Studies on Chemical Control of the Stem-Borers of Maize

By

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ABSTRACT

"Between 1962 and 1965 eight insecticides were tested against the stem-borers of maize in Ibadan. None of these insecticides was found to be outstanding but Carbaryl, both as dust and wettable powder was recommended for the control of stand loss due to stem-borer infestation on late maize. No statistically significant increases in yield were, however, obtained in both early and late crops probably because of the usually low infestation level on the early crop and the usually low fertility and moisture conditions during the late season."

INTRODUCTION

MAIZE is one of the most widely cultivated cereals in south-western Nigeria where the rainfall pattern permits the growing of two crops annually — an early crop from March to July or August and a late crop from September to December or January.

Stem-borers are among the most important pests of maize. Sutherland (1952) who surveyed stem-borer infestation on graminaceous crops grown in parts of Nigeria, estimated that they were responsible for an annual crop loss worth about £700,000. This estimate was based on average yearly production figures of the main cereal crops, current (1952) prices, and on the assumption that 0.5% loss in yield occurred for every 10% attack rate. Later surveys in western Nigeria by one of the present authors (unpublished) revealed that about 20% of the late maize stands are lost to stem-borers

A very comprehensive study of the importance, ecology and biology of the lepidopterous borers of cereals in Nigeria was published by Harris (1962). Although he recorded seven species on maize in Nigeria, the three principal species in Ibadan, in order of importance, are *Sesamia calamistis* Hamps., *Busseola fusca* Fuller, and *Eldana saccharina* Walk.

Experiments designed to compare the effects of various insecticides on borer infestation and yield of maize in Western Nigeria have been carried out since 1951 (Sutherland 1952; Sutherland and Gregory 1953; and Harris 1957-61). From these trials, Endrin emerged as the most effective insecticide for control even though such control did not always result in significant increases in yield. As Endrin could not be recommended to farmers because of its high mammalian toxicity the experiments reported here were carried out to obtain an equally effective and safer insecticide, especially among the newly introduced insecticides. It would also be possible to obtain further information on the effect of chemical control of borers on yield of maize. Laboratory experiments (unpublished) have established that the maize plant is most likely to be killed by borer infestation during the first four weeks after germination; these experiments would thus show the effectiveness of a 'rule of thumb' system of timing insecticide applications within this vulnerable period.

MATERIALS AND METHODS

From 1962-1965, six insecticide screening trials were conducted at Moor Plantation, Ibadan involving 3 early and 3 late crops. The trials were incorporated in the following 7-course rotation designed to maintain soil fertility without the use of inorganic fertilizers:

Course	*Crops*
1	Yams inter-cropped with Early Maize inter-planted with Cowpea.
2	Early Maize inter-planted with Cotton.
3	Groundnuts followed by Late Maize inter-planted with Cassava.
4	Cassava continued.
5	1st year Gamba grass.
6	2nd Year Gamba grass.
7	3rd Year Gamba grass.

The early season trials were incorporated in course 2 and the late season trials in course 3 of the above rotation. Each trial consisted of 6 insecticide treatments and a control. The 6 insecticides were not the same in every trial; as the series progressed, substitutions were made as shown in Table 1.

Every trial was laid out as a randomised block with 7 treatments and 4 or 5 replicates. The land was ploughed and harrowed before putting up ridges 3 feet apart. Nett plots were about 1/20th acre or about 1000 plants. Discards 2 yards wide were provided between plots and guard rows 6 yards by 9 yards were provided round the trial area. The maize variety throughout was E.S.1., a yellow dent variety. Planting was done during the last week of March for the early season trials and during the first week of September for the late season trials. Three seeds were planted but later thinned down to single plant stands 1 foot apart on the ridge. No chemical fertilizers were applied to plots. Each trial was weeded about thrice, by hand.

The 'rule of thumb' system of treatment investigated in these trials involved 2 applications of each insecticide 10-14 days and 20-24 days from date of emergence

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of the plants, at the rates given in Table 1. The liquid insecticides were applied in 20 gallons of water per acre. The dusts were applied by shaking into the plants from a small cigarette tin with numerous perforations in the bottom.

External symptoms of borer infestation on young maize plants are very characteristic for each species. *B. fusca* larvae usually scarify as well as eat tiny holes through the rolled leaves forming the 'funnel' of the plant while *S. calamistis* larvae usually tunnel into the stem under the leaf sheath and disperse within the plant. If the growing point is thereby affected this shows up later by its death but the immediate external sign of infestation is the point of entry into stem, under the leaf sheath, which is usually plugged with moist frass. Weekly counts were taken of such borer infested plants in all treatments and infested plants labelled with the date of first observation of borer attack. Summaries of these assessments are shown in Tables 1a and 1b. A total stand count for each plot was made before insecticidal treatments and again before harvest. The difference between these counts is recorded as stand loss in Tables 1a and 1b. At harvest, total yield per plot in terms of total weight of ears was recorded (Tables 1a and 1b).

RESULTS

Effect of Treatments on borer infestation and stand loss:

Tables 1a and 1b show that borer infestation was invariably much higher in the late than in the early season. Identical insecticide treatments also showed different results in both seasons; apart from 1963 very slight or no reduction in the degree of infestation between treated and control plots were shown in the early season while in the late season all insecticides significantly reduced borer infestation. However, no significant differences in ability to control borers could be detected among these insecticides in any of the trials.

The results for stand loss show a similar pattern to that of stem borer infestation. Except in 1965 early season, the percentage stand loss was usually lower than the percentage of the stands infested by borers. This suggests that not every stem-borer infested plant was lost. In 1965 early season more plants were in fact lost than were borer infested. This suggests that other agents besides borer infestation caused stand loss. The common causes include — stalk rot damage, storm damage and accidental losses during weeding. Stalk rot damage was very heavy during 1965 early season

Table 1. Details of insecticides used and their effects on stem-borers incidence and yield of maize.

1(a) — Early Season Trials

Insecticides	*Rate of application a.i./acre*	*% Borer infestation*	*% Stand Loss*	*'F' Trt. on Stand Loss*	*Yield in lb. Cobs/plot*	*'F' Treatment*
			1963			
Control	—	4.0	4.0	No	54.7	
* D.D.T. 5%	1½ lb.	—	—	effect	53.2	1.63
Dieldrin	6½ oz	—	—		52.8	N.S.
Endrin	5½ oz	—	—		50.3	
Telodrin	3 oz	0.1	0.08		56.2	
* Carbaryl 5%	1½ lb.	—	—		61.4	
Carbaryl 85%	1¼ lb.	0.3	0.2		53.4	
			1964			
Control	—	6.4	4.7		107.8	
* D.D.T. 5%	1½ lb	5.1	3.5	3.29	105.3	0.27
Dieldrin	6½ oz	8.2	1.8	N.S.	112.1	N.S.
Endrin	5½ oz	3.2	1.1		128.4	
Telodrin	3 oz	9.1	2.9		120.5	
* Carbaryl 5%	1½ lb	7.5	1.3		114.6	
Carbaryl 85%	1¼ lb	5.8	2.6		114.5	

			1965			
Control	—	7.5	9.2		73.4	
* D.D.T. 10%	1½ lb	6.7	7.5	0.26	76.9	0.43
D.D.T.	24 oz	7.2	7.4	N.S.	70.9	N.S.
* Carbaryl 5%	1½lb	8.7	9.7		74.1	
Carbaryl 85%	1¼ lb	6.9	10.0		66.4	
Fenitrothion	12 oz	8.4	9.5		70.1	
Diazinon	6 oz	8.9	8.5		73.1	

* Dust applications. All others were applied as liquid preparations.

1(b) Late Season Trials

Insecticides	*Rate of application a.i./acre*	*% Borer infestation*	*% Stand Loss*	*'F' Trt. on Stand Loss*	*Yield in lb Cobs/Plot*	*'F' Treatment*
			1962			
Control	—	46.0	25.2	33.1	36.8	2.33
* D.D.T. 5%	1½ lb	4.3	2.8	Highly	32.9	N.S.
Dieldrin	6½ oz	1.9	1.0	Sig.	40.6	
Endrin	5½ oz	3.7	3.2		44.2	
Telodrin	3 oz	1.4	2.5		32.6	
* Carbaryl 5%	1½ lb	3.5	1.8		50.6	
Carbaryl 85%	1¼ lb.	1.7	1.4		55.6	
			1963			
Control	—	22.2	6.3	11.6	39.8	
* D.D.T. 5%	1½ lb	3.7	1.8		42.8	0.77
Dieldrin	6½ oz	4.3	0.3	P less than	43.6	N.S.
Endrin	5½ oz	1.2	0.6	0.01	40.1	
Telodrin	3 oz	1.5	0.7		43.6	
* Carbaryl 5%	1½ lb	2.9	0.6		39.1	
Carbaryl 85%	1¼ lb	1.5	0.9		41.1	
			1964			
Control	—	59.7	33.2	17.9	28.3	
* D.D.T. 10%	1½ lb	20.4	13.7	P less than	36.0	0.7
* Carbaryl 5%	1½ lb	10.4	10.2	0.001	29.8	N.S.
Carbaryl 85%	1¼ lb	21.8	9.2		27.3	
Fenchlorphos	10 oz	27.9	16.6		37.0	
Fenitrothion	12 oz	32.0	7.3		39.0	
Diazinon	6 oz	28.0	17.3		32.8	

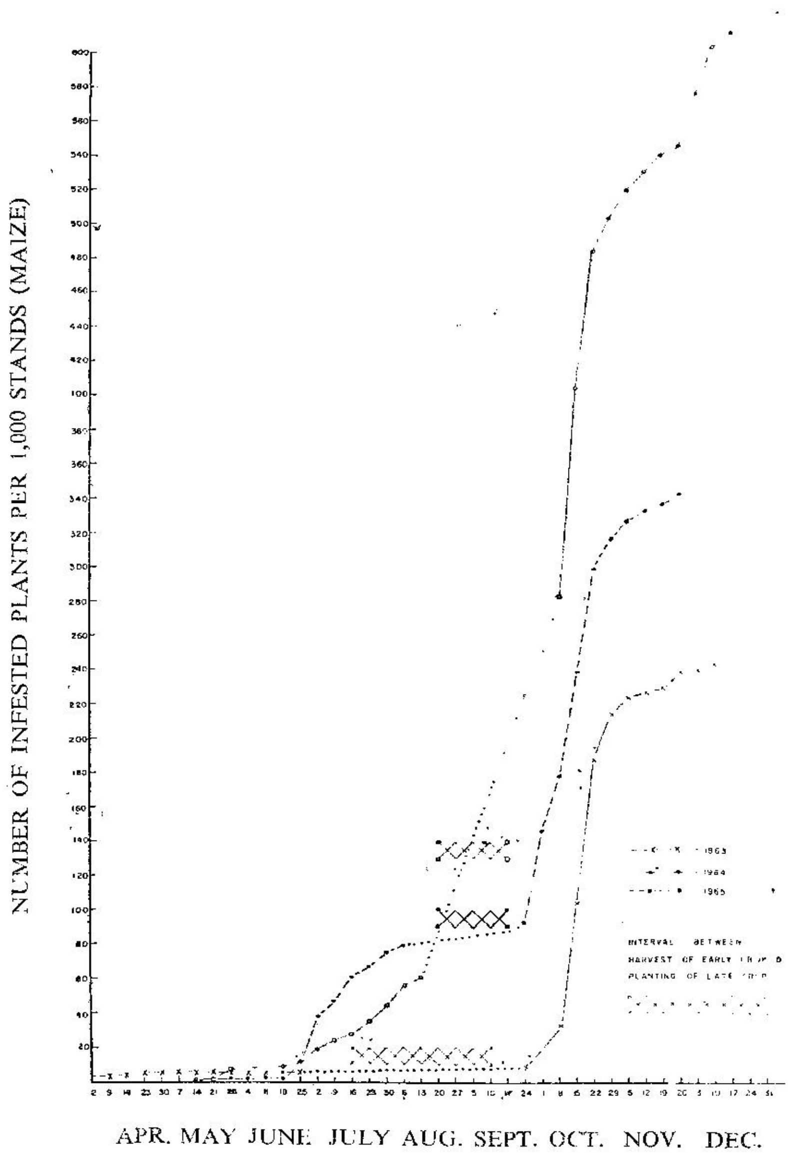
because of unusually heavy rainfall that year (Table II). Unfortunately, loss due to borer infestation was not separated from loss due to other causes in these trials but the close similarity in pattern of the stand loss and borer infestation figures, especially in the late season, suggests that stem borer infestation was a major cause of stand loss. Hence the difference in stand loss between treated and control plots was found to be significant in the three late season trials only.

Effect of Insecticide Treatment on Yield of Maize:

Means of maize yields obtained from the various treatments are shown in Tables 1a and 1b. As expected, yields were usually higher in the early than in the late season. Analysis of variance done on these results reveal that the treatment effect on yields was very nearly significant for 1962 late season but not significant for any other trial. In the 1962 trial, Carbaryl as 85% sprayable gave the highest yield followed by Carbaryl as 5% dust. These were significantly better than the yields from both the Telodrin treated and control plots. In every other trial, no significant differences could be detected among individual treatments. The superiority of Carbaryl was therefore not consistent.

Yields from some insecticide treated plots in all trials were lower than control yield. Each insecticide showed this anomaly in at least one trial but because no signs of phytotoxicity were observed, the apparent yield depression was probably not due to the insecticide.

Thus, reduction in level of infestation did not necessarily result in significant increases in yield. This will be discussed later.



DISCUSSION

Pattern of Borer Incidence:

During the course of these trials the pattern of borer incidence was closely examined. In fig. 1 the cumulative curves of the borer incidence per 1000 plants, on *untreated* plots are plotted for the years 1963, 1964 and 1965. The late season values were adjusted by adding the final cumulative value for the corresponding early season. This is based on the fact that the maize stubble from early season harvest is probably the most important source of infestation on the corresponding late crop.

Using this incidence per 1000 maize plants as an index of the actual borer population, it can be seen that in all 3 years borer population did not develop until after mid-June. Thereafter the population continued to rise until late October. The initial period of low incidence from about April to June represents the first generation. This population would most likely be made up of adults emerging from the diapausing generation of *B. fusca* larvae in maize stubbles at the end of the previous late crop, and *S. calamistis* from a variety of wild alternative host plants. The sharp rise in incidence after mid-June corresponds to the second generation and this gives rise to the third generation on late maize. However, it will be necessary to investigate this generalised pattern for individual species.

This pattern of borer infestation explains the earlier anomaly of no insecticidal control of borer infestation and stand loss in early maize and their successful control on late maize (Tables 1a and 1b). It is obvious from fig. 1 that in early maize crop, borer attack will be low or absent in the most susceptible stages of the crop and will not occur with any severity until the plants are old enough to withstand and survive the infestation. This wave of infestation is usually about 2 months after the second and last insecticide treatments were made, that is, it occurs when the effect of such treatments can be expected to have worn off. No differences in borer infestation were therefore observed between treated and untreated plots in the early season. Hence, insecticidal treatment of early maize for borer control is usually considered unnecessary.

Late maize is however planted just in time for the third borer generation; hence the more severe infestation and stand losses which can be significantly reduced by the application of insecticides included in these trials.

Effect of Population and Fertility on Yield:

It may be unexpected that cutting down stand loss from 33% to about 12% by insecticide treatment in, for example, late season 1964, should fail to result in a corresponding yield increase. Stand loss due to borers occurred early in the life of the crop. Reduction of the population size at this early stage would allow time for a compensation in yield to develop if nutritional or other fertility factors were not limiting. Under these conditions, yield would be independent of plant population size.

Fayemi (1953) showed that yield per acre of maize was independent of the plant population level at populations between 9,680 and 24,200 where nitrogen was applied at 25 lb per acre. Yield increased with increase in plant numbers per acre, however, when 80 lbs nitrogen was applied. He therefore concluded that a reliable response by maize to population level may not be achieved except in the presence of adequate soil nitrogen. In the present series of trials, the low fertility effect could have been caused by the fact that no fertilizers were applied to any stage in the rotation adopted and the usually low rainfall during the late season crop (Table II).

Table 2. Rainfall Figures on Moor Plantation.

Year	*Early Season* *(March—August)*	*Late Season* *(September—December)*
1962	44.96 ins	18.01 ins
1963	43.75 ,,	19.36 ,,
1964	31.55 ,,	10.53 ,,
1965	54.96 ,,	11.61 ,,

Hence in 1964, stand loss of up to 30% in the late season crop did not significantly reduce maize yields probably because of the low fertility level arising from the unusually low rainfall that year.

The importance of the fertility level in explaining the effect of stem borer infestation on maize yields was also shown by results obtained in East Africa by Walker (1960). He found that in trials in poor agronomic areas, yields were increased from 3½ bags to 7 bags per acre when stalk borer was controlled while in other trials where cultivation and growing conditions were excellent, the control of stalk borer increased yields from 4 to 25 bags per acre. He thus obtained different regression lines of high and low yielding groups (Walker, 1962). Fertility and moisture therefore appear to be more critical than stem borer infestation alone, in the determination of the yield of maize in western Nigeria.

Recommendation:

On the basis of these results, insecticide applications can be recommended for use on late maize especially where plant population is important, and also where the crop is being grown under high fertility conditions. In the only trial where a nearly significant treatment effect on yield was obtained (1962 late season), Carbaryl both as 85% W.P. and 5% dust was significantly better than control. In all the trials, it was as effective as other insecticides in controlling borer infestation but safer to users than others.

It can thus be recommended for controlling stand loss in late maize due to stem borer infestation when applied at 1¼ lb and 1½ lb respectively, of the active ingredient per acre, 10-14 days and 20-24 days after emergence of the maize plants.

Summary and Conclusions:

Insecticide screening trials against the stem borer complex of maize consisting of *S. calamistis*, *B. fusca* and *E. saccharina* were started in Nigeria in 1951. The present series of trials were designed to find a safe and effective insecticide for controlling these borers and to obtain information on factors that might affect the effectiveness of such chemical control.

All insecticides tested were found to significantly reduce borer infestation and stand loss especially on late maize. Mean yields from treated plots were, however, not significantly different from those of control plots in all trials.

Carbaryl (i.e. Sevin) either as 85% W.P. or 5% dust was recommended for controlling borer infestation on late maize but not on maize grown on poor soil with low water content.

These results were discussed in terms of the pattern of borer infestation observed on untreated plots during the period of the trials and also from results of maize population studies.

In conclusion, no significant treatment effects on yields were obtained in both early and late season trials probably because of usually low levels of stem borer infestation on the early crop and because of the usually low fertility and moisture conditions during the late season.

ACKNOWLEDGEMENT

The authors are greatly indebted to Mr. B. O. E. Amon, Chief Agricultural Research Officer, for permission to publish this work. We also wish to record our thanks to the field staff of the Entomology Division, Ministry of Agriculture and Natural Resources, who assisted in the weekly assessments of borer infestation throughout the period.

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Effect of 2-Chloro-6-(Trichloromethyl) Pyridine* on Conserving Ammonium Fertilizers in a Tropical Rain Forest Environment

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ABSTRACT

The effect of 2-chloro-6-(trichloromethyl) pyridine, known as N-serve, on the conservation of ammonium sulphate was investigated under field conditions in two soils in Ibadan, Nigeria. 40 ppm. of N-serve was not effective in conserving ammonium sulphate while 120 ppm. was partially effective for a short period. Its ineffectiveness was attributed to high soil temperature. The use of N-serve does not assist in conserving ammonium nitrogen in the soil under the conditions of this experiment, and we do not consider it to be of agronomic significance.

INTRODUCTION

Efficient utilization of both soil and fertilizer nitrogen has been a major concern of agronomists for many years. One of the most important factors responsible for inefficient use of nitrogen is leaching. This is particularly the case in areas where rainfall is high and nitrification occurs at a rapid rate. Any factor that can slow down the speed of nitrification will cut down on the leaching loss of nitrogen.

* Thanks are due to the Dow Chemical Company, Midland, Michigan, U.S.A., for the free supply of this chemical.