

CONTROL OF LEAF EATING CATERPILLARS IN CABBAGE USING AN INSECT GROWTH REGULATOR

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ABSTRACT

The control of insects by insect growth regulators, though often cited as a method of biological control, represents a sophisticated form of chemical control in integrated insect management programmes. Chlorfluazuron, an insect growth regulator which inhibits the formation of chitin in insect body, was evaluated with four insecticides cartap, methamidophos, mexacarbate, quinalphos and a bacterium *Bacillus thuringiensis* (Bt) against leaf eating caterpillars (*Plutella xylostella* and *Plusia* spp.) on cabbage at the Regional Agricultural Research Centre, Bandarawela during maha 1985/86 and yala 1986. Chlorfluazuron was applied at the rate of 50 ppm fortnightly, with the first signs of damage. Application was stopped three weeks before harvest. It was found that there was no survival of caterpillars in the chlorfluazuron treatment. The highest marketable yield and least damage to the produce were also obtained with chlorfluazuron. Bt, cartap, mexacarbate and methamidophos had poor control of the caterpillars. These treatments did not significantly increase cabbage yield over the control.

KEY WORDS: Cabbage (*Brassica oleracea*), Chlorfluazuron, Insect growth regulator, *Plusia* spp., *Plutella xylostella*

INTRODUCTION

Cabbage (*Brassica oleracea*) is a widely grown crop in the upcountry intermediate zone of Sri Lanka. Nuwara Eliya and Badulla districts account for nearly 81% of the area under cabbage (MADR, 1985). Leaf eating caterpillars (*Plutella xylostella* and *Plusia* spp.) are the main pests of this crop during both maha and yala seasons (Fernando, 1964). The insecticides, monocrotophos and methamidophos which were recommended by Department of Agriculture are highly toxic with oral LD₅₀ less than 500 mg/kg of body weight. These insecticides are harmful to the applicators and consumers as well as to the natural enemies of the pests. It is therefore, necessary to select insecticides with low mammalian toxicity as well as with a sparing effect on the natural enemies to control leaf eating caterpillars on cabbage.

Conventional insecticides with oral LD₅₀ of over 500 mg/kg of body weight are considered reasonably safe (Ware, 1983). The oral LD₅₀ values for insect growth

regulators are about 6 to 8 times higher than that of the reasonably safe values of organophosphates in common use (Ruscoe, 1972).

Insect growth regulators are a relatively new group of chemical compounds that alter growth and development in insects. Their effects have been observed on embryonic development, metamorphosis and reproductive behaviour in both males and females (Ware, 1983). These chemicals are effective when applied in very minute quantities and apparently have no undesirable effect on humans and wild life (Ruscoe, 1972). The high ingestion activity and no contact action of the compounds suggest, however, that they act selectively against gross feeders such as *Lepidoptera*, *Coleoptera* and *Acrididae*, and will probably have little effect on insect predators (Ruscoe, 1972).

Insect growth regulators include a series of chemicals including ecdysone (moulting hormone), juvenile hormone, juvenile hormone mimics, juvenile hormone analogues and chitin inhibitors. The growth effect of chitin inhibitors was identified very recently and few products of this category are in use to control insect pests like gypsy moth caterpillars in forests and ball weevil in cotton (Ware, 1983).

The objective of this study was to evaluate the comparative effectiveness of chlorfluazuron, a chitin inhibitor; *Bacillus thuringiensis* (Bt), a disease causing bacterium in insect body; and four insecticides, cartap, methamidophos, mexacarbate and quinalphos in controlling *Plutella xylostella* and *Plusia* spp. on cabbage. Methamidophos and quinalphos were insecticides recommended by the Department of Agriculture for the control of leaf eating caterpillars on cabbage at the time experiments were carried out.

MATERIALS AND METHODS

The experiment was conducted at the Regional Agricultural Research Centre, Bandarawela during maha 1985/86 and yala 86. Six insecticides with an untreated control (Table 1) were evaluated in field experiments. Seeds of cabbage variety, KY cross were sown in a nursery pre-treated with a mixture of 10% fenaminosulf and 70% quintozone (morut 80 WP) to control damping-off disease. Seedlings were kept in the nursery for four weeks. Healthy vigorous seedlings were transplanted at a spacing of 50cm x 40cm. The plot size was 3.6m x 3.0m and there were six rows with nine plants per row. Fertilizer was applied at the rate of 100 kg N, 200 kg P_2O_5 and 175 kg K_2O per ha as basal, 100 kg N per ha at two weeks, and 100 kg N and 175 kg K_2O per ha at six weeks after transplanting. N, P and K were given as urea, triple superphosphate and muriate of potash, respectively.

CONTROL OF LEAF EATING CATERPILLARS IN CABBAGE

Table 1. Treatments tested and their details

<i>Common name</i>	<i>Trade name</i>	<i>Formulation</i>	<i>kg ai/ha</i>	<i>Formulated product/ha</i>
Bt	Thuricide HP	-	-	0.5-1.0 kg
Chlorfluazuron	Atabron	5 EC	0.06-1.0	1.1-1.9 l
Cartap	Padan	50 SP	0.60-0.95	1.1-1.9 kg
Mexacarbate	Zectran	25 WP	0.5	2.0 kg
Quinalphos	Bayrusil	25 FC	0.35-0.53	1.4-2.1 l
Methamidophos	Aloran	60 LC	0.42-0.50	0.70-0.84 l
Untreated control	-	-	-	-

SP = soluble powder; LC = liquid concentrate; EC = emulsifiable concentrate;
WP = wettable powder; ai = active ingredient

Application of all insecticides except Bt was given fortnightly, starting after the first signs of damage and stopped three weeks before first harvest. Bt was sprayed weekly, commencing with other treatments and stopped two weeks before first harvest. Hand-operated knapsack sprayer was used for spraying the chemicals. The number of live caterpillars present in ten centre plants from each plot was counted one day before and two days after the treatments. As only caterpillars damage the crop, percentage survival of caterpillars on plants after treatments was calculated using these counts. These values were presented in results as the assessments made at respective application of treatments. The total number of applications of treatments made during maha and yala were three and two respectively. Marketable and unmarketable yields due to caterpillar damage were recorded at harvest. These parameters were taken as the indices to evaluate the efficacy of treatments. The cost of cabbage cultivation excluding the cost of insecticides was Rs. 12,250/ha. The selling price of cabbage during maha 85/86 and yala 86 was Rs. 2/kg and Rs. 3/kg respectively. The net income was calculated by subtracting the cost of cultivation including insecticides from the gross income obtained. The benefit/cost ratio for chlorfluazuron, quinalphos and methamidophos was calculated by dividing the additional income over the control by the additional cost incurred for pest control. The benefit/cost ratios for cartap, mexacarbate and Bt could not be calculated as they were not commercially available.

RESULTS AND DISCUSSION

Survival of caterpillars

In both seasons at all three assessments significantly lower percentage survival of caterpillars was observed in plots treated with chlorfluazuron compared to untreated control. Also, except at the first assessment in both seasons there was no survival of caterpillars at other assessments for the chlorfluazuron treatment (Table 2). The formation of cuticle is a continuous process in caterpillar body as the caterpillar has to shed it from time to time in the course of its development. This process would have been affected by chlorfluazuron since it inhibits chitin which is one of the important constituents in insect cuticle.

Table 2. Survival of caterpillars two days after treatment

	% Survival of caterpillars				
Treatment	maha 85/86			mala 86	
	Assesment			Assesment	
	1st	2nd	3rd	1st	2nd
Bt	95.5 ab	81.3 c	70.0 ab	52.0 ab	64.5 b
Chlorfluazuron	1.8 d	0.0 e	0.0 d	13.3 c	0.0 c
Cartap	68.3 b	86.0 b	85.8 a	51.8 ab	68.3 b
Mexacarbate	26.0 c	29.5 d	44.0 bc	28.5 abc	46.5 b
Quinalphos	8.3 cd	34.5 d	35.8 c	45.0 abc	44.0 b
Methamidophos	87.5 ab	100.0 a	81.3 a	24.5 bc	100.0 a
Untreated control	100.0 a	100.0 a	45.3 bc	66.8 a	72.0 ab
CV (%)	33.1	4.2	39.6	48.7	35.1

Analysis of variance was done on arcsine transformed values. Means followed by the same letter are not significantly different at 5% level

A significantly low percentage survival of caterpillars in Bt treatment compared to the untreated control was observed only at the 2nd assessment in maha (Table 2). However, percentage survival was rather high (81.3). Bt is a stomach poison with no contact action. It causes gut paralysis in caterpillar body if it is

CONTROL OF LEAF EATING CATERPILLARS IN CABBAGE

ingested by caterpillars. The ultimate result of ingestion of the bacterium is lethal septicaemia (Burgess, 1982). It had been observed that *Heliothis* larvae (caterpillars) stopped feeding on plants treated with the bacterium after a while, thus preventing intake of required amount of Bt to cause lethal septicaemia (Pourmirza, 1989). Many leaf eating caterpillars of cabbage also would not have ingested required amount of Bt thereby leading to high percentage survival of caterpillars on plants treated with the bacterium (Table 2):

Though with mexacarbate and quinalphos the percentage survival of caterpillars was significantly low over the untreated control at first and second assessments in maha, it was not the same for the third assessment in maha and the two assessments in yala. The treatment methamidophos gave significantly lower percentage survival of caterpillars than the untreated control only at the first assessment in yala. Methamidophos has been used by farmers for a long time in controlling these pests. Therefore, it is likely that the pests would have developed a certain degree of resistance to this insecticide.

In the cartap treatment during maha, the percentage survival of caterpillars was significantly lower than the untreated control only at the first two assessments; in yala there were no significant differences at both assessments.

There were no significant differences in percentage survival of caterpillars among untreated control, Bt, mexacarbate and quinalphos treatments at the third assessment in maha. Also, at the same assessment the percentage survival of caterpillars was significantly lower in the untreated control than cartap and methamidophos treatments. In yala, at both assessments the percentage survival of caterpillars in the untreated control was not significantly different from Bt, cartap, mexacarbate and quinalphos treatments (Table 2). Jesudasan and Yogaratnam (1984) reported that effect of parasitoids on *Plutella xylostella* varied during different arbitrary growing seasons. Parasitism was 57.0% between mid-January and mid-May, 29.4% between mid-May and mid-September, and 39.8% between mid September and mid-January. Therefore, mostly parasitism and to a small extent pupation of larvae, as few larvae could have pupated within two days of assessment, specially because their life cycle was not disturbed, would have acted in reducing the percentage survival of caterpillars in untreated plots.

Cabbage yield

The plots treated with chlorfluazuron gave significantly higher marketable yield than the untreated control in both seasons. The lowest percentage of unmarketable yield was also observed with the same treatment (Table 3).

Table 3. Effect of treatments on yield of cabbage

Treatment	Mean marketable yield (t/ha)		Mean % unmarketable yield due to caterpillar damage	
	maha 85/86	yala 86	maha 85/86	yala 86
Bt	37.8 bc	39.6 cd	19	29
Chlorfluazuron	48.8 a	57.9 a	8	18
Cartap	32.9 cd	41.3 cd	20	34
Maxacarbate	29.1 d	40.1 cd	23	33
Quinalphos	41.6 b	44.8 bc	14	28
Methamidophos	28.0 d	52.8 ab	26	24
Untreated control	30.1 d	36.1 d	26	59
CV (%)	11.9	12.5	-	-

Means followed by the same letter are not significantly different at 5% level

The marketable yield given by quinalphos treatment was also significantly high compared to the untreated control in maha as well as yala. However, in both seasons it was significantly lower than the yield given by chlorfluazuron treatment (Table 3). Bt gave a significantly higher yield than the untreated control only in the maha season. In both seasons, cartap and maxacarbate did not give significantly different yields over the untreated control (Table 3). Even though methamidophos gave significantly higher marketable yield than the untreated control in yala, the yield obtained during maha was the lowest among the treatments tested (Table 3).

Benefit/cost ratio

The benefit/cost ratio for chlorfluazuron was consistently high during both seasons; the ratio was higher than for quinalphos (Table 4). Methamidophos gave

CONTROL OF LEAF EATING CATERPILLARS IN CABBAGE

the highest benefit/cost ratio in yala 86; however the ratio was negative in maha. It is also relevant to note that during both seasons the highest net income was obtained with chlorfluazuron.

Table 4. Net income, cost of insecticides and benefit/cost ratio

Treatment	Net income (Rs.)		Cost of insecticides (Rs.)		Benefit/cost ratio	
	maha 85/86	yala 86	maha 85/86	yala 86	maha 85/86	yala 86
Chlorfluazuron	79,050	157,250	5400	3600	5.8	19.1
Quinalphos	68,975	119,525	3975	2625	5.3	8.9
Methamidophos	41,755	144,841	1955	1309	-3.0	37.2
Untreated control	4,750	96,050	-	-	-	-

The foregoing results indicate that the chitin inhibitor, chlorfluazuron could be a highly effective and economical insecticide for controlling leaf eating caterpillars of cabbage. However, studies are needed in farmers' fields to evaluate its potential before recommending it.

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TROPICAL AGRICULTURIST, VOL. 149, 1993

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