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Barry,B.D.; Andrews,D.J.

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A PRACTICAL CONTROL OF MAIZE STEM BORER, *BUSSEOLA FUSCA* ON SORGHUM IN NIGERIA

by

B.D. Barry and D.J. Andrews

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A PRACTICAL CONTROL OF MAIZE STEM BORER, BUSSEOLA FUSCA ON SORGHUM IN NIGERIA

B. D. Barry and D. J. Andrews

Introduction

The maize stem borer, Busseola fusca, Fuller is a major cereal pest and of all stem borers it probably has the greatest economic potential for damage to cereals in Africa due to its wide distribution and voracious feeding habits. This insect has received considerable publicity in Africa over the last 60 years since Fuller described it.

Several studies of taxonomy, biology and control of the borer have subsequently been reported by Mally (1920), Sutherland (1953), Jepson (1954), Coaker (1956), Bowden (1956), Swaine (1957), Smithers (1959), Walker (1960), Smith (1962), Harris (1962) and Usua (1968). These reports contain valuable basic biological information to approach the study of the problem although many areas of study are not complete or are untouched. Various degrees of control with parasites and predators, cultural practices and chemicals have been noted, but no satisfactory method of control for the African hand farmer has been developed. Nearly all workers have recognised the economic importance of the insect, although Harris (1962) reported an increase in sorghum grain yield in stems which have been bored. The present authors suggest that his sampling method was not statistically sound. Bowden (1956) reported increases of 10-35 per cent in yield of maize in the New Gold Coast by using 5 per cent DDT dust (quantity unknown) and in East Africa Swaine (1957) reported an increase of 83 per cent in maize treated 4 times with 10 pounds of 2.5 per cent DDT dust per acre; however, Coaker (1956) noted no difference in lodging or increase in yield although he gradually reduced the insect infestation by applying 20 pounds of DDT per acre (A. I. unknown).

The purpose of this paper is to report results and describe a method of control of B. fusca in sorghum, Sorghum bicolor L, which is safe and economically practical for the Nigerian hand farmer to use.

Materials and methods

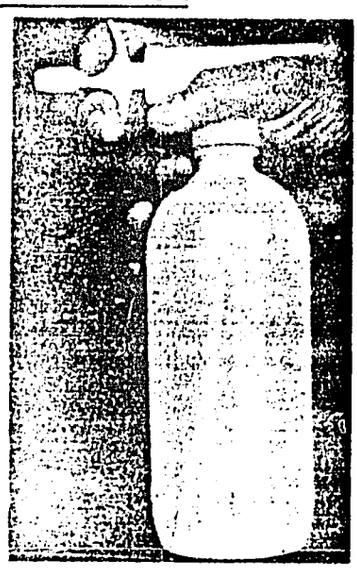


Figure 1. Pistol grip sprayer used for applying insecticide solution.

In this study we evaluated carbaryl at various rates and two different methods of applying it with a pistol grip sprayer (Fig. 1). (Sprayers used were obtained from the English Glass Co. Ltd, Scudamore Road, Leicester, LE 3 1UG England). The nozzle can at a twist, provide either a thin jet stream or a cone shaped spray mist. Each stroke delivers 1 millilitre of solution. Three replicated tests were conducted in sorghum plots heavily infested with early instar second generation borers.

Test No. 1 - This test consisted of 7 treatments replicated 3 times. Three rates of 85 per cent carbaryl wettable powder (2, 4 and 6 grams in 500 ml of water) were each applied either as a spray mist or a jet stream directed down the whorls (funnels) of the sorghum plants. These plus a control made up the treatments which were applied to a plot of 50 plants. (These rates were equivalent to: 0.19, 0.38, and 0.56 pound of actual ingredient (A. I.) per acre on these plots). Each whorl including tillers except for the controls, was treated with 1 ml of the above solutions. Ten infested plants of each plot were dissected 7 days after the application of the insecticide and the number of live larvae in the whorls (the few larvae found in the stem were not included in the analysis since these treatments were not designed to control them) were recorded. The plant population in this test was 23,000 plants per acre and by counting the number of plants exhibiting leaf feeding, it was found that 98 per cent of the plants were attacked by B. fusca (other stem borers were negligible).

Tests Nos. 2 and 3 - These tests were conducted on a production field of sorghum planted at 50-60,000 plants per acre with 100 per cent infestation of B. fusca. Each test consisted of 7 treatments replicated 6 times. These treatments were applied as indicated above in test number 1. The rates were 4, 5 and 6 grams of insecticide per 500 ml of water which in this case was equivalent to 0.75, 0.94 and 1.13 pounds of A.I. of insecticide per acre. Again, ten plants of each plot were dissected 7 and 5 days after treating on tests 2 and 3 respectively. Only 2 complete replications plus all of the control plots were dissected in test 2 since it was detected that spray drift of carbaryl from a tractor mounted sprayer working on the adjacent farm crop had killed some borers in the control plots. This source of drift was also noted in test 3, but apparently it was not as severe as in test 2.

Results

Tables 1 and 2 indicate the method and rate of the application of carbaryl and the degree of control achieved in tests 1 and 3 respectively. Data from only 2 replications of test 2 were collected and those are not tabulated. However, a high degree of control was observed in the treated plots of those 2 replications.

In tests 1 and 3 all treatments of carbaryl significantly reduced the stem borer population (61-90 per cent). In test 1 the treatment of 6 grams of carbaryl in 500 ml of water was significantly better than 2 grams as a jet stream and the controls, but not better than the other treatments (Table 1). Since the stand count in this test was 23,000 plants per acre the actual amount of insecticide applied at the 6 gram rate was equivalent to 0.56 pound A.I. per acre.

Table 1. Control of maize stem borer on sorghum with carbaryl in Nigeria (test no. 1)

Treatment	Rate * (gm/500 ml)	Avg. No. Larvae per whorl	% Control **
Spray	6	0.5	90a
Jet	6	0.7	86a
Spray	4	0.9	82ab
Jet	4	1.1	78ab
Spray	2	1.4	71ab
Jet	2	1.9	61 b
Control	0	4.9	0 c

* The rates indicated are the number of grams of 85 per cent carbaryl mixed with 500 ml of water. These rates: 2, 4, and 6 grams are equivalent to 0.08, 0.16 and 0.24 pounds A.I. per acre respectively for a population of 10,000 plants per acre.

** Numbers not followed by the same letters are significantly different at the 5 per cent level.

Table 2. Control of maize stem borer on sorghum with carbaryl in Nigeria (test no. 3)

Treatment	Rate * (gm/500 ml)	Avg. No. Larvae per stem	% Control **
Spray	6	0.07	88a
Jet	6	0.02	97a
Spray	5	0.05	92a
Jet	5	0.05	92a
Spray	4	0.02	97a
Jet	4	0.00	100a
Control	0	0.60	0b

* The rates indicated are the number of grams of 85 per cent carbaryl mixed with 500 ml of water. These rates 4, 5, and 6 grams are equivalent to 0.15, 0.19, and 0.23 pounds A.I. per acre respectively for a population of 10,000 plants per acre.

** Numbers not followed by the same letters are significantly different at the 5 per cent level.

The data from this test also indicated that the spray mist was significantly better than the jet stream application (paired t-test at 5 per cent probability). However, this was not confirmed in the third experiment, but this was probably due to the extremely low population of insects remaining in treated plots. In test 3 all treatments were significantly better than the control, but no differences were noted among the various levels of insecticide treatments or methods of application.

These experiments indicate that 4 grams of 85 per cent carbaryl in 500 ml of water applied as 1 ml of solution down the whorl(s) of each plant will control the maize stem borer feeding in them. More than 6 grams of carbaryl per 500 ml of water can produce "scorch" or phytotoxicity to sorghum plants, but although varieties differ in susceptibility, dosages of several times that sufficient to produce a visible effect do not produce permanent damage.

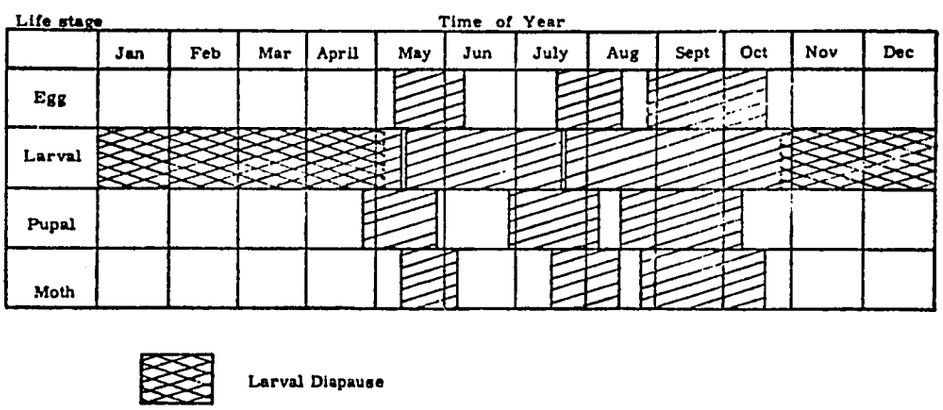
Discussion

In this paper it is assumed that the stem borer feeding on a sorghum plant is deleterious to the plant, but with the understanding that the degree of damage is dependent upon the number and size of larvae and the developmental stage of the plants under attack. It is particularly realized that sorghum plants can withstand considerable foliar damage without reduction in yield (Barry, 1970), but that the degree of foliar damage by B. fusca is highly correlated with damage to the growing tip and internal stem damage if the insect is not controlled in its early stages of development. Consequently whenever the infestation of this insect reaches a certain level it becomes economic to control that infestation.

As indicated in the above section of this paper, B. fusca can be controlled by the hand farmer by treating each whorl with 1 ml of solution of 4 grams of 85 per cent carbaryl (presently cost ranges from 7/- to 13/6d per pound A.I. depending on discount or subsidy) in 500 ml of water. This can be applied down the whorl of the plant by a small pistol grip sprayer (Fig. 1) and it is best done as a spray mist rather than a jet stream. The sprayer, which costs 5/3d, holds 500 ml of solution and delivers 1 ml at each stroke. However, several considerations must be kept in mind for this treatment to be effective and economic.

The first consideration is that insects must be present and feeding in the whorl of the plant. In the Samaru area of Nigeria, B. fusca has three generations per year with activity as illustrated in Figure 2. The first two generations are quite distinct, but much less so for the third. This has been reported earlier in Nigeria by Harris (1962) and in East Africa by Swaine (1957). The treatment discussed here is applicable to the first two generations, but not normally to the third since the sorghum may be quite tall or heading during this time.

Figure 2. Developmental activity of Busseola fusca throughout the year at Samaru, Nigeria



The first moths of the season which develop from diapause larvae from the dry season begin to emerge about four weeks after the rains start. They may emerge over a 2-3 week period and begin to oviposit within a day of emerging. The eggs require 6-9 days to hatch. From these figures it may be predicted that young first generation larvae will be attacking cereals about 6-7 weeks after the rains start. While the signs of leaf feeding are readily recognised (small holes and lesions in the leaves) (Fig. 3), the farmer should be careful to check his crop for

early indications of attack as young larvae are more susceptible to the insecticide than when larger and older.

Also if control is delayed too long feeding may reach the growing point. Individual plants showing leaf feeding may be treated singly in a crop but a blanket treatment of all whorls will not be worthwhile unless more than half of them are showing infestation.

The second generation may be expected to occur about 35-45 days after the first (Fig. 2) and a daily inspection should be made in anticipation. This attack is usually the worst and can result in the most damage. Fortunately at this time farmer's crops are not too tall to treat, being between 3 and 5 feet high.

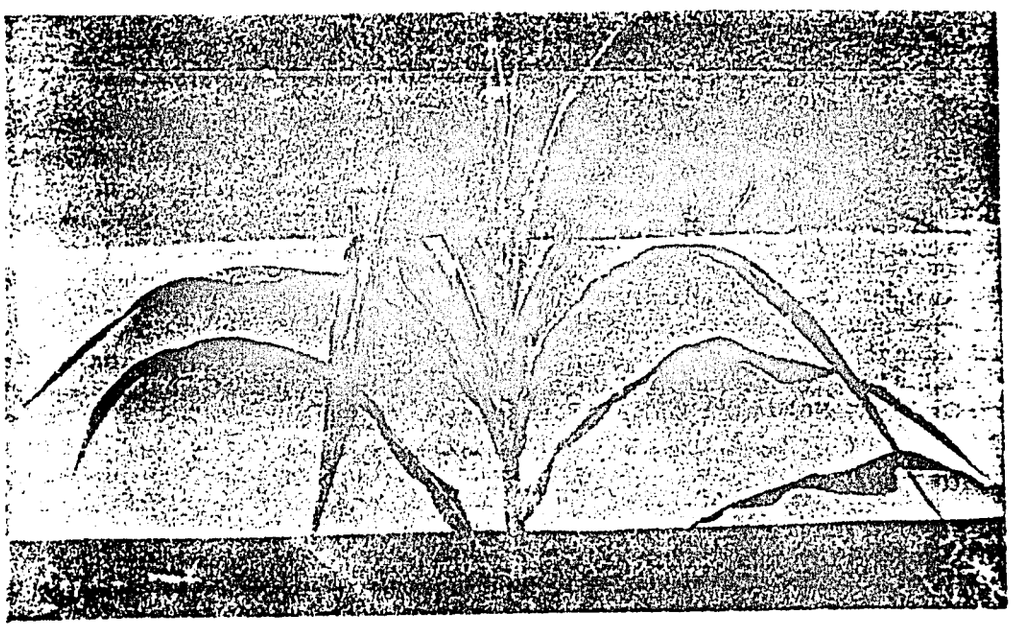


Figure 3. Sorghum plant exhibiting continuous leafing of the maize stem borer.

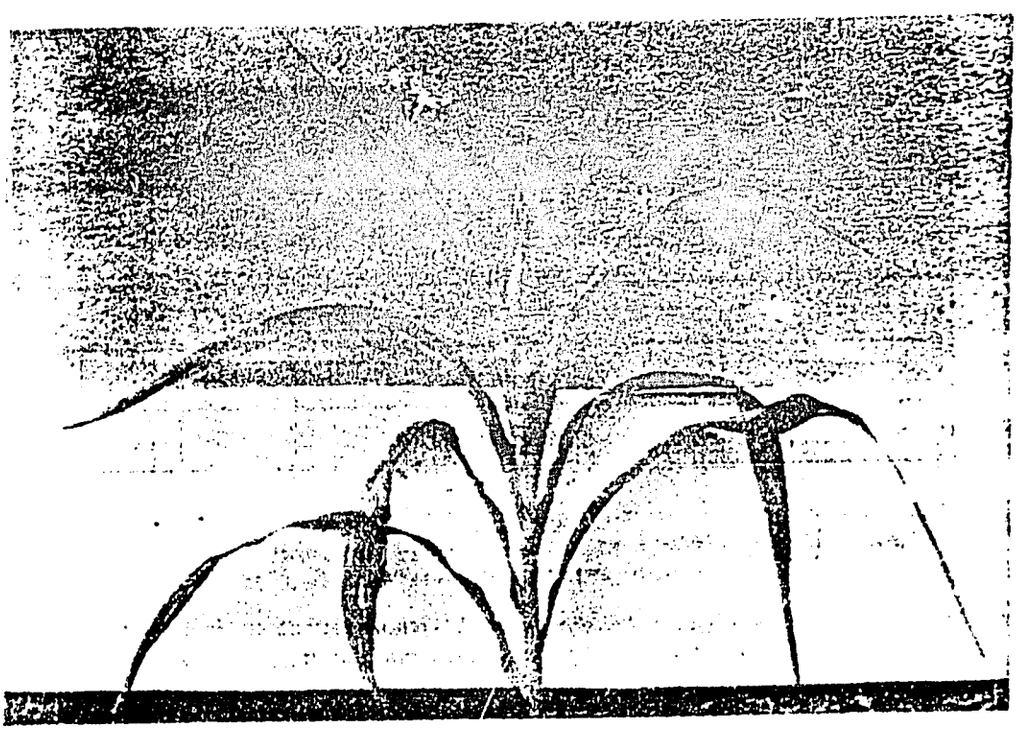


Figure 4. Sorghum plant free of maize stem borer leaf feeding in the whorl after it was sprayed with carbaryl.

Figure 5. Sorghum plant with a deadheart caused by advanced feeding of the maize stem borer.

Leaf feeding and a deadheart caused by B. fusca are illustrated further in figures 3 to 5. In figure 3, a plant is shown which has been attacked by B. fusca and not sprayed (note signs of continuous feeding) and figure 4 shows a plant that has been sprayed after an infestation was observed (note where leaf feeding stops). A deadheart caused by a larva feeding on the growing tip is shown in figure 5.

The eggs, larva, pupa, and adult stages of this stem borer are illustrated in figures 6, 7, 8, and 9 respectively. The first three stages are shown in a background depicting their habitat.

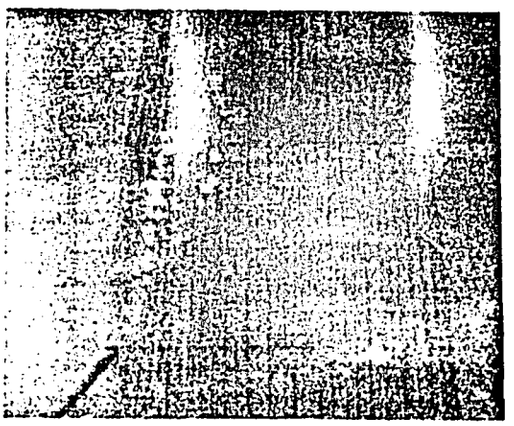


Figure 6. Eggs of the maize stem borer which have been deposited in the leaf sheath of a sorghum plant

In regard to the material and techniques of treating sorghum with carbaryl with the pistol grip sprayer, the "spray mist" is suggested as the better method of applying this insecticide. This allows for a larger area of the plant to be covered with insecticide, and the applicator does not have to be as accurate as he would with a "jet stream"; in consequence the spraying operation is faster. One man can treat an acre of 10,000 in about 3-4 hours. Since this sprayer delivers a measured application on a plant whorl basis, the farmer will not be involved in calculating a dosage rate per acre. He can mix up a bulk solution with a ratio of 4 grams of 85% carbaryl to 500 ml of water. Plants are treated irrespective of population per acre. This is a considerable advantage as the populations used by farmers vary widely, from as little as 400 per acre in an intercrop with groundnuts to 10,000 in a sole crop. However at wide spacing sorghum will, according to variety, produce tillers which means the number of whorls to be treated will exceed the actual number of plants present. Intercropping is the common practice and sorghum plant populations are frequently less than 5,000 plants per acre. At this plant density sprayers with a continuous delivery are wasteful due to the space between plants. Carbaryl being a carbamate insecticide has an LD_{50} for rabbits of over 5,000 mg/kg, making it relatively safe for farmer use. Compared to DDT, carbaryl is about 5 times safer and its residue is less persistent.

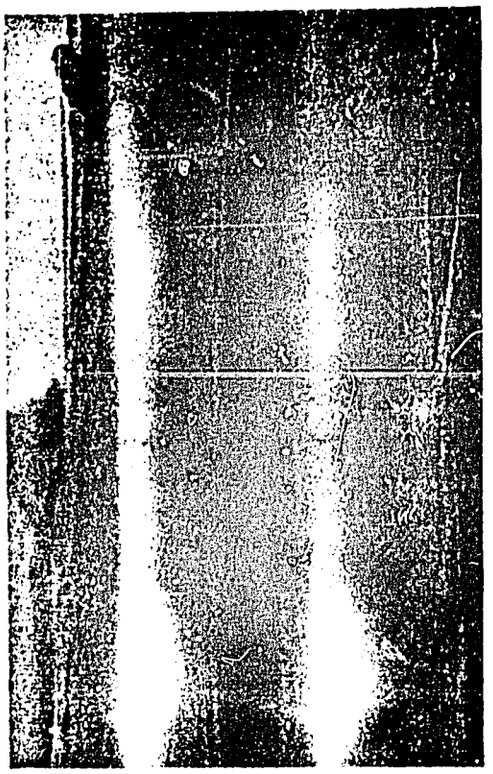


Figure 7. Full grown larva of the maize stem stem borer and internal stem damage caused by the insect.

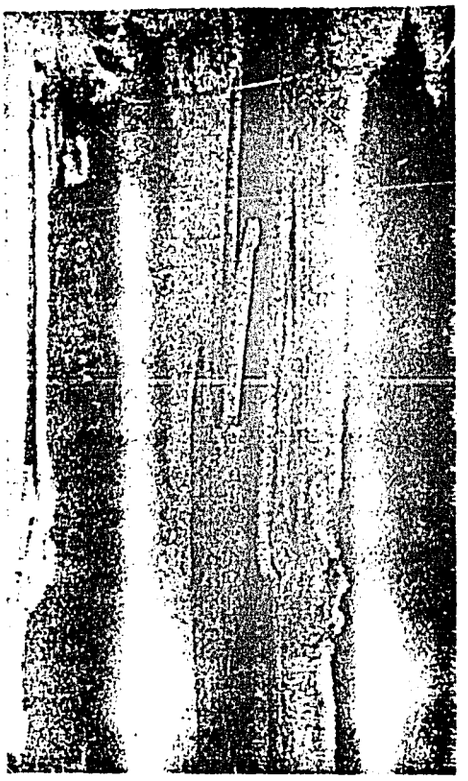


Figure 8. Pupa, the transformation stage of the maize stem borer before it becomes a moth, in a damaged stem.

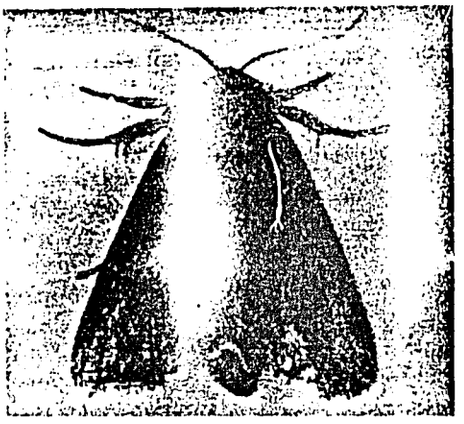


Figure 9. The adult or moth stage of the maize stem borer.

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