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Full Length Research Paper

Comparative efficacy of microbial and chemical insecticides on four major lepidopterous pests of cotton and their (insect) natural enemies

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Three microbial (biotrol, dipel and thuricide) and three chemical insecticides (monocrotophos, endosulfan and carbaryl) were compared for efficacy on four major lepidopterans and their natural enemies in replicated field trials at Moor Plantation, Ibadan. Thuricide was evaluated at different combinations with monocrotophos in a second trial. The results showed that the microbials caused the mortalities of destructive bollworms and leafroller but allowed the survival of their natural enemies. The chemicals on the other hand caused mortalities of both destructive and useful species. Both groups of insecticides enhanced seed cotton yields. Application of thuricide followed by monocrotophos was better than other combinations evaluated.

Key words: microbial insecticides, *Bacillus thuringiensis*, cotton.

INTRODUCTION

The cotton bollworm (*Helicoverpa armigera* Hubn), the spiny bollworms (*Earias insulana* Boisd and *E. biplaga* Wlk.), and the leafroller (*Sylepta derogata* F.) are major lepidopterous pests of cotton in Southwestern Nigeria. These insect pests are currently being controlled by the application of broad spectrum insecticides such as monocrotophos, endosulfan or carbaryl four times at weekly intervals during the growing season. However, these broad spectrum materials are highly toxic to insect natural enemies (Hamilton and Attia, 1976). On the other hand, *Bacillus thuringiensis* Berl, is active against many lepidopterous species and has no adverse effects on natural enemies of target pests (Fadare and Osisanya, 1998). The lepidopterous pests natural enemies include parasites (syrphids, tachnids, braconids) and predators (coccinelids, forficulids, pentatomids and reduviids).

A control programme based on selective materials, which would allow survival of beneficial species and cause the mortality of destructive ones is desirable. The efficacy of *B. thuringiensis* could be increased by the

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addition of sublethal doses of pesticides and could be used in such a programme. Here we report the comparative efficacy of three microbial insecticides, dipel, biotrol, thuricide and three chemical insecticides, monocrotophos, endosuslfan and carbaryl on cotton bollworm, spiny bollworms, the leafroller and their natural enemies.

MATERIALS AND METHODS

The treatments comprised three microbials, dipel at 0.52kg/ha, biotrol, 0.56, thuricide, 0.50 and three chemical insecticides, monocrotophos at 0.68kg. a.i./ha, endosulfan, 0.75, carbaryl, 1.50, each in 225 litres of water/ha, and different combinations of one microbial (thuricide) and one chemical insecticide (monocrotophos). The treatments were arranged in a randomized complete block design experiment with four replicates. The cotton (Samaru '77) plots of 10 m X 5 m each were established as per standard agronomic practices for cotton production in South-Western Nigeria. The experiment was conducted over two years.

The treatments were applied with a 9-liter pressurized Falcon sprayer to the plants when one plant per plot was infested by any of the target pests. Post spray counts of *Sylepta* were taken from 5 plants per plot while *Helicoverpa* and *Earias* damaged bolls were counted and removed from 10 randomly selected plants of each plot. Pre and post spray samplings of populations of natural enemies (parasites and predators) were carried out with an aerial net. Parasitised larvae and pupae were taken to the laboratory for emergence of parasites. The inner two rows of each 10 m X 5 m plot were used for the estimates of seed cotton yield. Data collected were subjected to statistical analysis. Efficacy of treatment was based on plot means of live leafroller, percentage bollworm damages, seed cotton yield and live leafroller enemies recovered from the sprayed and unsprayed plots.

RESULTS

Experiment I

The post spray application mean *Sylepta* (leafroller) counts ranged from 2.65 to 3.17 per plant for the microbial insecticides and from 1.57 to 2.15 per plant for the chemicals. Both were however better than the 6.57 live leafroller per plant from the unsprayed control plots (P = 0.05) (Table 1). Percentage bollworm damages ranged from 12.22 to 13.18 per plant for plots sprayed with the microbials and were significantly higher (P = 0.05) than the range of 5 – 7 per plant for plots sprayed with the chemical insecticides. The percentage bollworm damage from the unsprayedcontrol treatment was 20.00 and was significantly higher from those of microbial and chemical insecticide treated plots (P = 0.05). Corresponding percentage bollworm control ranged from 35 – 36 for the microbials and 65 – 75 for the chemical insecticides (Table 1).

Mean seed cotton yields ranged from 980 to 1080kg/ha for the microbials and 900 – 1108 for the chemicals, and were not significantly different. However, the 388kg/ha seed cotton yield from the control plots was significantly lower than those from the sprayed treatment (P = 0.05). Corresponding percentage yield increases of sprayed plots over the control plots ranged from 153 – 178 for the microbials and 132 – 186 for the chemical insecticides (Table 1). The mean numbers of parasites and predators recovered from plots sprayed with microbial – and chemical insecticides were low and similar for both and not significantly different from those of the unsprayed control plots (Table 2). The numbers of braconids recovered from each plot were higher than the numbers recovered for other parasites (Table 2). Also, numbers of parasites and predators generally increased after spraying with the microbials, but stayed the same or reduced with chemical insecticides.

Experiment II

The results of the different combinations of microbial and chemical insecticides (thuricide/monocrotophos) are presented in Table 3. All sprayed treatments were better than the unsprayed control treatment. Corresponding percentage yield increases of 132.35 over the control was highest for T_3 treated plots and lowest for T_5, 91.41%.

DISCUSSION

The post spray *Sylepta* larval counts for both microbial and chemical insecticides show that they were effective in reducing the level of live leafroller. There was no significant difference between both materials. However in bollworm damage, the chemicals performed significantly better (P = 0.05) than the microbials. The chemicals reduced the level of bollworm damage from 20 percent in the unsprayed control plots to 5.66 while the microbials reduced such a level to 13 percent which is more than two-folds that of the chemicals.

The seed cotton yields of plants sprayed with microbial or chemical insecticides were very high and superior to that of the control. Both raised the yield more than 2-fold. The high yields could be attributed to the effective control of the foliage pests and bollworms which consequently enhanced the quantity and quality of the end products.

The parasites and predators recovered from the microbial, chemical and control plots were similar and low in numbers in the pre-spray counts. Such numbers were marginally increased in the microbial and control plots but marginally reduced in the chemical plots in the post spray counts. Apparently the microbials allowed the survival of the beneficial species but caused the mortality of the destructive ones. On the other hand the chemicals caused the mortality of both the beneficial and destructive species. The parasites recovered from the trial plots included live syrphids, tachnids and braconids and, the predators were coccinellids, forficulids, pentatomids and

Table 1. Comparative effectiveness of microbial and chemical insecticides on cotton lepidopterans in the field.

Treatment	Rate/ha* (kg)	Leafroller count/plant	Bollworm Damage (%)	Boll damage control** (%)	Seed cotton yield (kg/ha)	Yield increase (%)
Dipel	0.52	2.65b	12.22b	34.78	1008a	159.80
Biotrol	0.56	3.17b	12.94b	36.16	980a	152.58
Thuricide	0.50	2.76b	13.18b	35.00	1080a	178.35
Monocrotophos	0.34	2.15b	5.06c	75.04	1108a	185.57
Endosulfan	0.38	1.95b	7.05c	65.22	920a	137.11
Carbaryl	0.75	1.75b	5.11c	74.80	900a	132.00
Check	0.00	6.57a	20.27a	-	388b	-

No significant different between means with same letters at 5% level.
*Each dispersed in 225 litres of water.
**Computed as C – T/C x 100, where T is % damage in sprayed treatments and C is % damage in unsprayed plot (control).

Table 2. Mean number of parasites and predators recorded in plots treated with microbial and chemical insecticides.

Treatment t/ha	**Parasites**			**Predators**			
	Syrphids	Tachinids	Braconids	Coccinellids	Forficulids	Pentatomids	Reduviids
Dipel 0.52kg	0 (3)*	1 (2)	21 (38)	2 (3)	2 (5)	4 (5)	1 (5)
Biotrol 0.56kg	2 (4)	0 (2)	20 (35)	4 (5)	3 (6)	3 (5)	3 (6)
Thuricide 0.50kg	1 (5)	1 (3)	26 (39)	3 (5)	1 (4)	2 (8)	4 (6)
Monocrotophos 0.68kg	1 (0)	1 (3)	23 (16)	3 (2)	2 (1)	2 (1)	3 (2)
Endosulfan 0.75kg	1 (1)	1 (1)	24 (15)	4 (3)	2 (2)	2 (0)	3 (3)
Carbaryl 1.5kg	1 (0)	0 (0)	26 (20)	5 (3)	4 (4)	1 (1)	4 (4)
Control	1 (2)	2 (2)	22 (23)	4 (4)	3 (4)	3 (2)	2 (3)

*Post-spray counts in parenthesis.

Table 3. Effect of different combinations of thuricide and monocrotophos on cotton lepidopterans.

Treatments	Live Sylepta per plant	Bollworm damage*/plant (%)	Boll damage** control (%)	Seed cotton yield (kg/ha)	Yield increase (%)
T_1	1.15cd	7.34bc	44.69	1322.50 (a)	104.72
T_2	1.27c	7.51bc	43.41	1255.50 (ab)	94.35
T_3	0.59d	5.49c	58.63	1501.00 (a)	132.35
T_4	2.10b	10.10b	23.89	994.00 (b)	53.87
T_5	2.53b	8.36b	37.00	1236.50 (ab)	91.41
T_6	4.52a	13.27a	-	646.00 (c)	-

* No significant different between means with same letters (5%).
**Computed as C – T/C x 100, where T = Percent damage in sprayed treatments and C = Percent damage in unsprayed treatment.

Legend:

T_1	Thuricide alone	=	4 Applications
T_2	Thuricide and Monocrotophos	=	4 Applications (Simultaneous)
T_3	Thuricide followed by Monocrotophos	=	2 Applications each
T_4	Monocrotophos followed by Thuricide	=	2 Applications each
T_5	Monocrotophos alone	=	4 Applications
T_6	Control	=	No Spray

reduviids as listed in an earlier report (Fadare and Osisanya, 1998).

All the treatments combinations of thuricide and monocrotophos were effective in reducing the level of live leafrollers population significantly. The seed cotton yields from all sprayed plots were significantly higher than that from the control. Based on the results of experiment II, treatment T_3 (thuricide followed by monocrotophos) is very consistent, giving either significantly superior or marginally higher performance than other sprayed treatments and the control. In general, the findings from these studies are similar to the reports of earlier research workers. Ali Niezee and Jensen (1973) working with spray formulations of biotrol, dipel and thuricide, found that the three formulations gave as good a control of the grape leaf-folder *Desmia funeralis* (Hubn) (Pyralidae) as the chemical insecticide, carbaryl. McGarr et al. (1970), compared the effect of microbial and chemical insecticides on cotton insects and reported percent bollworm damages of 23.8, 14.2, 18.7, 20.2 and 39.7 for methyl parathion, *B. thuringiensis* (HD-I), Toxaphene + methyl parathion, carbaryl + methyl parathion and control, respectively. They also reported significant yield increases of seed cotton over the unsprayed control treatments. They concluded that the *B. thuringiensis* was more effective than the chemicals in controlling the bollworms.

Based on the results of the second trial, straight applications of either microbial or chemical insecticide for the suppression of cotton pests may not be advisable. Microbial insecticides, being highly selective conserve the populations of parasites and predators as well as other beneficial species while they suppress lepidopterous populations for which they are specific. Applications of chemical insecticides for the control of cotton pests is not advisable early in the season as they may reduce yields due to an apparent adverse reactions by the plants, and such applications may result in increased bollworm, beet armyworm or cabbage looper populations. Bull et al. (1979) had reported a deliberate suppression of beneficial species populations with methyl parathion and subsequent rapid increases in outbreak of *Heliothis* sp. on cotton fields. Simultaneous application of both microbial and chemical insecticides though not significantly different from 'Thuricide' or monocrotophos alone, may not be advisable because of adverse reactions of emulsifiable concentrate insecticides (Morris and Armstrong, 1975; Morris 1975a; Patti and Carner, 1974). But with monocrotophos and *B. t*. there is no such risks as Morris (1976) has confirmed that both are compatible. However the chemical may have adverse effects on parasites and predators in the agroecosystem.

Sequential application of microbial insecticides and low doses of chemical insecticides has been a major input in the implementation of integrated control of insect pests. The expected effects of such an approach are reduced pest populations and crop damages, substantially reduced chemical hazards in the environment coupled with enhanced parasite and predator and other beneficial insect activities.

The trials have confirmed that microbial formulations can be as effective as the commonly used chemical insecticides on lepidopterous pests. There was also superior performance of sequential application of thuricide followed by monocrotophos over all other combinations. The potential application of a microbial insecticide followed by chemical insecticide should be adopted in cotton pest control programme for South-Western Nigeria.

REFERENCES

Ali Niazee NJ, Jensen FL (1973). Microbial control of the grape leaf-folder with different formulations of *Bacillus thuringiensis*. J. Econ. Entomol. 66: 151 – 158.

Bull DL, House VS, Ables JR and Morrison RK (1979). Selective methods for managing insect pests of cotton. J. Econ. Entomol. 72: 841–846.

Fadare TA, Osisanya EO (1998). Field evaluation of microbial insecticides on cotton bollworms and their natural enemies. Nig. Journ. Sci. 32: 72-75

Hamilton JR, Attia FI (1976). The susceptibility of the parasite *Apanteles glomeratus* (L.) Braconidae to Insecticides. J. Entomol. Soc. Aust. 9: 24 – 25.

Mcgarr RL, Dulmage HT, Wolfenbarger DA (1970). The delta endotoxin of *Bacillus thuringiensis* H.D. – 1 and chemical insecticides for the control of tobacco budworm and the bollworm. J. Econ. Entomol. 63: 1357 – 1358.

Morris ON (1975). Effect of some chemical insecticides on the germination and replication of commercial *Bacillus thuringiensis*. J. Invertebr. Pathol. 26: 198 – 204.

Morris ON, Armstrong JA (1975). Preliminary field trials, with *Bacillus thuringiensis*. Chemical insecticide combinations in the integrated control of the spruce/budworm *Choristomeura fumiferana*. Can. Ent. 107: 1281 – 1288.

Patti JH , Garner GR (1974). *Bacillus thuringiensis* investigations for the control of *Heliothis* sp. on cotton. J. Econ. Entomol. 67: 415 – 418.