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INSECT CONTROL ON MAIZE IN SURINAME

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SUMMARY

Major insect problems on maize are caused by *Scapteriscus spp* (mole cricket), *Spodoptera (Laphygma) frugiperda, Heliothis zea, Diatraea sacharalis* and harvesting ants *(Atta spp.)*.

Because the majority of the farmers grow maize only as a first crop just after clearing and burning their fields, insect infestation is rather low and regeneration is good. However, when maize is growing as a regular crop infestation of *Spodoptera* and *Heliothis* becomes high. Results of control experiments mainly on *Spodoptera frugiperda*, during the last two years, are presented.

INTRODUCTION

Insects which may be found regularly damaging maize plants in Suriname are mole-crickets *(Gryllotalpidae)*, stemborers *(Diatraea spp)* ants *(Atta. spp)*, *Heliothis zea* and *Spodoptera (Laphygma) frugiperda. Atta sexdens* L and *A. cephalotes* L. incidentally cause severe damage especially in the interior of the country.

No studies on economic losses have been done of these insects in Suriname. The ants are controlled by use of Mirex, Chlordane or aldrin, which in the interior is given free by the government to the farmers.

Scapteriscus spp and *Gryllotalpa spp* are found mostly on sandy soils in the coastal area, damaging seedlings during four weeks after emerging; in first two weeks plants may be cut off completely just under soil surface. Control has been done with chlordane (40% a.i.; 1 gr/m^2), but this is no longer adequate; diazinon and chlorfenvinphos have been introduced recently. Research on the biology of these mole-crickets has been started this year.

The effect of *Heliothis zea* on the yield of maize is regarded as of minor importance; 1, 1, 1.5 and 0.5 percent yield reduction have been recorded in four experiments during the last two years.

However, when maize is growing for selling it as a vegetable, economic losses are higher, as in these experiments about 25 percent of the cobs were infested with larvae and this makes them more difficult to sell as a vegetable.

Diatraea spp were found in 8, 9 and 30 percent of the stems in three experiments for the control of *Spodoptera*. Till now no study of the economic importance of this pest on maize in Suriname has been made.

Spodoptera frugiperda is the major pest in maize growing in Suriname. However, differences in infestation-level occur. When maize is grown as a first crop after cleaning bush, the population of *Spodoptera* doesn't reach a high infestation level, and plants recover well.

In Tijgerkreek-West Experiment Station, where maize is grown season after season, in the first season of 1977 fifty percent of the plants got infested dispite a spraying scheme with trichlorphon, carbaryl and malathion in weekly intervals. In two seasons following this experiment up to 60 and 70% infestation of non treated plots was observed. However, in the second season of 1978 (July – October) only 22% of plants in control-plots were infested (fig. 1.).

Bertels (1970) also mentioned the influence of humidity as a regulating factor of *Spodoptera frugiperda* in Rio Grande do Sul in Brasil. More population data are required to confirm this statement under conditions of Suriname.

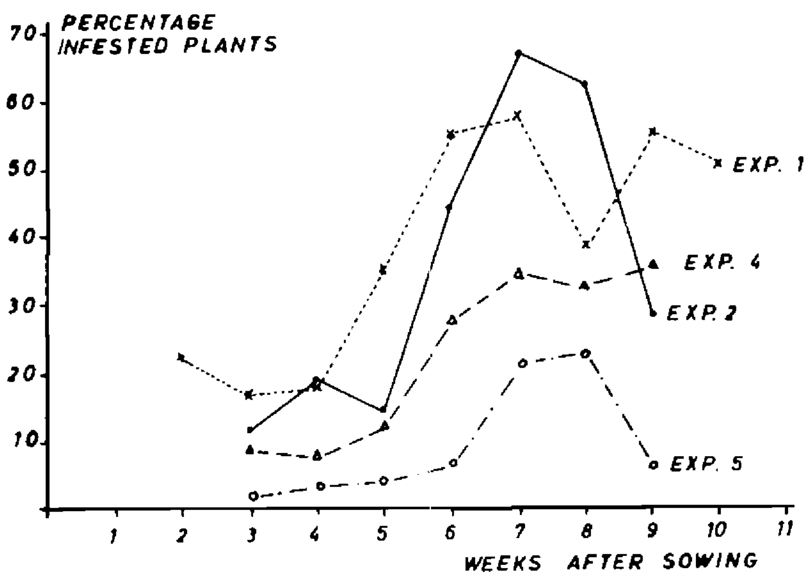

Fig.1. Population growth of *Spodoptera frugiperda* in nontreated plots of four control experiments on maize

NATURAL CONTROL

Van Dinther (1955) mentioned the following natural enpmies of *S. frugiperda* in Suriname: *Polybia liliacea* F., *P. striata* F., *P. sericea* 01., *P. chrysothorax* Web., *P. rejecta* F., *Gymnopolybia vulgaris* Ducke, *Polistes canadensis var. paramensis* Holm, *P. versicolor* 01., *Apanteles marginiventris* Cress, *Meteorus laphygmae* Vier and *Archytas piliventris* (Wulp). Birds were also noticed as predators viz. *Leistes militaris* ("roodborstje") and *Crotophaga ani* L. ("kawfoetoe-boi"). No details about the impact of these natural enemies on the population of *Spodoptera* are mentioned, however.

During 1977-1978 we did collect about 500 *Spodoptera* larvae of different ages and reared them in the laboratory. Only two percent appeared to be parasitized.

Two dipterous and two hymenopterous parasites, which still have to be identified, were found. *Polistes spp.* are frequently observed in the fields and the impact of these predators on the population of *Spodoptera* would be worthwile to study.

In July 1978 the egg-parasite *Telenomus remus* Nixon, which originates from Serawak and which is introduced in the Americas by CIBC (Trinidad), was introduced in Suriname. This parasite is now being reared in the laboratory and will be released in the field as soon as a sufficient number of parasites is available.

CHEMICAL CONTROL

In a first experiment 6 insecticides were screened for control of *Spodoptera*. Insecticides were sprayed with a knapsack sprayer, only carbofuran was applied as a granule to the whorl of the plants. Carbofuran and phosphamidon, both systemic insecticides, were applied twice with an interval of 4 weeks. The other insecticides were four times applied with intervals of two weeks.

Every week the rate of infestation was measured by observing 100 plants at regular distances in the plots; plot size was 16 x 15 m. From these figures the mean infestation percentage over the whole growing period up to blooming of the crop was calculated.

In table 1 results are given, without data of diazinon (Basudine)(25% a.i.; 24 l/ha) which proved to give some phytotoxic effect on maize.

Table 1. Effect of 5 insecticides on the infestation by *S. frugiperda* and yield of maize.

Treatment	a	b	Average infestation %	Yield/ha (kg)	LSD (5%) (kg)
trichlorphon (95% a.i.; 0.6 kg/ha)	4	3	10.2	1781	315
tetrachlorvinphos (24% a.i.; 2.4 l/ha)	4	2	23.2	1711	384
decamethrine (2,5% a.i.; 0,5 l/ha)	4	2	8.3	1670	384
phosphamidon (100% a.i.; 0.3 l/ha)	2	2	27.4	1517	384
carbofuran (5% a.i.; 22 kg/ha)	2	2	15.2	1577	384
control	–	3	38.7	1485	–

a = number of applications during the season
b = number of replications
LSD = Lowest Significant Difference test; at 5% level no differences in yield are significant.

Decamethrine, trichlorphon and carbofuran did control *Spodoptera* satisfactorily, although effectiveness of carbofuran was not longer than 3 weeks. Diazinon, tetrachlorvinphos and phosphamidon in these concentrations did not give adequate control.

Although a significant correlation between mean percentage infested plants per plot and yield per plot was found ($r = 0.59$; $a = 1806$ kg/ha $b = 8{,}8$ kg/% infestation) no significant differences in yield between the treatments have been found; maybe due to waterlogging in part of the plots.

In a second experiment another way of application of insecticides was tested. Sawdust was mixed with water (2:1) and the insecticide and applied to the whorl of the plant. About 0.6 gr. of sawdust per plant was given. This method is common in Central America and is suggested to be more effective with less use of insecticide. Six insecticides were tested and plots were treated three times with intervals of two weeks. Results are given in table 2.

Table 2. Effect on control of *S. frugiperda* by mixing insecticides with sawdust.

Treatment	a	b	Average infestation %	Yield/ha (kg)	LSD (5%) (kg)
trichlorphon (95% a.i.; 0.6 kg/ha)	3	2	7.5	4385	422
carbaryl (85% a.i.; 0.6 kg/ha)	3	2	7.7	4551	422
fenithrothion (50% a.i.; 1 l/ha)	3	2	4.2	4523	422
decamethrine (2.5% a.i.; 0.5 l/ha)	3	2	4.8	4852	422
control	–	2	27.3	4107	–

a = number of applications
b = number of replications
plotsize = 10 x 10 m
LSD = Lowest Significant Difference test

By this way of application diazinon did cause also some phytotoxicity, and results are not mentioned further.

All other insecticides did control the fall armyworm very well in this method of application. (fig 2.) Three ways of control with trichlorphon were tested in an experiment at Coebiti.

Application of the insecticide was done

a. with knapsack sprayer
b. mixed with sawdust
c. as a granular

In method a. 0.6 kg (95% a.i.) was used per hectare per treatment and in the other methods half of this quantity.

Three applications are given during the growing season, with intervals of two weeks. Control of *S. frugiperda* was as effective in each of these methods of application (table 3).

The method with the sawdust, although very effective and safe, is expensive regarding costs of labour in comparison with spraying the insecticide. Sparing costs of insecticides this method will be advisable when surplus of labour is available or a knapsack sprayer is not at hand.

As carbofuran is said to control soil-insects as well as plant-infesting insects an experiment was set up to check if granular carbofuran is controlling *Spodoptera* as well when applied to the soil as to the whorl.

Three different treatments are given:

a. in seed furrow (1x) + around plants (2x)
b. around plants (2x)
c. in whorl of plants (2x)

Table 3. Control of *S. frugiperda* by three ways of application of trichlorphon.

Treatment	Av. infestation %	Costs of application (Sf)/ha		
		Labour	Insecticide	Total
spraying (95% a.i.; 0.6 kg/ha)	7.2	43.50	18.90**	61.40
sawdust (95% a.i.; 0.3 kg/ha)	6.1	150	9.45	159.45
granules (2.5% a.i.; 10 kg/ha)	4.8	150	75	225.00
control	27.6	–	–	–

number of applications = 3

* spraying insecticides = 7 hours/ha

applying sawdust or granules in whorls: 25 hours/ha

** including costs of knapsack sprayer

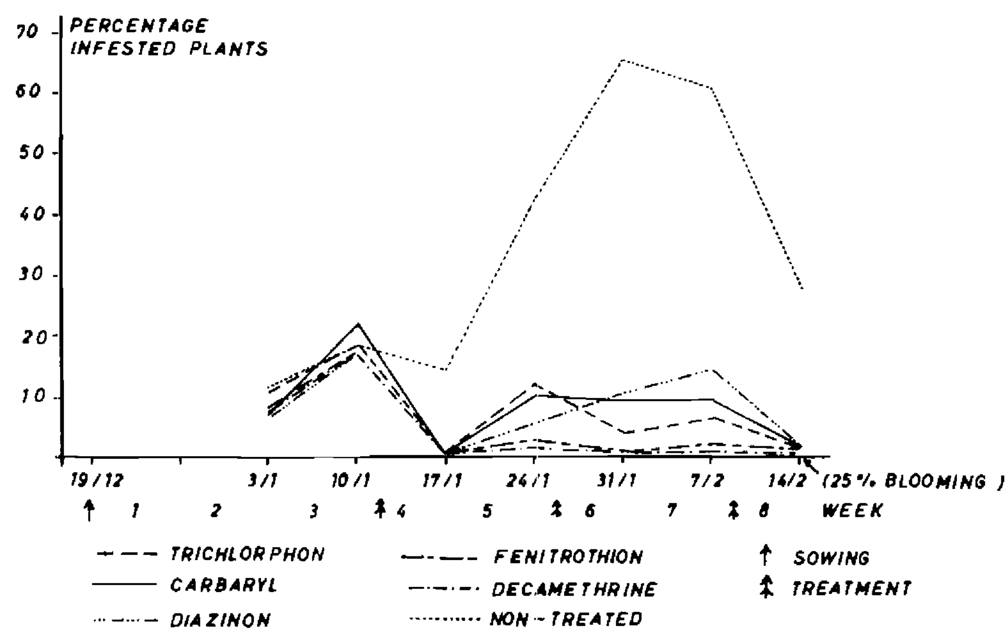

Fig. 2. Population growth of *Spodoptera frugiperda* during the growing season of maize with different insecticides mixed with sawdust.

Plots were made of one row of 15 m. Every week infestation level was measured on 25 plants per plot. Mole crickets did almost not occur; only 0.5 percent of plants were cut.

No differences in rate of infestation were found between the three methods of application, control of *Spodoptera* was even good; about 6 percent (average of whole season) got infested versus 23 percent in the control plots. Yields, however, were rather different between the three methods of application as is shown in table 4.

Table 4. Control of *S. frugiperda* with carbofuran, granular

Application	Average infestation %	Yield/ha (kg)	DMRT (5%)
1. seedfurrow (1x) + around plants (2x)	6.8	4096	a
2. around plants (2x)	5.2	3541	ab
3. leaf-whorl (2x)	6.9	3219	b
4. control	22.6	2542	c

dose: carbofuran 5% a.i. granules; ± 0.4 gr/plant
DMRT: Duncan's Multiple Range Test, yields with different letter are significant different (5%).

From these figures it is obvious that carbofuran is not only controlling the attack of *S. frugiperda,* but must have some other influence on the yield.

In a fifth experiment only one application was given to the plants in the seed furrow (0.25 gr/planthole) to analyse the effect of carbofuran in more detail. Plots were made 5 x 8 m, and the population was counted weekly. Population of *S. frugiperda* was very low during the whole season, as well in treated (4.3% av.) as non treated (6.7 av) plots, but differences in infestation-level are statistically significant.

The yield of treated plots is 10% higher as in control plots (see table 5). At harvest stem-borers *(Diatraea spp)* were found as much in treated (29.4%) as non treated (27.6%) plots.

Table 5. Effect of one dose of carbofuran in the seedfurrow on the infection-level of *S. frugiperda* and the yield of maize.

Treatment	Average infestation %	Yield/ha
carbofuran (5% a.i.; 0.25 gr/plant)	4.3	6174
control	6.7	5563

Differences in yield and infestation are statistically different (F-test, = 5%)

As no plants were found damaged by mole crickets or other soil inhabiting insects we must conclude carbofuran gives some extra growth to the plants besides the control of insects.

This was already shown at 6 weeks after sowing, when plant height was measured. The average length of the plants in the treated plots was 102.5 cm (n = 337) versus 83.2 cm in non treated plots (n = 1017). Regression-analysis of the data of four experiments is to support this hypothesis: regression coefficients are much higher when carbofuran is being used. (table 6)

Table 6. Regression analysis of yields and average percentage of infected plants (X) of four experiments on the control of *S. frugiperda.*

Exp. no and variety	a	insecticides	r	Regression equations	
				Yield/ha (kg)	Yield in %
1. CS 3	15	several	0.59*	1806—, 8.8 X	100-0.49 X
2. Gemiza	12	several	0.63*	4712—21.8 X	100-0.46 X
3. CS 3	28	carbofuran	0.43*	3826—46.7 X	100-1.22 X
4. Gemiza	16	carbofuran	0.71*	7243—253.0 X	100-3.5 X

r = correlation coëfficient
* = statistically significant at 5% level
a = number of observations

Where the impact of the leaf consumption by the larvae of *S. frugiperda* on the yield by the same level of infestation will be about the same with the use of different insecticides, the effect of carbofuran must be found in stimulating the growth, as shown in experiment 5.

DISCUSSION

The experiments on the control of *S. frugiperda* revealed decamethrine as a very promising insecticide.

The local price of this product, however, inhibits the use by the farmers in insect control of maize. Lowering the dose to 0.25 l/ha must be a following step in research — to see if this new insecticide may be of practical use in crop protection of maize.

On rice in Wageningen (W. Suriname) this concentration has proved to be adequate. Spraying trichlorphon is the cheapest way of control, when applied in correct way to the whorls of the plants. As fenitrothion may be effective for longer periods and proved to be very effective when mixed with sawdust, this insecticide will further be tested.

The method of mixing insecticides with sawdust is very safe and easy to do, but is costly with the local prices of labour.

The use of carbofuran may be acceptable as higher output can be expected. From the regression equation of % infection and yield shown above, extra yields due to insect control can be derived and compared with costs of application. (table 7).

Table 7. Comparison of costs and yields of four insect control experiments in maize.

Treatment	Application	No. exp.	Costs of insect control (Sf)*				Yield/ ha (kg)	$\Delta Y = \frac{Yt - Ynt}{Ynt} \times 100\%$	$\Delta Y = b\,(Xt - Xnt)$
			Insecticide	Labour	Total	% of yield[xx]			
trichlorphon (95% a.i.;	spray 4x	1	25.20	58	83.20	18.7	1781	19.9	14.0
0.6 kg/ha)	sawdust 3x	2	18.90	150	168.90	15.4	4385	6.8	9.1
fenitrothion (50% a.i.;	spray 3x	–	31.50	43.50	75	–	–	–	–
1 l/ha)	sawdust 3x	2	31.50	150	181.50	16.1	4523	10.1	10.6
decamethrine (2.5% a.i.;	spray 4x	1	130	58	188	45	1670	12.5	14.9
0.5 l/ha)	spray 3x (1/2con)	–	48.75	43.50	92.25	–	–	–	–
	sawdust 3x	2	97.50	150	247.50	20.4	4852	17.9	10.4
carbofuran	whorl 2x	1	90	100	190	48.2	1577	6.2	11.5
(50% a.i.;	whorl 2x	4	90	100	190	23.6	3219	26.6	19.2
22 kg/ha)	soil 1x	5	45	50	95	6.2	6174	11	8.4
	soil 2x	4	90	100	190	21.5	3541	39.3	21.2
	soil 3x	4	135	150	285	27.8	4096	61.1	19.3
			maximum costs:		125	10	5000	10	
					187.50	15	5000	15	
					250	20	5000	20	

* Costs of insect control: (Labour Sf 2.00/h), spraying = Sf 14.50/ha, sawdust-granular application = Sf 50.–/ha
xx = *Price of maize* (14% M.S.) = Sf. 0.25/kg

Y = Yield, Yt = yield of treated plots, Ynt = yield of non-treated plots, ΔY = extra yield
b = regression coefficient
X = average percentage of infection during growing season. Xt = % infection in treeted plots. Xnt = % infection in non-treated plots.

In a final experiment with fenitrothion and carbofuran the economic threshold (1, 2 or 3 applications during a growing season) for the use of these insecticides will be evaluated.

REFERENCES

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NAME OF PAPER: Insect Control on Maize in Suriname
P. Segeren & Sharma

Questions by: Van Marrewijk
Country: The Netherlands

QUESTIONS:

1. It is very striking that in many reports on maize experiments in Suriname but also in other Central American or Caribbean countries the fall armyworm is mentioned as the causal agent of disappointing results. This should be a good reason to intensify activities in the field of biological control of *Spodoptera,* including search for resistant genotypes. What is the reason that so far this pest escaped attention of entomologists and breeders in a high measure (compared e.q. with borers)?
Were it not advisable to include tests for *Spodoptera* resistance in the maize variety trials of the Suriname Agricultural Experiment Station?

2. What is the chemical structure of carbofuran?
Is it related to any known growth-regulating compound which could explain growgt-enhancement by this pesticide?
Did you find other reports mentioning growth-enhancement by carbofuran?

ANSWERS:

1. CIMMYT (Mexico) is screening all maize varieties now for tolerance/resistance of *Spodoptera frugiperda.* I am not sure the varieties we did obtain from CIMMYT have also been tested.

2. Chemical structure of carbofuran:
N-methyl carbamate.

Question by: The audience

QUESTIONS:

1. Don't you think that the other effect of furadan on maize can be due to the control of soil living organisms as cricket or for example nematodes that could live in the soil and were not initially considered?

2. What about applying granulate insecticides by plane and a large corn producing scale? Would that decrease the cost of applying insecticides?

ANSWERS:

1. Mole cricket damage was checked three or four times in two weeks after emergence. No differences between treated and not treated plots did occur.

Total number of plants was very low however, the occurrence of nematodes has not been checked.

2. The use of granular insecticides by plane is possible as known from the rice cultivation. If it will be as effective in maize has not yet been revealed
It will surely decrease the costs of application strongly.

Question by: C.A.L. Phillips
Country: Trinidad

QUESTIONS:

1. What are the carriers and spray volumes employed in the trials?

2. If high volumes were employed have low volume and ultra low volumes application techniques using mineral spray oils as the chemical carrier been tried in or considered for future trials with the object of reducing application costs?

ANSWERS:

1.

carbofuran	:	granule	)
trichlorphon	:	s.p.	)
fenitrothion	:	e.c.	) + 320-400 liters of water/ha
decamethrine	:	e.c.	)
carbaryl	:	w.p.	)
phosphamidon	:	e.c.	

2. Low and ultra low-volumes applications are supposed not to be effective as the insecticide may not reach the *Spodoptera* in the whorl of the plant.

Questions by: K.E. Neering
Country: Suriname

QUESTIONS:

1. 500 *Spodoptera* larvae where collected in order to obtain information about parasitism. In what kind of areas were they collected and are there any influences of pesticides in those particular areas?

2. About *Telenomus remus:* is there enough known about the pest and the parasite to justify release? Maybe the parasite is already existing in areas were little insecticides are used?

3. There is quite a difference in yields between the different experiments mentioned. Is there anything known about the cause?

ANSWERS:

1. Most larvae are collected in Tijgerkreek-West Experimental Garden from non-treated plots. Another part is collected from Coebiti

Experimental Garden.

2. Advises are given by Dr. Bennett from Commonwealth Institute of Biological Control (Trinidad).

3. Reasons for differences in yield:
   - climatic conditions
   - soil preparation
   - different varieties.

Questions by: Horace Payne
Country: Jamaica

QUESTIONS: Please supply more informations on the conditions of experiment.

1. What was the condition of Field Sanitation
2. Weedness
3. Soil Type
4. Variety + Population

ANSWERS:

1. Experiments are laid down on beds, as shown at Tijgerkreek-West (with exception of exp.3 (Coebiti)). Fields areploughed and rotavated yust before sowing. In experiment drainage was poor.

2. A pre-emergence herbicide (Probe 2 kg/ha) was used one day after sowing in all experiments. After six weeks grasses did give some concurrence and have been eliminated by hand-weeding.

3. Soil: exp. 1, 2 and 4: loamy sand or sandy loam: Tijgerkreek-West exp. 5 sandy loam with shell grit: Tijgerkreek-West; exp. 3 loamy sand on sandy loam on sandy clay loam: Coebiti

4. Population Density: 40.000-44.000 plants/hectare
   Variety: Exp.: 1, 3, 4: CS3: local, synthetic variety
   2, 5: Gemiza: CIMMYT synthetic variety

Questions by: K. Ittyeipe
Country: Jamaica

QUESTIONS:

1. Is there a nematode problem in maize? If there is, was the increase in yield due to soil application of carbofuran due to the control of nematodes?

2. Was any leaf analyses done to detect possible increase in uptake of nutrients — possibly potassium — in carbofuran-treated plots?

ANSWERS:

1. Nematode problems in maize are not yet identified in Suriname. Some specimen of *Pratylenchus Sp.* have been found in a first survey.

2. No leaf analysis has been done in this experiment.

Question by S.K. Vasal
Country: Mexico

QUESTION:

I wonder if you have tried seed treatment with furadan. I am mentioning this because at Cimmyt we have found it very effective to control *Spodoptora* in the first three weeks after planting.

ANSWER:

We have not tried yet.

Questions by: K.U. Buckmire
Country: St. Kitts

QUESTIONS:

1. What are the effects of weedicides, weed population, fertilizer amount and regime, the water availability on the insect population on Maize?

2. Have any work been done on the effects of insecticides especially the systemics on the natural predators and parasites of *Spodoptera frugiperda?*

3. Are the varieties (maize) generally used been tested for tolerance or resistence to both field and storage pests?

ANSWERS:

1. Weedicides were applied 1 day after sowing and are non-systemic, so no effect on *Spodoptera* is expected. Weed population, especially grasses may have quite a high infestation of *Spodoptera*. Van Huis (UNDP — Nicaragua) did some research on this subject. We have not done any study on the subject. Also effects of fertilizing, and water availability on the insect population have not yet been studied.

2. No research has been done.

3. The Cimmyt varieties are tested for *Spodoptera* resistance tolerance at CIMMYT – Mexico. The local variety has not been tested as far as I know.

Question by: Miss E. Metcalf
Country: Antigua

QUESTION: Was the population of nematodes in the soil mentioned in the experiment? Possible reason for improved performance of carbofuran when applied in the soil.

ANSWER: No observations have been done in this experiment.