length of area fed by caterpillar was, 2.11 m the thickness of bark was 0.15 cm.

Bindra (1957) and Verma et al., (1974) found the bark borer damaging to the guava trees. Siddiqui and Pandly (1976) and Sandhu and Khangura (1979) reported the serious infestation of Indarbela quadrinotata Wlk. on Guava trees.

The infestation on citrus trees, Citrus sinensis was severe to mild with an average holes per tree was 8.6. The average length of area fed by caterpillar was 1.27m. the thickness of bark was 0.18 cm. The earliar workers viz. Lafroy and Hawlett (1909); Fletcher (1921); Sontakay(1945); Bindra (1957); Verma et al. (1974) reported that the citrus is the host plant of bark eating caterpillar.

The infestation on Tamarind, Tamarindus indica was mild. The average number of holes per tree was 2.5 and the length of area fed by caterpillar was 0.78 m. The thirkness of bark was 0.58 cm. Tamarind was not reported by any earliar worker as the host of Indarbela spp.

Bindra (1957) and verma et al (1974) reported that the jamun as a host of Indarbela quadrinotata. The infestation on Jamun Syzygium cumini was mild. The average number of holes per

tree was 0.2 and the average length of area fed by caterpillar was 0.05 m. The thickness of bark was 0.15 cm.

Infestation on Custard apple was mild. Earliar workers had not reported the Custard apple as a host of Indarbela spp. The average number of holes per tree was 0.3 and the average length of area fed by caterpillar was 0.15 m. The thickness of bark was 0.20 cm.

The infestation on Mango, Mangifera indica was mild. The average number of holes per tree was 0.30 and the average length of area fed by caterpillar was 0.32 m. The thickness of bark was 0.85 cm.

The infestation was not observed on Sapota in the present survey. However, the earlier workers reported Sapota as the host of the bark eating caterpillar.

5.1.4. Survey for infestation of Indarbela spp. on garden trees

Two garden trees were surveyed for the infestation of Indarbela spp. viz. Casuarina equisetifolia. i.e. casuarina tree and Callistemon lanceolatus, bottle brush. Out of these two types of trees surveyed only Casuarina tree was found to be infested with an average holes per tree was 2.8 and the length of area fed by

capterpillar was 1.78 m. The intensity of attack was severe. The thickness of bark was 0.35 cm. Ayyar (1940) reported that casuarina tree as the host of bark eating caterpillars.

The Bottle brush tree *callistemon lanceolatus* was observed free from infestation and none of the earlier workers had reported it as the host of bark borer.

5.1.5 Survey for infestation of *Indarbela* spp on medicinal trees

Two different types of medicinal trees were surveyed for infestation of *Indarbela* spp. Both the trees were infested by the pest. Aonla, *Embilica officinalis* and Nilgiri, *Eucalyptus globulus*. Aonla was mildly attacked by the pest with an average no. of holes per tree 0.4. The average length of area fed by caterpillar was 0.13 m. and the thickness of bark was 0.30 cm. Fletcher (1921) recorded bark borer causing damage to the *Embilica officinalis*.

The infestation on *Eucalyptus globulus* was severe to mild with average number of holes per tree was 1.14 and the average length of area fed by caterpillar was 0.75 m. The thickness of bark was 0,25 m. Verma *et al* (1974) also reported safeda trees, *Eucalyptus citriodara* as host of this pest.

5.2 Chemical control of Indarbela spp

Indarbela spp. larvae is a polyphagous pest infesting several trees. It remains conceaded in webs and retreats into the hole at the slightest disturbance. It has nocturnal habit of feeding so it is very difficult to control this pest. However, the present experiments were conducted to find out the most efficient method of controlling the bark eating caterpillar. Experiments were conducted on two different hosts, guava and sweet orange with seven different insecticides at various concentrations on experimental farm of Horticulture Department, M.A.U. Parbhani.

The details of experimental findings are discussed as follows.

5.2.1 Chemical control of Indarbela spp infesting guava trees.

Out of seven insecticides tested, the fumigants were most effective agent for controlling the bark borer at tunneling stage.

Chloroform (L.R.) @ 3ml/hole was the most effective treatment giving hundred per cent reduction within 3 days of application. Petrol treatment found to be effective next to the chloroform , it gave 97.24 per cent reduction followed by Phorate 10 G with 95.83 per cent

reduction after 3 days of application. Patel et al (1964) found that injection of stem borer solution (2 parts of carbon disulphide + 1 part of chloroform + 1 part of cresote oil) into the bore holes @ 5 cc. per hole gave ninety per cent mortality of the pest after a week.

Patil, et al. (1990) found that treating the holes with Petrol 10 ml per hole gave 96.7 per cent control after 7 days of application.

Next to the fumigants, the effective insecticides after 3 days of application were found to be Endosulfan 0.05 per cent, Dichlorvos 0.05 per cent Cypermethrin 0.01 per cent and Monocrotophos 0.05 per cent. Corresponding figures for per cent reduction were 86.25 per cent, 85.63 per cent, 79.55 per rent and 79.51 per cent, respectively.

Verma, et al. (1972) observed that insertion of cotton lint dipped in Dichlorvos 0.025 per rent gave 90 per cent mortality after 15 days of application.

The experimental findings after 7 days of insecticides were similar as that of 3 days of application with slight change in the effectiveness of insecticides. viz. Phorate 10 G which has increased to 98.61 per cent reduction.

Patel, et al. (1964) found that injection of Petrol into the live hole @ 5 cc. per hole gave

better control after a week period recording 95 per cent mortality.

Ambekar, et al. (1981) found that application of Monocrotophos 50 per cent E.C. was the most promising for control of Indarbela quadrinotata followed by E.C. 50 per cent Fenitrothion, 100 per cent Dichlorvos and 35 per cent Bromophos with 2-15 days after application.

Verma et al. (1972) found that Endosulfan 0.1 per cent gave 75 per cent mortality after 15 days of application.

Singh et al. (1988) found that application of Petrol and Kerosene at 100 per cent to the borer holes afforded 95.54 per cent and 73.55 per cent control, respectively.

Teli et al. (1983) revealed that application of monocrotophos 40 cc. gave 93.33 per cent kill after 15 days of application.

The experimental findings after 15 and 30 days showed that the insecticidal treatment differ with slight changes in effectiveness of the insecticide.

It was evident from the results that fumigants had given effective control of the pest within short period. The fumigants gave 100 per cent reduction i.e. chloroform at 3 days, petrol at 15 days and phorate 10 G at 30 days of application.

Other insecticides were also equally effective up to 15 to 30 days after application viz. Endosulfan 0.05 per cent, Dichlorvos 0.05 per cent, Monocrotophos 0.05 per cent and Cypermethrin 0.01 per cent gave 95.10, 94.51, 93.03 and 91.26 per cent control, respectively after 15 days.

At 30 days of application all most all insecticides achieved similar effect as that of fumigants in controlling the Indarbela spp with slight difference in values for per cent reduction from 95.66 to 97.65 per cent.

From above discussion , it is revealed that after fumigants, Endosulfan 0.05 per cent was most effective followed by Dichlorvos 0.05 per cent Monocrotophos 0.05 per cent and Cypermethrin 0 01 per cent.

5.2.3 Chemical control of Indarbela spp infesting sweet orange trees.

The similar experiment was carried out on Sweet orange trees by using seven insectirides with one control and the concentration used was also the same.

After 3 days of insecticidal application Petrol gave the highest redurtion in pest (95.37 per cent) followed by Chloroform (L.R.) 95.13 per cent, Phorate 10 G (92.89 per cent), Monocrotophos

0.05 per cent (87.56 per cent), Dichlorovos 0.05 per cent (82.46 per cent) and Endosulfan 0.05 per cent (67.41 per cent).

Verma, et al. (1972, 1974) got effective control of bark eating caterpillar by injecting 5 ml of Dichlorvos 0.0125 per cent into the borer holes. It gave 100 per cent kill after 4 days of application.

Sandhu, et al. (1978) found that 90 per cent of control after 3 days of application of 0.05 per cent permithrin or 0.05 per cent Monocrotophos by wash bottles. All the fumigants were also effective at 7 days of insecticides followed by Cypermethrin 0.01 (94.20 per cent), Monocrotophos 0.05 (92.14 per cent), Dichlorvos 0.05 per rent(87.52 per rent) and Endosulfan 0.05 per cent (77.70 per cent).

It was also observed that all the treatements did not differ in their effectiveness except Endosulfan @ 0.05 per cent after 15 and 30 days of application. The treatment Endosulfan 0.05 per cent recorded 96.66 per cent and 97.33 per cent at 15 and 30 days, respectivelly.

Verma, et al, (1985) found that, injecting the tunnels with 10 ml of Endosulfan @ 0.05 per cent gave 90 per cent mortality after 25 to 40 days of application.

The fumigants were effective for controlling the pest within 7 days of application but rest of the insecticides also gave better results after 15 and 30 days. Almost similar trend of results were also reported by earliar workers.

Summary

VI SUMMARY

The bark eating caterpillar, Indarbela spp is a polyphagous pest. It has many host plants viz. avenue trees, fruit trees, forest trees, road side trees, ornamental bushes and garden trees. The larvae is nocturnal in feeding habit. It lives concealed life in webs. The webs are brownish silkan strands in which pieces of bark and excretal pallets are entrapped. It remains in tunnels during rest and feeds on bark. The extensive feeding results into drying up of branches. The bearing capasity of the fruit trees are also reduced.

The present experiment was carried out on two aspects.

6.1 Survey on the incidence of Indarbela spp.

The present survey was carried out at two different places. viz. Marathwada Agricultural University campus, Parbhani and Dnyaneshwar garden, Paithan, Dist. Aurangabad. The observations were recorded on avenue trees, fruit trees, forest trees, garden trees and medicinal trees. Observations were recorded on percentage of trees afferted, height of first hole from ground level, number of holes length of area fed, type of bark,

thickness of bark, intensity of attack and general condition of the plants at the time of observations.

Six types of avenue trees were selected for the survey. Amongst them, only peltophorum (Peltophorum pterocarpum) was found to be attacked by the pest. 60 per cent of the trees were infested by the pest.

Eleven types of forest trees were observed for infestation by the pest. Out of which only eight types of trees were infested. The percentage of infestation is given in bracket.

Mahagani, Swetenia mahagonia (30 per cent);

Ranbhendi, Thespesia populnia (25 per cent);

Australian babul, Acacia nilotica(80 per cent);

Rudraksha, Eleocorpus ganitrus (70 per cent);

Bauhinia tree, Bauhinia veriegata (50 percent);

Tasar, Terminalia spp (90 per cent);Vilayati imli, Pithecolobium dulce (80 percent); Sisso, Dalbergia sisso (60 per cent). The pangara Erytrina variegata; pipri, Ficus spp and bauhinia tree, Bauhinia purpurea was found to be free from infestation of pest.

Five types of fruit trees were surveyed for infestation. Out of which infestation on Guava, Psidium guajava (100 per cent); Sweet orange,Citrus sinensis (100 per cent); Jamun, Syzygium cumini (20 per cent); Custard apple, Annona squamosa (30

per cent) and Mango, Mangifera indica (30 per rent) were infested by the host.

The sapota, Achras zapota was found to be free from infestation.

Two types of garden trees were observd Casuarina, Casuarina equisetifolia was severly infested with 80 per cent infestation, Bottle brush, Calistemon lanceolatus was free form infestation.

Two medicinal trees viz. Aonla, Embilica officinalis and Nilgiri, Eucalyptus globulus were also observed. About 40 per cent and 80 per rent infestation was on Aonla and Nilgiri tree, respectively.

6.2 Chemical control of Indarbela spp.

The expermients for chemical control of Indarbela spp were conducted on two hosts viz. Guava and Sweet orange trees.

Seven insecticides were used to control the bark eating caterpillar on guava. Out of which three fumigants viz. Chloroform (L.R.) @ 3 ml/hole, Petrol @ 3 ml/hole and Phorate 10 G @ 1.5 gm/hole were poured into the tunnels and sealed with mud. The four chemicals viz. Dichlorvos 0.05 per rent, Cypermethrin 0.01 per cent, Endosulfan 0.05 per cent and Monocrotophos 0.05 per cent @ 3ml/hole were used. It was observed that, the fumigants were most effective but their method of application was difficult.

Dichlorvos 0.05 per cent and Endosulfan 0.05 per cent has also given better results within 7 days of application.

The same insecticides were tested on sweet orange for the control of bark eating caterpillar . The concentration used was also same. It was observed that the fumigants were most effective chemicals within short period after application. It was also observed that chloroform (L.R.) gave 100 per cent control within 3 days after application, Petrol gave 100 per cent control within 7 days after application and Phorate 10 G gave 100 per cent control within 15 days after application of insecticides. Besides this, Monocrotophos 0.05 per cent, Cypermethrin 0.01 per cent and Dichlorvos 0.05 per cent gave effective control after 15 days of application of insecticides.

From the experimental findings, results are summerised as follows.

It was observed from summary that the pest attarked eighteen species out of twenty eight species of trees observed.

It was revealed from experiments on chemical control of the pest that petrol treatment was most effective as compared to other fumigants.

It was also easily available, easy for handling and economical, but method of application was cumbersome.

After fumigants Dichlorvos 0.05 per cent and Cypermethrin gave effective control than Endosulfan and Monocrotophos 0.05 per cent for controlling the pest infesting sweet orange trees, where as Dichlorvos and Endosulfan was effective than Monocrotophos and Cypermethrin for controlling the pest infesting guava trees.

Literature Cited

LITERATURE CITED

Anonymus,(1955) Fruit tree borer (Cyptophase unipunctata) Agric. Gaz. N.S.W. 66 (1) :37.

Ambekar, J.S. ; Teli, V S and Chandele, A.G. (1981) Effectiveness of different insecticides against bark eating caterpillar,Indarbela quadrinotata(walker) infesting guava. Pestology, 5 (11): 15-16

Ayyar, T.V.R. (1940) Hand book of economic Entomology for south India. Supdt Govt. press, Madras pp. 283 :337.

Bindra, O.S. (1957) Insect post of citrus and their control. Indian J. Hort., 14 (2) : 89-98.

Butani ,D.K. (1978) Insect pests of fruit crops and their control: 21. Pomegranate. Pesticides, 10 (6) :23-26.

Braithwaite, J D. (1941) Entomological Research Report Silv. Ent. Burma, pp : 99 113

Cherian, M. C. (1942) Our present position with regard to the control of fruit pests. Madras Agric. J., 30 : 14--17.

Das, S.C.; Kakoty,N.N. and Goswami, N.G. (1985) Note on the biology and control of bark eating caterpillar, Indarbela quadrinotata wlk. a pest of shade trees in North east India. Two and a Bud. 32 (1-2). 40-41.

Davi[illegible], B.V (1963) Feeding habit of Indarbela tetraonis. Madras Agric. J., 50.195-199.

Davi[illegible], B.V., Vijayraghvan, S. and Narayanswamy, P.S. (1963) Indarbela tetraonis. Moore-a new bark borer pest of curry leaf tree and its control Madras Agric. J., 50:195-199.

Dohatey, K.L. and Butani, D.K. (1985) Newer Approches in the management of citrus pests Pesticides; 19 (4) : 38-40.

Fletcher, T.B. (1921) Annottated list of Indian crop pest. Bull. Agric. Res-Inst. Pusa. 100.1-246.

Isse[illegible], P.V (1931) Indarbela tetraonis Moore on mango and quava in India. Report of the Imperical Entomologist., Sci. Rep.Imp. Inst. Agric. Res., Pusa, 1929-30, pp72-79.

Khurana, A.P. and Verma, A.N. (1976) Some avenue trees as new hosts of Indarbela spp (Lepidopter: Metarbelidae), J. Res. Haryana Agric. Univ., 6 (1) :78-79.

Lal, H and Singh, Y.P. (1982) Incidence of bark eating caterpillar on different loquat (Eriobotrya japonica Lindl.) cultivars. Sci. and Culture; 48(3): 98-100.

Lefr[illegible], H.M. (1909) Indian Insect life. Thacker, and Spink Co., Calcutta. 786 pp. (reprinted in 1971 by Today and Tomorrow, Printers and Publishers, New Delhi).

Lefroy, H.M and Hawlett, H.M. (1909) Indian Insect life. Thacker, Spink and co , Calcutta. 786 pp. (Reprinted in 1971 by Today and Tomorrow printers and publishers, New Delhi)

Mann,G.S. and Bindra, O.S.(1977) Field Screening of different jujubae cultivars against the bark eating caterpillar. Indian J. Hort. 34 (1) : 313-315.

Mann,G.S. and Bindra, O.S. (1978) Incidence of bark eating caterpillar on different guava cultivars in Punjab. Punjab Hort. J., 18 : 97-98.

Noor, A and Kushwaha, K.S. (1976) Epidemic of bark eating caterpillar Indarbela quadrinotata wlk. and its control at Udaipur. All India Symposium In Modern concepts In plant Protection, March 26-28. Abstract on pp. 29-30.

Patel, V.C., Patel,H.K. and Patel,R.C.(1964) Effect of various recent insecticides on the bark boier(Indarbela spp.) of road side trees of Gujrat Indian J. Ent., 26(1): 103-106.

Patel, V.C., Patel,H.K. and Patel,R.C.(1964) Effect of various recent insecticides on the bark boier Indarbela spp of road side trees in Gujrat. Indian J. Ent., 26(1): 103-106.

Patil.V C., Patil,V.K. and Deshpande, A.D.(1990) Incidence and control of bark eating caterpillar, Indarbela spp on guava trees. J. Maharashtra Agric. Univ.,15 (2): 230.

Ramachandran, S. (1954) Insect pests of oranges in the Madras State. Madras Agric. Department, Madras. pp.16.

Ray A.S. (1943) Report of the Entomologist 1942-43. Rep. Tea Scient . Dep. Lin. Pirs. Ass. Stn.India, 1942-43 : pp 10-15.

Remadevi, O.K. (1989) Indarbela quadrinotata (walker) attacks mulbery too. News letter vent. Seri. Res. and training. Inst, Mysore.

Sandhu, G.S., and Khangura, J.S. (1976) Chemical control of bark eating caterpillar on guava in Punjab. Paper presented in All India Fruit Work Shop held at Hyderabad, May , 24-28.

Sandhu,G.S. Sohi,A.S. and Batra, R.C. (1978) Evaluation of different methods for the control of Indarbela quadrinotata wlk. on citrus in the Punjab. Indian J. Ent., 40 (3) : 280-284.

Sandhu, G.S., and Khangura, J.S. (1979) . Chemical control of bark eating caterpillar on guava in Punjab. Pesticides., 13 (8) . 32-34.

Sandhu, G S , Sohi, A.S. and Batra, R.C.(1979) ield preference of bark eating caterpillar,

Indarbela quadrinotata on Citrus and Guava cultivars. Indian J. Ent., 41 (3) 274-276.

Sandhu,G.S., Sohi,A.S. and Batra,R.C. (1987) Comparison of different control methods for the management of bark eating caterpillar, Indarbela quadrinotata Walker (Metarbelidae: Lepidoptera) infesting fruit and avenue trees in Punjab. Indian J. Ent., 27 (3-4): 255-259.

Sharma, D.D. and Kumar, H. (1986) How to control bark eating caterpillar. Indian Hort., 31 (1):25.

Shewale, B.S. (1991) Control of bark eating caterpillar, Indarbela quadrinotata (walke) in Pomegranate through insecticidal sprays. Plant prot. Bull. 4 :31-32.

Siddiqui.M.S. and Pandey,R.K.(1976) Efficacy of different methods of application of endrin20 EC for the control of bark eating caerpillar, Indarbela quadrinotata Wlk. Indian J. Agric. Sci., 46 (M) : 601-603.

Singh,J.P (1970) Pests of guava and their contro. Lebdev J. Sci. and Tech. B-8 : [illegible] 24

Singh,K., Sharma, V.K. and Shant, P.S. (1988) Efficacy of insecticide soaked cotton plugs against caterpillar of Indarbela sp infesting guava trees. Pesticides., 22 (9): 19-20.

Sontakay, K R (1945) The bark eating borer of orange. Indian fmg., 6 (2) : 74-75.

Shivastava, A.S. and Siddiqui, M.S. (1962) A preliminary study of bionomics and control of Indarbela quadrinotata Wlk. Proc. Acad. Sci. India., B; 32(3): 265-270.

Srivastava,O.S.(1972) Chemical control of bark eating caterpillar, Indarbela quadrinotata wlk. in guava trees Indian J. Agric. Sci. ; 45(9): 847-848.

Tell,V.S., Ambekar, J.S. and Chandele, A.G. (1981) Efficasy of different insecticides to control bark eating caterpillar, Pesticides; 15(8):35-36.

Tell V.S., Ambekar, J.S. and Chandele, A.G. (1983) Chemical control of bark eating caterpillr, Indarbela quadrinotata Wlk. in cashewnut; Pesticides; 17 (6) :20-21.

Verma, A.N., Khurana, A.D., Singh, R. and Bhanot, J.P. (1972) Control of bark eating caterpillar, Indarbela quadrinotata Wlk. with insecticide soaked cotton plugs. Haryana J. Hort. Sci 1 (1 4) : 79 82.

Verma, A.N. and Khurana, A.D. (1974) Further new host records of Indarbela spp Haryana Agric. Univ.J. Res., 4 (3) : 253-254.

Verma, A.N., Khurana, A.D. and Singh , R. (1974) Chemical control of bark eating caterpillar, Indarbela quadrinotata Wlk. infesting Pomegranate Indian J. Ent., 36 (4) : 297-301

Verma, A.N. and Singh, R. (1975) Chemical control of bark eating caterpillar Indarbela quadrinotata Wlk. by painting the bark with insecticides Haryana J. Hort. Sci., 4 (3 and 4) : 145-149.

Verma, A.N. and Khurana, A.D. (1976) Survey on the incidence of bark eating caterpillar, Indarbela spp. on different fruit tree sap in Haryana. Haryana Agric. Univ. J. Res., 6(2): 93-104.

Verma, A.N. and Khurana, A.D. (1977) Intensity of attack of Indarbela quadrinotata Walker. Indian J. Agric. Sci., 55(2):131-132.

Verma, I.D. (1985) Incidence and chemical control of bark eating caterpillar, Indarbela quadrinotata Wlk. on plum trees. Indian . Agric. Sci., 55 (2):131-132.

Wadhi, S.I. and Batra, H.N. (1964) Pests of tropical food trees. In. N. C. Pant. (ed). Entomology in India. The Entomological Society of India.

ABBREVATIONS USED

@	At the rate of
BHC	Benzene Hexachloride
C.C.	Cubic centimeter
C.D.	Critical difference
Cm	Centimeter
CS_2	Carbon bisulphide
DDT	Dichloro diphenyl trichloro ethane
E.C.	Emulsifiable concentrate
ED/CT	Ethylene dibromide Carbon tetrachloride
et al.	And others
G	Grannules
g	Gram
i.e.	That is
L.R.	Laboratory Reagent
ml	Milli litre
S.C.	Soluble concentrate
S.E.	Standard error
Viz.	Namely