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Studies on coconut caterpillar, Brassolis sophoras Linnaeus and moth borer, Castnia daedalus Cramer, two major pests of coconut palm, in Guyana

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INTRODUCTION

Coconut, Cocos nucifera is the third most important crop of Guyana and the area under its cultivation in 1969, was estimated at 18,700 ha. Studies on two major pests of coconut palm i.e., coconut caterpillar, Brassolis sophorae Linnaeus (Brassolidae: Lepidoptera) and moth borer, Castnia daedalus Cramer (Castnidae: Lepidoptera) have been carried out and are reported herein. Most of the pests of coconut palm readily attact other species of palm (Lever, 1969) and thus studies on pests of coconut palm are also expected to be useful in cultivation of other economic palms like oil palm.

A. Braesolis sophorae, Linnaeus

B. sophorae is distributed throughout tropical South America and the distribution of its four forms is: B. sophorae sophorae Linn., Guianas to South Brazil; B. sophorae larida Stichel, Colombia; B. sophorae vulpecules Stichel, Paraguay and B. sophorae ardeus Stichel, South Peru (Fruhstorfer, 1924). B. sophorae sophorae is also recorded from Trinidad (Kaye, 1921).

Besides coconut palm, the caterpillars also feed on other palms like oil palm (Elaeis guineensis), the royal palm (Roystonea elata) and the cabbage palm (R. oleracea); bananas; plantains and other large monocotyledons (Van Dinther, 1960).

Severely attacked coconut palms are stripped of their leaves and bare mid ribs are left. Such palms lose an entire crop of nuts and a period of 12-18 months

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after such attack must elapse before there is another crop, withstanding that there is no further infestation.

A coconut estate at De Hoop, East Coast Demerara, average height of palms 7 m., has been repeatedly infested with the coconut caterpillar since early 1969. No control measures were undertaken. Observations in June, 1971, revealed that about 20% palms had died and there were no mature or developing nuts on the surviving palms.

Larger caterpillar make nests up to 45 cm. long by webbing together the leaflets, wherein they hide during the day. Caterpillars feed at night. Sometimes, specially the smaller caterpillars hide about the bases of the leaves, in fibrous material. Detailed biology and bionomics of this pest in Guyana, has been worked out by Cleare and Squire (1934). The adult butterfly lays the eggs in masses of 100 or more, cemented to the leaves, leaf bases and fibrous material at crown. Incubation period is 20-25 days. There are seven larval intars. Larval duration is 76-91 days. Gregarious larvae tend to turn solitary near pupation. Pupal stage lasts 11-14 days. Life cycle is completed in about 120 days and there are three generations per year, starting in March - April, June - July and October -December.

Though coconut caterpillar is to be found in greater or lesser numbers every year but now and then outbreaks occur (Cleare and Squire, 1934). An outbreak of this pest started in 1968 and is continuing through June, 1971. A survey carried out in June, 1969, revealed that 600 ha. each were heavily infested in Mahaicony-Abary and Berbice.

MATERIALS AND METHODS

Comparative toxicity of insecticides: Technical grades of insecticides were formulated as emulsions using benzene as solvent and Ratzloff PNS 737 as emulsifier. Insecticides not soluble in benzene, were dissolved in other suitable

solvents. Coconut leaflets were dipped in emulsions for one minute and were slightly shaken to remove excess fluid. The liquid on leaflets was allowed to dry and then the leaflets were placed in glass jars. Field collected, 4th and 5th instar caterpillars were used in tests.

There were three replications of ten insects each for each treatment. Insects were introduced in jars at 4 p.m. Mortality data were recorded 48 hours later. Corrected percentage kill was worked out by Abbots' formula (Finney, 1964).

Injection of coconut palms: In earlier stages of work, an injection apparatus described in Shell Chemical Bulletin BID/L/3, June, 1965 was used for injecting commercial monocrotophos 60% E.C. into the palms. Subsequently, a hand operated chest brace drill with 0.79 cm. (5/16th inch), 0.95 cm. (3/8th inch) and 1.27 cm. (1/2 inch) drill bits, was used. 7.6 cm. deep hole at a convenient place on the trunk, say within a metre from ground, was drilled. The hole went down and towards the centre of the trunk. An exact amount of liquid insecticide was pipetted into the hole.

RESULTS AND DISCUSSION

Comparative toxicity of insecticides: Based on the results of comparative toxicity of insecticides to the caterpillars of B. sophorae, an effort has been made to arrange insecticides in order of toxicity (Table I). Five insecticides which gave more than 90% kill at 0.01% concentration were: methomyl, azinphos-methyl, monocrotophos, trichlorfon and endosulfan. Out of these five insecticides, trichlorfon is suited for spraying of coconut palms in view of its comparatively low cost and greater safety to operators while monocrotophos, the only systemic insecticide, was selected for injection into the palm, for the control of the caterpillar.

Spraying of coconut palms for control of the caterpillar: Spraying of infested coconut areas with trichlorfon solution at 1 kg. a.i. in 11 litres of spray fluif/ha. from fixed wing aircraft, gave excellent control of the caterpillar. Similarly, spraying of coconut palms with trichlorfon at 1.0 - 1.5 kg. a.i. in 20 to 30 litres of spray fluid/ha. with a tractor mounted sprayer gave an excellent control of the caterpillar, on palms up to 12 m. high.

The specifications of the sprayer were:

Engine capacity.....6.1 H.P. at 5000 r.p.m.

Air capacity.....166 m^3/minute.

Air speed.....159 km/hr.

Nozzle.....open rotating dis.

Vertical swath.....15-20 m.

Under conditions on the coast, with horizontal wind velocity of 5-10 km./hr., the effective vertical swath of the sprayer was found to be 12 m.

Injection of coconut palms for control of the caterpillar: About 9 m. high coconut palms, infested with the caterpillar were injected with different dosages of monocrotophos 60% E.C. and the results presented in Table III indicate that 2.4 to 3.6 gm. a.i. or 4 to 6 ml. of 60% monocrotophos E.C. in one hole/palm, kill all the B. sophorae in 4 days.

Table I. Comparative toxicity of insecticides to the caterpillar of B. sophorae

Insecticide	Corrected percentage kill at conc. of	
	0.01%	0.003%
Methomyl	100.0	77.3
Azinphos - methyl	100.0	31.8
Monocrotophos	95.5	54.5
Trichlorfon	90.9	54.5
Endosulfan	91.3	30.4
Chlorphenvinphos	82.6	4.3
Dicrotophos	68.2	13.6
Amidithion	45.5	31.8
Fenitrothion	43.5	0.0
Aldrin	30.4	8.7
Mecarbum	31.8	4.5
Unden	18.2	0.0
Folimat	13.6	0.0
Fensulfothion	13.6	0.0
Carbaryl	9.1	4.5
Disyston	4.5	4.5
Cyolane	9.1	0.0
Heptachlor	9.1	0.0
Lindane	0.0	4.3
Phorate	0.0	0.0
Cyanamid 47470	0.0	0.0
D.D.T.	0.0	0.0
Malathion	0.0	0.0
Iodfenphos	0.0	0.0

Caynamid 47470 = 2 - (diethoxyphos - phinylimino) - 4 - methyl - 1, 3 - dithiolene.

Data presented in table II indicate that out of 816 palms observed in three different typical coconut areas, 31 trees were more than 12m. high. Thus for these 31% trees, control measures alternative to use of tractor mounted sprayer, require to be found.

Table II. Data on height of coconut palms and infestation by C. daedalus.

Area	Height of coconut palms (metres)														
	3 - 6			6 - 9			9 - 12			12 - 15			15		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Unity	25	4.0	5.5	81	6.2	8.8	118	8.0	11.6	106	7.1	14.0	0	-	-
Handvelth	14	4.1	5.2	64	5.5	7.6	75	6.2	10.7	77	5.8	8.1	0	-	-
Grove	48	4.0	5.5	71	5.7	8.5	67	7.0	10.7	61	6.3	10.1	9	7.3	9.8
Total/mean*	87	4.0*		216	5.8		260	7.1		244	6.4		9		

a = No. of palms observed b = Average height of galleries, c = Maximum height of galleries.

Table III. Control of B. sophorae by injection of infested palms with monocrotophos.

Dosage	No. of injections per palm.	No of infested palm treated	No. of palms with all caterpillars dead in no. of days after injection		
			1	2	4
3.6	1	5	2	3	5
3.0	1	5	4	5	5
2.4	1	5	2	3	5
0.0	1	5	0	0	0

To determine the duration of effectiveness of injected monocrotophos to control the pest, leaflets from palms injected 72 days earlier were provided to 3rd and 4th instar caterpillars in glass jars. Data presented in Table IV indicate that both 4.8 and 3.6 gm. a.i./palm gave 100% kill of the caterpillars in 9 days and that treatment with 4.8 gm. a.i./palm was slightly superior to that with 3.6 gm. a.i./palm. Injection of 3.6 gm. a.i./palm was effective against adult stick insect, Graeffea crouanii (Le Guillon) up to 16 weeks after tratment (Stelzer, 1970).

In May, 1971, about 10,000 palms were successfully injected with monocrotophos to control B. sophorae. The treatment was not effective in about ten old palms. Redrilling of holes in trunks of such palms, revealed that the drilled out wood was reddish and dry in comparision to white and wet of other trees.

Table IV. Toxicity of monocrotophos, 72 days after injection into coconut palm, to caterpillar of B. sophorae.

Dosage a.i. (gm.)/ palm	No. of injection per palm	Corrected* percentage kill No. of days later.					
		1	3	4	6	8	9
4.8	1	0*.0*	44.8	69.0	75.9	89.7	100.0
3.6	1	10.3	10.8	44.8	69.0	82.8	100.0

* Mortality in control was 2.5%
** Average of 3 replications of ten insects each

Residues of monocrotophos in milk and meat of mature and immature nuts from 2 to 70 days after injection of coconut palms, (Table V) were less than 0.01 p.p.m. i.e, the detectable limit. These data were provided by the courtesy of Dr. D. E. Chandool of the Shell Trinidad Ltd.

In view of the results reported above, injection of 3.6 gm. a.i. or 6 ml. of 60% monocrotophos E.C. in one hole per palm is recommended. 7.6 cm. deep hole made with a 0.95 cm. (3/8 inch) drill bit, in trunk, just holds 6 ml. of fluid. Thus a 7.6 cm. deep hole with a 0.95 cm. drill bit is made. Monocrotophos 60% E.C. is filled in the hole, with the help of a plastic bottle, stoppered with a rubber cork having a metal tube. This bottle is tilted, the metal tube opening is inserted into the hole and the bottle is gently squeezed to fill the hole with the insecticide. One man can inject 150 to 170 palms per day or can treat about 1.3 ha. per day. The cost of insecticides is G. $1.00 for 16 palms.

Suitability of the three techniques of control of the coconut caterpillar: Collection and destruction of nests from palms is not only difficult but those caterpillar which hide in the leaf bases, are left on the palms.

Data presented in Table VI indicate that generally the pest is destructive from March to September. At any one time during this period, almost all stages of the pest could be found in field. When aerial or ground spraying is carried out, no doubt caterpillars get killed and there is relief for sometime but the pest reappears because other stages of the pest survive. Two times i.e., in March and August, 1969 (Table VI), all the infested area was aerially sprayed but yet the pest continued unabated, because of the overlapping generations.

Table V. Data on residues of monocrotophos in coconut' milk and meat (Provided by Shell Trinidad Ltd).

Quantity of monocrotophos injected/palm (gm.)	Treatment to sampling interval in days	Residues in ppm. Milk	Meat	
			Mature	Immature
3.6	2	0.01	0.01	0.01
3.6	7	0.01	0.01	0.01
3.6	14	0.01	0.01	0.01
3.6	28	0.01	0.01	0.01
3.6	70	0.01	0.01	0.01
0	2,7,14,28,70	0.01	0.01	0.01

Analysis carried out by G.L.C. flame photometric detector.
The detectable limit was 0.01 ppm.

Under these circumstances, an effective treatment should be long lasting. Injected monocrotophos remains toxic to the caterpillars for at least up to 72 days and is thus ideally suited. Excessive height of some palms, horizontal winds of 5 - 10 km./hr., camber bed system of layout of estates and establishment of drop nut palms, make the use tractor mounted sprayer impossible in most of the estates. In estates where it could be used, it can treat only 5 ha./per day with the help of two men, due to the above mentioned difficulties. The sprayer only costs about G $3,000.00 Four persons can inject 5 ha. per day and four hand drills cost G. $76.00.

Unlike other crop pests, the coconut caterpillar does not come in contact with poison when the palms are sprayed in day time since the caterpillars are hidden in nests or in the fiberous material at leaf bases. The caterpillar comes into contact with poison at night when they come out to feed on foliage: Rains between spraying and feeding time, can wash out the insecticide from palm and reduce the efficacy of treatment. Heavy rains in May-June, restricted the spraying operations.

Table VI. Incidence of coconut caterpillar.

These data are from an estate where about 300 ha. were infested, out of a total of 650 ha.

MONTH	No. of nests collected			
	1968	1969*	1970**	1971***
January	0	0	0	0
February	0	0	0	95
March	2,693	10,032	1,009	
April	2,715	11,232	1,050	
May	2,310	12,199	1,060	
June	3,533	38,575	1,930	
July	2,214	5,787	0	
August	0	27,783	1,101	
September	250	4,765	479	
October	0	0	0	
November	0	0	0	
December	4,335	0	0	

* In 1969, additionally, 324 ha. each were sprayed aerially with insecticide, in March and August.

** In 1970, additionally, 220 ha. were sprayed with insecticide from tractor mounted sprayer.

*** In 1971, additionally, from March to May; 150 ha. were sprayed from tractor mounted sprayer and in May, about 6000 palms (43 ha.) were injected with monocrotophos. (Injection technique was given out only in May, 1971).

The following insect parasites of B. sophorae have been recorded from Guyana by Cleare and Squire (1934):-

(i) Telenomus nigrocoxalis Ashm. and Anastatus reduvii How, parasitize the eggs.

(ii) Chaetolyga pyrrhopyga Wied parasitizes the caterpillar.

(iii) Spilochalcis morleyi Ashn., Brachymeria incerta Cress. and B. annulata F. parasitize the pupae.

The eggs and pupal parasites are very effective and parasitize the respective hosts up to 70 and 30 percent respectively. According to Cleare and Squire (1934), these natural enemies play a very important part in determing the prevalence of the pest and to a great extent determine the occurrence of outbreaks of the caterpillar. In view of the importance of natural enemies, injection rather than spraying of palms with insecticides, suggests itself.

B. Castnia daedalus Cramer

C. daedalus is distributed from Amazone valley through the Guianas to Panama (Van Dinther, 1960). Besides coconut palm, it also infests oil palm (stachel, 1944) and other ornamental palms like royal palm, Maximiliana maripa, Pritchardia pacifica, Phoenix dactylifera, Livistona sp. and Sabal sp. (Van Dinther, 1960).

Creamy white, young larvae, tunnel rather shallow into the leaf stalks and adjacent parts of trunk. Gradually, the larvae penetrate deeper into these parts. Holes and tunnels in the trunk, run horizontally to a depth of 5 - 10 cm. and continue vertically upwards. Tunnels by several larvae may unite. Because of the nature of attack, the lower leaves droop to an almost vertical position and are shed prematurely. Palms attacked year after year, may survive but when larvae bore into growing tip, the palm invariably dies.

The female moths, lay spindle shaped pink eggs, 4.3 to 4.7 m. long, near base of the coconut crown. The eggs are deposited in groups of 2 - 8. The records

of rearing of this insect in Guyana, in 1929, by L.D. Cleare indicate the duration of various stages to be:

Eggs stage.....17 days.

Larval stage.....10 1/2 months

Pupal stage.....35 days

According to Reyne (1929), the complete period of larval development is about one year. Pupation takes place in a 7.0 - 10.5 cm. long, brown cocoon, composed of fibrous wood chips. The cocoon is often found in a shallow excavation on the inner side of leaf base.

Heights of palm and infestation by C. daedalus: The coconut palm becomes valnerable at the age of 4 - 5 years i.e, when formation of trunk starts. The tree may then be attacked for the rest of the life (Van Dinther, 1960). A survey carried out at East Coast of Demerara (Table II) indicates that in 6 - 9, 9 - 12 and 12 - 15 m. high palms, the average heights of highest Castnia galleries were 5.8, 7.1 and 6.4 m. respectively. These data suggest that Castnia prefers palms up to 7 m. high. In this survey, the highest gallery of Castnia was observed at a height of 14 m.

Extent of infestation and loss due to C. daedalus: 250 palms each from five coconut areas on East Coast Demerara, were observed for presence or absence of Castnia holes on trunks and the data collected are presented in Table VII which indicate that 46 % palms were attacked by Castnia at some stage of their life. A similar figure was 85% at Lesbeholden, Corentyne.

Table VII. Extent of infestation of coconut palms due to C. daedalus at East Coast Demerara

Area	No. of palms observed	Percent palms Infested
De Hoop	250	41
Good Hope	250	42
Handenveldt	250	50
Lancaster	250	46
Unity	250	49
Average	-	46

For studying the extent of loss caused by Castnia, number of nuts was counted from 20 infested and 20 uninfested palms, in proximity of each other and of comparable height. There was an error of 5 - 10% in counting the number of nuts on the palms. The data presented in Table VIII indicate that:

(i) The infested palms bear nuts in button stage about 85% as much as uninfested ones.

(ii) At East Coast Demerara, the proportion of semi-mature plus mature nuts to nuts in button stage was 0.92 for uninfested trees against 0.75 for infested trees. Similar figures for Lesbeholden were 0.73 and 0.54 respectively. These data suggest that a larger proportion of nuts drop during maturation process in the infested than in uninfested palms.

(iii) Infested plams bear 68% and 54% as much semi-mature plus mature nuts as the uninfested ones, at East Coast Demerara and Lesbeholden respectively. Further, the size of nuts is also reduced, due to Castnia infestation.

Control C. caedalus: During studies on the control of B. sophorae by injecting coconut palms with monocrotophos, some larvas of Castnia were also observed to have died. Detailed experiments were then carried out to find the dosage of monocrotophos and number of injection required per palm, for control of this pest. The technique of injection was same as for B. sophorae. Castnia holes/galleries just below the oldest leaf indicated that the palm was then infested and was thus selected for treatment. Two weeks after treatment, ten lower leaves were removed and leaf bases and trunk were observed for live and dead Castnia. The data collected are presented in Table IX which indicated that:

(i) 3 or 4 injections per palm result in more kill than 1 or 2 injections at any one dosage of toxicant.

(ii) 3.6 to 6.0 gm. monocrotophos in 3 injections per palm, give almost 100% kill of the Castnia, located deep in tissues.

Van Dinther (1960) reported spraying of the crown base with 0.5% emulsion of DDT, aldrin or dieldrin and Anon. (1959) recommended spraying of centre of crown with 1% dieldrin emulsion at 2.2 litres per palm, for control of this pest. These treatments only control the newly hatched and young larvae which have not penetrated deep into the tissues.

In view of these results, injection of 4.8 gm. a.i. or 8 ml. of 60% monocrotophos E.C. at three points distributed around the trunk, is recommended. 7.6 cm. deep hole made with 0.79 cm. (5%16th inch) drill bit, in trunk, holds 4.5 ml. of fluid. Three holes will hold 13.5 ml. of fluid. Since, only 8 ml. of 60% monocrotophos E.C. is to be applied per palm, this insecticidal formulation is diluted with water in proportion of 16 parts of insecticide and 11 parts of water. The diluted insecticide is then used to fill the three holes which will give a dosage of 60% monocrotophos or 4.8 gm. a.i./palm. One man can inject 100-120 palms per day. The cost of insecticide is G. $1.00 for 12 palms.

About 5,000 palms were successfully injected with monocrotophos to control C. daedalus, specially at Lesbeholden, Corentyne. During these large scale operations, it was observed that some borer larvas, in bases of leaves which had got partially detached from trunk, did not die. In view of this it is felt that drooping leaves which could be easily pulled off the palms, should be removed and burnt.

SUMMARY

Coconut caterpillar, Brassolis sophorae Linnaeus and moth borer, Castnia daedalus Cramer are two major pests of coconut palm, in Guyana. Continous stripping of leaves by the caterpillar results in death of some palms while the others do not bear any nuts. Laboratory studies on comparative toxicity of 24 insecticides to the caterpillar indicated that methomyl, azinphos-methyl, monocrotophos trichlorfon and endosulfan were more toxic than the rest. Spraying of trichlorfon at 1.0 kg. a.i. in 11 litres and 1.0- 1.5 kg. a.i. in 20-30 litres of spray fluid/ ha. from aircraft, and tractor mounted sprayer respectively, gave immediate control of the caterpillar but the pest infestation continued because of overlapping generations. Injection of 3.6 gm. a.i. or 6 ml. of 60% monocrotophos E.C. in one hole/ palm, gave complete kill of the caterpillar. The treatment was effective for at least 72 days and was thus ideally suited to control overlapping generations of the pest. Further, in view of the natural abundance of insect parasites, injection rather than spraying of palms with insecticide, suggests itself. One man can inject 150-170 palms (1.3 ha.)/ day with the help of a hand operated, chest brace drill. About 10,000 palms were successfully treated for the caterpillar control.

Moth borer, Castnia tunnels the trunk near to leaf bases. As a result the leaves droop almost vertically. Egg, larval and pupal stages last for 17 days, 10 1/2 month and 35 days respectively. It prefers palms up to 7 m. high. It infested 46% and 85% of palms in two different areas. The infested palms bear

semimature plus mature nuts up to 54% as much as uninfested palms. Injection of 4.8 gm. a.i. or 8 ml. of 60% monocrotophos E.C. at three points around the trunk, results in kill of the borer, in situ. One man can inject 100-120 palms/day. 5,000 palms we successfully injected for its control.

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