FINAL REPORT

NATURAL INSECTICIDES FOR *SPODOPTERA LITURA* FABR.

A RESEARCH PROJECT
USAID/PSTC PROGRAM
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SUBMITTED BY

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BACKGROUND

S. litura Fabr is a widespread insect pest. It is polyphagous and regarded as one of the most damaging pests in the world agriculture Pandy and Srivastava (1967) reported that the insect attacks 112 specie of cultivated crops all over the world. In Thailand, at least 30 varieties of plants are found to be host plants of this insect[1]. These include vegetables, floral plants, ornamental plants, economic field crops and weeds.

The time required for egg, larval and pupal development are 2-3, 14 and 7-8 days respectively[2]. The adult longevity is 8-10 days in the male and 10-12 days in the female. The larva molts 5 times. It is at this stage that the insect is most damaging. Since the early larval instars are quite vulnerable to external damage, it has been chosen as the target organism for this work.

For self-defence, it is not surprising that plants would contain substances which are insect antifeedants, insect repellents and insecticides. Some naturally occurring antifeedants which have been published are: glycosides of steroidal alkaloids, demissine[3], solacauline[4], tomatine[5], leptines I and II[6], ring A enone and/or ring D aromatic steroids, the nicandrenones and other[7,8,9,10]; juglone (5-hydroxynaphthoquinone)[10]; the isoquinoline alkaloid isoboldine[11], phenylpropanoids[12], germacranes sesquiterpenes shiromodiol and shiromol[13,14]; *ent*-clerodane and clerodane diterpenes, clerodendrin[15]; caryoptin and others[16]; the hydroxylated steroid meliantriol[17]; azadirachtin[18]; xylomolin[19]; ajugarins[20]; harrisonin[21]; polygodial ugandensidial and warburganal[22]; inflexin[23]; and isodomedin[24]; crotepoxide[24] and unedoside[25]. However there is no report of any of these substances being used effectively in agriculture.

A number of naturally occurring compounds have been found to exhibit insecticidal activity. These include alkaloids, terpenoids, phenolics, amines, chromenes, prenylated quinones and sesquiterpenes esterified with phenolic acids[26]. Commercially, the substances which have found their way to agricultural application are nicotine, derris, pyrethrum and the newer product, ryania[27]. Crude extracts of the plant producing these substances, or dried and powdered plant tissue have a long history of use in SE Asia as insecticides. However, none of these natural products is a universal insecticide : Tobacco leaf containing nicotine is subject to attack by several insects, the root of derris-containing plant is attacked by the larvae of a species of beetle, the flower from which pyrethrins are extracted needs synthetic insecticides for protection from insects in the fields. In addition, insects can develop resistance to a certain chemicals after a long exposure. New and better insecticides will, therefore, have to be constantly sought.

Since *S. litura* is one of the major pests in SE Asia, the discovery of a new and more effective insecticide with low mammalian toxicity from local plants would produce enormous benefit to the region as well as to Thailand in general.

OBJECTIVES

1. To isolate and identify natural insecticides and antifeedants, which have low mammalian toxicity for *S. litura*.
2. Extract or synthesizing those compounds on a practical scale and design of industrial extraction procedure.
3. Evaluation of their applicability in the field.

MATERIALS AND METHODS

Plants investigated were collected in the southern region of Thailand. Samples were classified taxonomically and vouchers were deposited in the herbarium in the Department of Biology, Prince of Songkla University.

Ground plant materials were steam distilled or exhaustively extracted with solvents. The extracts/steam distillates were screened for insecticidal and antifeedant activity with *S. litura* and the active extracts resolved into fractions. Each fraction was screened for activity and the active fraction, again, separated into individual constituents using quick column and preparative layer chromatography on silica gel.

Each of the individual components was tested again for activity and the LC_{50} value of the active compound determined. The structure of the compound was elucidated using spectroscopic techniques.

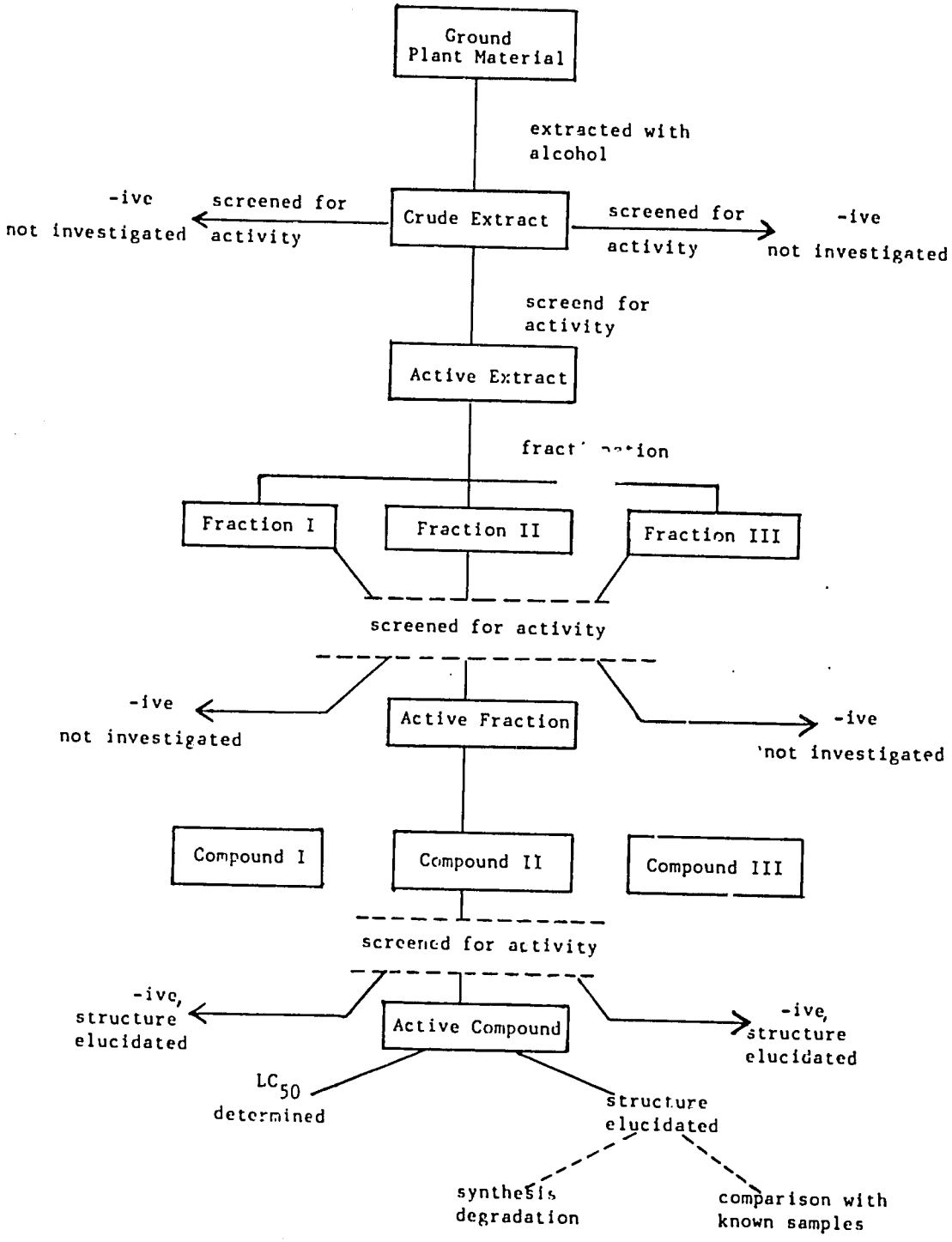


Diagram showing work plan

The leaf dipping (LD) method was used for the detection of stomach poisoning and antifeeding activity, the third instars of *Spodoptera litura* larvae were left to feed on the leaves of *Vigna radiata* which had been immersed in the tested solution then air-dried. Ten larvae were used in each of the four replications (one as control). The number of dead organisms was recorded at the end of each day. The amount of the leaf consumption and the larvae size ware also estimated.

The topical application (TA) method was used for the detection of dermal toxicity, the tested solution was dropped on the thorax of the third instar larvae. The organisms were then left to feed on untreated leaves of *Vigna radiata* in a plastic container. Ten larvae were used in each of the four replications (one as control). The number of dead organisms was recorded at the end of each day.

The LD coupled with TA method was used for the detection of the combined effect of stomach poisoning and dermal toxicity. The tested solution was dropped on the thorax of the third instar larvae. The organisms were then left to feed on the leaves of *Vigna radiata* which had been immersed in the same tested solution then air-dried. Ten larvae were used in each of the four replications (one as control). The number of dead organisms was recorded at the end of each day.

RESULTS AND DISCUSSIONS

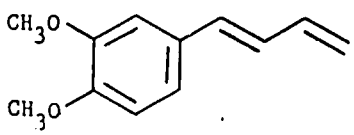
The workplan for this investigation was of three stages. Firstly, plants which are reputed to have insecticidal and antifeeding property were collected and screened for their activity. Secondly, the promising plant species were investigated for their active ingredients and the activity of these ingredients measured. Thirdly, field tests were carried on the appropriate formulations derived from the 'best' extracts/substances.

Over 150 plant species were collected and classified. Herbarium specimens were deposited either at the Prince of Songkla University Herbarium or Chiang Mai's Faculty of Pharmacy Herbarium. They were extracted either with alcohol to give crude alcoholic extracts or with a series of solvent with increasing polarity e.g. hexane, dichloromethane, methanol. The screening results of these extracts are recorded in Tables in the progressive reports. The investigation further carried out on the interesting species are now summarized.

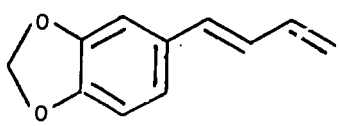
Zingiber Purpureum

Systematic screening indicated that the active ingredients are a series of non-polar compounds which are steam volatile. Attempt to identify these compounds in the steam distillate from this plant revealed that they are a mixture of phenylbutanoids, in agreement with previous report.[28, 29] The most active component appeared to be 4(3', 4'-dimethoxyphenyl) but -1, 3 diene(1). The compound was then synthesized, using the method previously described[29], and then tested. LC_{50} for this compound was found to be 1.27% (48 hr), 0.52% (72 hr), 0.40% (96 hr), 0.24 (120 hr).

In the study on the activity of pyrethrins, it was found that compounds containing a methylenedioxyphenyl group can act as synergists for the pyrethrins[30]. The compound 4-(3', 4'-methylenedioxyphenyl) but -1, 3-diene (2) was then synthesized, from sesamol with the same reaction scheme, and tested for activity, both alone and in combination with compound (1) While no synergism was observed, the activity of compound (2) was found to be higher than that of (1). LC_{50} of the compound was found to be 0.45% (48 hr), 0.23% (72 hr), 0.20% (96 hr), 0.18% (120 hr); and the LD_{50} value was 3.04 μg/insect (24 hr) in the TA test. (see detail in Progressive Report no. 1).



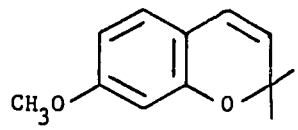
(1)



(2)

Ageratum conyzoides

The steam distillate of this common weeds was found to be the active fraction. Isolation of the active substances gave precocene I (3) and precocene II (4), which were previously found to be antijuvenile hormones of considerable interest.[31] The LC_{50} (TD) for the crude steam distillates, precocene I and precocene II are shown below:



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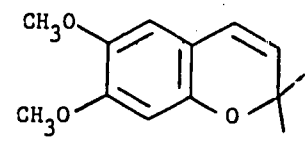
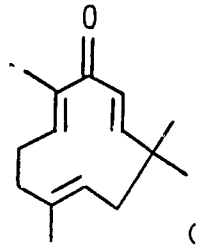


(4)

	% LC_{50} (TD)		
	48 hr	72 hr	96 hr
Distillate	0.83	0.37	0.29
Precocene I	0.66	0.29	0.11
Precocene II	0.84	0.71	0.35

Zingiber zerumbet

The active ingredients in the rhizomes of this common Zingiberraceous plant was found to be steam volatile and zerumbone (5) was isolated as the most active component in the mixture. The LD_{50} was found to be 527 µg/insect (24 hr) in the TA test.



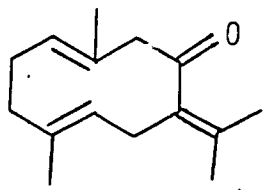
(5)

Field trial was carried out with various formulation derived from *Z. zerumbet* rhizome. The results, however, were not sufficiently satisfactory.

'Kaidum'

This plant species is used in Thai medicine. The specimen investigated was obtained from the Bangkok's Wat Mahadhat herbal market. Up to the time of this report, flowering has not occurred from the plant cultivated from the purchased rhizomes. The identity was therefore uncertain, although it was believed to be a member in the Zingiberraceous family, known to the Thais as 'Kaidum'.

Test results showed that the steam distillates from the rhizomes contained the activity. The active principle isolated was identified as germacrone (6) and the LD_{50} value was similar to that of zerumbone.

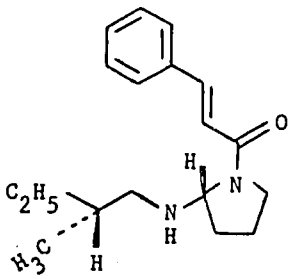


(6)

Aglaia odorata

Five species of *Aglaia*: *A. odorata*, *A. odoratissima*, *A. argentea*, *A. kunstlerii* and *A. squamulosa* were extensively tested for activity and the best antifeeding result was obtained from *A. odorata*.

From an active fraction, odorine (7) was isolated. This compound was, however, later found to be inactive. Further attempt resulted in an active substance which appeared to be one component on thin layer chromatography. This substance, from its spectroscopic evidences, was identified as scopoletin (8).



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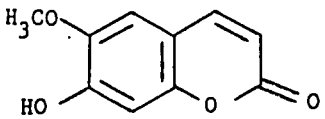
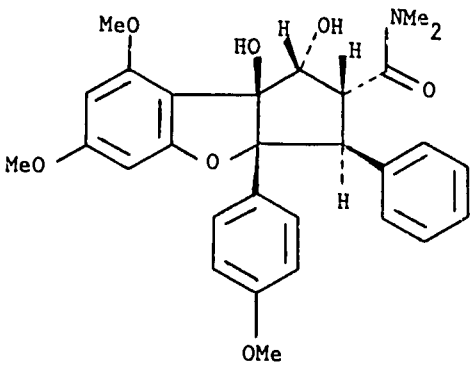


(8)

Small field trials was conducted on *Vigna radiata* with the methanolic extract and the aqueous extract of *A. odorata*, from which satisfactory levels of control, 81.3% and 75.5% respectively, were obtained. Similar experiments on broccoli also gave satisfactory results. Trial on broccoli in farmer plots, however, yielded less satisfactory results. This was attributed to the inefficient method of spraying the formulations which did not reach the 'under' side of plant leaves where the insect larvae usually hide. It is believed that if a better spraying equipment which will deposit the formulation evenly on the plant leave, this could be a formulation of choice for the control of *Spodoptera litura*. (see detail on Progressive Report No. 4)

Upon repeating the tests on scopoletin in order to obtain an LC_{50} value, it was found that an authentic sample of scopoletin did not give any activity. It was then understood that the sample of scopoletin previously tested must contain a very small amount of other component which was a very active antifeedant. After several attempts, a very small amount of this substance was isolated. Spectroscopic evidences showed that this compound was rocaglamide (9). The concentration which inhibited 99% feeding (AFC_{99}) was found to be 18 ppm.



(9)

Piper sp.

This plant species collected in Songkhla Province is a vine free from any insect infestation. It is now being cultivated for flowers for taxonomical classification.

The fruits and leaves of the plant were extracted separately with hexane, dichloromethane and then methanol. The most active fraction was found to be the hexane extract of the fruits. Test results indicated that the extract had a 'knock-down' effect and was effective by topical application.

Seven pure components had been isolated from the extract and are presently being examined spectroscopically for their structure at the time this report is being written. Two of these compounds, referred to as F 5.1.3.1 and F 6 (1.6) appeared to be active, and the combination of which exhibited the activity comparable to pyrethrin II.

Compound	LD_{50} (1 hr) µg/insect
F 5.1.3.1	1.6×10^{-2}
F 6 (1.6)	4.5×10^{-3}
F 5.1.3.1 + F 6 (1.6) (1:1)	1.83×10^{-3}
pyrethrin II	1.97×10^{-3}
crude hexane extract	1.04×10^{-2}

The results obtained warrant further investigation in the chemical structure and the field application of these active ingredients.

CONCLUSION

From this investigation, several chemical components which showed antifeeding and insecticidal activities against *S. litura* larvae were isolated and identified from plants growing in Thailand. The most active antifeedant was isolated from *Aglaia odorata*, the crude extract of which gave satisfactory results in the field trials. The most active insecticidal compounds which have a 'knock down' effect were isolated from a Piper species. Two of these act synergistically to give the activity level comparable to pyrethrin II.

PROGRESS REPORT 1

Reporting Period : 1 December 1985 - 30 May 1986

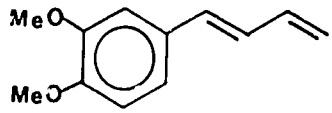
RESULTS/DISCUSSION/TABLES

Using the basic references for plants which are reported to be toxic to lower form of living organisms and insects[26,27], 80 plants were selected for testing. The results of the screening of their crude extracts or fractions of those that showed interesting activities were recorded in Table I.

Four plants were selected on the bases of their availability and activity for further investigation. The active components appeared to be in the steam distillates. The results of the screening of these steam distillates are recorded in Table II.

The active components from these steam distillates are presently being investigated. Of particular interest from our findings, the steam distillate of *Zingiber purpureum* (*Z. cassumunar*) contains a mixture of phenylbutanoids in agreement with previous reports[28,29]. The most active component appear to be 4(3',4'-dimethoxyphenyl) but -1,3-diene (1). The compound was then synthesized and tested. LC_{50} was found to be 1.27% (48 hr), 0.52% (72 hr), 0.40% (96 hr), 0.24% (120 hr).

Previous work showed that compounds containing a methylenedioxyphenyl group can act as synergists[30] for pyrethrins. The compound 4-(3',4'-methylenedioxyphenyl) but -1-3-diene(2) was then synthesized and tested for activity, both alone and with compound (1). While no synergism was observed, the activity of compound (2) was found to be higher than that of compound (1). LC_{50} of the compound was found to be 0.45% (48 hr), 0.23% (72 hr), 0.20% (96 hr), 0.18% (120 hr); and the LD_{50} value was 3.04 µg/insect (24 hr) in the TA test. These results are shown in Table III.



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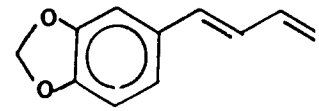
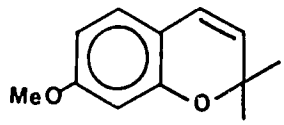


(2)

Another steam distillate which shows consistant activity is that of *Ageratum conyzoides*. Preliminary results show that it contain precocene I (3) and precocene II (4) which are the antijuvenile hormone compounds of considerable interest[31]. The LC_{50} of the crude steam distillate was found to be 0.61% (48 hr), 0.22% (96 hr).



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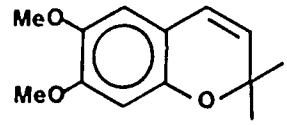


(4)

(Tables I, II, III attached)

Table Explanation

TA	=	Topical application	LD	=	Leaf dipping
C_6H_{14}	=	Hexane	EtOAc	=	Ethyl acetate
QC	=	Quick column chromatography	EtOH	=	Ethanol
MeCOMe	=	Acetone	CH_2Cl_2	=	Dichloromethane
crys	=	Crystal	rep	=	Replication
sol	=	Soluble	insol	=	Insoluble

Indentation in the Fraction column indicates further separation from the preceeding samples/fractions. Solvent A/Solvent B in this column indicates a solvent fractionation and the substances contained in the first solvent were used for testing.

Table I

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Achasma megalocheilos	rhizome, root	EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Acronychia laurifolia	leaf	EtOH	Crude	20(EtOH)	TA 0.2 ul	0.00	0.00	0.00	-	-	-	-	
					0.4 ul	0.00	0.00	0.00	-	-	-	-	
					0.8 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	6.67	36.67	46.67	-	-	-	-	
					0.4 ul	6.67	36.67	43.33	-	-	-	-	
					0.8 ul	20.00	36.67	40.00	-	-	-	-	
					LD	3.33	16.67	20.00	-	-	-	-	
			C_6H_{14}/MeOH	20(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	6.67	16.67	-	-	-	-	
			MeOH/C_6H_{14}	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
	bark	EtOH	Crude	-	-								
			EtOH/oil	20(EtOH)	TA 0.4 ul	0.00	0.00	6.67	-	-	-	-	sticky
					LD	0.00	0.00	3.33	6.67	13.33	13.33	13.33	larvae size 1/3
			QC(MeCOMe)	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	3.33	23.33	33.33	33.33	36.67	larvae size 1/2
			oil/EtOH	-	-								
			EtOAc(sol)	20(EtOH)	TA 0.4 ul	73.33	90.00	93.33	93.33	100.00	-	-	sticky
					LD	23.33	60.00	86.67	100.00	-	-	-	do
			QC(C_6H_{14})	20(EtOH)	TA 0.4 ul	100.00	-	-	-	-	-	-	very sticky
					LD	43.33	96.67	100.00	-	-	-	-	do
			MeOH(sol)	10(MeCOMe)	TA 0.4 ul	53.33	67.67	67.67	73.33	73.33	73.33	73.33	sticky
					LD	33.33	73.33	90.00	100.00	-	-	-	do
				5(MeCOMe)	TA 0.4 ul	16.67	16.67	16.67	16.67	16.67	16.67	16.67	slightly sticky
					LD	6.67	46.67	70.00	76.67	93.33	93.33	93.33	larvae size 1/8
				2.5(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	slightly sticky
					LD	6.67	23.33	46.67	50.00	56.67	63.33	66.67	larvae size 1/8
			QC(C_6H_{14})	2.5(MeCOMe)	TA 0.4 ul	80.00	86.67	90.00	-	-	-	-	sticky
					LD	20.00	76.67	96.67	-	-	-	-	no feeding

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Acronychia laurifolia			oil/crys	2.5(MeCOMe)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	3.33	3.33	16.66	26.66	larvae size 1/2
			QC(CH_2Cl_2)	-	-								
			QC(CH_2Cl_2/C_6H_{14})	1(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			QC(MeCOMe)	5(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
			Crude*	-	-	-	-	-	-	-	-	-	*Repeat
			oil/EtOH	-	-	-	-	-	-	-	-	-	
			EtOAc(sol)	-	-	-	-	-	-	-	-	-	
			QC(C_6H_{14})	5(MeCOMe)	TA 0.4 ul	13.33	20.00	23.33	-	-	-	-	sticky
					LD	16.67	76.67	96.67	100.00	-	-	-	no feeding
			QC(CH_2Cl_2)	5(MeCOMe)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	
					LD	0.00	0.00	10.00	20.00	36.67	56.67	63.33	larvae size 1/6
			QC(MeCOMe)	5(MeCOMe)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	
					LD	0.00	0.00	0.00	3.33	3.33	3.33	3.33	larvae size 1/3
		C_6H_{14}-1	Crude	-	-	-	-	-	-	-	-	-	
			C_6H_{14}(sol)	20(EtOH)	TA 0.4 ul	60.00	66.67	66.67	-	-	-	-	no feeding
					LD	83.33	100.00	-	-	-	-	-	very sticky
			C_6H_{14}(insol)	10(MeCOMe)	TA 0.4 ul	16.67	36.67	43.33	-	-	-	-	
					LD	10.00	93.33	96.67	96.67	96.67	-	-	no feeding
				2.5(MeCOMe)	TA 0.4 ul	13.33	20.00	23.33	-	-	-	-	
					LD	6.67	23.33	40.00	46.67	70.00	86.67	93.33	larvae size 1/4
			upper layer/lower layer	-									
			steam distillate	5(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			lower layer/upper layer	-									
			C_6H_{14}(insol)	-									
			MeOH(insol)	10(MeCOMe)	TA 0.4 ul	73.33	76.67	76.67	-	-	-	-	less feeding
					LD	20.00	83.33	90.00	-	-	-	-	
			MeOH(sol)	20(EtOH)	TA 0.4 ul	0.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	23.33	26.67	26.67	36.67	46.67	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Aegle marmelos	leaf	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
Ageratum conyzoides	whole	EtOH	Crude	20(EtOH)	TA 0.4 ul	6.67	6.67	6.67	10.00	10.00	10.00	10.00	
					LD	13.33	13.33	20.00	40.00	46.67	53.33	63.33	larvae size 1/4
		C_6H_{14}	Crude	20(EtOH)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	very sticky
					LD	100.00	-	-	-	-	-	-	
			QC(C_6H_{14})	8(EtOH)	TA 0.4 ul	86.67	86.67	86.67	-	-	-	-	
					LD	30.00	70.00	100.00	-	-	-	-	no feeding
			QC(C_6H_{14}-1)	3(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	less feeding
					LD	0.00	3.33	16.67	36.67	50.00	63.33	63.33	larvae size 1/5
			QC(C_6H_{14}-2)	3(EtOH)	TA 0.4 ul	33.33	33.33	33.33	-	-	-	-	larvae size 1/3
					LD	0.00	23.33	76.67	96.67	96.67	100.00	-	no feeding
			QC(C_6H_{14}-3)	3(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			QC(C_6H_{14}-4)	3(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	53.33	83.33	100.00	-	-	no feeding
			QC(C_6H_{14}-5)	3(EtOH)	TA 0.4 ul	3.33	3.33	6.67	-	-	-	-	larvae size 1/4
					LD	0.00	10.00	46.67	86.67	96.67	96.67	-	no feeding
			QC(C_6H_{14}-6)	3(EtOH)	TA 0.4 ul	23.33	23.33	23.33	-	-	-	-	
					LD	0.00	10.00	70.00	100.00	-	-	-	no feeding
			QC(CH_2Cl_2)	3(EtOH)	TA 0.4 ul	3.33	6.67	6.67	-	-	-	-	
					LD	0.00	0.00	0.00	63.67	90.00	100.00	-	less feeding
			QC(MeOH)	8(EtOH)	TA 0.4 ul	13.33	20.00	20.00	-	-	-	-	larvae size 1/4
					LD	3.33	10.00	23.33	26.67	40.00	43.33	46.67	larvae size 1/3
		CH_2Cl_2	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	53.33	60.00	100.00	-	-	-	-	black,lumpy solid
		EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
Aglaia argentea	leaf, twig	C_6H_{14}	Crude	20(EtOH)	LD	46.67	53.33	56.67	56.67	56.67	63.33	70.00	larvae size 1/3
					TA 0.4 ul	3.33	13.33	13.33	-	-	-	-	
		CH_2Cl_2	Crude	20(EtOH)	LD	6.67	30.00	66.67	76.67	86.67	86.67	93.33	larvae size 1/5
					TA 0.4 ul	3.67	6.67	6.67	-	-	-	-	
		EtOH	Crude	20(EtOH)	LD	13.33	46.67	100.00	-	-	-	-	no feeding
					TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	3.33	6.67	50.00	63.33	66.67	larvae size 1/5

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Aglaia kunstleri	leaf, twig	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	20.00	20.00	20.00	-	-	-	-	
					LD	3.33	10.00	16.67	30.00	60.00	63.33	76.67	larvae size 1/5
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	10.00	13.33	16.67	-	-	-	-	
					LD	23.33	70.00	83.33	93.33	93.33	93.33	96.67	larvae size 1/6
		MeOH	Crude	10(EtOH)	TA 0.4 ul	10.00	10.00	13.33	-	-	-	-	
					LD	6.67	23.33	23.33	63.33	76.67	100.00	-	
Aglaia odorata	leaf, twig	EtOH	Crude	20(EtOH)	TA 0.4 ul	10.00	40.00	40.00	-	-	-	-	
					LD	6.67	6.67	100.00	-	-	-	-	less feeding
				10(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	93.33	100.00	-	-	-	-	
			QC(C_6H_{14})	5(MeCOMe)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
			QC(CH_2Cl_2)	5(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	86.67	96.67	96.67	100.00	-	-	
			QC(MeOH)	5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	13.33	23.33	70.00	100.00	-	-	-	
			EtOAc(insol)	5(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	30.00	0.00	0.00	3.33	6.67	
			EtOAc(sol)	5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	30.00	66.67	90.00	96.67	100.00	
Aglaia odoratissima	leaf, twig	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	3.33	6.67	10.00	-	-	-	-	
					LD	0.00	0.00	0.00	20.00	43.33	70.00	76.67	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	3.33	46.67	80.00	93.33	100.00	-	-	
		MeOH	Crude	10(EtOH)	TA 0.4 ul	0.00	6.67	10.00	-	-	-	-	
					LD	23.33	32.00	66.67	100.00	-	-	-	
Alpinia mutica	rhizome	C_6H_{14}	Crude	10(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	6.67	2.33	40.00	46.67	56.67	larvae size 1/3
		CH_2Cl_2	Crude	7.5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	16.67	33.33	46.67	73.33	83.33	90.00	larvae size 1/5
			solid/liquid	3.5(EtOH)	TA 0.4 ul	0.00	0.00	6.67	-	-	-	-	
					LD	3.33	3.33	6.67	-	-	-	-	
			liquid/solid	3.5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	3.33	3.33	3.33	16.67	16.67	46.67	larvae size 1/3
		EtOH	Crude	10(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	3.33	3.33	3.33	6.67	6.67	13.33	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Amomum sp.	rhizome, root	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Amomum testaceum	rhizome	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	6.67	26.67	-	-	-	-	small larvae
Anacardium occidentale	leaf, branch	EtOH	Crude	20(EtOH)	TA 1 ul	13.33	13.33	13.33	-	-	-	-	
					3 ul	20.00	20.00	20.00	-	-	-	-	
					5 ul	33.33	33.33	33.33	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	3.33	3.33	3.33	-	-	-	-	5 larvae/rep
					0.4 ul	0.00	0.00	0.00	-	-	-	-	do
					0.8 ul	0.00	0.00	0.00	-	-	-	-	do
					LD	0.00	0.00	0.00	-	-	-	-	less feeding
Annona muricata	leaf, branch	EtOH	Crude	20(EtOH)	TA 1 ul	0.00	0.00	0.00	-	-	-	-	5 larvae/rep
					3 ul	13.33	13.33	13.33	-	-	-	-	do
					5 ul	20.00	20.00	20.00	-	-	-	-	do
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	3.33	3.33	3.33	-	-	-	-	
					0.4 ul	6.67	6.67	6.67	-	-	-	-	
					0.8 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Azadirachta indica	leaf, branch		Crude	20(EtOH)	TA 1 ul	33.33	33.33	33.33	-	-	-	-	5 larvae/rep.
					3 ul	26.67	26.67	26.67	-	-	-	-	do
					5 ul	40.00	40.00	40.00	-	-	-	-	do
					LD	3.33	3.33	3.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	6.67	6.67	6.67	-	-	-	-	
					0.4 ul	3.33	3.33	3.33	-	-	-	-	
					0.8 ul	3.33	3.33	3.33	-	-	-	-	less feeding
					LD	0.00	0.00	0.00	-	-	-	-	
Barringtonia pterocarpa	testa	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
	endosperm	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Blumea balsamifera	leaf, branch	EtOH	Crude	20(EtOH)	TA 1 ul	6.67	6.67	6.67	-	-	-	-	5 larvae/rep.
					3 ul	40.00	40.00	40.00	-	-	-	-	do
					5 ul	33.33	33.33	33.33	-	-	-	-	do
					LD	10.00	10.00	10.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	0.00	0.00	-	-	-	-	
					0.4 ul	3.33	3.33	3.33	-	-	-	-	
					0.8 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Boesenbergia pandurata (red variety)	rhizome	C_6H_{14}	Crude	2(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	16.67	16.67	16.67	16.67	16.67	16.67	
		$CHCl_3$	Crude	2(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	10.00	13.33	13.33	13.33	13.33	13.33	
Boesenbergia pandurata (white variety)	rhizome	$CHCl_3$	Crude	2(EtOH)	TA 0.4 ul	3.33	10.00	10.00	10.00	13.33	13.33	13.33	larvae size 1/2
					LD	3.33	10.00	10.00	10.00	13.33	13.33	13.33	larvae size 1/2
Caesalpinia andamanica	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	0.00	0.00	0.00	-	-	-	-	
					0.4 ul	0.00	0.00	0.00	-	-	-	-	
					0.8 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.4 ul	-	-	-	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Caesalpinia pulcherrima	leaf flower, pod	EtOH	Crude	20(EtOH)	TA 0.2 ul	3.33	10.00	10.00	-	-	-	-	
					0.4 ul	0.00	3.33	6.67	-	-	-	-	
					0.8 ul	6.67	13.33	16.67	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	LD	0.00	0.00	0.00	-	-	-	-	
Callicarpa cana	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	6.67	-	-	-	-	
Callicarpa longifolia	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	10.00	13.33	23.33	-	-	-	-	
					0.4 ul	13.33	20.00	26.67	-	-	-	-	
					0.8 ul	10.00	20.00	36.67	-	-	-	-	
					LD	0.00	10.00	23.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	13.33	-	-	-	-	-	-	5 larvae/rep.
					0.4 ul	13.33	-	-	-	-	-	-	do
					0.8 ul	13.33	-	-	-	-	-	-	do
					LD	0.00	-	-	-				

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Calopogonium mucunoides	leaf, branch	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	10(EtOH)	TA 0.4 ul	20.00	20.00	20.00	-	-	-	-	
					LD	0.00	3.33	3.33	-	-	-	-	
Calycopteris floribunda	leaf	EtOH	Crude	20(EtOH)	TA 0.2 ul	3.33	20.00	30.00	-	-	-	-	
					0.4 ul	3.33	13.33	20.00	-	-	-	-	
					0.8 ul	13.33	16.67	23.33	-	-	-	-	
					LD	0.00	36.67	63.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	larvae size 1/2
					LD	3.33	33.33	53.33	73.33	93.33	96.67	100.00	
			C_6H_{14}/MeOH	20(EtOH)	TA 0.4 ul	3.33	3.33	6.67	-	-	-	-	
					LD	0.00	0.00	6.67	-	-	-	-	
			MeOH/C_6H_{14}	20(EtOH)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	
					LD	0.00	3.33	16.67	-	-	-	-	small larvae
		C_6H_{14}	Crude	20(C_6H_{14})	LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	-									
			QC(CH_2Cl_2-1)	5(MeCOMe)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			QC(CH_2Cl_2-2)	20(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	46.67	90.00	96.67	96.67	96.67	96.67	96.67	less feeding larvae size 1/4
			QC(CH_2Cl_2-3)	-									
			MeOH+C_6H_{14}(sol)	20(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	53.33	100.00	-	-	-	-	no feeding
			MeOH+C_6H_{14}(insol)	-									
			MeOH(crys)	2(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			QC(CH_2Cl_2-4)	20(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	10.00	13.33	16.67	16.67	36.67	less feeding larvae size 1/4
			QC(MeCOMe)	5(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	10([illegible])	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	[illegible]	[illegible]	[illegible]					

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Calycopteris floribunda	bark	EtOH	Crude	-									
			EtOAc/H_2O	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			H_2O/EtOAc	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Cassia alata	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
				10(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	3.33	3.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	
					0.4 ul	0.00	-	-	-	-	-	-	
					0.8 ul	10.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Cerbera manghas	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	23.33	23.33	26.67	-	-	-	-	
					0.4 ul	3.33	6.67	13.33	-	-	-	-	
					0.8 ul	13.33	13.33	16.67	-	-	-	-	
					LD	6.67	13.33	13.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	LD	0.00	0.00	16.67	-	-	-	-	
Clerodendron villosum	leaf, branch	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	0.00	3.33	6.67	-	-	-	-	
					LD	0.00	10.00	33.33	46.67	66.67	70.00	86.67	larvae size 1/3
			QC(C_6H_{14})	10(C_6H_{14})	LD	3.33	13.33	16.67	16.67	20.00	26.67	30.00	
			QC(CH_2Cl_2)	10(C_6H_{14})	LD	0.00	3.33	3.33	3.33	3.33	10.00	10.00	
				10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	6.67	13.33	13.33	-	-	-	-	sticky
			QC(MeCOMe)	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	6.67	6.67	10.00	10.00	13.33	
			QC(MeOH)	10(EtOH)	TA 0.4 ul	0.00	0.00	16.67	-	-	-	-	
					LD	10.00	10.00	10.00	10.00	10.00	16.67	16.67	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	23.33	53.33	70.00	76.67	76.67	80.00	
		EtOH	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	6.67	-	-	-	-	
Derris sp.	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	0.00	0.00	0.00	-	-	-	-	5 larvae/rep.
					0.4 ul	0.00	-	-	-	-	-	-	do
					0.8 ul	13.33	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Derris sp.			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	6.67	10.00	-	-	-	-	
					0.4 ul	3.33	3.33	23.33	-	-	-	-	
					0.8 ul	6.67	6.67	10.00	-	-	-	-	
					LD	0.00	3.33	10.00	-	-	-	-	
Dalbergia rostrata	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	3.33	10.00	13.33	20.00	26.67	36.67	larvae size 1/6
				10(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			MeOH/C_6H_{14}	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	3.33	6.67	6.67	-	-	-	-	
			C_6H_{14}/MeOH	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			ppt	6.61(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	10.00	13.00	
Derris amoena var.amoena	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	13.33	-	-	-	-	-	-	5 larvae/rep.
					0.4 ul	20.00	-	-	-	-	-	-	do
					0.8 ul	33.33	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	
					0.4 ul	3.33	-	-	-	-	-	-	
					0.8 ul	3.33	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Derris scandens	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	23.33	16.67	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	3.33	3.33	6.67	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	3.33	-	-	-	-	-	-	
					0.4 ul	13.33	-	-	-	-	-	-	
					0.8 ul	16.67	-	-	-	-	-	-	
					LD	6.67	-	-	-	-	-	-	
Derris thyrsiflora	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	6.67	13.33	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	3.33	3.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	26.67	35.67	43.33	-	-	-	-	
					0.4 ul	36.67	40.00	40.00	-	-	-	-	
					0.8 ul	46.67	53.33	56.67	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Derris thyrsiflora			C_6H_{14}/MeOH	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			MeOH/C_6H_{14}	20(EtOH)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Diospyros wallichii	leaf	EtOH	Crude	20(EtOH)	TA 1 ul	26.67	-	-	-	-	-	-	5 larvae/rep.
					3 ul	33.33	-	-	-	-	-	-	do
					5 ul	40.00	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	
					0.4 ul	0.00	-	-	-	-	-	-	
					0.8 ul	3.33	-	-	-	-	-	-	
					LD	3.33	-	-	-	-	-	-	
Elettariopsis curtisii	rhizome	C_6H_{14}	Crude	10(EtOH)	TA 0.4 ul	3.33	10.00	13.33	-	-	-	-	
					LD	0.00	10.00	40.00	70.00	80.00	90.00	100.00	larvae size 1/5
		CH_2Cl_2	Crude	7(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	slightly sticky
					LD	0.00	0.00	3.33	20.00	46.67	60.00	63.33	larvae size 1/5
		C_6H_{14} CH_2Cl_2	Crude	-									
			QC(C_6H_{14})	5(C_6H_{14})	LD	3.33	20.00	21.00	56.67	-	-	-	
			QC(CH_2Cl_2)	5(MeCOMe)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	3.33	3.33	16.67	30.00	43.33	
			QC(MeOH)	5(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	6.67	10.00	10.00	
Entada spiralis	seed	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.4 ul	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
					LD	40.00	52.33	76.67	-	-	-	-	
		C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	3.33	3.33	10.00	10.00	16.67	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	16.67	36.67	36.67	-	-	-	-	
					LD	3.33	53.33	100.00	-	-	-	-	no feeding
		MeCOMe	Crude	10(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	6.67	13.33	43.33	larvae size 1/4
Erythroxylum cuneatum	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	5 larvae/rep.
					0.4 ul	0.00	-	-	-	-	-	-	do
					0.8 ul	6.67	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Erythroxylum cuneatum			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	10.00	20.00	23.33	-	-	-	-	
					0.4 ul	13.33	16.67	26.67	-	-	-	-	
					0.8 ul	13.33	16.67	26.67	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
Eupatorium odoratum	leaf	EtOH	Crude	20(EtOH)	TA 1 ul	13.33	-	-	-	-	-	-	5 larvae/rep.
					3 ul	53.33	-	-	-	-	-	-	do
					5 ul	66.67	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	3.33	-	-	-	-	-	-	
					0.4 ul	6.67	-	-	-	-	-	-	
					0.8 ul	0.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
		H_2O	Crude	50(H_2O)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Fibraurea tinctora	branch	CH_2Cl_2	Crude										
			MeOH(sol)	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	30.00	36.67	50.00	73.33	86.67	96.67	larvae size 1
			MeOH(insol)										
			MeOH(crys)	0.5(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		MeOH	Palmatin	2.5(H_2O)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	3.33	10.00	13.33	13.33	16.67	
Gliricidia sepium	leaf, branch	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Hedychium coronarium	leaf	C_6H_{14}	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(EtOH)	TA 0.4 ul	13.33	13.33	13.33	-	-	-	-	
					LD	23.33	30.00	30.00	30.00	36.67	40.00	43.33	larvae size 2/
		EtOH	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Hura crepitans	leaf	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	6.67	13.33	-	-	-	-	
					LD	0.00	3.33	13.33	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Hura crepitans			$EtOAc/H_2O$	20(EtOH)	TA 0.2 ul	3.33	-	-	-	-	-	-	
					0.4 ul	6.67	-	-	-	-	-	-	
					0.8 ul	6.67	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Kleinhovia hospita	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	6.57	6.67	6.67	10.00	23.33	30.00	33.33	
				10(EtOH)	TA 0.4 ul	0.00	6.67	10.00	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	0.00	6.67	
			$EtOAc/H_2O$	20(EtOH)	TA 0.2 ul	3.33	-	-	-	-	-	-	
					0.4 ul	13.33	-	-	-	-	-	-	
					0.8 ul	0.00	-	-	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Lantana camera	flower	C_6H_{14}	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	3.33	6.67	13.33	16.67	16.67	20.00	larvae size 1/2
	leaf	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
lantana camara (local type)	leaf	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
Maesa ramentacea	leaf	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	6.67	13.33	13.33	-	-	-	-	
					LD	0.00	3.33	3.33	3.33	3.33	26.67	50.00	
			$QC(C_6H_{14})$	10(MeCOMe)	TA 0.4 ul	13.33	13.33	13.33	-	-	-	-	
					LD	0.00	0.00	0.00	3.33	13.33	33.33	40.00	
			$QC(CH_2Cl_2)$	10(MeCOMe)	TA 0.4 ul	3.33	16.67	16.67	-	-	-	-	
					LD	0.00	3.33	3.33	3.33	3.33	13.33	16.67	
		MeCOMe	Crude	10(MeCOMe)	TA 0.4 ul	0.00	3.33	10.00	-	-	-	-	
					LD	0.00	0.00	6.67	10.00	13.33	13.33	26.67	larvae size 1/2
		MeOH	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	3.33	3.33	10.00	36.67	46.67	50.00	
Milia azedarach	leaf	EtOH	Crude	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	5 larvae/rep.
					0.4 ul	0.00	-	-	-	-	-	-	do
					0.8 ul	0.00	-	-	-	-	-	-	do
					LD	3.33	-	-	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Milia azedarach			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	3.33	-	-	-	-	-	-	
					0.4 ul	6.67	-	-	-	-	-	-	
					0.8 ul	10.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Millettia atropurpurea	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	23.33	23.33	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
				10(EtOH)	TA 0.4 ul	3.33	23.33	23.33	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	
					0.4 ul	0.00	-	-	-	-	-	-	
					0.8 ul	3.33	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Myrica esculenta	leaf, branch	EtOH	Crude	20(EtOH)	TA 1 ul	0.00	-	-	-	-	-	-	5 larvae/rep.
					3 ul	13.33	-	-	-	-	-	-	do
					5 ul	46.67	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	3.33	-	-	-	-	-	-	
					0.4 ul	3.33	-	-	-	-	-	-	
					0.8 ul	0.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Neonauclea pallida	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.2 ul	20.00	-	-	-	-	-	-	5 larvae/rep.
					0.4 ul	13.33	-	-	-	-	-	-	do
					0.8 ul	0.00	-	-	-	-	-	-	do
					LD	0.00	-	-	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	6.67	6.67	10.00	-	-	-	-	
					0.4 ul	6.67	6.67	16.67	-	-	-	-	
					0.8 ul	3.33	13.33	13.33	-	-	-	-	
					LD	3.33	6.67	16.67	-	-	-	-	
Nephelium lappaceum	seed	C_6H_{14}	Crude	20(C_6H_{14})	LD	0.00	0.00	0.00	0.00	0.00	23.33	26.67	
				20(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	20(MeCOMe)	TA 0.4 ul	10.00	13.33	13.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	

Table I contd.

Screening of activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Pachyrhizus erosus	seed	C_6H_{14}	Crude	20(EtOH)	TA 0.4 ul	16.67	20.00	20.00	-	-	-	-	
					LD	53.33	90.00	96.67	96.67	100.00	-	-	dead from wax-like substances?
				2.5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	3.33	3.33	-	-	-	-	
				0.67(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	4(EtOH)	TA 0.4 ul	10.00	20.00	20.00	-	-	-	-	
					LD	80.00	93.33	96.67	100.00	-	-	-	larvae size 1/3
				2.5(EtOH)	TA 0.4 ul	13.33	13.33	13.33	-	-	-	-	granule & lumpy solid
					LD	0.00	20.00	36.67	63.33	66.67	73.33	80.00	larvae size 1/6
				0.67(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	6.67	-	-	-	-	
		EtOH	Crude	20(EtOH)	TA 0.4 ul	10.00	10.00	10.00	-	-	-	-	
					LD	46.67	73.33	76.67	83.33	83.33	86.67	90.00	larvae size 1/3
				2.5(EtOH)	TA 0.4 ul	6.67	6.67	6.67	-	-	-	-	granule & lumpy solid
					LD	6.67	16.67	23.33	40.00	53.33	60.00	63.33	larvae size 1/4
				0.67(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
Persea americana	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	6.67	10.00	10.00	10.00	10.00	10.00	
					LD	0.00	0.00	0.00	10.00	10.00	16.67	16.67	larvae size 1/2
Pittosporum ferrugineum	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	10.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	
					0.4 ul	0.00	-	-	-	-	-	-	
					0.8 ul	3.33	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Planchonella obovata	leaf	EtOH	Crude	10(EtOH)	TA 0.4 ul	10.00	10.00	13.33	-	-	-	-	
					LD	0.00	3.33	3.33	-	-	-	-	
Polygonum tomentosum	leaf, branch	EtOH	Crude	20(EtOH)	TA 1 ul	20.00	-	-	-	-	-	-	5 larvae/rep.
					3 ul	0.00	-	-	-	-	-	-	do
					5 ul	20.00	-	-	-	-	-	-	do
					LD	10.00	-	-	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	0.00	-	-	-	-	-	-	
					0.4 ul	0 00	-	-	-	-	-	-	
					0.8 ul	0.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Sapium indicum	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	13.33	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	6.67	-	-	-	-	-	-	
					0.4 ul	0.00	-	-	-	-	-	-	
					0.8 ul	10.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Shima wallichii	leaf, branch	EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			EtOAc/H_2O	20(EtOH)	TA 0.2 ul	10.00	-	-	-	-	-	-	
					0.4 ul	16.67	-	-	-	-	-	-	
					0.8 ul	10.00	-	-	-	-	-	-	
					LD	0.00	-	-	-	-	-	-	
Tephrosia vestita	leaf	C_6H_{14}	Crude	20(MeCOMe)	TA 0.4 ul	3.33	6.67	6.67	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
		CH_2Cl_2	Crude	10(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	3.33	10.00	20.00	20.00	23.33	40.00	40.00	larvae size 2/3
			QC(C_6H_{14}-1)	8(MeCOMe)	TA 0.4 ul	6.67	6.67	6.67	-	-	-	-	
					LD	0.00	3.33	6.67	-	-	-	-	
			QC(C_6H_{14}-2)	8(MeCOMe)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	6.67	6.67	6.67	-	-	-	-	
			QC(C_6H_{14},CH_2Cl_2)	8(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	3.33	3.33	6.67	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Tephrosia vestita			QC(MeOH)	8(EtOH)	TA 0.4 ul	0.00	0.00	6.67	-	-	-	-	
					LD	0.00	16.67	20.00	-	-	-	-	
		MeOH	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	3.33	6.67	10.00	10.00	
			QC(CH_2Cl_2)	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	3.33	3.33	3.33	3.33	13.33	23.33	26.67	
			QC(MeOH)	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	3.33	3.33	3.33	3.33	6.67	
		EtOH	Crude	20(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	36.67	46.67	50.00	50.00	50.00	
Vernonia cinerea	leaf, branch	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	6.67	10.00	10.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	10(EtOH)	TA 0.4 ul	10.00	10.00	16.67	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
Vitex pubescens	leaf, branch	C_6H_{14}	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(MeCOMe)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	10(EtOH)	TA 0.4 ul	13.33	13.33	13.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Wedelia bifora	whole	EtOH	Crude	-									
			EtOAc/H_2O	20(EtOH)	TA 0.4 ul	10.00	10.00	10.00	13.33	13.33	13.33	13.33	very sticky
					LD	33.33	66.67	70.00	86.67	90.00	93.33	93.33	do
		C_6H_{14}	Crude	20(EtOH)	TA 0.4 ul	6.67	30.00	30.00	30.00	30.00	40.00	40.00	sticky
					LD	10.00	33.33	33.33	36.67	36.67	40.00	40.00	do
		CH_2Cl_2	Crude	20(EtOH)	TA 0.4 ul	6.67	10.00	10.00	10.00	10.00	10.00	10.00	
					LD	3.33	3.33	3.33	-	-	-	-	
		EtOH	Crude	20(EtOH)	TA 0.4 ul	6.67	6.67	6.67	16.67	16.67	16.67	16.67	
					LD	0.00	3.33	23.33	33.33	53.33	63.33	63.33	
			QC(C_6H_{14})	20(EtOH)	TA 0.4 ul	0.00	6.67	6.67	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			QC(CH_2Cl_2)	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	30.00	46.67	56.67	60.00	black, lumpy solid

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Wedelia bifora			QC(MeOH)	20(EtOH)	TA 0.4 ul	0.00	0.00	3.33	-	-	-	-	
					LD	0.00	10.00	16.67	16.67	56.67	70.00	83.33	larvae size 1/4
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	larvae size 1/3
			QC(MeCOMe)	10(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	larvae size 1/3
			QC(MeOH)	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	larvae size 1/3
Wedelia trilobata	whole	EtOH	Crude	-	-								
			$EtOAc/H_2O$	20(EtOH)	TA 0.4 ul	0.00	3.33	3.33	3.33	3.33	3.33	6.67	very sticky
					LD	20.00	76.67	80.00	80.33	90.00	90.00	96.67	do
		C_6H_{14}	Crude	10(EtOH)	TA 0.4 ul	20.00	30.00	30.00	-	-	-	-	
					LD	23.33	33.33	50.00	50.00	53.33	60.00	73.33	sticky larvae size 1/6
				5(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
				2.5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			QC(C_6H_{14})	-									
			QC(C_6H_{14})	5(MeCOMe)	TA 0.4 ul	3.33	3.33	3.33					
					LD	0.00	0.00	30.33	50.00	50.00	50.00	50.00	
			QC(C_6H_{14}:CH_2Cl_2)	10(MeCOMe)	TA 0.4 ul	0.00	6.67	6.67	-	-	-	-	
					LD	10.00	36.33	63.33	83.33	90.00	90.00	90.00	slightly sticky
		CH_2Cl_2	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	10.00	50.00	86.67	93.33	100.00	-	-	very sticky larvae size 1/3
				10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
				5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
				2.5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	30.00	43.33	46.67	53.33	53.33	53.33	53.33	slighty sticky repellent larvae size 1/4
				10(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	black, very lumpy solid

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Wedelia trilobata				10(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	black, very lumpy solid
					LD	6.67	6.67	6.67	-	-	-	-	
				5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		C_6H_{14}	Crude	-									
			QC(C_6H_{14}-1)	5(MeCOMe)	TA 0.4 ul	6.67	6.67	6.67	-	-	-	-	
					LD	0.00	0.00	3.33	3.33	6.67	6.67	10.00	larvae size 1/3
			QC(C_6H_{14}-2)	5(MeCOMe)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	0.00	0.00	6.67	6.67	larvae size 1/3
			QC(C_6H_{14}-3)	5(MeCOMe)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	0.00	3.33	6.67	6.67	10.00	larvae size 1/2
			QC(CH_2Cl_2)	10(MeCOMe)	TA 0.4 ul	33.33	36.67	36.67	-	-	-	-	
Zingiber multibracteatum	rhizome	C_6H_{14}	Crude	10(EtOH)	LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
					TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(EtOH)	LD	0.00	0.00	0.00	-	-	-	-	
					TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude	10(EtOH)	LD	0.00	0.00	0.00	-	-	-	-	
					TA 0.4 ul	6.67	6.67	6.67	-	-	-	-	
Zingiber officinale	rhizome	C_6H_{14}	Crude	10(MeCOMe)	LD	0.00	0.00	0.00	-	-	-	-	
					TA 0.4 ul	3.33	6.67	6.67	-	-	-	-	
				5(EtOH)	LD	0.00	86.67	100.00	-	-	-	-	
					TA 0.4 ul	36.67	43.33	43.33	-	-	-	-	
			C_6H_{14}(sol)	10(MeCOMe)	LD	0.00	6.67	13.33	16.67	50.00	66.67	66.67	larvae size 1/5
					TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
			C_6H_{14}(insol)	10(MeCOMe)	LD	0.00	0.00	0.00	-	-	-	-	
					TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	10(MeCOMe)	LD	0.00	0.00	0.00	-	-	-	-	
					TA 0.4 ul	3.33	6.67	6.67	-	-	-	-	
				5(EtOH)	LD	0.00	70.00	90.00	90.00	93.33	93.33	93.33	larvae size 1/4 less feeding
					TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Zingiber officinale		EtOH	Crude	10(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	3.33	3.33	3.33	-	-	-	-	
				2.5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
Zingiber ottensii	rhizome	C_6H_{14}	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		CH_2Cl_2	Crude	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
		EtOH	Crude(upper layer)	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
			Crude(lower layer)	20(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	10.00	16.67	16.67	16.67	20.00	20.00	20.00	larvae size 1/3
Zingiber purpureum	rhizome	EtOH	Crude	8(EtOH)	TA 0.4 ul	-	-	-	-	-	-	-	
					LD	0.00	6.67	86.67	-	-	-	-	
			MeOH(insol)	8(3:1,H_2O: MeCOMe)	TA 0.4 ul	-	-	-	-	-	-	-	
					LD	0.00	0.00	3.33	-	-	-	-	
			MeOH(sol)	-	-								
			MeOH/C_6H_{14}	8(EtOH)	TA 0.4 ul	-	-	-	-	-	-	-	
					LD	13.33	46.67	100.00	-	-	-	-	
			C_6H_{14}/MeOH	8(EtOH)	TA 0.4 ul	-	-	-	-	-	-	-	
					LD	20.00	80.00	100.00	-	-	-	-	
			juice	100	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	0.00	0.00	-	-	-	-	
				20(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	0.00	6.67	-	-	-	-	
			solution/solid	20(EtOH)	TA 0.4 ul	0.00	3.33	3.33	6.67	6.67	6.67	6.67	
					LD	0.00	0.00	13.33	-	-	-	-	
			solid/solution	20(EtOH)	TA 0.4 ul	0.00	0.00	10.00	10.00	10.00	10.00	10.00	
					LD	0.00	10.00	50.00	63.33	93.33	100.00	-	larvae size 1/4
			C_6H_{14}(insol)	-									
			MeOH/C_6H_{14}	-									
			QC(C_6H_{14})	5(EtOH)	TA 0.4 ul	90.00	96.97	100.00	-	-	-	-	
					LD	26.67	90.00	100.00	-	-	-	-	
			QC(CH_2Cl_2)	5(EtOH)	TA 0.4 ul	20.00	20.00	20.00	33.33	33.33	33.33	33.33	
					LD	0.00	0.00	0.00	10.00	26.67	43.00	50.00	larvae size 1/3
			QC(MeCOMe)	5(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	
					LD	0.00	3.33	10.00	-	-	-	-	

Table I contd.

Screening of Activity of Plants on *Spodoptera litura* Fabr

PLANT SPECIES	PART	SOLVENT	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Zingiber purpureum			residue	-									
			C_6H_{14}	8(EtOH)	TA 0.4 ul	0.00	3.33	6.67	10.00	10.00	10.00	10.00	
					LD	0.00	3.33	16.67	30.00	36.67	66.67	90.00	larvae size 1/4
Zingiber zerumbet	rhizome	EtOH	Crude	-	-								
			EtOAc/H_2O	20(EtOH)	TA 0.4 ul	90.00	93.33	93.33	93.33	93.33	93.33	93.33	
					LD	63.33	90.00	100.00	-	-	-	-	
			C_6H_{14}(sol)	5(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	10.00	16.67	-	-	-	-	
			C_6H_{14}(insol)	5(EtOH)	TA 0.4 ul	20.00	20.00	23.33	30.00	30.00	30.00	30.00	
					LD	0.00	0.00	3.33	10.00	-	-	-	larvae size 1/3
			QC(C_6H_{14})	5(EtOH)	TA 0.4 ul	56.67	56.67	60.00	-	-	-	-	dead in 1-5 hour after application
					LD	50.00	96.67	100.00	-	-	-	-	
				2.5(EtOH)	TA 0.4 ul	36.67	36.67	40.00	-	-	-	-	
					LD	53.33	70.00	70.00	73.33	86.67	86.67	86.67	larvae size 1/5
				1.25(EtOH)	TA 0.4 ul	3.33	3.33	3.33	-	-	-	-	
					LD	0.00	50.00	60.00	60.00	60.00	60.00	60.00	larvae size 1/3
			QC(CH_2Cl_2)	5(EtOH)	TA 0.4 ul	0.00	3.33	3.33	-	-	-	-	
					LD	0.00	43.33	43.33	43.33	43.33	46.67	46.67	larvae size 1/2
			QC(MeCOMe)	5(EtOH)	TA 0.4 ul	0.00	6.67	10.00	-	-	-	-	
					LD	0.00	3.33	3.33	-	-	-	-	
	flower	C_6H_{14}	Crude	10(EtOH)	TA 0.4 ul	0.00	6.67	6.67	10.00	13.33	13.33	13.33	
Zingiber sp.	rhizome	C_6H_{14}	Crude		LD	0.00	0.00	3.33	-	-	-	-	
				2(EtOH)	TA 0.4 ul	0.00	0.00	0.00	-	-	-	-	lumpy solid
					LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		CH_2Cl_2	Crude	10(EtOH)	TA 0.4 ul	16.67	16.67	20.00	-	-	-	-	slightly sticky lumpy solid
					LD	0.00	20.00	20.00	26.67	26.67	26.67	26.67	larvae size 1/4

Table II

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

Note : Results in the second line of each test are obtained by substracting the number of larvae lost by escaping or cannabilized.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Ageratum conyzoides (1'st test)	whole	total	5.00(MeCOMe)	TA-LD	26.67	90.00	100.00	-	-	-	-	
					26.67	90.00	100.00	-	-	-	-	
				LD	0.00	100.00	-	-	-	-	-	
					0.00	100.00	-	-	-	-	-	
			1.00(MeCOMe)	TA-LD	30.00	70.00	96.67	100.00	-	-	-	
					0.00	40.00	66.67	70.00	-	-	-	
				LD	30.00	96.67	100.00	-	-	-	-	
					16.67	83.33	86.67	-	-	-	-	
			0.50(MeCOMe)	TA-LD	0.00	0.00	0.00	3.33	10.00	36.67	53.33	larvae size 1/5
					0.00	0.00	0.00	3.33	10.00	36.67	53.33	
				LD	0.00	0.00	3.33	16.67	20.00	36.67	56.67	larvae size 1/5
					0.00	0.00	3.33	13.33	16.67	33.33	43.33	
			0.25(MeCOMe)	TA-LD	10.00	10.00	10.00	10.00	13.33	16.67	16.67	larvae size 1/3
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
				LD	0.00	0.00	0.00	0.00	3.33	6.67	13.33	larvae size 1/2
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			0.125(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	6.67	13.33	23.33	larvae size 1/3
					0.00	0.00	0.00	0.00	3.33	3.33	3.33	
				LD	0.00	0.00	0.00	0.00	6.67	16.67	20.00	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			MeCOMe	TA-LD	0.00	0.00	0.00	13.33	13.33	13.33	13.33	
					0.00	0.00	0.00	10.00	10.00	10.00	10.00	
				LD	0.00	0.00	0.00	3.33	6.67	16.67	16.67	
					0.00	0.00	0.00	3.33	6.67	6.67	6.67	
Ageratum conyzoides	whole	total	0.50(MeCOMe)	TA-LD	0.00	3.33	40.00	83.33	100.00	-	-	
					0.00	3.33	40.00	83.33	100.00	-	-	
				TA-LD*	0.00	3.33	80.00	100.00	-	-	-	*with piperonyl butoxide
					0.00	3.33	80.00	100.00	-	-	-	(25% of tested sample)
				LD	0.00	3.33	26.67	63.33	96.67	100.00	-	
					0.00	3.33	26.67	63.33	83.33	86.67	-	
				LD*	0.00	3.33	50.00	100.00	-	-	-	
					0.00	3.33	50.00	100.00	-	-	-	
			0.25(MeCOMe)	TA-LD	0.00	0.00	0.00	26.67	30.00	40.00	70.00	larvae size 1/4
					0.00	0.00	0.00	26.67	30.00	40.00	70.00	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Ageratum conyzoides	whole	total	0.25(MeCOMe)	TA-LD*	0.00	0.00	3.33	20.00	46.67	53.33	53.33	larvae size 1/4
					0.00	0.00	3.33	20.00	46.67	53.33	53.33	*with piperonyl butoxide (25% of tested sample)
				LD	0.00	0.00	10.00	70.00	70.00	86.67	96.67	larvae size 1/4
					0.00	0.00	10.00	70.00	70.00	86.67	96.67	
				LD*	0.00	0.00	0.00	16.67	73.33	83.33	90.00	larvae size 1/4
					0.00	0.00	0.00	16.67	56.67	66.67	73.33	
			0.125(MeCOMe)	TA-LD	0.00	0.00	0.00	13.33	13.33	13.33	23.33	larvae size 1/2
					0.00	0.00	0.00	13.33	13.33	13.33	23.33	
				TA-LD*	0.00	0.00	0.00	6.67	6.67	6.67	16.67	larvae size 1/2
					0.00	0.00	0.00	6.67	6.67	6.67	6.67	
				LD	0.00	0.00	0.00	3.33	6.67	10.00	13.33	larvae size 1/2
					0.00	0.00	0.00	3.33	6.67	10.00	13.33	
				LD*	3.33	3.33	3.33	30.00	33.33	33.33	43.33	larvae size 1/2
					0.00	0.00	0.00	26.67	30.00	30.00	40.00	
			MeCOMe	TA-LD	13.33	13.33	13.33	16.67	16.67	26.67	33.33	
					0.00	0.00	0.00	3.33	3.33	10.00	16.67	
				TA-LD*	0.00	0.00	0.00	23.33	33.33	33.33	46.67	* with 0.25% piperonyl
					0.00	0.00	0.00	23.33	30.00	30.00	33.33	butoxide
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
				LD*	0.00	0.00	0.00	3.33	3.33	3.33	3.33	
					0.00	0.00	0.00	3.33	3.33	3.33	3.33	
Ageratum conyzoides (2'nd test)	whole	total	0.75(MeCOMe)	TA-LD	70.00	100.00	-	-	-	-	-	
					56.67	83.33	-	-	-	-	-	
				LD	46.67	86.67	100.00	-	-	-	-	
					43.33	83.33	86.67	-	-	-	-	
			0.50(MeCOMe)	TA-LD	10.00	86.67	100.00	-	-	-	-	
					6.67	80.00	86.67	-	-	-	-	
				LD	0.00	20.00	83.33	96.67	100.00	-	-	
					0.00	13.33	73.33	93.33	96.67	-	-	
			0.25(MeCOMe)	TA-LD	20.00	86.67	100.00	-	-	-	-	
					13.33	73.33	86.67	-	-	-	-	
				LD	16.67	73.33	96.67	100.00	-	-	-	
					10.00	30.00	53.33	56.67	-	-	-	
			0.125(MeCOMe)	TA-LD	26.67	86.67	100.00	-	-	-	-	
					16.67	63.33	76.67	-	-	-	-	
				LD	16.67	60.00	76.67	86.67	86.67	86.67	86.67	
					16.67	50.00	56.67	66.67	66.67	66.67	66.67	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Ageratum conyzoides (2'nd test)	whole	total	0.125(MeCOMe)*	TA-LD	50.00	73.33	100.00	-	-	-	-	larvae size 1/2
					43.33	66.67	83.33	-	-	-	-	*with 4-(3',4'-methylene dioxyphenyl) buta -1,3-diene (50% Of tested sample)
				LD	33.33	76.67	96.67	100.00	-	-	-	
					13.33	53.33	70.00	73.33	-	-	-	
			0.25(MeCOMe)*	TA-LD	0.00	0.00	0.00	0.00	0.00	13.33	13.33	*with 4-(3,4-methylene dioxyphenyl)-buta-1,3-diene (10% of tesed sample)
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
				LD	3.33	3.33	3.33	6.67	10.00	16.67	20.00	larvae size 1/2
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			0.125(MeCOMe)*	TA-LD	0.00	0.00	0.00	3.33	10.00	13.33	20.00	larvae size 1/3
					0.00	0.00	0.00	0.00	6.67	10.00	16.67	
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	larvae size 1/3
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			MeCOMe	TA-LD	6.67	13.33	16.67	16.67	16.67	16.67	16.67	
					0.00	3.33	6.67	6.67	6.67	6.67	6.67	
				LD	3.33	3.33	16.67	26.67	36.67	53.33	53.33	
					3.33	3.33	6.67	10.00	16.67	30.00	30.00	
Wedelia trilobata (2'nd test)	whole	total	5.00(MeCOMe)	TA-LD	76.67	86.67	96.67	96.67	96.67	100.00	-	
					76.67	86.67	96.67	96.67	96.67	100.00	-	
				TA-LD*	96.67	100.00	-	-	-	-	-	*with piperonyl butoxide (25% of tested sample)
					96.67	100.00	-	-	-	-	-	
				LD	30.00	53.33	86.67	96.67	100.00	-	-	
					30.00	53.33	86.67	96.67	100.00	-	-	
				LD*	3.33	96.67	100.00	-	-	-	-	
					3.33	96.67	100.00	-	-	-	-	
			4.00(MeCOMe)	TA-LD	53.33	73.33	90.00	90.00	96.67	96.67	96.67	
					53.33	73.33	90.00	90.00	96.67	96.67	96.67	
				TA-LD*	66.67	96.67	100.00	-	-	-	-	
					66.67	96.67	100.00	-	-	-	-	
				LD	23.33	60.00	93.33	96.67	96.67	100.00	-	
					23.33	60.00	90.00	93.33	93.33	96.67	-	
				LD*	3.33	53.33	70.00	100.00	-	-	-	
					0.00	50.00	66.67	96.67	-	-	-	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMAR.
Wedelia trilobata (2'nd test)	whole	total	3.00(MeCOMe)	TA-LD	50.00	73.33	80.00	80.00	80.00	90.00	93.33	
					50.00	73.33	80.00	80.00	80.00	90.00	93.33	
				TA-LD*	40.00	100.00	-	-	-	-	-	*with piperonyl butoxide
					40.00	100.00	-	-	-	-	-	(25% of tested sample)
				LD	23.33	56.67	90.00	90.00	90.00	96.67	100.00	
					16.67	50.00	83.33	83.33	83.33	90.00	93.33	
				LD*	10.00	70.00	76.67	96.67	96.67	100.00	-	
					0.00	60.00	66.67	86.67	86.67	90.00	-	
			2.00(MeCOMe)	TA-LD	0.00	13.33	33.33	50.00	66.67	66.67	83.33	
					0.00	13.33	33.33	50.00	63.33	63.33	80.00	
				TA-LD*	13.33	40.00	63.33	96.67	96.67	96.67	100.00	
					0.00	26.67	50.00	70.00	73.33	73.33	73.33	
				LD	0.00	26.67	70.00	86.67	100.00	-	-	
					0.00	26.67	70.00	86.67	100.00	-	-	
				LD*	0.00	80.00	90.00	100.00	-	-	-	
					0.00	80.00	90.00	100.00	-	-	-	
			1.00(MeCOMe)	TA-LD	0.00	0.00	20.00	23.33	36.67	36.67	43.33	
					0.00	0.00	20.00	23.33	33.33	33.33	36.67	
				TA-LD*	0.00	43.33	56.67	93.33	100.00	-	-	
					0.00	36.67	50.00	63.33	70.00	-	-	
				LD	3.33	16.67	50.00	93.33	96.67	96.67	100.00	
					3.33	13.33	46.67	86.67	90.00	90.00	93.33	
				LD*	3.33	56.67	63.33	86.67	93.33	96.67	96.67	
					0.00	46.67	53.33	76.67	76.67	76.67	76.67	
			0.50(MeCOMe)	TA-LD	0.00	3.33	6.67	10.00	23.33	23.33	36.67	
					0.00	0.00	3.33	6.67	13.33	13.33	26.67	
				TA-LD*	3.33	40.00	63.33	80.00	93.33	96.67	100.00	
					3.33	36.67	50.00	70.00	90.00	93.33	86.67	
				LD	20.00	20.00	56.67	90.00	93.33	93.33	100.00	
					20.00	20.00	60.67	86.67	93.67	80.67	[illegible]	
				LD*	13.33	46.67	60.00	66.67	73.00	[illegible]	[illegible]	
					3.33	[illegible]	[illegible]	6.67	[illegible]	[illegible]	[illegible]	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Wedelia trilobata (1'st test)	whole	total	0.25(MeCOMe)	TA-LD	0.00	0.00	3.33	10.00	26.67	66.67	80.00	
					0.00	0.00	3.33	10.00	26.67	66.67	80.00	
				TA-LD*	0.00	10.00	13.33	46.67	53.33	80.00	83.33	* with piperonyl butoxide
					0.00	10.00	13.33	46.67	53.33	80.00	83.33	(25% of tested sample)
				LD	0.00	0.00	0.00	0.00	3.33	6.67	26.67	
					0.00	0.00	0.00	0.00	3.33	3.33	6.67	
				LD*	0.00	0.00	0.00	0.00	16.67	26.67	26.67	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			0.125(MeCOMe)	TA-LD	0.00	0.00	0.00	40.00	43.33	53.33	63.33	
					0.00	0.00	0.00	40.00	43.33	50.00	60.00	
				TA-LD*	0.00	0.00	3.33	16.67	26.67	66.67	80.00	
					0.00	0.00	3.33	16.67	26.67	66.67	80.00	
				LD	3.33	3.33	3.33	3.33	16.67	26.67	26.67	
					0.00	0.00	0.00	0.00	13.33	20.00	20.00	
				LD*	0.00	0.00	0.00	0.00	0.00	0.00	26.67	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			MeCOMe	TA-LD	13.33	13.33	13.33	16.67	16.67	26.67	33.33	
					0.00	0.00	0.00	3.33	3.33	10.00	16.67	
				TA-LD*	0.00	0.00	0.00	23.33	33.33	33.33	46.67	*with 0.25% piperonyl
					0.00	0.00	0.00	23.33	30.00	30.00	33.33	butoxide
				LD	0.00	0.00	0.00	0.00	6.67	13.33	13.33	
					0.00	0.00	0.00	0.00	6.67	6.67	6.67	
				LD*	0.00	0.00	0.00	3.33	3.33	3.33	3.33	
					0.00	0.00	0.00	3.33	3.33	3.33	3.33	

Table II contd.

Screening of Activity of Plant Steam Distillates on Spodoptera litura Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Wedelia trilobata (2'nd test)	whole	total	MeCOMe	TA-LD	0.00	0.00	3.33	6.67	10.00	10.00	10.00	
					0.00	0.00	0.00	3.33	6.67	6.67	6.67	
				TA-LD*	6.67	43.33	53.33	53.33	53.33	53.33	53.33	*with 0.25% piperonyl
					3.33	23.33	53.33	53.33	53.33	53.33	53.33	butoxide
				LD	0.00	3.33	6.67	13.33	23.33	33.33	36.67	
					0.00	3.33	3.33	10.00	13.33	16.67	20.00	
				LD*	6.67	20.00	23.33	46.67	53.33	53.33	53.33	
					0.00	13.33	16.67	33.33	40.00	40.00	40.00	
Wedelia trilobata (1'st test)	whole	total	1.00(MeCOMe)	TA-LD	0.00	6.67	13.33	40.00	46.67	56.67	80.00	
					0.00	6.67	13.33	40.00	46.67	56.67	80.00	
				TA-LD*	0.00	20.00	20.00	23.33	30.00	36.67	43.33	*with piperonyl butoxide
					0.00	16.67	16.67	20.00	26.67	33.33	40.00	(25% of tested sample)
				LD	0.00	0.00	0.00	0.00	10.00	13.33	23.33	
					0.00	0.00	0.00	0.00	10.00	10.00	10.00	
				LD*	10.00	10.00	10.00	10.00	10.00	16.67	23.33	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			0.75(MeCOMe)	TA-LD	0.00	0.00	0.00	40.00	40.00	53.33	66.67	
					0.00	0.00	0.00	40.00	40.00	53.33	66.67	
				TA-LD*	6.67	6.67	10.00	36.67	43.33	73.33	80.00	
					6.67	6.67	10.00	36.67	43.33	73.33	80.00	
				LD	0.00	0.00	0.00	0.00	0.00	0.00	20.00	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
				LD*	0.00	0.00	0.00	0.00	0.00	0.00	3.33	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			0.50(MeCOMe)	TA-LD	0.00	0.00	0.00	53.33	60.00	60.00	66.67	
					0.00	0.00	0.00	53.33	60.00	60.00	66.67	
				TA-LD*	6.67	6.67	6.67	26.67	30.00	63.33	63.33	
					6.67	6.67	6.67	26.67	30.00	63.33	63.33	
				LD	0.00	0.00	0.00	3.33	3.33	6.67	13.33	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
				LD*	0.00	0.00	0.00	0.00	6.67	10.00	16.67	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Zingiber purpureum	rhizome	total	2.00(MeCOMe)	TA-LD	70.00	90.00	93.33	96.67	96.67	100.00	-	
					70.00	90.00	93.33	96.67	96.67	100.00	-	
				TA-LD*	100.00	-	-	-	-	-	-	*with piperonyl butoxide
					100.00	-	-	-	-	-	-	(25% of tested sample)
				LD	33.33	73.33	80.00	96.67	96.67	96.67	96.67	
					33.33	73.33	80.00	93.33	93.33	93.33	93.33	
				LD*	46.67	80.00	93.33	100.00	-	-	-	
					46.67	73.33	86.67	93.33	-	-	-	
			1.00(MeCOMe)	TA-LD	50.00	63.33	66.67	73.33	73.33	76.67	80.00	
					50.00	63.33	66.67	73.33	73.33	76.67	80.00	
				TA-LD*	53.33	63.33	76.67	90.00	96.67	96.67	100.00	
					53.33	63.33	73.33	86.67	93.33	93.33	96.67	
				LD	36.67	66.67	73.33	76.67	76.67	80.00	80.00	larvae size 1/5
					33.33	50.00	56.67	60.00	60.00	63.33	63.33	
				LD*	43.33	83.33	96.67	100.00	-	-	-	
					43.33	80.00	93.33	96.67	-	-	-	
			0.75(MeCOMe)	TA-LD	20.00	33.33	43.33	56.67	66.67	73.33	73.33	larvae size 1/4
					20.00	33.33	43.33	56.67	66.67	73.33	73.33	
				TA-LD*	40.00	56.67	66.67	76.67	96.67	100.00	-	
					40.00	56.67	66.67	76.67	96.67	100.00	-	
				LD	23.33	43.33	46.67	56.67	63.33	70.00	76.67	larvae size 1/4
					10.00	23.33	26.67	36.67	43.33	50.00	56.67	
				LD*	46.67	60.00	63.33	66.67	76.67	80.00	80.00	larvae size 1/4
					43.33	56.67	60.00	63.33	73.33	76.67	76.67	
			0.50(MeCOMe)	TA-LD	13.33	23.33	23.33	30.00	30.00	40.00	43.33	
					3.33	13.33	13.33	20.00	20.00	30.00	30.00	
				TA-LD*	20.00	40.00	50.00	76.67	80.00	86.67	86.67	larvae size 1/3
					16.67	36.67	43.33	70.00	73.33	80.00	80.00	
				LD	10.00	13.33	20.00	23.33	30.00	43.33	46.67	
					10.00	13.33	20.00	23.33	30.00	43.33	46.67	
				LD*	26.67	70.00	80.00	90.00	93.33	93.33	100.00	
					23.33	63.33	73.33	83.33	86.67	86.67	93.33	

Table VI contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Zingiber purpureum	rhizome	total	0.25(MeCOMe)	TA-LD	16.67	23.33	26.67	26.67	36.67	36.67	40.00	larvae size 1/2
					3.33	10.00	13.33	13.33	23.33	23.33	26.67	
				TA-LD*	3.33	23.33	36.67	43.33	50.00	63.33	66.67	*with piperonyl butoxide
					3.33	23.33	36.67	43.33	50.00	63.33	66.67	(25% of tested sample)
				LD	3.33	10.00	10.00	13.33	30.00	33.33	36.67	
					3.33	10.00	10.00	13.33	26.67	30.00	30.00	
				LD*	6.67	13.33	16.67	23.33	23.33	33.33	46.67	larvae size 1/3
					6.67	13.33	16.67	20.00	20.00	26.67	40.00	
			0.125(MeCOMe)	TA-LD	10.00	20.00	26.67	30.00	50.00	63.33	63.33	
					10.00	20.00	26.67	30.00	43.33	56.67	56.67	
				TA-LD*	0.00	10.00	20.00	36.67	36.67	50.00	50.00	
					0.00	10.00	20.00	36.67	36.67	50.00	50.00	
				LD	10.00	13.33	16.67	16.67	20.00	23.33	26.67	
					6.67	10.00	10.00	10.00	13.33	16.67	16.67	
				LD*	10.00	16.67	26.67	26.67	33.33	46.67	63.33	larvae size 1/2
					6.67	13.33	16.67	16.67	20.00	33.33	36.67	
			MeCOMe	TA-LD	0.00	10.00	13.33	13.33	20.00	23.33	26.67	
					0.00	3.33	6.67	6.67	13.33	16.67	20.00	
				TA-LD*	23.33	50.00	56.67	66.67	70.00	73.33	76.67	*with 0.25% piperonyl
					20.00	46.67	50.00	56.67	60.00	63.33	63.33	butoxide
				LD	0.00	3.33	3.33	6.67	13.33	16.67	20.00	
					0.00	3.33	3.33	6.67	6.67	10.00	10.00	
				LD*	10.00	30.00	43.33	56.67	70.00	73.33	76.67	
					10.00	20.00	30.00	36.67	46.67	50.00	53.33	
Zingiber zerumbet	rhizome	total	2.00(MeCOMe)	TA-LD	90.00	100.00	-	-	-	-	-	
					90.00	100.00	-	-	-	-	-	
				TA-LD*	100.00	-	-	-	-	-	-	*with piperonyl butoxide
					100.00	-	-	-	-	-	-	(25% of tested sample)
				LD	26.67	76.67	86.67	86.67	90.00	96.67	96.67	larvae size 1/5
					26.67	76.67	86.67	86.67	90.00	96.67	96.67	
				LD*	50.00	66.67	73.33	83.33	93.33	96.67	96.67	
					50.00	66.67	73.33	76.67	83.33	86.67	86.67	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Zingiber zerumbet	rhizome	total	1.00(MeCOMe)	TA-LD	96.67	100.00	-	-	-	-	-	
					96.67	100.00	-	-	-	-	-	
				TA-LD*	53.33	76.67	83.33	86.67	100.00	-	-	* with piperonyl butoxide
					53.33	76.67	76.67	80.00	93.33	-	-	(25% of tested sample)
				LD	6.67	20.00	20.00	20.00	43.33	53.33	56.67	
					6.67	20.00	20.00	20.00	33.33	43.33	46.67	
				LD*	23.33	33.33	33.33	36.67	43.33	46.67	56.67	
					23.33	33.33	33.33	36.67	36.67	40.00	46.67	
			0.75(MeCOMe)	TA-LD	93.33	100.00	-	-	-	-	-	
					93.33	100.00	-	-	-	-	-	
				TA-LD*	60.00	83.33	90.00	100.00	-	-	-	
					60.00	83.33	83.33	90.00	-	-	-	
				LD	13.33	30.00	40.00	56.67	73.33	76.67	76.67	larvae size 1/5
					13.33	30.00	40.00	53.33	70.00	73.33	73.33	
				LD*	6.67	16.67	30.00	36.67	60.00	63.34	70.00	
					6.67	16.67	13.33	30.00	53.33	56.67	63.33	
			0.50(MeCOMe)	TA-LD	20.00	66.67	70.00	73.33	83.33	93.33	93.33	
					20.00	66.67	70.00	73.33	80.00	86.67	86.67	
				TA-LD*	23.33	80.00	90.00	90.00	96.67	96.67	96.67	
					23.33	80.00	90.00	90.00	93.33	93.33	93.33	
				LD	10.00	33.33	53.33	56.67	63.33	66.67	80.00	
					10.00	23.33	43.33	46.67	60.00	63.33	66.67	
				LD*	23.33	40.00	100.00	-	-	-	-	
					6.67	33.33	83.33	-	-	-	-	
			0.25(MeCOMe)	TA-LD	10.00	46.67	76.67	90.00	90.00	93.33	93.33	
					3.33	40.00	70.00	83.33	83.33	86.67	86.67	
				TA-LD*	6.67	33.33	46.67	66.67	76.67	83.33	83.33	
					6.67	33.33	46.67	66.67	73.33	80.00	80.00	
				LD	0.00	13.33	23.33	30.00	36.67	50.00	53.33	
					0.00	13.33	23.33	30.00	36.67	50.00	50.00	
				LD*	6.67	30.00	43.33	73.33	76.67	80.00	86.67	
					3.33	26.67	40.00	70.00	73.33	76.67	83.33	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Zingiber zerumbet	rhizome	total	0.125(MeCOMe)	TA-LD	3.33	36.67	60.00	63.33	66.67	66.67	73.33	
					3.33	36.67	60.00	63.33	66.67	66.67	66.67	
				TA-LD*	13.33	33.33	43.33	56.67	63.33	73.33	83.33	* with piperonyl butoxide
					10.00	30.00	40.00	46.67	56.67	66.67	76.67	(25% of tested sample)
				LD	0.00	23.33	56.67	56.67	70.00	80.00	80.00	
					0.00	23.33	56.67	56.67	60.00	63.33	63.33	
				LD*	23.33	30.00	56.67	60.00	70.00	73.33	80.00	
					13.33	20.00	46.67	50.00	60.00	63.33	70.00	
			MeCOMe	TA-LD	13.33	13.33	13.33	13.33	13.33	13.33	13.33	
					13.33	13.33	13.33	13.33	13.33	13.33	13.33	
				TA-LD*	0.00	43.33	60.00	63.33	80.00	80.00	80.00	*with 0.25% piperonyl
					0.00	23.33	33.33	33.33	50.00	50.00	50.00	butoxide
				LD	0.00	0.00	0.00	0.00	3.33	3.33	6.67	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
				LD*	0.00	3.33	10.00	13.34	30.00	30.00	33.33	
					0.00	0.00	3.33	6.67	10.00	10.00	10.00	
Wedelia trilobata +	whole	total	1.00(MeCOMe)	TA-LD	40.00	60.00	100.00	-	-	-	-	
Ageratum conyzoides (1:1)	whole				40.00	60.00	100.00	-	-	-	-	
				LD	30.00	83.33	96.67	100.00	-	-	-	
					30.00	83.33	96.67	100.00	-	-	-	
			0.75(MeCOMe)	TA-LD	30.00	60.00	80.00	86.67	96.67	96.67	96.67	larvae size 1/5
					30.00	60.00	80.00	86.67	96.67	96.67	96.67	
				LD	20.00	73.33	86.67	90.00	93.33	100.00	-	
					16.67	56.67	70.00	73.33	76.67	86.67	-	
			0.50(MeCOMe)	TA-LD	0.00	3.33	16.67	26.67	50.00	63.33	70.00	larvae size 1/4
					0.00	3.33	16.67	26.67	46.67	60.00	66.67	
				LD	3.33	16.67	43.33	56.67	60.00	80.00	80.00	larvae size 1/3
					3.33	16.67	43.33	56.67	60.00	80.00	80.00	

Table II contd.

Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Fabr.

PLANT SPECIES	PART	FRANCTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY Day 1	2	3	4	5	6	7	REMARK
Wedelia trilobata +	whole	total	0.25(MeCOMe)	TA-LD	6.67	23.33	36.67	46.67	46.67	56.67	56.67	larvae size 1/3
					6.67	23.33	36.67	46.67	46.67	56.67	56.67	
Ageratum convzoides (1:1)	whole			LD	0.00	3.33	10.00	16.67	20.00	36.67	40.00	
					0.00	0.00	6.67	13.33	16.67	33.33	33.33	
			0.125(MeCOMe)	TA-LD	3.33	6.67	16.67	33.33	36.67	40.00	40.00	larvae size 1/2
					3.33	6.67	13.33	16.67	30.00	33.33	33.33	
				LD	10.00	10.00	13.33	16.67	20.00	36.67	36.67	
					0.00	0.00	3.33	6.67	10.00	26.67	26.67	
			MeCOMe	TA-LD	6.67	13.33	13.33	16.67	20.00	26.67	26.67	
					3.33	10.00	10.00	13.33	13.33	13.33	13.33	
				LD	3.33	6.67	10.00	10.00	10.00	13.33	20.00	
					0.00	0.00	3.33	3.33	3.33	3.33	3.33	
Wedelia trilobata +	whole	total	1.00(MeCOMe)	TA-LD	30.00	36.67	46.67	60.00	66.67	83.33	83.33	larvae size 1/2
					30.00	36.67	46.67	60.00	66.67	83.33	83.33	
Zingiber zerumbet (1:1)	whole			LD	3.33	10.00	23.33	30.00	46.67	56.67	63.33	larvae size 1/4
					3.33	10.00	23.33	30.00	46.67	56.67	63.33	
			0.75(MeCOMe)	TA-LD	23.33	23.33	23.33	33.33	56.67	60.00	63.33	larvae size 1/4
					23.33	23.33	23.33	30.00	46.67	50.00	53.33	
				LD	3.33	6.67	13.33	20.00	20.00	23.33	40.00	
					3.33	3.33	6.67	13.33	13.33	16.67	33.33	
			0.50(MeCOMe)	TA-LD	6.67	30.00	33.33	43.33	50.00	53.33	60.00	larvae size 1/2
					6.67	30.00	33.33	40.00	46.67	50.00	56.67	
				LD	10.00	20.00	40.00	45.67	53.33	66.67	70.00	
					10.00	20.00	40.00	46.67	53.33	66.67	70.00	
			0.25(MeCOMe)	TA-LD	6.67	13.33	13.33	43.33	66.67	70.00	73.33	
					6.67	13.33	13.33	43.33	63.33	66.67	70.00	
				LD	6.67	20.00	33.33	46.67	53.33	70.00	76.67	
					6.67	10.00	20.00	33.33	40.00	56.67	60.00	
			0.125(MeCOMe)	TA-LD	10.00	10.00	16.67	23.33	26.67	36.67	50.00	
					10.00	10.00	16.67	20.00	20.00	30.00	43.33	
				LD	0.00	10.00	20.00	30.00	40.00	76.67	80.00	
					0.00	10.00	20.00	30.00	40.00	66.67	70.00	
			MeCOMe	TA-LD	6.67	10.00	13.33	16.67	20.00	26.67	26.67	
					3.33	6.67	10.00	10.00	10.00	13.33	20.00	
				LD	3.33	6.67	10.00	10.00	10.00	13.33	20.00	
					0.00	0.00	3.33	3.33	3.33	3.33	3.33	

Table III

Activity of Compounds on *Spodoptera litura* Fabr.

Note : Results in the second line of each test are obtained by substracting the number of larvae lost by escaping or cannabilized.

Compounds	%Conc(Solv)	Test Method	Accumulative % Mortality Day 1	2	3	4	5	6	7	Remark
4-(3',4'-dimethoxyphenyl)- buta -1,3-diene (1'st test)	2.00(MeCOMe)	TA-LD	43.33	96.67	100.00	-	-	-	-	
			43.33	96.67	100.00	-	-	-	-	
		TA-LD*	86.67	100.00	-	-	-	-	-	*with piperonyl butoxide (25% of tested sample)
			86.67	100.00	-	-	-	-	-	
		LD	33.33	93.33	100.00	-	-	-	-	
			26.67	86.67	93.33	-	-	-	-	
		LD*	23.33	76.67	100.00	-	-	-	-	
			23.33	76.67	100.00	-	-	-	-	
	1.00(MeCOMe)	TA	43.33	46.67	53.33	53.33	53.33	53.33	53.33	
			43.33	43.33	43.33	43.33	43.33	43.33	43.33	
		TA-LD	6.67	36.67	86.67	96.67	100.00	-	-	
			6.67	36.67	86.67	96.67	100.00	-	-	
		TA-LD*	46.67	93.33	100.00	-	-	-	-	
			46.67	93.33	100.00	-	-	-	-	
		LD	3.33	40.00	73.33	100.00	-	-	-	
			3.33	40.00	73.33	100.00	-	-	-	
		LD*	6.67	50.00	83.33	100.00	-	-	-	
			6.67	50.00	83.33	96.67	-	-	-	
	0.75(MeCOMe)	TA	16.67	23.33	36.67	36.67	36.67	36.67	36.67	
			16.67	16.67	16.67	16.67	16.67	16.67	16.67	
		TA-LD	20.00	56.67	90.00	96.67	100.00	-	-	
			20.00	53.33	86.67	93.33	96.67	-	-	
		TA-LD*	33.33	90.00	100.00	-	-	-	-	
			33.33	90.00	100.00	-	-	-	-	
		LD	3.33	73.33	90.00	96.67	100.00	-	-	
			3.33	66.67	83.33	90.00	93.33	-	-	
		LD*	6.67	63.33	83.33	93.33	100.00	-	-	
			6.67	63.33	83.33	93.33	96.67	-	-	
	0.50(MeCOMe)	TA	3.33	6.67	13.33	13.33	13.33	13.33	13.33	
			3.33	6.67	6.67	6.67	6.67	6.67	6.67	
		TA-LD	10.00	36.67	70.00	93.33	100.00	-	-	
			10.00	30.00	63.33	83.33	90.00	-	-	
		TA-LD*	40.00	80.00	100.00	-	-	-	-	
			36.67	76.67	96.67	-	-	-	-	
		LD	10.00	20.00	53.33	70.00	80.00	93.33	96.67	
			0.00	16.67	36.67	43.33	50.00	63.33	66.67	

Activity of Compounds on *Spodoptera litura* Fabr.

Compounds	%Conc(Solv)	Test Method	Accumulative % Mortality Day 1	2	3	4	5	6	7	Remark
4-(3',4'-dimethoxyphenyl)- buta -1,3-diene (1'st test)	0.25(MeCOMe)	LD*	13.33	50.00	83.33	90.00	100.00	-	-	* with piperonyl butoxide
			13.33	40.00	73.33	83.33	80.00	-	-	(25% of tested sample)
		TA	3.33	6.67	43.33	43.33	43.33	43.33	43.33	
			3.33	3.33	3.33	3.33	3.33	3.33	3.33	
		TA-LD	13.33	20.00	20.00	23.33	30.00	36.67	46.67	
			13.33	20.00	20.00	23.33	26.67	33.33	43.33	
		TA-LD*	0.00	0.00	0.00	3.33	6.67	6.67	16.67	
			0.00	0.00	0.00	3.33	6.67	6.67	16.67	
		LD	0.00	3.33	10.00	36.67	63.33	90.00	96.67	
			0.00	3.33	10.00	36.67	63.33	90.00	96.67	
		LD*	6.67	6.67	23.33	33.33	73.33	83.33	100.00	
			6.67	6.67	23.33	23.33	73.33	83.33	93.33	
	0.125(MeCOMe)	TA	10.00	10.00	23.33	23.33	23.33	23.33	23.33	
			0.00	0.00	3.33	3.33	3.33	3.33	3.33	
		TA-LD	0.00	0.00	0.00	0.00	6.67	16.67	33.33	
			0.00	0.00	0.00	0.00	6.67	10.00	20.00	
		TA-LD*	0.00	0.00	0.00	6.67	10.00	20.00	20.00	
			0.00	0.00	0.00	6.67	6.67	6.67	6.67	
		LD	0.00	0.00	0.00	13.33	70.00	76.67	76.67	
			0.00	0.00	0.00	13.33	70.00	76.67	76.67	
		LD*	10.00	13.33	23.33	43.33	76.67	80.00	83.33	
			10.00	13.33	23.33	43.33	76.67	80.00	83.33	
	MeCOMe	TA-LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		TA-LD*	6.67	43.33	53.33	53.33	53.33	53.33	53.33	* with 0.25% piperonyl butoxide
			3.33	23.33	33.33	33.33	33.33	33.33	33.33	
		LD	6.67	6.67	6.67	6.67	6.67	10.00	10.00	
			6.67	6.67	6.67	6.67	6.67	10.00	10.00	
		LD*	6.67	20.00	23.33	46.67	53.33	53.33	53.33	
			6.67	13.33	16.67	33.33	40.00	40.00	40.00	
4-(3',4'-methylenedioxy phenyl)-buta -1,3-diene (1'st test)	2.00(MeCOMe)	TA-LD	100.00	-	-	-	-	-	-	
			100.00	-	-	-	-	-	-	
		TA-LD*	100.00	-	-	-	-	-	-	*with piperonyl butoxide
			100.00	-	-	-	-	-	-	(25% of tested sample)
		LD	90.00	100.00	-	-	-	-	-	
			90.00	100.00	-	-	-	-	-	
		LD*	96.67	100.00	-	-	-	-	-	
			96.67	100.00	-	-	-	-	-	

Activity of Compounds on *Spodoptera litura* Fabr.

Compounds	%Conc(Solv)	Test Method	Accumulative % Mortality							Remark
			Day 1	2	3	4	5	6	7	
4-(3',4'-methylenedioxy phenyl)-buta -1,3-diene (1'st test)	1.00(MeCOMe)	TA	66.67	70.00	73.33	73.33	73.33	73.33	73.33	
			66.67	70.00	73.33	73.33	73.33	73.33	73.33	
		TA-LD	100.00	-	-	-	-	-	-	
			100.00	-	-	-	-	-	-	
		TA-LD*	100.00	-	-	-	-	-	-	
			100.00	-	-	-	-	-	-	*with piperonyl butoxide (25% of tested sample)
		LD	96.67	100.00	-	-	-	-	-	
			96.67	100.00	-	-	-	-	-	
		LD*	100.00	-	-	-	-	-	-	
			100.00	-	-	-	-	-	-	
	0.75(MeCOMe)	TA	33.33	36.67	46.67	46.67	46.67	46.67	46.67	
			33.33	36.67	36.67	36.67	36.67	36.67	36.67	
		TA-LD	86.67	96.67	100.00	-	-	-	-	
			86.67	96.67	100.00	-	-	-	-	
		TA-LD*	96.67	100.00	-	-	-	-	-	
			96.67	100.00	-	-	-	-	-	
		LD	53.33	76.67	100.00	-	-	-	-	
			53.33	76.67	100.00	-	-	-	-	
		LD*	96.67	100.00	-	-	-	-	-	
			96.67	100.00	-	-	-	-	-	
	0.50(MeCOMe)	TA	30.00	36.67	43.33	43.33	43.33	43.33	43.33	
			30.00	36.67	36.67	36.67	36.67	36.67	36.67	
		TA-LD	76.67	93.33	96.67	100.00	-	-	-	
			76.67	93.33	96.67	100.00	-	-	-	
		TA-LD*	80.00	93.33	96.67	100.00	-	-	-	
			80.00	93.33	96.67	100.00	-	-	-	
		LD	36.67	46.67	96.67	100.00	-	-	-	
			36.67	46.67	96.67	100.00	-	-	-	
		LD*	63.33	73.33	96.67	96.67	100.00	-	-	
			63.33	73.33	93.33	93.33	96.67	-	-	
	0.25(MeCOMe)	TA	6.67	10.00	23.33	23.33	23.33	23.33	23.33	
			6.67	10.00	10.00	10.00	10.00	10.00	10.00	
		TA-LD	3.33	6.67	10.00	60.00	76.67	90.00	100.00	
			3.33	6.67	10.00	60.00	76.67	86.67	96.67	
		TA-LD*	33.33	73.33	83.33	93.33	93.33	96.67	96.67	
			33.33	73.33	83.33	93.33	93.33	96.67	96.67	
		LD	46.67	53.33	76.67	86.67	93.33	96.67	100.00	
			46.67	53.33	76.67	86.67	93.33	96.67	100.00	

Activity of Compounds on *Spodoptera litura* Fabr.

Compounds	%Conc(Solv)	Test Method	Accumulative % Mortality							Remark
			Day 1	2	3	4	5	6	7	
4-(3',4'-methylenedioxy phenyl)-buta-1,3-diene (1'st test)	0.25(MeCOMe)	LD*	30.00	30.00	43.33	73.33	83.33	86.67	93.33	* with piperonyl butoxide
			30.00	30.00	43.33	73.33	83.33	86.67	90.00	(25% of tested sample)
	0.125(MeCOMe)	TA	0.00	0.00	13.33	13.33	13.33	13.33	13.33	
			0.00	0.00	3.33	3.33	3.33	3.33	3.33	
		TA-LD	0.00	3.33	6.67	10.00	26.67	43.33	50.00	
			0.00	3.33	3.33	6.67	20.00	30.00	36.67	
		TA-LD*	6.67	13.33	46.67	70.00	80.00	90.00	96.67	
			6.67	13.33	36.67	60.00	70.00	76.67	83.33	
		LD	3.33	3.33	20.00	23.33	33.33	50.00	60.00	
			3.33	3.33	20.00	23.33	33.33	50.00	56.67	
		LD*	10.00	16.67	30.00	56.67	80.00	96.67	96.67	
			10.00	16.67	30.00	56.67	80.00	90.00	90.00	
	MeCOMe	TA-LD	3.33	3.33	6.67	26.67	26.67	0.39	26.67	
			3.33	3.33	6.67	10.00	10.00	10.00	10.00	
		TA-LD*	10.00	10.00	10.00	30.00	33.33	36.67	40.00	*with 0.25% piperonyl butoxide
			10.00	10.00	10.00	30.00	33.33	33.33	36.67	
		D	3.33	3.33	6.67	26.67	30.00	53.33	60.00	
			3.33	3.33	6.67	23.33	23.33	30.00	36.67	
		D*	6.67	20.00	23.33	46.67	53.33	53.33	46.67	
			6.67	13.33	16.67	33.33	40.00	40.00	40.00	

CONCLUSION/REMARKS

From 1000 tests performed on the 80 plant extracts/fractions, several plants showed promising insecticidal and antifeedant activity on *S. litura*. Four plants were selected for further studies. These are *Zingiber purpureum*, *Zingiber zeumbet*, *Wedelia trilobata* *Ageratum conyzoides*.

The active component from *Z. purpureum* has been identified to be 4-(3',4'-dimethoxyphenyl) but -1,3-diene. The compound and its analogue, 4-(3',4'-methylenedioxyphenyl) but -1,3-diene, have been synthesized and their LC_{50} and LD_{50} values determined.

The steam distillate of *Ageratum conyzoides* contains precocene I and precocene II, which may be the most active components. The LC_{50} of the crude steam distillate was determined to be 0.61% (48 hr), 0.22% (96 hr).

Since the project goal is to find natural insecticide which can be easily prepared in large scale and tested for their application in the field, irrespective of whether they are known or novel compounds, we are not discouraged that no compounds of new structure has been isolated. In fact, it is our preference that the active molecules identified so far are of simple structures since this will lead to convenient syntheses, and consequently to their possible application at low cost. The marked activity of the crude steam distillate from *Ageratum conyzoides*, which is a common weed, is also promising. With appropriate formulation and suitable addition of synergists, this weed may be directly used for crop protection by small farmers.

WORKPLAN FOR THE NEXT PERIOD

Since plants in the Zingiberraceae Family are specified as the primary target plants in the proposal and that interesting results have already been obtained from the steam distillates of some species in the Family, further work will be concentrated on the steam distillates of other species in this Family. The active components may or may not be obtainable in large scale by extraction, but the syntheses of these substances and of the more active analogues can be easily acheived. Additional analogues of the active component from *Z. purpureum* will also be synthesized for testing.

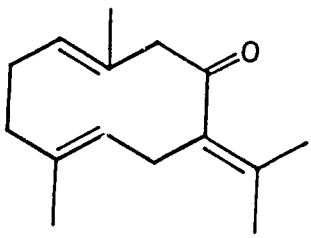
For *Wedelia trilobata* and *Ageratum conyzoides* which are the commonly grown and easily cultivated plants, effort will be made on identifying the active components and on assessing the direct applicability of the crude steam distillates.

PROGRESS REPORT 2

Reporting Period : 1 June 1986 - 30 November 1986

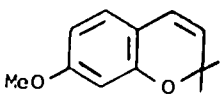
RESULTS/DISCUSSION/TABLES

From the previous findings, steam distillates of Zingiberraceous plants exhibited better insecticidal activity than the fractions obtained from solvent extraction. The steam distillates of 16 Zingiberraceous plants were then obtained for testing (Table I), together with the steam distillates of 4 common weeds (Table II). Tests were also done on the fractions obtained from solvent extraction of the residue from steam distillation of the 16 Zingiberraceous plants (Table I). The resullts showed that the steam distillates of all the tested Zingiberraceous plants were the active fractions. Of these, the best activity was obtained from a species tentatively identified as 'Kaidum'. The active principle isolated was identified spectroscopically as germacrone.



germacrone

Additional work has been done on *Ageratum conyzoides*. Although the data on the LC_{50} of the active components is still confusing and need repeating, the spectroscopic data confirms that they are precocene I and precocene II.



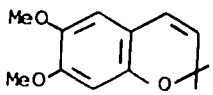


Table here

Table Explanation

TA-LD	=	Topical application and Leaf dipping	LD	=	Leaf dipping
			CT	=	Chromatotron
QC	=	Quick column chromatography	MeCOMe	=	Acetone
C_6H_{14}	=	Hexane	CH_2Cl_2	=	Dichloromethane

Note: Results in the second line of each test are obtained by substracting the number of larvae lost by escaping or cannabilized.

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera Litura* Fabr.(Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST-METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Alpinia mutica	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	30.00	46.67	66.67	90.00	90.00	93.33	
					0.00	30.00	46.67	66.67	90.00	90.00	93.33	
				LD	3.33	86.67	86.67	96.67	96.67	96.67	96.67	
					3.33	86.67	86.67	96.67	96.67	96.67	96.67	
			0.75(MeCOMe)	TA-LD	6.67	10.00	30.00	46.67	56.67	56.67	66.67	
					6.67	10.00	30.00	36.67	40.00	40.00	40.00	
				LD	3.33	6.67	6.67	10.00	30.00	56.67	43.33	
					3.33	3.33	3.33	6.67	13.33	13.33	16.67	
			0.50(MeCOMe)	TA-LD	3.33	10.00	16.67	23.33	33.33	70.00	70.00	
					3.33	6.67	13.33	16.67	23.33	43.33	43.33	
				LD	6.67	6.67	10.00	16.67	26.67	26.67	36.67	
					0.00	0.00	3.33	3.33	6.67	6.67	6.67	
			0.25(MeCOMe)	TA-LD	3.33	13.33	30.00	33.33	16.67	66.67	76.67	
					3.33	6.67	23.33	23.33	26.67	30.00	30.00	
				LD	3.33	3.33	3.33	6.67	26.67	43.33	56.67	
					0.00	0.00	0.00	0.00	13.33	20.00	20.00	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	6.67	13.33	13.33	13.33	20.00	30.00	larvae size 1/4
					0.00	6.67	6.67	6.67	6.67	10.00	13.33	
				LD	0.00	0.00	0.00	0.00	3.33	20.00	20.00	larvae size 1/4
					0.00	0.00	0.00	0.00	3.33	20.00	20.00	
Amomum occaleatum	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	6.67	16.67	30.00	66.67	76.67	76.67	
					0.00	6.67	16.67	26.67	26.67	26.67	26.67	
				LD	3.33	20.00	20.00	23.33	30.00	33.33	53.33	
					3.33	3.33	3.33	6.67	10.00	10.00	10.00	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	0.00	3.33	3.33	3.33	6.67	20.00	
					0.00	0.00	3.33	3.33	3.33	6.67	20.00	
				LD	0.00	0.00	0.00	0.00	3.33	6.67	20.00	
					0.00	0.00	0.00	0.00	3.33	6.67	20.00	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera Litura* Fabr.(Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Amomum aff. *testaceum*	rhizome	total	1.00(MeCOMe)	TA-LD	3.33	3.33	3.33	10.00	13.33	26.67	40.00	larvae size 1/3
					3.33	3.33	3.33	3.33	3.33	3.33	3.33	
				LD	0.00	0.00	3.33	10.00	13.33	26.67	50.00	
					0.00	0.00	0.00	3.33	3.33	3.33	13.33	
Amomum hastilabium	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	3.33	26.67	53.33	56.67	76.67	83.33	
					0.00	3.33	26.67	40.00	43.33	60.00	63.33	
				LD	0.00	0.00	13.33	40.00	53.33	66.67	93.33	
					0.00	0.00	6.67	10.00	10.00	10.00	33.33	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	3.33	3.33	3.33	3.33	16.67	26.67	
					0.00	3.33	3.33	3.33	3.33	16.67	26.67	
				LD	0.00	0.00	0.00	0.00	0.00	6.67	10.00	
					0.00	0.00	0.00	0.00	0.00	6.67	10.00	
Amomum uliginosum	rhizome	total	1.00(MeCOMe)	TA-LD	6.67	6.67	10.00	13.33	30.00	36.67	46.67	
					6.67	6.67	6.67	6.67	6.67	6.67	10.00	
				LD	3.33	3.33	3.33	6.67	13.33	20.00	33.33	
					3.33	3.33	3.33	3.33	3.33	3.33	3.33	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	3.33	26.67	26.67	30.00	36.67	36.67	36.67	
					0.00	23.33	23.33	23.33	23.33	23.33	23.33	
				LD	0.00	0.00	0.00	16.67	23.33	23.33	23.33	
					0.00	0.00	0.00	16.67	23.33	23.33	23.33	
Boesenbergia basispicata	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	6.67	30.00	30.00	33.33	46.67	56.67	
					0.00	6.67	20.00	20.00	26.67	26.67	26.67	
				LD	0.00	3.33	13.33	13.33	30.00	40.00	56.67	
					0.00	3.33	13.33	13.33	16.67	20.00	23.33	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera Litura* Fabr.(Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Boesenbergia basispicata	rhizome	residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	3.33	3.33	3.33	10.00	10.00	10.00	
					0.00	3.33	3.33	3.33	3.33	3.33	3.33	
				LD	3.33	6.67	10.00	16.67	20.00	36.67	36.67	
					0.00	3.33	3.33	10.00	10.00	10.00	10.00	
Costus speciosus	rhizome	residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	0.00	3.33	3.33	3.33	13.33	30.00	
					0.00	0.00	3.33	3.33	3.33	3.33	3.33	
				LD	0.00	3.33	3.33	3.33	6.67	6.67	23.33	
					0.00	0.00	0.0 0	0.00	3.33	3.33	3.33	
Etettariopsis curtisii	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	0.00	50.00	56.67	76.67	76.67	80.00	
					0.00	0.00	50.00	56.67	60.00	60.00	63.33	
				LD	0.00	0.00	0.00	3.33	20.00	33.33	46.67	
					0.00	0.00	0.00	0.00	0.00	6.67	10.00	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	6.67	6.67	6.67	6.67	10.00	13.33	23.33	
					3.33	3.33	3.33	3.33	3.33	3.33	3.33	
				LD	0.00	0.00	0.00	0.00	3.33	23.33	43.33	
					0.00	0.00	0.00	0.00	0.00	3.33	3.33	
Etlingera littoralis	rhizome	total	1.00(MeCOMe)	TA-LD	6.67	40.00	63.33	73.33	80.00	93.33	93.33	
					6.67	40.00	63.33	73.33	76.67	83.33	83.33	
				LD	0.00	0.00	3.33	20.00	33.33	46.67	56.67	
					0.00	0.00	0.00	6.67	6.67	10.00	13.33	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	3.33	3.33	3.33	3.33	10.00	26.67	40.00	
					0.00	0.00	0.00	0.00	6.67	13.33	13.33	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera Litura* Fabr.(Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Etlingera littoralis	rhizome	MeCOMe	5.00(MeCOMe)	LD	3.33	3.33	3.33	6.67	10.00	13.33	20.00	
Etlingera mainyayi	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
					0.00	0.00	0.00	6.67	33.33	43.33	43.33	
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
					0.00	16.67	16.67	20.00	33.33	56.67	63.33	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	10.00	10.00	10.00	16.67	16.67	16.67	
					0.00	0.00	3.33	3.33	3.33	3.33	3.33	
				LD	3.33	3.33	10.00	10.00	13.33	20.00	30.00	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Etlingera venusta	rhizome	total	1.00(MeCOMe)	TA-LD	3.33	6.67	6.67	6.67	10.00	10.00	13.33	
					3.33	6.67	33.33	60.00	76.67	76.67	86.67	
				LD	3.33	6.67	33.33	36.67	36.67	36.67	43.33	
					0.00	6.67	23.33	33.33	46.67	66.67	73.33	
Kaidum	rhizome	total	1.00(MeCOMe)	TA-LD	0.00	6.67	23.33	23.33	30.00	40.00	40.00	
					86.67	100.00	-	-	-	-	-	
				LD	86.67	100.00	-	-	-	-	-	
					26.67	80.00	100.00	-	-	-	-	
			0.75(MeCOMe)	TA-LD	26.67	80.00	100.00	-	-	-	-	
					16.67	20.00	23.33	26.67	26.67	40.00	60.00	larvae size 1/3
				LD	0.00	3.33	6.67	10.00	10.00	16.67	20.00	
					0.00	0.00	3.33	3.33	6.67	13.33	30.00	
			0.50(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	0.00	3.33	3.33	
					0.00	0.00	0.00	0.00	16.67	26.67	56.67	larvae size 1/3
				LD	0.00	0.00	0.00	0.00	10.00	13.33	23.33	
					0.00	0.00	3.33	6.67	26.67	30.00	30.00	
			0.25(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	3.33	10.00	10.00	
					0.00	10.00	10.00	13.33	16.67	23.33	36.67	
					0.00	10.00	10.00	13.33	13.33	16.67	23.33	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera Litura* Fabr.(Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Kaidum	rhizome	total	0.25(MeCOMe)	LD	0.00	6.67	13.33	20.00	23.33	36.67	56.67	
		solid	1.00(MeCOMe)	TA-LD	0.00	0.00	6.67	6.67	6.67	13.33	13.33	
					23.33	23.33	23.33	23.33	36.67	43.33	60.00	
				LD	23.33	23.33	23.33	23.33	26.67	30.00	36.67	
					0.00	0.00	0.00	0.00	0.00	6.67	26.67	
		QC-1	1.00(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	0.00	6.67	26.67	
					86.67	90.00	90.00	96.67	96.67	96.67	100.00	
				LD	86.67	86.67	86.67	93.33	93.33	93.33	96.67	
					26.67	66.67	80.00	86.67	93.33	96.67	96.67	
		QC-2	1.00(MeCOMe)	TA-LD	26.67	66.67	80.00	86.67	93.33	96.67	96.67	
					90.00	93.33	93.33	100.00	-	-	-	
				LD	90.00	93.33	93.33	100.00	-	-	-	
					33.33	33.33	90.00	90.00	96.67	96.67	100.00	
		QC-3	1.00(MeCOMe)	TA-LD	33.33	83.33	90.00	90.00	96.67	96.67	100.00	
					100.00	-	-	-	-	-	-	
				LD	100.00	-	-	-	-	-	-	
					20.00	50.00	50.00	70.00	80.00	86.67	96.67	
		liquid	1.00(MeCOMe)	TA-LD	20.00	50.00	50.00	70.00	70.00	70.00	80.00	
					20.00	23.33	23.33	23.33	23.33	26.67	26.67	
				LD	20.00	23.33	23.33	23.33	23.33	26.67	26.67	
					0.00	0.00	0.00	0.00	0.00	6.67	26.67	
		QC-1	1.00(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	0.00	6.67	26.67	
					66.67	93.33	96.67	96.67	100.00	-	-	
				LD	66.67	93.33	96.67	96.67	100.00	-	-	
					26.67	50.00	60.00	76.67	93.33	100.00	-	
		QC-2	1.00(MeCOMe)	TA-LD	26.67	43.33	46.67	60.00	76.67	76.67	-	
					43.33	63.33	70.00	80.00	90.00	93.33	93.33	
					43.33	63.33	70.00	80.00	90.00	93.33	93.33	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Farb. (Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Kaidum	rhizome	QC-2	1.00(MeCOMe)	LD	16.67	66.67	73.33	90.00	96.67	96.67	100.00	
					6.67	66.66	70.00	90.00	96.67	96.67	100.00	
		QC-3	1.00(MeCOMe)	TA-LD	45.67	86.67	86.67	-	-	-	-	
					46.67	86.67	86.67	-	-	-	-	
				LD	0.00	0.00	10.00	-	-	-	-	
					0.00	0.00	0.00	-	-	-	-	
		residue MeCOMe	1.00(MeCOMe)	TA-LD	0.00	0.00	0.00	-	-	-	-	
					0.00	0.00	0.00	-	-	-	-	
				LD	0.00	0.00	0.00	-	-	-	-	
					0.00	0.00	0.00	-	-	-	-	
Unknown	rhizome	total	1.00(MeCOMe)	TA-LD	76.67	76.67	76.67	76.67	76.67	80.00	80.00	
					76.67	76.67	76.67	76.67	76.67	80.00	80.00	
				LD	3.33	3.33	6.67	33.33	43.33	60.00	60.00	
					3.33	3.33	6.67	33.33	43.33	60.00	60.00	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	3.33	6.67	10.00	10.00	20.00	23.33	23.33	larvae size 1/3
					3.33	6.67	6.67	6.67	6.67	6.67	6.67	
				LD	0.00	0.00	0.00	0.00	10.00	13.33	16.67	
					0.00	0.00	0.00	0.00	10.00	13.33	16.67	
Zingiber aff. *multibracteatum* Holtt Var. *multibracteatum*	rhizome	total	1.00(MeCOMe)	TA-LD	13.33	30.00	50.00	60.00	66.67	70.00	76.67	larvae size 1/3
					13.33	30.00	50.00	60.00	66.67	70.00	73.33	
				LD	0.00	6.67	13.33	36.67	50.00	60.00	76.67	
					0.00	3.33	3.33	13.33	20.00	30.00	40.00	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	0.00	6.67	6.67	6.67	20.00	23.33	23.33	
					0.00	0.00	0.00	0.00	6.67	6.67	6.67	
				LD	0.00	0.00	0.00	0.00	16.67	26.67	36.67	larvae size 1/3
					0.00	0.00	0.00	0.00	6.67	6.67	13.33	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Farb. (Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Zingiber officinale	rhizome	total	1.00(MeCOMe)	TA-LD	3.33	3.33	13.33	20.00	23.33	40.00	63.33	larvae size 1/3
					0.00	0.00	10.00	10.00	13.33	23.33	36.67	
				LD	0.00	3.33	6.67	6.67	10.00	16.67	30.00	
					0.00	0.00	3.33	3.33	6.67	6.67	6.67	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	3.33	3.33	3.33	6.67	13.33	20.00	40.00	
					0.00	0.00	0.00	0.00	6.67	10.00	26.67	
				LD	3.33	6.67	6.67	6.67	6.67	23.33	30.00	
					0.00	0.00	3.33	3.33	3.33	10.00	23.33	
Zingiber zerumbet	rhizome	total	1.00(MeCOMe)	TA-LD	53.33	53.33	73.33	93.33	96.67	96.67	96.67	
					53.33	53.33	73.33	93.33	96.67	96.67	96.67	
				LD	40.00	46.67	63.33	90.00	90.00	96.67	100.00	
					20.00	26.67	43.33	70.00	70.00	76.67	80.00	
			0.75(MeCOMe)	TA-LD	0.00	10.00	53.00	76.67	76.67	76.67	80.00	
					0.00	0.00	33.33	46.67	46.67	46.67	46.67	
				LD	6.67	10.00	63.33	63.33	73.33	73.33	73.33	
					0.00	3.33	46.67	46.67	53.33	53.33	53.33	
			0.50(MeCOMe)	TA-LD	0.00	20.00	63.33	86.67	93.33	93.33	96.67	
					0.00	20.00	56.67	76.67	80.00	80.00	83.33	
				LD	0.00	23.33	30.00	30.00	40.00	43.33	43.33	
					0.00	20.00	20.00	23.33	30.00	30.00	40.00	
			0.25(MeCOMe)	TA-LD	0.00	30.00	66.67	80.00	80.00	80.00	86.67	
					0.00	23.33	50.00	70.00	70.00	70.00	70.00	
				LD	3.33	6.67	6.67	13.33	16.67	16.67	16.67	
					0.00	0.00	0.00	3.33	6.67	6.67	6.67	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Farb. (Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Zingiber zerumbet	rhizome	total	0.125(MeCOMe)	TA-LD	10.00	23.33	66.67	76.67	86.67	90.00	90.00	
					0.00	10.00	36.67	53.33	63.33	66.67	66.67	
				LD	13.33	13.33	16.67	23.33	26.67	26.67	26.67	
					0.00	0.00	3.33	3.33	6.67	6.67	6.67	
		1:1, solid:liquid	2.00(MeCOMe)	TA-LD	50.00	63.33	66.67	70.00	73.33	76.67	76.67	
					43.33	56.67	60.00	63.33	66.67	70.00	70.00	
				LD	10.00	36.67	60.00	70.00	73.33	76.67	80.00	
					3.33	30.00	53.33	63.33	63.33	63.33	63.33	
			1.00(MeCOMe)	TA-LD	16.67	20.00	23.33	30.00	33.33	40.00	40.00	
					13.33	16.67	16.67	16.67	16.67	16.67	16.67	
				LD	6.67	6.67	13.33	13.33	13.33	16.67	16.67	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		solid	2.00(MeCOMe)	TA-LD	6.67	36.67	43.33	56.67	70.00	76.67	80.00	
					3.33	33.33	40.00	50.00	63.33	63.33	66.67	
				LD	0.00	10.00	16.67	30.00	33.33	43.33	46.67	
					0.00	10.00	13.33	23.33	26.67	30.00	30.00	
			1.00(MeCOMe)	TA-LD	13.33	13.33	13.33	16.67	16.67	33.33	33.33	
					6.67	6.67	6.67	10.00	10.00	10.00	10.00	
				LD	0.00	0.00	0.00	3.33	20.00	23.33	23.33	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		liquid	2.00(MeCOMe)	TA-LD	16.67	20.00	23.33	30.00	40.00	70.00	76.67	
					10.00	13.33	13.33	20.00	26.67	50.00	50.00	
				LD	10.00	10.00	20.00	33.33	40.00	43.33	53.33	
					3.33	3.33	10.00	23.33	26.67	26.67	26.67	
			1.00(MeCOMe)	TA-LD	16.67	16.67	16.67	16.67	20.00	36.67	36.67	
					10.00	10.00	10.00	10.00	10.00	16.67	16.67	
				LD	6.67	10.00	13.33	13.33	13.33	16.67	20.00	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Farb. (Zingiberace)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Zingiber zerumbet	rhizome	QC-1	1.00(MeCOMe)	TA-LD	0.00	13.33	23.33	23.33	23.33	30.00	36.67	
					0.00	3.33	3.33	3.33	6.67	6.67	10.00	
				LD	0.00	3.33	6.67	10.00	13.33	16.67	16.67	
					0.00	3.33	3.33	3.33	3.33	3.33	3.33	
		QC-2	1.00(MeCOMe)	TA-LD	33.33	50.00	56.67	56.67	56.67	63.33	73.33	
					3.33	3.33	3.33	3.33	3.33	3.33	3.33	
				LD	3.33	16.67	23.33	23.33	26.67	36.67	40.00	
					0.00	0.00	3.33	3.33	3.33	10.00	10.00	
		QC-3	1.00(MeCOMe)	TA-LD	20.00	33.33	40.00	46.67	50.00	56.67	56.67	
					10.00	16.67	20.00	26.67	30.00	36.67	36.67	
				LD	3.33	6.67	6.67	6.67	26.67	36.67	36.67	
					3.33	6.67	6.67	6.67	13.33	16.67	16.67	
		QC-4	1.00(MeCOMe)	TA-LD	50.00	83.33	86.67	90.00	96.67	96.67	96.67	
					46.67	66.67	70.00	73.33	80.00	80.00	80.00	
				LD	6.67	23.33	33.33	36.67	53.33	56.67	56.67	
					0.00	3.33	10.00	10.00	13.33	16.67	16.67	
		QC-5	1.00(MeCOMe)	TA-LD	0.00	3.33	3.33	3.33	3.33	-	-	
					0.00	0.00	0.00	0.00	0.00	-	-	
				LD	0.00	3.33	3.33	3.33	3.33	-	-	
					0.00	0.00	0.00	0.00	0.00	-	-	
		residue MeCOMe	5.00(MeCOMe)	TA-LD	3.33	3.33	3.33	6.67	20.00	36.67	43.33	larvae size 1/3
					3.33	3.33	3.33	6.67	10.00	10.00	16.67	
				LD	0.00	0.00	0.00	0.00	6.67	23.33	26.67	
					0.00	0.00	0.00	0.00	0.00	0.00	3.33	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Farb.

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Blumea balsamifera	leaf	total	1.00(MeCOMe)	TA-LD	33.33	56.67	60.00	63.33	63.33	63.33	73.33	
					16.67	26.67	30.00	30.00	30.00	30.00	33.33	
				LD	6.67	13.33	13.33	13.33	16.67	20.00	30.00	
					3.33	10.00	10.00	10.00	10.00	10.00	10.00	
Contza japonica	whole	total	2.00(MeCOMe)	TA-LD	50.00	76.67	76.67	83.33	86.68	90.00	93.33	
					50.00	76.67	76.67	83.33	86.67	86.67	90.00	
				LD	20.00	50.00	66.67	76.67	86.67	93.33	96.67	
					13.33	43.33	60.00	70.00	73.33	76.67	80.00	
			1.00(MeCOMe)	TA-LD	0.00	0.00	0.00	3.33	3.33	6.67	-	
					0.00	0.00	0.00	0.00	0.00	0.00	-	
				LD	0.00	3.33	3.33	6.67	10.00	20.00	-	
					0.00	0.00	0.00	3.33	3.33	3.33	-	
Eupatorium odoratum	leaf	total	1.00(MeCOMe)	TA-LD	33.33	40.00	40.00	63.33	93.33	93.33	93.33	
					33.33	40.00	40.00	63.33	93.33	93.33	93.33	
				LD	23.33	40.00	46.67	56.67	73.33	83.33	90.00	
					6.67	23.33	30.00	40.00	56.67	66.67	73.33	
Eupatorium odoratum +	leaf	total	1.00(MeCOMe)	TA-LD	3.33	6.67	6.67	10.00	13.33	40.00	60.00	
					3.33	3.33	3.33	3.33	3.33	3.33	3.33	
				LD	3.33	3.33	10.00	10.00	10.00	10.00	10.00	
					0.00	0.00	3.33	3.33	3.33	3.33	3.33	
Wedilia trilobata	leaf, branch											
Wedilia trilobata	whole	total										
		QC(C_6H_{14})										
		CT(C_6H_{14})	3.00(MeCOMe)	TA-LD	0.00	0.00	0.00	0.00	13.33	13.33	13.33	
					0.00	0.00	0.00	0.00	13.33	13.33	13.33	
				LD	0.00	3.33	3.33	3.33	10.00	10.00	10.00	
					0.00	3.33	3.33	3.33	10.00	10.00	10.00	

Table II contd. Screening of Activity of Plant Steam Distillates on *Spodoptera litura* Farb.

PLANT SPECIES	PART	FRACTION	%CONC(SOLV.)	TEST METHOD	ACCUMULATIVE % MORTALITY DAY 1	2	3	4	5	6	7	REMARK
Wedilia trilobata	whole	CT(C_6H_{14})	1.00(MeCOMe)	TA-LD	0.00	0.00	10.00	16.67	40.00	53.33	56.67	
					0.00	0.00	3.33	6.67	16.67	23.33	23.33	
				LD	0.00	6.67	10.00	16.67	46.67	66.67	67.67	
					0.00	6.67	6.67	6.67	13.33	13.33	20.00	
		CT(MeCOMe)	3.00(MeCOMe)	TA-LD	3.33	3.33	3.33	10.00	36.67	46.67	46.67	
					3.33	3.33	3.33	6.67	10.00	10.00	10.00	
				LD	0.00	10.00	13.33	30.00	53.33	60.00	60.00	
					0.00	6.67	10.00	10.00	16.67	20.00	20.00	
			1.00(MeCOMe)	TA-LD	0.00	3.33	6.67	10.00	50.00	60.00	73.33	
					0.00	3.33	3.33	3.33	10.00	10.00	13.33	
				LD	3.33	6.67	13.33	20.00	56.67	70.00	73.33	
					3.33	3.33	10.00	10.00	20.00	20.00	20.00	
		QC(C_6H_{14}-2)	1.00(MeCOMe)	TA-LD	0.00	0.00	3.33	6.67	10.00	13.33	20.00	
					0.00	0.00	0.00	0.00	0.00	0.00	6.67	
				LD	0.00	0.00	0.00	0.00	0.00	3.33	3.33	
					0.00	0.00	0.00	0.00	0.00	3.33	3.33	
		QC(CH_2Cl_2)	3.00(MeCOMe)	TA-LD	53.33	56.67	56.67	60.00	66.67	70.00	70.00	
					50.00	50.00	50.00	53.33	53.33	53.33	53.33	
				LD	6.67	26.67	46.67	50.00	70.00	76.67	86.67	
					6.67	16.67	30.00	30.00	36.67	40.00	46.67	
			1.00(MeCOMe)	TA-LD	0.00	0.00	0.00	6.67	6.67	-	-	
					0.00	0.00	0.00	3.33	3.33	-	-	
				LD	0.00	0.00	0.00	3.33	6.67	-	-	
					0.00	0.00	0.00	0.00	0.00	-	-	

REMARK/WORKPLAN

The test results to this date indicates that *Ageratum conyzoides* consistantly exhibits better activity than other plants tested (see Progress Report No. 2). In view of its abundance, major effort will be made to test its applicability in the field.

On the synthetic aspect of the project, additional analogues of the active component from Zingiber purpureum, 4-(3′,4′-dimethoxy phenyl) but-1,3-diene, will be prepared and tested for activity. The synergistic effect of these synthetic products with the active fraction of *Ageratum conyzoids* will also be explored.

PROGRESS REPORT 3

Reporting Period : 1 December 1986 - 30 May 1987

RESULTS/DISCUSSION/TABLES

From our findings in the previous reporting period, *Ageratum conyzoides* was found to be a possible candidate for use as an insecticidal plant. The active ingredients were identified as precocene I & precocene II.

In this reporting period, the LC_{50} for both substances were measured. The results are

Precocene I		Precocene II	
% LC_{50} (TD)	= 0.66 (48 hr)	% LC_{50} (TD)	= 0.84 (48 hr)
	= 0.29 (72 hr)		= 0.71 (72 hr)
	= 0.11 (96 hr)		= 0.35 (96 hr)

These values are not better than the LC_{50} of the whole distillate previously obtained. It seemed, therefore, that the whole steam distillate should be chosen for field trial. The activity of the whole steam distillate was then re-evaluated in detail to determine the optimum concentration for this purpose. The result obtained was similar to the previous findings and in the same proximity as that of precocene I & precocene II.

Whole distillate	% LC_{50} (TD)	= 0.83 (48 hr)
		= 0.36 (72 hr)
		= 0.29 (96 hr)

Table I shows the observed accumulative % mortality while Table I' shows the accumulative % mortality calculated from Abbott's Formula.

Table I. Activity of Steam Distillate of *Ageratum conyzoides* on *S. litura* Fabr. (Observed % Mortality)
(Five larvae are used for each replication)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY						
					DAY 1	2	3	4	5	6	7
Ageratum conyzoides	whole plant	total	1.00 (MeCOMe)	TD	20.00	60.00	100.00	-	-	-	-
				LD	0.00	6.67	80.00	100.00	-	-	-
			0.75 (MeCOMe)	TD	26.67	53.33	86.67	100.00	-	-	-
				LD	0.00	0.00	80.00	100.00	-	-	-
			0.50 (MeCOMe)	TD	6.67	26.67	66.67	93.33	93.33	93.33	100.00
				LD	0.00	0.00	40.00	66.67	86.67	93.33	100.00
			0.25 (MeCOMe)	TD	0.00	0.00	20.00	46.67	80.00	100.00	100.00
				LD	0.00	6.67	13.33	40.00	86.67	100.00	-
			0.12 (MeCOMe)	TD	0.00	0.00	6.67	20.00	46.67	46.67	46.67
				LD	6.67	13.33	13.33	26.67	26.67	26.67	53.33
	flower	total	1.00 (MeCOMe)	TD	13.33	53.33	93.33	100.00	-	-	-
				LD	6.67	26.67	93.33	100.00	-	-	-
			0.75 (MeCOMe)	TD	26.67	40.00	100.00	-	-	-	-
				LD	0.00	13.33	80.00	100.00	-	-	-
			0.50 (MeCOMe)	TD	0.00	6.67	73.33	86.67	100.00	-	-
				LD	0.00	13.33	53.33	80.00	100.00	-	-
			0.25 (MeCOMe)	TD	0.00	0.00	40.00	80.00	93.33	93.33	93.33
				LD	0.00	0.00	20.00	93.33	100.00	-	-
			0.12 (MeCOMe)	TD	0.00	0.00	20.00	53.33	86.67	86.67	86.67
				LD	0.00	6.67	6.67	20.00	40.00	60.00	73.33
		control	MeCOMe	TD	0.00	0.00	6.67	26.67	26.67	46.67	46.67
				LD	0.00	0.00	0.00	20.00	40.00	40.00	53.33

Table I'. Activity of Steam Distillate of *Ageratum conyzoides* on *S. litura* Fabr. (Calculated % Mortality by Abbott's Formula)
(Five larvae are used for each replication)

PLANT SPECIES	PART	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY						
					DAY 1	2	3	4	5	6	7
Ageratum conyzoides	whole plant	total	1.00 (MeCOMe)	TD	20.00	60.00	100.00	-	-	-	-
				LD	0.00	6.67	80.00	100.00	-	-	-
			0.75 (MeCOMe)	TD	26.66	53.33	85.71	100.00			
				LD	0.00	0.00	80.00	100.00	-	-	-
			0.50 (MeCOMe)	TD	13.33	26.66	64.28	90.91	90.91	90.91	100.00
				LD	0.00	0.00	40.00	58.33	77.78	88.90	100.00
			0.25 (MeCOMe)	TD	0.00	0.00	14.28	27.27	72.72	100.00	-
				LD	0.00	6.67	13.33	25.00	77.78	100.00	-
			0.12 (MeCOMe)	TD	0.00	0.00	0.00	0.00	27.27	27.27	27.27
				LD	6.67	13.33	13.33	13.33	13.33	13.33	13.33
	flower	total	1.00 (MeCOMe)	TD	13.33	53.33	92.86	100.00	-	-	-
				LD	6.67	26.67	93.33	100.00	-	-	-
			0.75 (MeCOMe)	TD	26.66	40.00	100.00	-	-	-	-
				LD	0.00	13.33	80.00	100.00	-	-	-
			0.50 (MeCOMe)	TD	0.00	6.66	71.43	81.82	100.00	-	-
				LD	0.00	13.33	53.33	75.00	100.00	-	-
			0.25 (MeCOMe)	TD	0.00	0.00	35.71	72.72	90.91	90.91	90.91
				LD	0.00	0.00	20.00	91.67	100.00	-	-
			0.12 (MeCOMe)	TD	0.00	0.00	14.28	36.36	81.82	81.82	81.82
				LD	0.00	6.67	6.67	6.67	6.67	33.33	42.84

Preliminary screening of the activity of a few *Aglaia* species gave good results (see Table I, Progress Report No. 2). Their activity was furthur investigated in detail. The results are shown in Table II & II'.

The results warrants the testing of *A. adorata* in the field.

Table II. Activity of *Aglaia* species on *S. litura* Fabr.* (Observed % Mortality)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia argentea	C_6H_{14}										
	CH_2Cl_2	crude	10.00 (EtOH)	TD	40.00	80.00	93.33	100.00	-	-	-
				LD	13.33	80.00	100.00	-	-	-	-
			5.00 (EtOH)	TD	6.66	40.00	53.33	60.00	86.66	100.00	-
				LD	6.66	33.33	73.33	80.00	93.33	100.00	-
			2.50 (EtOH)	TD	6.66	40.00	60.00	66.66	80.00	93.33	100.00
				LD	20.00	33.33	53.33	73.33	93.33	93.33	100.00
			1.25 (EtOH)	TD	6.66	20.00	33.33	40.00	60.00	66.66	73.33
				LD	0.00	13.33	13.33	33.33	46.66	53.33	60.00
		control	EtOH	TD	0.00	0.00	0.00	6.66	6.66	13.33	20.00
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		QC.C_6H_{14}	3.00 (MeCOMe)	TD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				LD	0.00	6.66	6.66	6.66	6.66	13.33	13.33
		QC.C_6H_{14}/CH_2Cl_2 (1/1)	3.00 (MeCOMe)	TD	0.00	13.33	26.66	33.33	46.66	46.66	•
				LD	0.00	0.00	0.00	0.00	0.00	6.66	•
		QC.CH_2Cl_2	3.00 (MeCOMe)	TD	6.66	13.33	13.33	13.33	20.00	26.66	33.33
				LD	6.66	13.33	13.33	13.33	13.33	13.33	20.00
		QC.CH_2Cl_2/MeOH (1/1)	3.00 (MeCOMe)	TD	13.33	26.66	•	•	•	•	•
				LD	6.66	13.33	•	•	•	•	•
		QC.MeOH	3.00 (MeCOMe)	TD	13.33	73.33	100.00	-	-	-	-
				LD	6.66	93.33	100.00	-	-	-	-
			2.00 (MeCOMe)	TD	0.00	0.00	66.66	86.66	93.33	100.00	-
				LD	0.00	0.00	26.66	73.33	100.00	-	-
			1.00 (MeCOMe)	TD	0.00	0.00	13.33	46.66	93.33	93.33	100.00
				LD	0.00	0.00	0.[illegible]	33.33	66.66	80.00	93.33
			0.75 (MeCOMe)	TD	0.00	0.00	[illegible].00	6.66	33.33	60.00	86.66
				LD	0.00	0.00	0.00	13.33	40.00	53.33	60.00

(• not tested further due to insufficient solution)

Table II. Activity of *Aglaia* species on *S. litura* Fabr. (Observed % Mortality)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	-
Aglaia argentea	CH_2Cl_2	QC,MeOH	0.50(MeCOMe)	TD	0.00	0.00	0.00	6.66	26.66	26.66	53.33
				LD	0.00	0.00	0.00	6.66	26.66	46.66	46.66
		control	MeCOMe	TD	0.00	0.00	0.00	0.00	6.66	6.66	6.66
				LD	0.00	0.00	0.00	0.00	6.66	6.66	13.33
Aglaia kunsterii	MeOH	crude									
		QC,CH_2Cl_2	5.00(EtOH)	TD	0.00	6.66	6.66	13.33	*	*	*
				LD	0.00	0.00	6.66	6.66	*	*	*
		QC.CH_2Cl_2/MeOH	5.00(EtOH)	TD	6.66	26.66	33.33	40.00	46.66	46.66	53.33
		(4/1)		LD	0.00	0.00	26.66	26.66	40.00	46.66	46.66
		QC.CH_2Cl_2/MeOH	5.00(EtOH)	TD	0.00	0.00	0.00	6.66	13.33	26.66	40.00
		(3/1)		LD	0.00	0.00	0.00	0.00	13.33	20.00	26.66
		QC.CH_2Cl_2/MeOH	5.00(EtOH)	TD	13.33	13.33	13.33	13.33	13.33	20.00	20.00
		(2/1)		LD	0.00	0.00	0.00	0.00	13.33	33.33	46.66
		QC.CH_2Cl_2/MeOH	5.00(EtOH)	TD	6.66	6.66	6.66	6.66	6.66	13.33	*
		(1/1)		LD	0.00	0.00	6.66	13.33	26.66	26.66	*
		QC.MeOH	5.00(EtOH)	TD	0.00	0.00	0.00	0.00	0.00	26.66	26.66
				LD	0.00	0.00	0.00	6.66	13.33	40.00	40.00
		control	EtOH	TD	0.00	0.00	0.00	13.33	13.33	13.33	20.00
				LD	0.00	6.66	13.33	13.33	13.33	13.33	13.33

(* not tested further due to insufficient solution)

Table II. Activity of *Aglaia* species on *S. litura* Fabr. (Observed % Mortality)

FLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia odorata	MeOH										
		C_6H_{14}/MeOH/ppt	2.50 (MeCOMe)	TD	0.00	0.00	13.33	46.66	66.66	80.00	80.00
				LD	0.00	0.00	0.00	13.33	40.00	66.66	73.33
			1.25 (MeCOMe)	TD	0.00	0.00	6.66	13.33	26.66	46.66	46.66
				LD	0.00	0.00	6.66	6.66	13.33	33.33	40.00
			0.62 (MeCOMe)	TD	0.00	0.00	6.66	6.66	20.00	20.00	20.00
				LD	0.00	0.00	0.00	0.00	0.00	0.00	6.66
			0.31 (MeCOMe)	TD	0.00	6.66	6.66	6.66	13.33	13.33	20.00
				LD	0.00	0.00	0.00	0.00	0.00	0.00	6.66
			0.16 (MeCOMe)	TD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		control	MeCOMe	TD	0.00	0.00	0.00	0.00	6.66	6.66	6.66
				LD	0.00	0.00	0.00	0.00	6.66	6.66	13.33
		MeOH/C_6H_{14}/ppt	10.00 (EtOH)	TD	13.33	80.00	100.00	-	-	-	-
				LD	0.00	73.33	100.00	-	-	-	-
			7.50 (EtOH)	TD	0.00	40.00	93.33	100.00	-	-	-
				LD	0.00	73.33	93.33	100.00	-	-	-
			5.00 (EtOH)	TD	0.00	53.33	100.00	-	-	-	-
				LD	0.00	73.33	100.00	-	-	-	-
			2.50 (EtOH)	TD	0.00	93.33	100.00	-	-	-	-
				LD	0.00	100.00	-	-	-	-	-
			1.25 (EtOH)	TD	0.00	80.00	100.00	-	-	-	-
				LD	0.00	60.00	100.00	-	-	-	-
			0.62 (EtOH)	TD	0.00	53.33	100.00	-	-	-	-
				LD	0.00	33.33	100.00	-	-	-	-
			0.32 (EtOH)	TD	0.00	40.00	100.00	-	-	-	-
				LD	0.00	26.66	86.66	100.00	-	-	-

Table II. Activity of *Aglaia* species on *S. litura* Fabr. (Observed % Mortality)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia odorata		MeOH/C_6H_{14}/ppt	0.15 (EtOH)	TD	0.00	6.66	86.66	93.33	100.00	-	-
				LD	0.00	6.66	60.00	100.00	-	-	-
		control	EtOH	TD	0.00	0.00	6.66	20.00	26.66	**	**
				LD	0.00	6.66	6.66	6.66	6.66	**	**
		ppt/MeOH/C_6H_{14}	2.50 (H_2O)	TD	0.00	0.00	20.00	26.66	**	**	**
				LD	6.66	20.00	26.66	40.00	**	**	**
		control	H_2O	TD	0.00	0.00	13.33	20.00	**	**	**
				LD	0.00	6.66	13.33	13.33	**	**	**

(** not tested further due to low activity)

Table II'. Activity of *Aglaia* species on *S. litura* Fabr. (Calculated % Mortality by Abbott's Formula)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia argentea	C_6H_{14}	-	-	-							
	CH_2Cl_2	crude	10.00(EtOH)	TD	40.00	60.00	93.33	100.00	-	-	-
				LD	13.33	60.00	100.00	100.00	-	-	-
			5.00(EtOH)	TD	6.66	40.00	53.33	57.14	85.71	100.00	-
				LD	6.66	33.33	73.33	80.00	93.33	100.00	-
			2.50(EtOH)	TD	6.66	40.00	60.00	64.28	76.57	92.31	100.00
				LD	20.00	33.33	53.33	73.33	93.33	93.33	100.00
			1.25(EtOH)	TD	6.66	20.00	33.33	35.71	57.14	61.53	66.67
				LD	0.00	13.33	23.33	33.33	46.66	53.33	60.00
		QC.C_6H_{14}	3.00(MeCOMe)	TD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				LD	0.00	6.66	6.66	6.66	6.66	7.14	7.14
		QC.C_6H_{14}/CH_2Cl_2 (1/1)	3.00(MeCOMe)	TD	0.00	13.33	21.42	28.57	38.46	38.46	*
				LD	0.00	0.00	0.00	0.00	0.00	0.00	*
		QC.CH_2Cl_2	3.00(MeCOMe)	TD	6.66	13.33	13.33	13.33	13.33	15.38	16.67
				LD	6.66	13.33	13.33	13.33	13.33	13.33	14.28
		QC.CH_2Cl_2/MeOH (1/1)	3.00(MeCOMe)	TD	13.33	13.33	*	*	*	*	*
				LD	6.66	13.33	*	*	*	*	*
		QC.MeOH	3.00(MeCOMe)	TD	13.33	73.33	100.00	-	-	-	-
				LD	6.66	93.33	100.00	-	-	-	-
			2.00(MeCOMe)	TD	0.00	0.00	66.66	86.66	92.86	100.00	-
				LD	0.00	0.00	26.66	73.33	100.00	-	-
			1.00(MeCOMe)	TD	0.00	0.00	13.33	26.66	92.86	92.86	100.00
				LD	0.00	0.00	0.00	33.33	64.28	76.57	92.11
			0.75(MeCOMe)	TD	0.00	0.00	0.00	6.66	28.57	57.00	85.71
				LD	0.00	0.00	0.00	13.33	35.71	43.33	53.84
			0.50(MeCOMe)	TD	0.00	0.00	0.00	6.66	21.42	21.42	50.00
				LD	0.00	0.00	0.00	6.66	21.42	42.85	42.85

(* not tested further due to insufficient solution)

Table II'. Activity of *Aglaia* species on *S. litura* Fabr. (Calculated % Mortality by Abbott's Formula)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia kunsterii	MeOH	crude									
		QC,CH_2Cl_2	5.00(EtOH)	TD	0.00	6.66	6.66	0.00	*	*	*
				LD	0.00	0.00	0.00	0.00	*	*	*
		QC,CH_2Cl_2/MeOH (4/1)	5.00(EtOH)	TD	6.66	26.66	33.33	33.33	38.46	38.46	41.67
				LD	0.00	0.00	15.38	15.38	30.76	38.46	38.46
		QC,CH_2Cl_2/MeOH (3/1)	5.00(EtOH)	TD	0.00	0.00	0.00	0.00	0.00	15.38	25.00
				LD	0.00	0.00	0.00	0.00	0.00	7.68	15.39
		QC,CH_2Cl_2/MeOH (2/1)	5.00(EtOH)	TD	13.33	13.33	13.33	13.33	13.33	13.33	13.33
				LD	0.00	0.00	0.00	0.00	0.00	23.07	38.46
		QC,CH_2Cl_2/MeOH (1/1)	5.00(EtOH)	TD	6.66	6.66	6.66	6.66	6.66	6.66	6.66
				LD	0.00	0.00	0.00	0.00	15.39	15.39	15.39
		QCMeOH	5.00(EtOH)	TD	0.00	0.00	0.00	0.00	0.00	15.38	15.38
				LD	0.00	0 00	0.00	0.00	0.00	28.57	30.76

(* not tested further due to insufficient solution)

Table II'. Activity of *Aglaia* species on *S. litura* Fabr. (Calculated % Mortality by Abbott's Formula)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia odorata	MeOH	crude									
			2.50 (MeCOMe)	TD	0.00	0.00	13.36	44.67	64.28	78.57	78.57
		C_6H_{14}/MeOH/ppt		LD	0.00	0.00	0.00	13.33	37.92	64.28	69.23
			1.25 (MeCOMe)	TD	0.00	0.00	6.66	13.33	27.42	42.85	42.85
				LD	0.00	0.00	6.66	6.66	7.14	21.90	30.76
			0.62 (MeCOMe)	TD	0.00	0.00	6.66	6.66	12.28	12.28	12.28
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.32 (MeCOMe)	TD	0.00	6.66	6.66	6.66	7.14	7.14	14.28
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.16 (MeCOMe)	TD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				LD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		MeOH/C_6H_{14}/ppt	10.00 (EtOH)	TD	13.13	30.00	100.00	-	-	-	-
				LD	0.00	71.43	100.00	-	-	-	-
			7.50 (EtOH)	TD	0.00	40.00	93.33	100.00	-	-	-
				LD	0.00	71.43	92.31	100.00	-	-	-
			5.00 (EtOH)	TD	0.00	53.33	100.00	-	-	-	-
				LD	0.00	71.43	100.00	-	-	-	-
			2.50 (EtOH)	TD	0.00	93.33	100.00	-	-	-	-
				LD	0.00	100.00	-	-	-	-	-
			1.25 (EtOH)	TD	0.00	80.00	100.00	-	-	-	-
				LD	0.00	57.14	100.00	-	-	-	-
			0.62 (EtOH)	TD	0.00	60.00	100.00	-	-	-	-
				LD	0.00	28.57	100.00	-	-	-	-
			0.32 (EtOH)	TD	0.00	40.00	100.00	-	-	-	-
				LD	0.00	21.42	85.71	100.00	-	-	-
			0.16 (EtOH)	TD	0.00	6.66	85.71	91.67	100.00	-	-
				LD	0.00	0.00	57.14	100.00	-	-	-

Table II'. Activity of *Aglaia* species on *S. litura* Fabr. (Calculated % Mortality by Abbott's Formula)

PLANT SPECIES	SOLVENT	FRACTION	%CONC(SOLV)	TEST METHOD	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)						
					DAY 1	2	3	4	5	6	7
Aglaia odorata		ppt/MeOH/C_6H_{14}	2.50 (H_2O)	TD	0.00	0.00	14.28	15.38	**	**	**
				LD	6.66	14.28	15.38	30.76	**	**	**

(** not tested further due to low activity)

REMARKS/ WORKPLAN

Active ingredient in *Aglaia odorata* will be isolated and its structure determined in the next reporting period. Field test will be carried out on the crude or purified extract.

PROGRESS REPORT 4

Reporting Period : 1 June 1987 - 30 May 1988

RESULTS/DISCUSSION/TABLES

Reinvestigation of the antifeeding activity of 4 *Aglaia* species, e.g. *A. adorata*, *A. adamantica*, *A. argentea*, *A. squamulosa*, revealed the significant activities even at low concentration. Attempt was then made to fully explore the reaction of *S. litura* larvae to these extracts/fractions.

A soy bean antificial diet was admixed with these crude extracts/fractions and used as feed for the larvae. Outstanding results were obtained from extracts/fractions from *A. odorata*. The feeding of larvae was significantly reduced, the larval growth was therefore slow. They eventually died. Table I, Ill. 1 show these results in detail.

Ill. 1

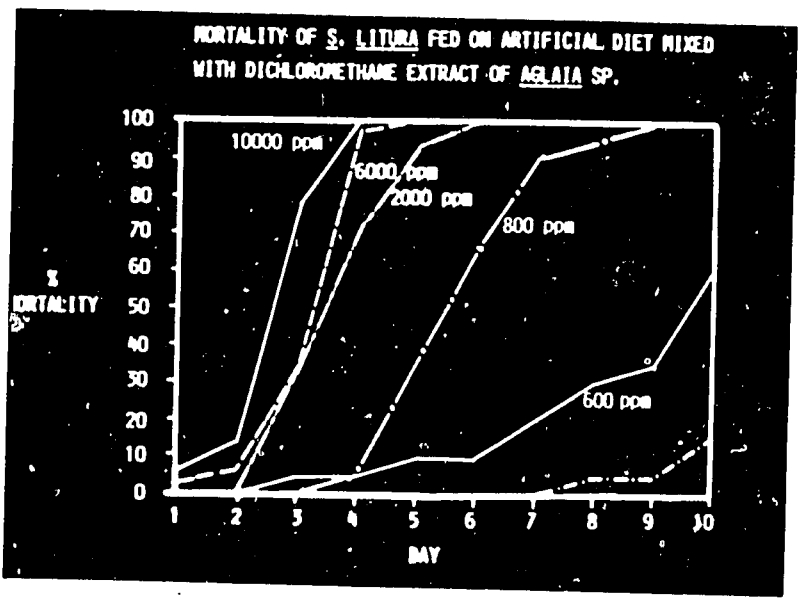


TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGLAIA* SPECIES

PLANT SPECIES	FRACTION	CONC(PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
			DAY 1	2	3	4	5	6	7	8	9	10
Aglaia odorata	C_6H_{14}	10000	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	-
	CH_2Cl_2	10000	6.67	13.33	16.67	100.00	-	-	-	-	-	-
		8000	3.37	6.67	33.33	96.67	100.00	-	-	-	-	-
		6000	3.33	6.67	33.33	96.67	100.00	-	-	-	-	-
		4000	0.00	0.00	53.33	100.00	-	-	-	-	-	-
		2000	0.00	0.00	33.33	70.00	93.33	100.00	-	-	-	-
	1) $QC(C_6H_{14})$	6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-
	2) $QC(CH_2Cl_2)$	10000	0.00	0.00	3.44	57.14	92.86	96.43	100.00	-	-	-
		8000	0.00	0.00	10.34	42.85	78.57	100.00	-	-	-	-
		6000	0.00	0.00	3.44	24.99	78.57	96.43	100.00	-	-	-
		4000	10.00	10.00	17.23	24.99	39.29	57.14	67.85	85.71	100.00	-
		2000	0.00	0.00	0.00	0.00	14.28	32.14	42.85	75.00	92.60	96.15

TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGIAIA* SPECIES

PLANT SPECIES	FRACTION	CONC(PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
			DAY 1	2	3	4	5	6	7	8	9	10
Aglaia odorata	3) QC(C_6H_{14}:CH_2Cl_2,3:1)	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4) QC(CH_2Cl_2)	10000	0.00	0.00	100.00	-	-	-	-	-	-	-
		8000	0.00	0.00	100.00	-	-	-	-	-	-	-
		6000	0.00	3.33	90.00	100.00	-	-	-	-	-	-
		4000	0.00	0.00	73.34	100.00	-	-	-	-	-	-
		2000	0.00	0.00	30.00	93.11	100.00	-	-	-	-	-
	5) QC (MeOH)	10000	3.34	3.44	65.51	100.00	-	-	-	-	-	-
		8000	0.00	0.00	30.00	93.11	100.00	-	-	-	-	-
		6000	0.00	0.00	62.38	93.10	100.00	-	-	-	-	-
		2000	0.00	0.00	27.58	89.65	96.43	100.00	-	-	-	-

TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGLAIA* SPECIES

PLANT SPECIES	FRACTION	CONC(PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)										
			DAY 1	2	3	4	5	6	7	8	9	10	11
Aglaia odorata	MeOH	10000	0.00	3.67	23.33	93.33	100.00	-	-	-	-	-	-
		8000	0.00	3.33	66.67	66.67	89.85	96.55	100.00	-	-	-	-
		6000	0.00	0.00	60.00	66.67	86.20	93.10	96.55	100.00	-	-	-
		4000	0.00	0.00	3.33	3.33	16.67	44.82	62.07	82.76	82.76	96.55	100.00
		2000	0.00	0.00	3.33	3.33	3.44	6.89	24.13	26.58	37.92	55.55	-
	EtOAc (insol)	10000	0.00	0.00	0.00	0.00	0.00	0.00	3.44	27.58	34.47	51.72	-
		8000	0.00	0.00	0.00	0.00	0.00	0.00	3.44	20.68	20.68	27.58	-
		6000	0.00	0.00	0.00	0.00	0.00	0.00	3.44	3.44	10.34	10.34	-
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
	EtOAc (sol)	10000	0.00	10.34	48.27	96.55	100.00	-	-	-	-	-	-
		8000	0.00	6.89	55.17	100.00	-	-			-		
		6000	0.00	6.87	27.58	89.65	100.00	-	-		-	-	-
		4000	0.00	0.00	10.34	96.55	100.00	-	-		-	-	
		2000	0.00	6.89	20.69	62.07	89.65	100.00	-				

TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGLAIA* SPECIES

PLANT SPECIES	FRACTION	CONC(PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)												
		Day	1	2	3	4	5	6	7	8	9	10	11	12	13
Aglaia odorata	CH_2Cl_2	800	0.00	0.00	0.00	5.00	35.00	65.00	90.00	95.00	100.00	-	-	-	-
		600	0.00	0.00	5.00	5.00	10.00	10.00	20.00	30.00	35.00	60.00	60.00	65.00	75.
		400	0.00	0.00	0.00	0.00	0.00	5.00	20.00	30.00	40.00	40.00	40.00	40.00	40.
		200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	15.00	15.00	15.00	15.
	MeOH	800	0.00	0.00	0.00	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.
		600	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.
		400	0.00	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.
		200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
75.00	84.21	89.47	98.47	89.47	89.47	94.73	100.00	-	-	-	-	-	-	-	-	-
80.00	78.94	84.21	89.47	94.73	94.73	94.73	94.73	94.73	100.00	-	-	-	-	-	-	-
20.00	15.78	26.31	31.57	31.57	81.57	36.84	42.10	42.10	52.63	52.63	52.63	52.63	-	-	-	-
15.00	15.00	30.00	40.00	40.00	40.00	40.00	50.00	55.00	55.00	60.00	65.00	70.00	70.00	80.00	80.00	85.00
5.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	25.00	30.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

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TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGLAIA* SPECIES

PLANT SPECIES	FRACTION	CONC (PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
		Day	1	2	3	4	5	6	7	8	9	10
Aglaia andamanica	C_6H_{14}	10000	0.00	0.00	0.00	3.33	3.33	3.33	3.33	3.33	3.33	3.33
		8000	0.00	0.00	0.00	3.33	3.56	3.56	3.56	3.56	3.56	3.56
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_2Cl_2	10000	0.00	0.00	3.33	10.00	10.71	10.71	10.71	10.71	10.71	10.71
		8000	0.00	0.00	0.00	16.67	16.67	16.67	16.67	16.67	16.67	16.67
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MeOH	10000	0.00	0.00	3.33	10.00	13.34	13.34	20.00	23.34	23.34	23.34
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	3.33	3.33
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	3.33	3.33
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGLAIA* SPECIES

PLANT SPECIES	FRACTION	CONC (PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
			Day 1	2	3	4	5	6	7	8	9	10
Aglaia argentea	C_6H_{14}	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		8000	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_2Cl_2	10000	0.00	0.00	0.00	20.00	63.33	70.00	83.33	93.3	100.00	-
		8000	0.00	0.00	0.00	3.33	43.33	63.33	83.33	96.67	100.00	-
		6000	0.00	0.00	0.00	16.67	23.33	46.67	60.00	86.67	93.33	96.67
		4000	0.00	0.00	3.33	10.00	26.67	43.33	63.33	90.00	96.66	100.00
		2000	0.00	0.00	3.33	13.33	20.00	20.00	60.00	73.33	83.33	93.33
	MeOH	10000	0.00	0.00	3.33	10.00	23.33	53.33	70.00	8[illegible]33	86.67	93.33
		8000	3.33	3.33	6.67	16.67	36.67	50.00	60.00	80.00	83.33	93.33
		6000	0.00	0.00	0.00	6.67	10.00	30.00	46.67	70.00	83.33	96.67
		4000	0.00	0.00	0.00	0.00	3.33	10.00	23.33	36.67	60.00	83.33
		2000	0.00	0.00	3.33	3.33	3.33	6.66	20.00	40.00	46.66	76.67

TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *AGLAIA* SPECIES

PLANT SPECIES	FRACTION	CONC (PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
			Day 1	2	3	4	5	6	7	8	9	10
Aglaia squamulosa	C_6H_{14}	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	6.67	6.67
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_2Cl_2	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MeOH	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *DYSOXYLUM* SPECIES

PLANT SPECIES	FRACTION	CONC (PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
			Day 1	2	3	4	5	6	7	8	9	10
Dysoxylum procerum	C_6H_{14}	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.66	6.66	16.67
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.66	10.00	20.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	3.33	6.67	10.00	26.67
	CH_2Cl_2	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	3.33	3.33
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	3.33	3.33
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	16.67	23.33
	1) crystal	10000	0.00	0.00	0.00	0.00	0.00	0.00	3.33	6.67	6.67	16.67
		8000	0.00	0.00	0.00	0.00	0.00	3.33	3.33	6.67	6.67	16.67
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	3.33	10.00
	2) non-crystal	10000	0.00	0.00	0.00	0.00	0.00	0.00	10.00	10.00	16.67	16.67
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	10.00	13.33
	MeOH	10000	0.00	0.00	0.00	0.00	0.00	0.00	13.33	13.33	13.33	13.33
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	0.00	0.00	0.00	3.33	3.33	[illegible]	[illegible]			

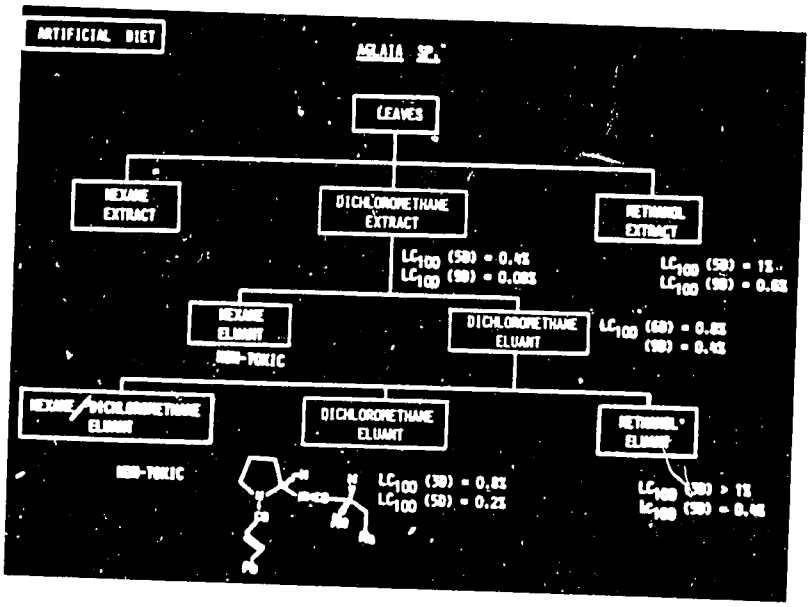
TABLE I

MORTALITY OF *S. LITURA* F. FED ON ARTIFICIAL DIET MIXED WITH EXTRACT OF *DYSOXYLUM* SPECIES

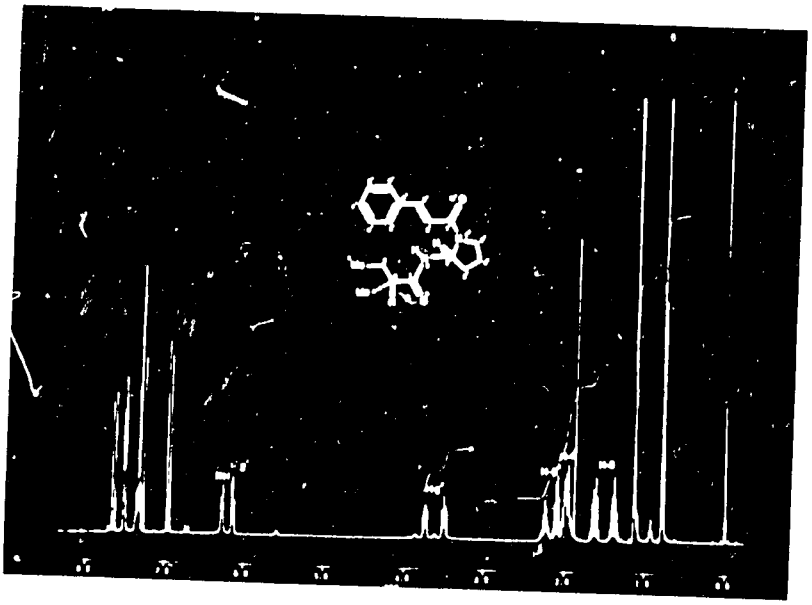
PLANT SPECIES	FRACTION	CONC(PPM)	ACCUMULATIVE % MORTALITY (ABBOTT'S FORMULA)									
			Day 1	2	3	4	5	6	7	8	9	10
Dysoxylum sp.	C_6H_{14}	10000	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	10.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	6.67	10.00
	CH_2Cl_2	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	3.33
		8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MeOH	10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		8000	0.00	3.33	3.33	3.33	3.33	6.67	6.67	6.67	6.67	6.67
		6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Separation was carried out to isolate the active constituents from *A. odorata* using the scheme as shown in Ill. 2. From the purified fraction of high activity, a bisamide, odorine(1) was isolated. Its structure was evidence from its NMR spectra (Ill. 3) and the stereochemistry was confirmed by x-ray crystallography (Ill. 4).

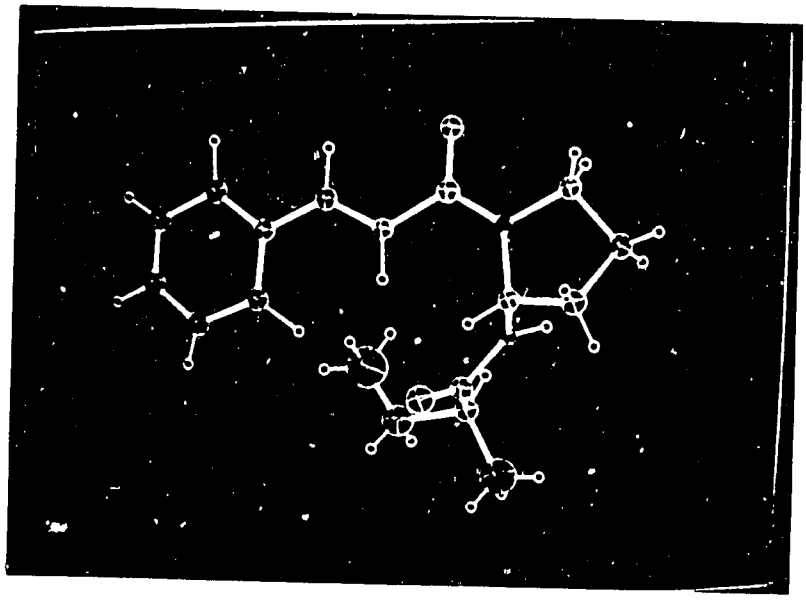
Ill. 2 - Diagram showing separation scheme for odorine



Ill. 3 - 400 MHz H^1-NMR spectrum of odorine

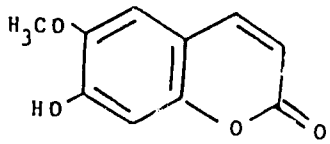


Ill. 4 - Crystal structure of odorine



Upon re-testing the activity of this pure component, no significant antifeeding activity was observed. Therefore this compound cannot be the active ingredient and may only acts as a synergist in the active fraction.

Further attempt was then made to isolate the minor constituents in the active fraction. Finally, with extensive chromatography (quick column, chromatotron) scopoletin (2) was isolated.



(2)

This substance was confirmed as the active ingredient since 100% larval mortality resulted from an LD method using 160 ppm solution of this substance.

Experiment was carried out to pre-determine the formulation and application method for testing the antifeeding efficiency of the crude extract in the field: ten third instar of *S. litura* were left to feed on each of 4 *Vigna radiata* plants in clay pots. The pots were surrounded by water in clay trays to prevent the larvae to leave the plant pots.

Crude methanolic extract was admixed with bentonite in 1:3 by weight : 3 parts of bentonite were added to 1 part of methanolic extract in methanol, the solvent was then evaporated to dryness to give a brown powder.

An aqueous emulsion containing 0.05% Triton and an equivalent of 2% crude methanolic extract was made from the brown powder and sprayed on two of the *Vigna radiata* plants. As a control, the other two plants were sprayed with a solution containing the same concentration of Triton and bentonite. A marked difference in the leave damage between the two sets of plants was observed. After 6 days, the control plants were completely eaten up while the treated plants remained healthy. The results is shown in Ill. 5.

Ill. 5 - *Vigna radiata* 6 days after treatment with crude methanolic extract (treated-control-treated-control).

A small scale field test was then carried out with this formulation. 150 *Vigna radiata* plants were grown in cement pots (Ill. 6). After 30 days, 300 third instar larvae of *S. litura* were left to feed on the leaves in each pot (Ill. 7). The plants in 4 pots were sprayed with the tested solution (Ill. 8). As a control, another 4 pots were sprayed with an aqueous solution containing the same concentration of bentonite and Triton. A marked difference in the degree of feeding was observed (Ill. 9, Ill. 10) at 24 hours. Visual estimation of the area of leaf damage and number counts of remaining larvae were done at 24, 48 and 72 hours after spraying, using the following formula :-

Calculation of area of leaf damage by *S. litura*

$$\% \text{ of leaf damage} = \frac{a(5 \times 0.5) + b\,(5 \times 0.38) + c\,(5 \times 0.18)}{5^{*} \times n^{**}}$$

$$= \frac{a(2.5) + b(1.9) + c\,(0.9) \times 100}{5 \times n}$$

a = no. of leaves which were damaged more than 50%

b = no. of leaves which were damaged more than 25%

c = no. of leaves which were damaged more than 10% (or no. of leaves with continued damaged spots)

d = no. of leaves which were less than 10% damaged (or no. of leaves with discontinued damaged spots)

e = no. of leaves which were not damaged

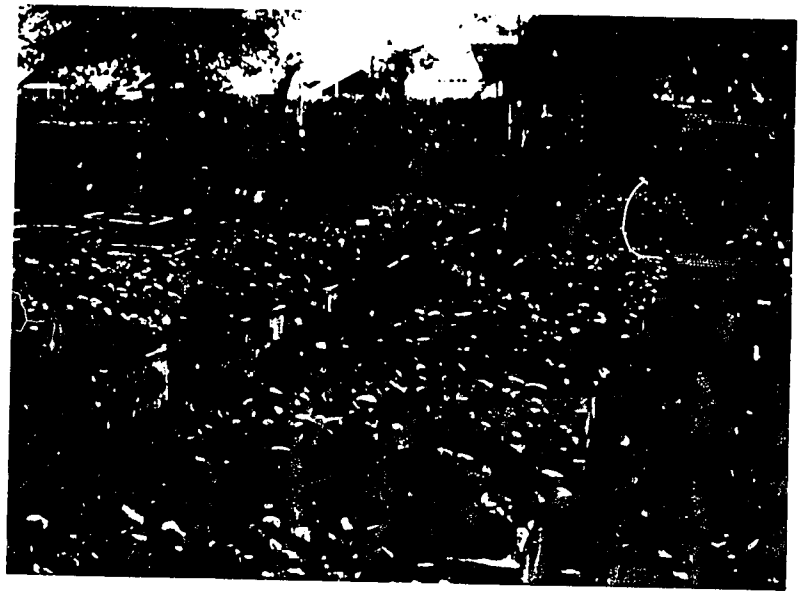
5^{*} = approx. area of 5 cm^2, in which degree of damage was estimated

n^{**} = no. of leaves randomly selected for checking in each treatment

Similar test was also carried out with an aqueous extract of 10% ($^{w}/w$) fresh leave and 0.05% Triton.

The results of both tests were shown in Ill. 11 and Ill. 12.

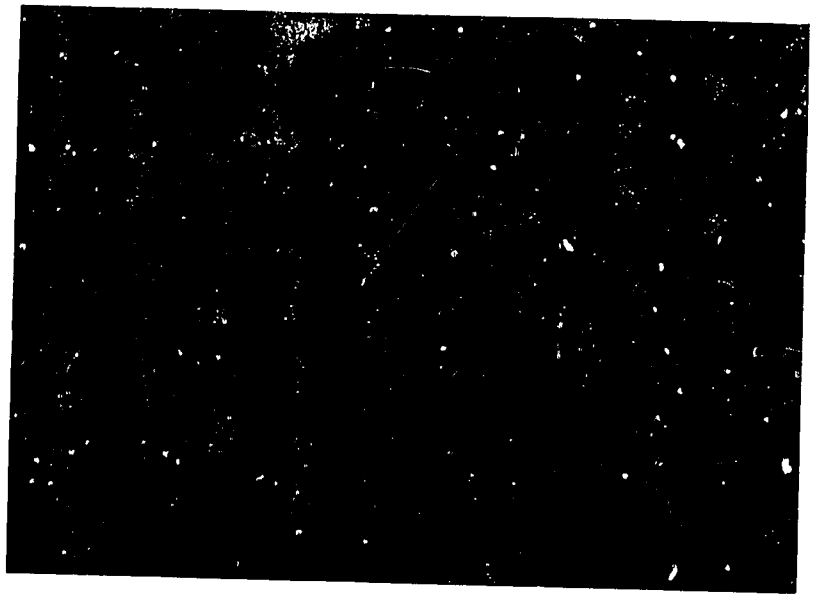
Ill. 6 - *Vigna radiata* in cement pot, 30 days old.



Ill. 7 - *S. litura* were left to feed on *Vigna radiata* leave.

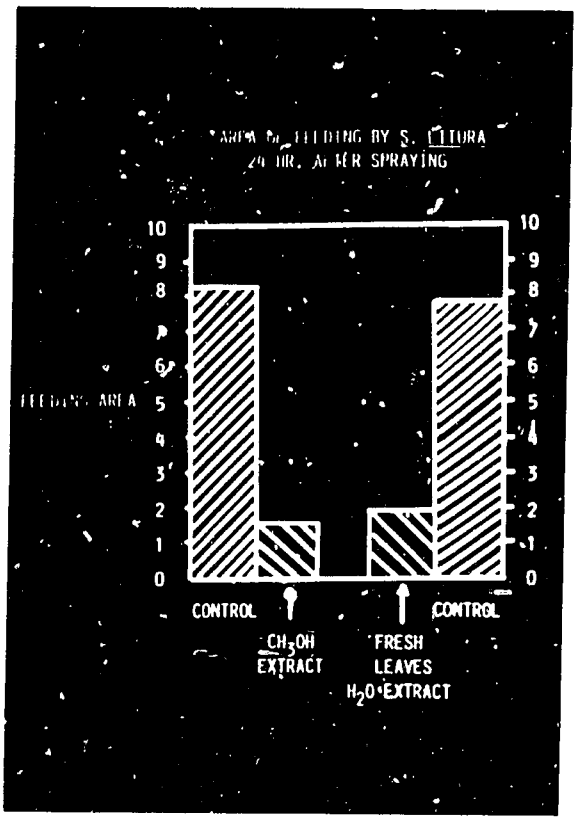
Ill. 8 - Spraying with tested solution.

Ill. 9 - *Vigna radiata* 24 hrs after spraying with control solution.

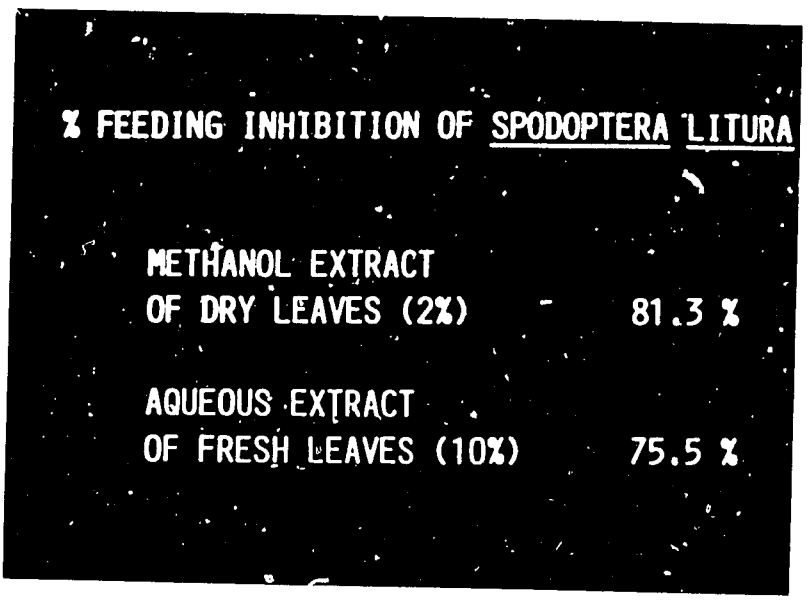


Ill. 10 - *Vigna radiata* 24 hrs after spraying with tested solution.

Ill. 11 - Comparison of feeding area in tested and control experiment.



Ill. 12 - % Feeding inhibition by tested solutions.



The efficacy of the *Aglaia sp* in crop protection was tested in the farmer plots:

Field Test 1, Ill. 13

Date : 10 December 1987

Place : Farmer plots at Ban Mae Tae, Amphur Sun-Sai, Chiang Mai

Crop : Cauliflowers, 45 days after seedling transfer

Number of larva : *S. litura*'s eggs were attached to the cauliflower's leaves (Ill. 14). After 7 days, larvae hatched and grew to third instar (Ill. 15), at which time the number of larvae was counted prior to spraying.

Treatments T_1, sprayed with control solution, 0.05% Triton in aqueous solution

T_2, sprayed with an aqueous suspension containing 8% of methanolic extract-bentonite (1:3) mixture and 0.05% Triton

T_3, sprayed with 10% fresh leaf aqueous extract with 0.05% Triton

T_4, sprayed with 10% dry leaf aqueous extract with 0.05% Triton

Observation - count number of larvae prior to spraying, 12, 24 and 48 hours after spraying

Results - summarized in Ill. 16.

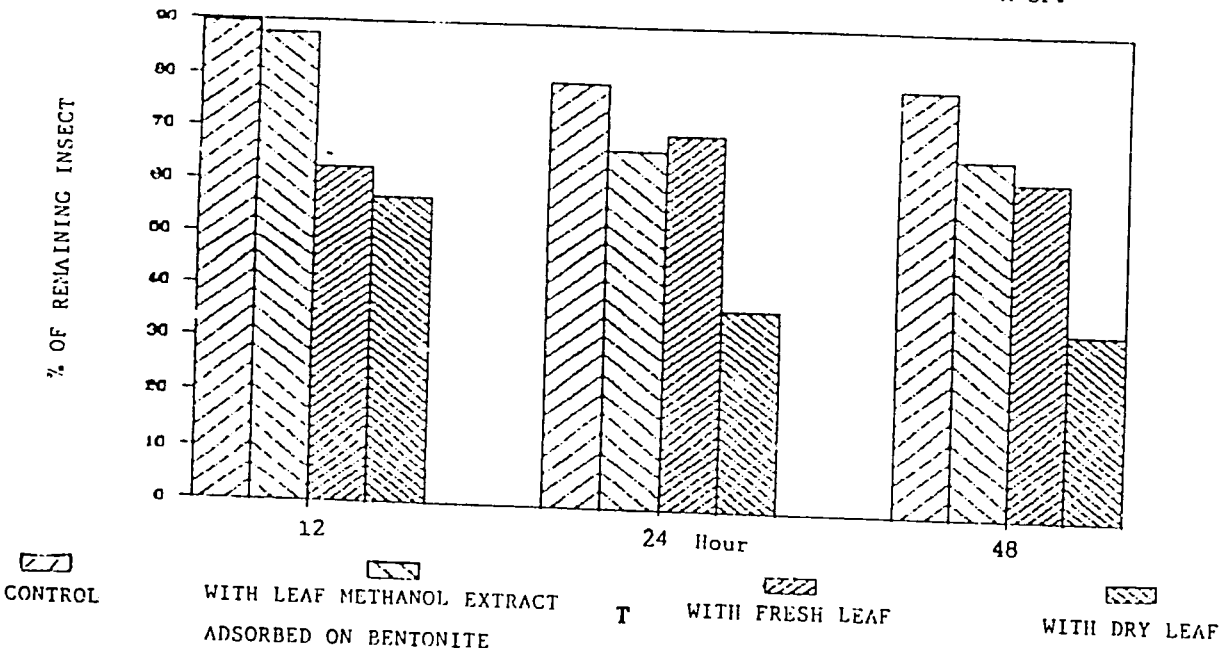
Ill. 13

Cauliflowers plots used in Field Test I.

Ill. 14 Attaching *S. litura'* eggs to cauliflowers' leaves.

<u>Ill. 15</u> - Third instar larvae from the attached eggs.

III. 16 - NUMBER OF INSECT AFTER TREATMENT WITH AGLAIA SP.



Field Test 2

Date : 21 February 1988

Place : Farmer plots beside road leading to Wat Sart Luang, Chiang Mai

Crop : Broccoli, 40 days after seedling transfer

Number of plants : 200/rep.

Number of replications : 3 replications of 1 x 3 m^2 plot.

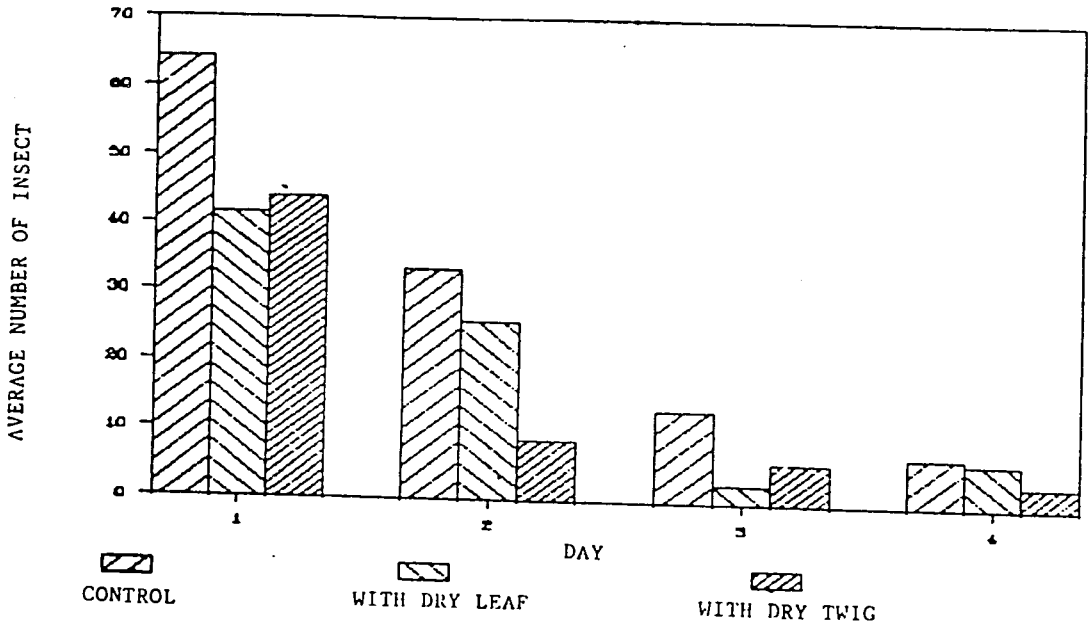
Treatment : T_1, sprayed with control solution, 0.05% Triton in aqueous solution.

T_2, sprayed with 10% dry leaf aqueous extract with 0.05% Triton.

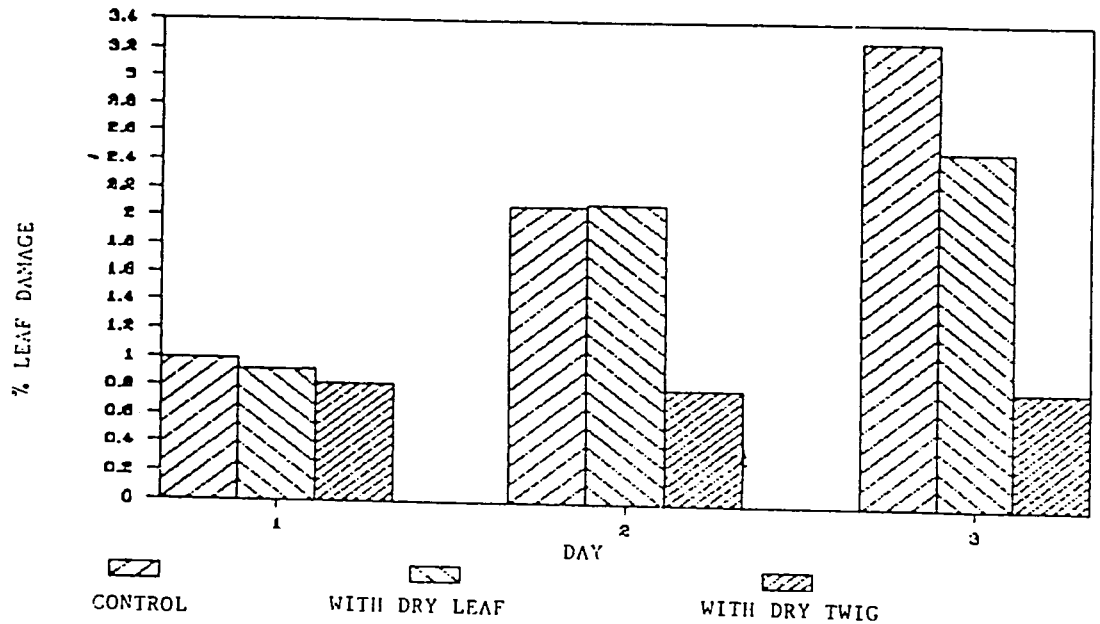
T_3, sprayed with 10% dry twig aqueous extract with 0.05% Triton.

Results summarized in Ill. 17, and Ill. 18.

Ill. 17 - NUMBER OF INSECT AFTER TREATMENT WITH AGLAIA SP.



Ill. 18 - % LEAF DAMAGE AFTER TREATMENT WITH AGLAIA SP.



Although some degree of efficacy of *Aglaia sp.* extract in crop protection was observed, accurate results could not be acheived due to the diminishing numbers of larvae both in the treated and control experiment.

Another experiment was then carried out under the better controlled conditions.

Date : 30 March 1988

Place : Post-harvest Centre, Chiang Mai University

Crop : Broccoli (25 days after seedling transfer) in clay pot surrounded by 1 inch of water in clay tray to prevent the larvae from escaping.

Number of larvae : 20/pot

Replications : 4 replications of 10 pots

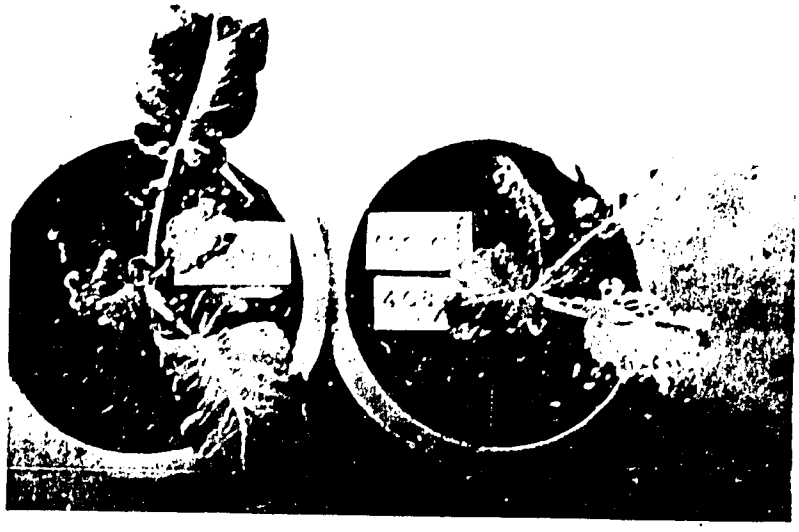
Treatment : T_1, sprayed with control solution, 0.05% Triton in aqueous solution

T_2, sprayed with an aqueous emulsion of 2% leaf methanolic extract and 0.05% Triton.

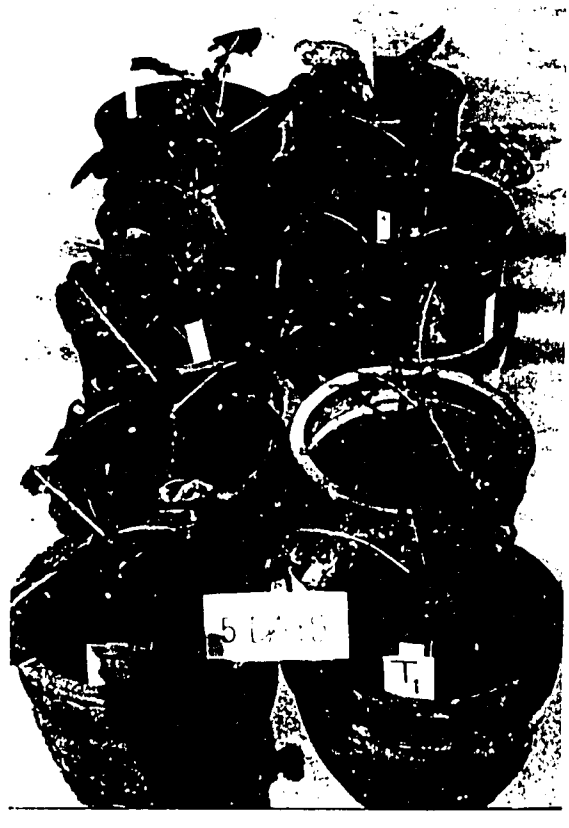
T_3, sprayed with an aqueous emulsion of 2% twig methanolic extract and 0.05% Triton.

Results : summarized in Ill. 19, 20, 21, 22, 23.

Ill. 19 - Comparison of leaves damage 4 days after treatment with 2% leaf methanolic extract and control.

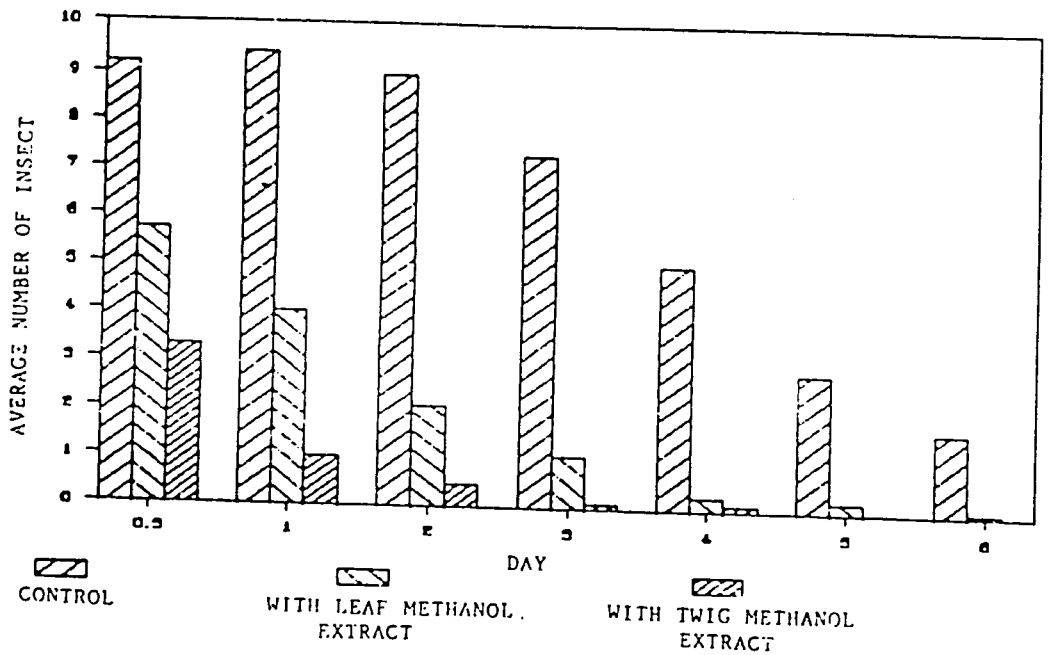


Ill. 20 - Comparison of leaf damage 5 days after treatment with 2% leaf methanolic extract and control.

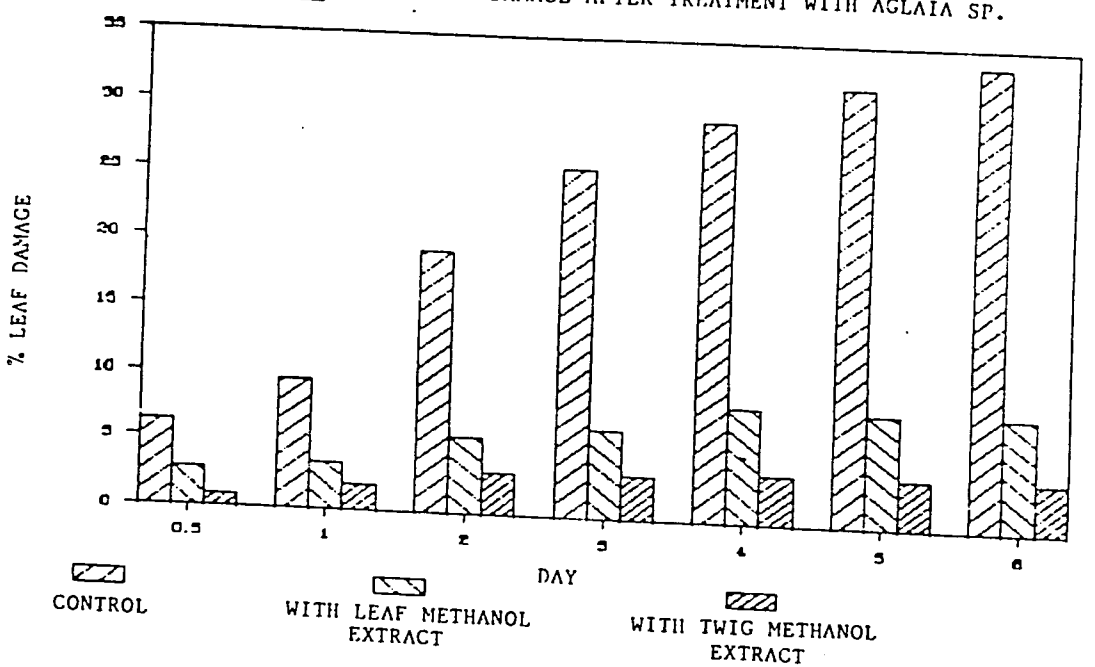


Ill. 21 - Comparison of leaf damage 5 days after treatment with 2% leaf methanolic extract (T_2), 2% twig methanolic extract (T_3), and control (T_1).

111. 22 - NUMBER OF INSECT AFTER TREATMENT WITH AGLAIA SP.



Ill. 23 - % LEAF DAMAGE AFTER TREATMENT WITH AGLAIA SP.



REMARK/WORKPLAN

It can be concluded from the experiments on *Aglaia sp.* that there exist a possibility of using this plant as an antifeedant for *Spodoptera litura* in agriculture. Plans have been made for the following studies:

1) Further assess other formulations of *Aglai sp.* in the field.

2) Compare the activity of scopoletin, which is the active antifeedant, in this plant, with other analogues.

Toward the end of this reporting period, we had reassessed the insecticidal activity of the plants which had been previously studied and recorded in our earlier report with various formulations. Remarkable results were obtained from the preliminary studies. The final period of this project will then be also spent in evaluating their applicability in the fields.

PROGRESS REPORT 5

Reporting Period : 1 June 1988 - 31 January 1989

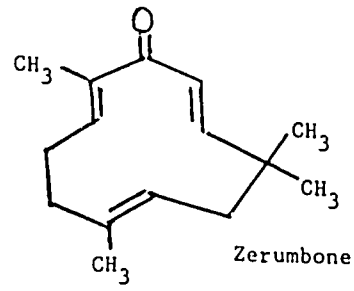
Background

In our earlier report, the steam distillates of Zingiber zerumbet was found to posses contact insecticidal activity. Since this plant is common and can be easily cultivated in Thailand, attempt has been made to further evaluate its applicability for insect control.

Zingiber zerumbet

Result and Discussion

Steam distillation of 4 kg of the tubers gave 83.25 g of cloudy oil (~ 2%). Upon standing the oil at 5°C, colourless glittering crystals formed. Spectroscopic and physical data revealed that the crystalline substance is zerumbone.



Zerumbone

Comparison of the activities of various fractions obtained from this plant indicated that zerumbone is the (or one of the) active ingredient.

Since only a moderate yield of the oil was obtained from the steam distillation, a more convenient and economical method of obtaining the active substances had to be developed.

In view of the fact that the final spraying insecticidal solutions is most convenient in the aqueous solution containing a surfactant to facilitate the spreading of the solution over the surface of target plant leaves, the spraying solutions from Z. zerumbet was then prepared by grinding the Z. zerumbet tubers in an aqueous solution containing various concentrations of sodium lauryl sulphate (SLS).

The first spraying was performed on broccoli released with 20 third instar S. litura's larvae. Three replications were used for each concentration. Broccoli leaves were sprayed until the solution started running off. Observation was made 3 hours after spraying, and the result is shown in Table 1.

Table 1. Effect of Z. zerumbet solution on S. litura larvae.

Dose	% survival
Wt. of Z. zerumbet : Wt. of H_2O (% SLS)	
1 : 4 (1)	16
1 : 3 (1)	10
1 : 2 (1)	9
0 : 0 (1)	33

Since the activity varies significantly with the proportion of the plant material to the aqueous solution, additional attempts were made to further determine the optimum proportion. Spraying was performed on broccoli released with 30 S. litura third instar larvae. Three replications were used for each formulation. The result is shown in Table 2.

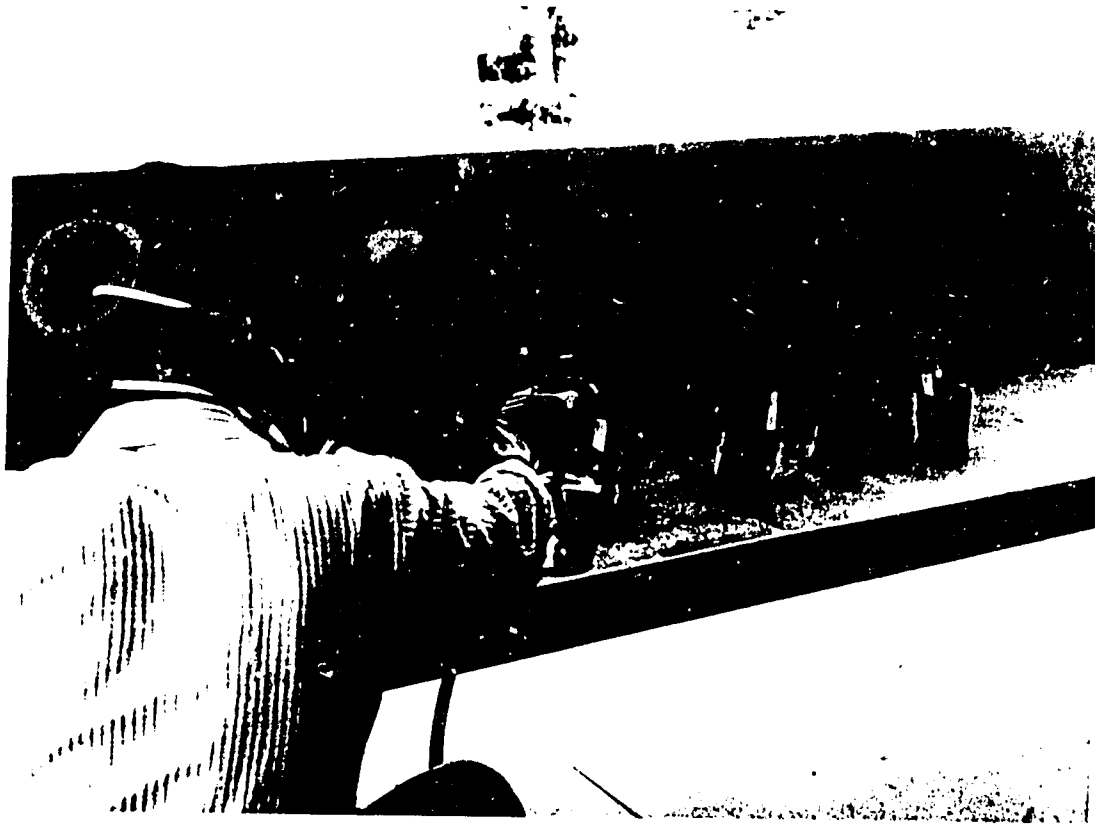
Table 2. The effect on *Z. zerumbet* solution on *S. litura* larvae.

Dose	% survival		
Wt. of *Z. zerumbet* : Wt. of H_2O (% SLS)	15 hr	24 hr	48 hr
1 : 4 (2)	3.33	3.33	4.17
1 : 3 (2)	4.17	7.50	8.33
0 : 0 (2)	15.83	14.17	12.50
1 : 4 (1)	6.67	5.85	5.83
1 : 3 (1)	3.33	4.17	1.67
1 : 2 (1)	5.00	5.83	6.67
0 : 0 (1)	24.17	17.50	20.00
- - - - -	- - -	- - -	- - -
1 : 2 (0.25)	10.00	11.67	6.67
1 : 2 (0.50)	4.17	2.50	2.50

No conclusion can be drawn on which is the most appropriate or most effective formulation to be used for testing in the field. Further experiments were done with another series of formulations. 20 *S. litura* third instar larvae were left on each broccoli leave. The leaves were then sprayed with the formulation until the solution started running off. The results are shown in Table 3.

Table 3. The effect of *Z. zerumbet* solution on *S. litura* larvae.

Dose	% Mortality
Wt. of *Z. zerumbet* : Wt. of H_2O (% SLS)	
1 : 2 (1)	100
1 : 3 (1)	100
1 : 4 (1)	100
0 : 0 (1)	85



Spraying of *Z. zerumbet* formulation.

The result: 3 hours after spraying.

The concentration used, obviously, was excessive

In order to further determine the most appropria concentration, a stock solution was made from a mixture of 1 : 2 of Z. zerumbet : H_2O (4% SLS). Half dilution was used to obtain a series of formulations from the stock solution. Spraying of these formulation was then made on 20 third instar larvae on each broccoli leave until the solution started running off. Twelve replications were used for each treatment. The results are shown in Table 4.

Table 4. Effect of *Z. zerumbet* on *S. litura*.

Dose Wt. of *Z. zerumbet* : Wt. of H_2O (% SLS)	% Mortality
1 : 2 (4)	not tested
1 : 4 (2)	"
1 : 8 (1)	"
1 : 16 (0.5)	89.59
1 : 32 (0.25)*	92.92
1 : 64 (0.125)	66.25
1 : 128 (0.063)	not tested

*The formulation affecting 92.92% mortality was then chosen for testing in the field together with a formulation of *Eupatorium odoratum* which is a common weed.

Field trial

Location	:	Tambon Mae Fak Ampur Sunsai Chiang Mai
Plot size	:	1 x 3 m. containing two rows of 60 days cauliflowers, 10 in each row. Sixty 3rd instar larvae were released on each plant.
Formulation used	:	T_1, *Z. zerumbet* : H_2O (% SLS) = 1: 2 (4) diluted to 1 : 32 (0.25) T_2, *E. odoratum* : H_2O (% SLS) = 1 : 2 (5) diluted to 1 : 32 (0.32) T_3, water
Replications	:	2 plots (4 rows) were used. Each row was taken as a replication.
Spraying method	:	with fan-head 3 K sprayer once each day for two consecutive days.
Observation of results	:	1 hr, 3 hr, 24 hr and 48 hr after spraying

Field trial

The results are shown in Table 5, 6.

Table 5. Result of Field test of Z. zerumbet.

Time after spraying	Average number of larvae remined on treated plant (and on control plant)				
	Rep 1	Rep 2	Rep 3	Rep 4	$\bar{X}$
1 hr	22.8(49.9)	19.4(50.4)	22.4(42.0)	23.4(32.9)	22.0(43.8)
3 hr	26.7(40.6)	22.0(36.0)	13.5(40.4)	14.2(28.4)	19.1(36.4)
24 hr	10.9(38.3)	10.2(33.6)	11.3(37.5)	15.1(24.7)	11.9(33.5)
48 hr	4.8(28.3)	2.5(17.6)	6.5(27.5)	5.5(34.0)	4.8(26.9)

Table 6. Result of Field test of *E. odoratum*.

Time after spraying	Average number of larvae remained on treated plants (and on control plants)				
	Rep 1	Rep 2	Rep 3	Rep 4	$\bar{X}$
1 hr	16.3(49.9)	15.1(50.4)	11.9(42.0)	15.6(32.9)	14.7(43.8)
3 hr	18.8(40.6)	11.5(36.0)	12.1(40.4)	5.2(28.4)	11.9(36.4)
24 hr	17.2(38.3)	13.5(33.6)	10.7(37.5)	10.4(24.7)	12.9(33.5)
48 hr	10.8(28.3)	7.0(17.6)	5.8(27.5)	4.7(34.0)	7.1(26.9)

Observation & Conclusion from field trial

1) *Z. zerumbet* formulation is more efficacious than *E. odorata* formulation. The result, however, is far less satisfactory than that obtained in the laboratory.

2) Larvae on upper side of leaves are more severely affected than those hiding underneath.

3) A method of effective spraying which will give better contact insect hiding underneath leaves should render more satisfactory result.

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