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PRELIMINARY STUDIES IN THE DEVELOPMENT OF A PEST MANAGEMENT PROGRAMME FOR CRUCIFEROUS CROPS IN TRINIDAD AND TOBAGO

M. YASEEN[°] - R.M. BARROW[°°] - G.S. KATWARU[°°]

INTRODUCTION

In Trinidad the diamond-back moth *Plutella xylostella* (L.), the cabbage looper *Trichoplusia ni* (Hubner) and the cabbage budworm *Hellula phidilealis* Wlk. are major pests of cabbage and cauliflower crops which are cultivated extensively to satisfy both the local and export markets (144,000 lbs. of fresh cabbage exported in 1975, CSO report).

Very few native parasites are known to attack *Plutella* (Bennett and Yaseen 1972 ; Yaseen 1974), *Hellula* (Fennah 1947) and *Trichoplusia* (senior authors' unpublished data). It is customary to use chemical pesticides against these pests and while satisfactory control can be achieved (Parasram/1969 & 1973 ; Buckmire 1975) repeated applications can have adverse effects on the consumer and spray operator, on the agroecosystem and the cost of crop production.

It is desirable therefore to develop a system of pest management integrating all available measures of control in a manner which will require the minimal use of chemical pesticides. The experiment reported in this paper is one of a series being conducted jointly by the Ministry of Agriculture and the Commonwealth Institute of Biological Control in an effort to develop such a system of pest management for insect pests of cultivated crucifers in Trinidad and Tobago.

MATERIALS AND METHODS

The investigations were undertaken at St. Augustine Nurseries from mid-December 1976 - March 1977. Early Patna variety of cauliflower (Keystone, California) was grown using standard agronomic practices as outlined by Ganpat (1973). A completely randomized design was used and the experimental area was divided into three blocks - bio (20' x 47') and chemical integrated (20' x 94 '). In the integrated and chemical blocks there were four replicates per treatment. The following were the chemicals tested :

Cyanofenphos (Surecide (R) at a dosage rate of 1 ml./litre
Acephate (Orthene (R) at a dosage rate of 1.65 g./litre
Bacillus thuringiensis (Dipel (R) at a dosage rate of 1.25 g./litre

These were applied in 2.27 litres of water.

In the chemical control block pesticide applications were applied at regular intervals of 7 days where as in the integrated control block applications were made only if pest populations approached the economic threshold. Plants were not sprayed prior to transplanting into the field.

Nucleus stocks of exotic parasites *Trichogramma chilotraeae* Nag. and Nagar. for trial against *Trichoplusia*, *Bracon hebetor* Say against *Hellula* and *Tetrastichus sokolowskii* Kurdj. against *Plutella* were obtained from the Indian Station, CIBC,

(°) Commonwealth Institute of Biological Control Curepe, Trinidad

(°°) Ministry of Agriculture, Trinidad

and that of *Apanteles plutellae* (Kurdj.) against *Plutella* from Barbados where it has been established from stocks obtained earlier from the Indian Station, CBC. Laboratory production of all of the parasites was maintained at the West Indian Station, CIBC at a level adequate to provide material for release. Parasite adults were fed on honey and held for at least a day in the laboratory to permit mating before release. Samples were taken at weekly intervals and the numbers of immature stages of each pest was recorded. A sample consisted of 12 plants per plot selected at random in the integrated and chemical control plots and 48 plants in the biocontrol plot. For the determination of the extent of leaf damage done by *Plutella* and *Trichoplusia* measurements of the damage was done on the leaf closest to the flower head. To determine yield and quality per plot ten plants were chosen at random when the plots were harvested on March 17-20.

RESULTS

Integrated control plots

Cauliflower seedlings were transplanted into the plots on January 18. Observations for insect attack were initiated on January 24. When first sampled on January 24, several plants had been damaged by mode cricket (*Scapteriscus vicinus* Scudd.). Of the three pests under study *Hellula* was the main pest, *Plutella* was scarce and damage by *Trychoplusia* had commenced. As the young plants were very susceptible to *Hellula*, i.e., attack by a single larva can destroy the growing point, pesticides were applied on January 26. Subsequent observations for the three pests were made on February 7, 15, 23, March 2 and 16.

Hellula : Incidence of *Hellula* encountered during periodic observations is given in Table 1.

Table 1 - Total larval population of *Hellula phidilealis* on treated and control plots

Parasite Release/ Chemical Appl'n	Date	Dipel	Surecide	Orthene	Control
Parasite Release	Jan. 18	7	5	2	4
	Jan. 24				
Chemical Appl'n	Jan. 26				
	Feb. 7		2	3	5
	Feb. 15	9	6	16	15
Parasite Release	Feb. 23	19	9	21	13
Chemical Appl'n	Feb. 14				
	Mar. 2			2	16
	Mar. 16	6	3	8	11

Approximately 650 adults of *Bracon hebetor* Say, a larval ectoparasite of *Hellula* and several other lepidopterous pests were released during January 18 to February 23. Populations of *Hellula* were checked by the first chemical treatment but an increase in larval populations had occurred by February 15. As there was no evidence of parasitism the increasing pest population was suppressed by a second application of pesticides on February 24. *Hellula* had again increased slightly but additional treatments were not necessary as the crop was harvested the following weeks.

Plutella : Attacks of *Plutella* were negligible when the observations were initiated and remained at a very low density as can be seen from Table 2.

Table 2 - Total no. of larvae and pupae of *Plutella* in samples from control plots (Figures in parenthesis denote % parasitism by *A. plutellae).*

Date	Dipel		Surecide		Orthene		Control	
	Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Larvae	Pupae
Jan. 24					2			
			Chemical applied Jan. 26					
Feb. 7	3		8	1	5		13	
			Parasite released Feb. 9-20					
Feb. 15	28(17.1)	2	26(7.6)		35(-)	3	31(3.2)	-
Feb. 23	18(-)		21(4.7)		27(3.7)		29(6.8)	1
			Chemical applied Feb. 24					
Mar. 2	1				2		11(18.2)	
Mar. 16	7(14,2)		2(-)		8(-)		16(12.5)	

A few eggs of *Plutella* were obtained from some but all hatched normally. As an increase in the population was noticed on February 7, about 290 adults of *Apanteles plutellae* (Kurdj.) and 200 adults of *Tetrastichus sokolowskii* Kurdj. were released during February 9 - 20. *A. plutellae* was recovered (table 2) from plots treated with Dipel and Surecide and from the control a week-after the first release and from plots treated with Orthene on February 23. The parasite was not recovered from the three larvae in the samples from the treated plots on March 2 but was obtained from the control plots. The parasite was again obtained on March 16 from the Dipel-treated and the control plots more than three weeks after the last release indicating that the parasite had established in the experimental area. *T. sokolowskii* was not recovered. The low host densities were not conducive to establishment.

Trichoplusia : While a few eggs of *T. ni* were observed during the first observation on January 24 no parasites were released at that time because a pesticide application was required against *Hellula.* However, as the rate of oviposition was increasing, about 200 adults of *Trichogramma chilotraeae* known to attack eggs of *T. ni* in south India (Manjunath 1972) were released between February 9 and 17. The incidence of eggs per sample is given in Table 3.

Table 3 - Number (mean ± S.D.) of eggs of T. ni and % parasitism (mean ± S.D.) per plot in each treatment.

	Dipel		Surecide		Orthene		Control	
	Eggs	Par.	Eggs	Par.	Eggs	Par.	Eggs	Par.
Jan. 24	5.3 ± 2.2	25.5 ± 20.1	-	-	-	-	11.9 ± 2.5	11.9 ± 6.1
			Chemical application Jan. 26					
Feb. 7	14.5 ± 7.1	13.9 ± 8.3	12.0 ± 2.9	18.7 ± 11.2	12.8 ± 6.5	8.1 ± 6.5	6.3 ± 5.2	17.1 ± 8.2
			Parasites released Feb. 9 - 17					
Feb. 15	52.0 ± 29.6	29.2 ± 13.9	56.3 ± 19.0	43.3 ± 16.2	50.0 ± 5.7	32.1 ± 9.2	51.5± 20.5	26.3 ± 11.1
Feb. 23	61.3 ± 8.2	27.1 ± 26.7	49.3 ± 17.2	48.3 ± 14.9	57.3 ±11.7	33.2 ± 11.2	55.3 ± 21.2	32.6 ± 15.2
			Chemical applied Feb. 24					
Mar. 2	6.25 ± 2.5	-	11.0 ± 4.3	-	6.8 ± 4.9	8.2 ± 7.1	8.0 ± 5.7	18.7 ± 7.5
Mar. 16	10.5 ± 4.4	20.8 ± 13.2	7.8 ± 3.3	37.0 ± 29.5	11.0 ± 1.9	10.6 ± 5.5	10.5 ± 3.7	25.4 ± 18.5

Egg parasitism Four native species of Trichogrammatids *Trichogramma brasiliensis* (ashm.), *T. perkinsi* Gir., *T. fasciatum* (Perkins) and T. sp. nov. were reared from the samples of T. ni eggs. *T. chilotraeae* was not recovered. Larval populations of T. ni remained considerably low as seen from table 4.

Table 4 - *Trichoplusia ni* larvae in samples from treated and control plots.

Date	Dipel	Surecide	Orthene	Control
Jan. 24	1	1	2	
		Chemicals applied Jan. 26		
Feb. 7	6	5	2	6
		Parasites released Feb. 9 - 17		
Feb. 15	11	13	17	23
Feb. 23	12	9	21	18
		Chemicals applied Feb. 24		
Mar. 2	-	-	-	17
Mar. 16	5	2	3	11

As a result of high egg parasitism few eggs eclosed. The larval densities were further reduced by the activities of "Jack Spaniard" the common wasp *Polistes canadensis* L. which also actively preyed upon larvae of the other pests. An egg-larval Encyrtid parasite *Litomastix truncatulla* (Dalman) and a Tachinid *Eucelatoria* sp. attacking larvae have previously been reared occasionally but none were obtained during these investigations.

The mean percentage leaf area damaged by *Plutella* and T. ni at harvest time and the number of plants damaged by *Hellula* expressed as mean percentage per plot in each treatment are shown in table 5.

Table 5 - Mean ± SD % of plants damaged by *Hellula* and leaf area damaged by T. ni and *Plutella*

Treatment	*Hellula*	T. ni and *Plutella*
Dipel	27.9 ± 3.0	4.2 ± 0.5
Surecide	19.8 ± 8.5	3.0 ± 2.2
Orthene	28.9 ± 3.0	4.7 ± 4.3
Control	34.1 ± 9.9	7.4 ± 3.6

Biocontrol plot. Very minor attacks of *Plutella* and *Trichoplusia* were noticed a week after the nursery stock was transplanted. About 100 adults each of *A. plutellae* and *T. sokolowskii* against *Plutella* and 150 adults of *T. chilotraeae* for trial against *Trichoplusia* were released during the first week of February. Damage by *Hellula* was noticed during the first week of February and about 500 adults of *B. hebetor* were released against the pest during February 4 to 23. Counts of the pests and parasites obtained from the samples are given in table 6.

Table 6 - Incidence of *Hellula*, *Plutella* and *Trichoplusia* and % parasitism in biocontrol plot.

Date	*Hellula*	*Plutella*			*Trichoplusia*		
	(larvae)	Larvae	% par.	Pupae	Eggs	% par.	Larvae
January 24	-	-	-	1	6	33.3	-
February 7	5	3	-	-	24	29.2	3
15	21	21	14.4	2	166	71.7	11
23	16	16	18.8	3	181	60.8	21
March 2	19	9	22.2	2	48	31.3	15
16	27	11	18.2	-	38	55.3	10

A. plutellae was first recovered from the samples obtained on February 15 and regularly thereafter parasitizing 18 - 22 % of the larvae. *T. sokolowskii* was not recovered ; the scarcity of the host pupae may have contributed towards its failure to establish. While *T. chilotraeae* was not recovered the high incidence of native Trichogrammatids destroyed fairly appreciable numbers of *Trichoplusia* eggs (table 6) and the incidence of damage remained low. Most larvae were destroyed by *Polistes canadensis* and very few survived to pupate.

At harvest an average of 2.8 % of the leaf area was destroyed by the combined feeding action of *Plutella* and *T. ni*.

Bracon hebetor failed to establish. In the absence of an effective measure of control *Hellula* inflicted heavy damage ; about 38.1 % of the plants failed to develop flower heads.

Chemical control plots

Four pesticide treatments commencing seven days after the seedlings were transplanted and then at successive intervals of seven days each were applied. Since the pesticides were applied as a routine counts of pests or parasites were not made nor exotic parasites released. The man percentage leaf area damaged by *Plutella* and *T. ni* at harvest and the number of plants damaged by *Hellula* as mean percentage per plot in each treatment are shown in table 7.

Table 7 - Mean ± SD % of plants damaged by *Hellula* and leaf area damaged by *Plutella* and T. ni.

	Hellula	*Plutella* and T. ni
Dipel	30.2 ± 5.2	8.3 ± 2.9
Surecide	17.7 ± 9.6	1.3 ± 2.1
Orthene	10.4 ± 4.2	1.3 ± 1.1
Control	53.1 ± 6.2	1.5 ± 9.4

Yield

Table 8 gives the yield data obtained from the 3 blocks - bio, integrated and chemical. The data are based on the average weight of marketable cauliflower produced per treatment (96 plants per treatment). Also based on the same data for yield and the amount of insecticides used the estimated production of cauliflower and cost of application are presented in table 8.

Table 8 - Yield + cost per acre of cauliflower from treated and control plots.

Treatment	No. cauliflower reaped	(Wt. gm)	Av. Wt. cauliflower (gm)	Production/ acre (gm)	Rate per acre (gm) of insecticides	Total cost of applications) (insecticide per acre US
Integrated plot						
Surecide	77	9540.3	123.9	1759045.4	417.7	11.49
Orthene	68	7711.2	113.4	1421922.6	690.0	28.16
Dipel	69	7286.4	105.6	1342852.2	522.0	23.04
Control	63	5896.8	93.6	747446.4	-	-
Chemical plot						
Surecide	79	6722.9	85.1	1238846.4	417.7	22.98
Orthene	86	13656.8	158.8	2515901.4	690.0	56.32
Dipel	67	5473.9	81.7	1808067.5	522.0	46.08
Control	45	2731.5	60.7	503306.1	-	-
Biocontrol plot						
	237	1613.7	68.1	746512.2		

DISCUSSION AND CONCLUSIONS

The high incidence of a complex of native Trichogrammatid egg parasites and the consequent low larval densities of T. ni indicates the control potential of the former. The sharp decline in parasitism in the treated plots after the second chemical treatment but comparatively high incidence in the control plots indicates to some extent the adverse effects the chemicals exert on natural enemies. This may also reflect the reason for complete absence or scarcity of parasites and high larval densities of the pests in commercial gardens which are subjected to chemical sprays as a routine.

Establishment of *A. plutellae* even when the host densities were very low in the experimental plots suggests that the Braconid may establish permanently. Also, the absence or scarcity of effective native larval and pupal parasites of *Plutella* and *Trichoplusia* warrants introduction of additional known parasites in order to obtain biological control of both these pests.

Reliance will have to be placed on insecticides to control *Hellula*. From the results obtained in Table 5 Surecide-treated plots had a significantly lower number of plants damaged by *Hellula* than the other treatments. It may be argued that if chemicals have to be used then why attempt biological control of *Plutella* or T. ni. The present studies do indicate that *Hellula* may be kept at low densities by judicious use of chemicals without greatly disrupting the balance of natural control with respect to other pests. The yield data obtained in Table 8 would substantiate this point, i.e., there is no significant difference in yield between the integrated and chemical control blocks. For integrated control only two chemical applications were made, where as in the chemical control there were four spray applications. As *Hellula* may be the key pest to the development of a satisfactory pest management programme further investigations into the biology and seasonal development of *Hellula* are warranted to determine the factors regulating its populations. This will help to develop a more ecological approach for its control.

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