

Trials with Decamethrin* for the Control of *Heliothis armigera*? on Tomatoes in Senegal

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Summary. Trials carried out during 1976 and 1977 have demonstrated the high insecticidal activity of decamethrin against *Heliothis armigera*, one of the major pests of the tomato crop in the Cap Vert region of Senegal. Acephate, carbaryl and tetrachlorvinphos also gave acceptable levels of control, whereas *Bacillus thuringiensis*, dichlorvos and dimethoate were unsatisfactory. The effectiveness of all the products was diminished when tomatoes were irrigated by means of overhead rotary sprinklers.

Introduction

The tomato is grown on a fairly extensive scale in the Cap Vert region of Senegal which comprises the peninsula extending for a distance of 40 km or so to the east of Dakar: cropping estimates show that in the 1974 season for example, between 400 and 500 ha of tomatoes were grown, both for local consumption and for export to Europe between December and June.

One of the most serious constraints on production is the damage caused by the tomato fruit worm, *Heliothis armigera* (Hübner), which attacks the young tomato fruits and renders them unsaleable: at the highest point of the attack it is not uncommon to find up to 85% of the fruits damaged. By calculating the percentage of damaged fruits at regular intervals it is possible to construct a curve reflecting the rise and fall of the population at different times of the year.

Figure 1 shows two such curves based on weekly counts made on several hundred fruits harvested from unsprayed plots of tomatoes in the Cap Vert region during 1976 and 1977. From this it can be seen that the attack started about mid-January, and rose to a peak during May/June and March/April in 1976 and 1977 respectively. Between mid-August and mid-December in both years, a negligible amount of damage was recorded.

Experience of tomato growing in this region since 1972 suggests that the pattern of population development is similar in other years, though precise information is not available for 1972-75. However, the months during which the population of *H. armigera* is highest coincide with the most important production period. Hence, the use of insecticides has to be considered to protect the main tomato crop.

The majority of the farms in the Cap Vert region are small, many being of the order of 2000-4000 m², and the farmers themselves have little or no experience in handling pesticides. One of the primary considerations, therefore, in selecting insecticides for trial was that they should have a low or a relatively low mammalian toxicity.

Another important factor which has to be considered is that of irrigation. Some of the tomato crops are grown on land with a fairly high water-table and, apart from watering-in at transplanting, receive no irrigation during the whole of their growth cycle; whereas other crops, grown on fairly light, well-drained soil are watered several times per week by means of watering-carts fitted with a coarse sprinkler-rose. Thus, one of the 1977 trials was carried out on a tomato crop which was irrigated three times per week by means of overhead rotary sprinklers.

*It was learnt while this article was in press that decamethrin, although widely used, has not been accepted as a common name for NRDC 161 by ISO.

†Lepidoptera: Noctuidae, Melicetptriinae.

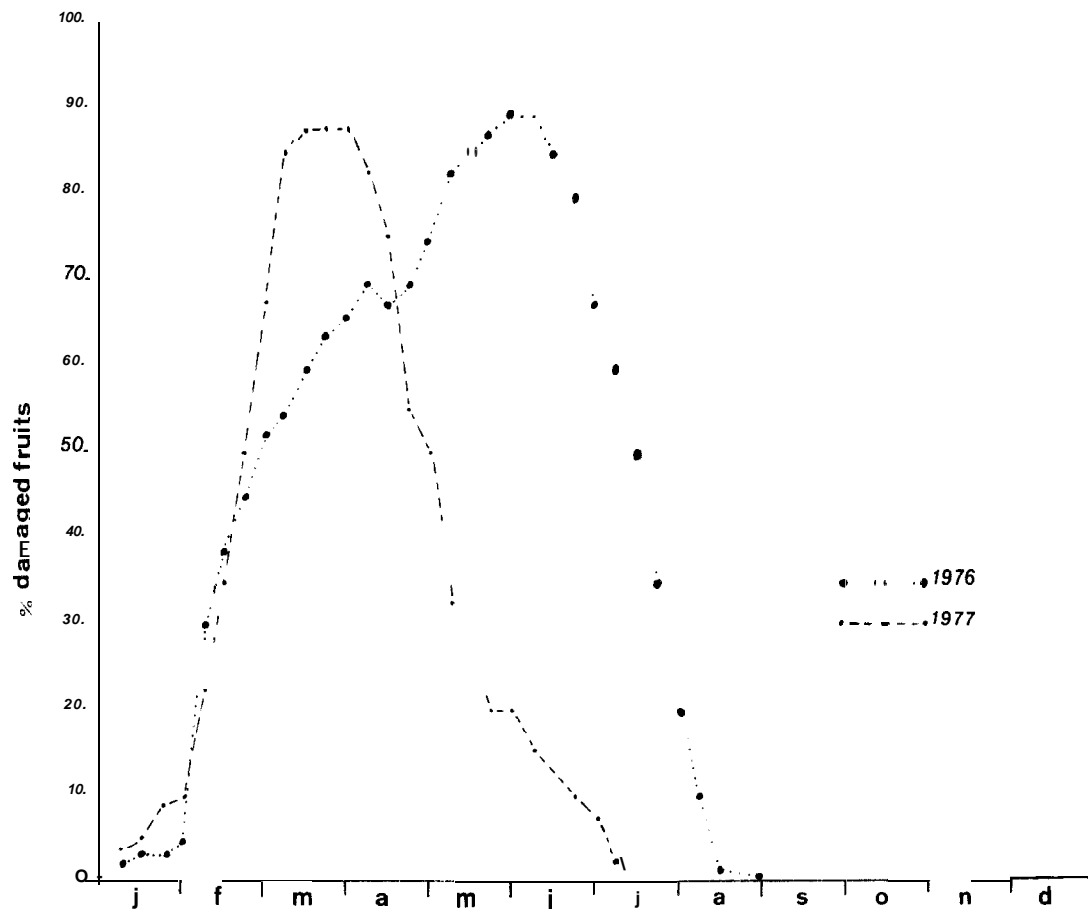


Fig. 1. Percentage of tomato fruits damaged by the tomato fruitworm *Heliothis armigera* during 1976 and 1977.

In 1973, Elliott *et al.* succeeded in synthesising a photostable pyrethroid, thus opening up the possibility of using this category of insecticide for the control of certain insect pests of agricultural crops.

Towards the end of 1975 another photostable pyrethroid, decamethrin (supplied by *PROCIDA*) became available in limited quantities and a series of trials was planned to compare this material with other selected insecticides in 1976 and 1977. The 1977 selection included two insecticides of short persistence for use if necessary during the harvesting period.

Materials and methods

The trials described below were carried out at the Centre pour le Développement de l'Horticulture which is in the Cap Vert region approximately 10 km east of Dakar.

1976 trial

The site used for this trial consisted of a fairly sandy topsoil with a heavier underlying layer rich in organic matter. Irrigation was not necessary during the growing period. Four insecticides were included in this trial namely, acephate, decamethrin, dimethoate and tetrachlorvinphos.

The trial comprised a randomised block design with four replications: treatment plots were 5 m x 2 m and were each planted with two lines of ten tomato plants, cultivar UHN 11 (VFN determinate), which has a determinate growth form. The transplanting date was 1 April which, due to the rather wet state of the soil, was several weeks later than originally planned.

Insecticides were applied once every week during the late afternoon by means of a knapsack sprayer, in a volume of water equivalent to 2000 l/ha. The first of seven weekly applications was made on 10 May: the timing of the first spray for this and subsequent trials was determined by the date of hatching of *Heliothis* eggs and the

TABLE 1. EFFECTIVENESS OF VARIOUS INSECTICIDES AGAINST *HELIOTHIS ARMIGERA*, 1976 TRIAL (NON-IRRIGATED)

Insecticide	Dosage of active ingredient per hectare (g)	Average percentage attack	Mean number of healthy fruits per plot
Decamethrin	25	0.1	356 a
Tetrachlorvinphos	1500	5.7	308 ab
Acephate	750	8.0	295 b
Dimethoate	400	17.9	219 c
Control (untreated)	—	61.6	98 d

Means not followed by the same letter are significantly different ($P=0.05$) (based on Duncan's multiple range test).

appearance of the first young caterpillars on the plants. Harvesting began on 8 June and continued until 22 July by which time the crop was completely mature. At the peak of the production period harvesting was carried out twice per week.

Results of the 1976 trial are shown in Table 1, which also indicates the dosages of insecticide used in this trial.

1977 trials

During the 1977 season two trials were carried out, one with no irrigation during the growing season, the other irrigated three times per week by means of overhead rotary sprinklers, giving a total of approximately 30 mm of water per week.

For the two 1977 trials the tomato cultivar 'Rossol' (VFN determinate) was used: this cultivar produces fairly large numbers of medium-sized fruits compared with the fewer and larger fruits of UHN 11. This is reflected in the considerably larger total number of fruits harvested in the 1977 trials, compared with 1976.

All treatments in the 1977 trials were applied in a volume of water equivalent to 1000 l/ha.

Non-irrigated trial 1977

In this trial, the following insecticides were compared:

- acephate, *Bacillus thuringiensis*,* carbaryl, decamethrin, dichlorvos, dimethoate and tetrachlorvinphos, all applied once per week
- decamethrin 2, applied once every two weeks.

The layout of the trial was essentially the same as that used in 1976. Plants of tomato cv. Rossol were transplanted on 30 November 1976. The first insecticide application was made on 3 January 1977, there being a total of eight treatments with the weekly-applied insecticides, and four with the decamethrin applied at fortnightly intervals. The first of five weekly harvests was carried out on 25 February.

Dosages and results are shown in Table 2.

Irrigated trial 1977

Insecticides evaluated were the same as described in the trial above, except that the 25 g a.i./ha rate of decamethrin applied every two weeks was replaced by a weekly application of 15 g a.i./ha.

Transplanting date was 8 January: the first of six weekly treatments was applied on 2 March and the first of five weekly harvests was carried out on 23 March. As in the other two trials, harvesting was continued until the crop reached maturity. There were only three replications of each treatment in the irrigated trial as space was limited.

Dosages and results are shown in Table 3.

**Bacillus thuringiensis* Berliner, var. *Kurstaki*, serotype 3a, 3b; — 16,000 international units of potency per mg of product.

TABLE 2. EFFECTIVENESS OF VARIOUS INSECTICIDES AGAINST
HELIOTHISARMIGERA, 1977 TRIAL (NON-IRRIGATED)

Insecticide	Dosage of active ingredient per hectare (g)	Average percentage attack	Mean number of healthy fruits per plot
Decamethrin 1	25	0.2	3207 a
Decamethrin 2 *	25	4.1	1160b
Tetrachlorvinphos	1500	5.2	1147 b
Acephate	750	7.4	1120 bc
Carbaryl	1500	8.9	1100 bc
Dimethoate	760	30.6	848 d
Dichlorvos	750	33.3	814 d
<i>Bacillus thuringiensis</i>	800 (product)	44.4	668 e
Control (untreated)	—	70.0	360 f

Means not followed by the same letter are significantly different ($P=0.05$) (based on Duncan's multiple range test).

* Decamethrin 2, treatment applied once every two weeks.

TABLE 3. EFFECTIVENESS OF VARIOUS INSECTICIDES AGAINST
HELIOTHISARMIGERA, 1977 TRIAL (IRRIGATED)

Insecticide	Dosage of active ingredient per hectare (g)	Average percentage attack	Mean number of healthy fruits per plot
Decamethrin	25	10.4	1079 a
Decamethrin	15	12.4	1064 a
Acephate	750	19.0	969 b
Tetrachlorvinphos	1500	22.3	937 b
Carbaryl	1500	20.5	926 b
Dichlorvos	750	43.5	687 c
Dimethoate	750	44.2	683 c
<i>Bacillus thuringiensis</i>	800 (product)	54.9	537 d
Control (untreated)	—	67.6	389 e

Means not followed by the same letter are significantly different ($P=0.05$) (based on Duncan's multiple range test).

Statistical analyses were carried out to compare the numbers of healthy fruits harvested from the various treatments. Following Bartlett's tests of homogeneity of variances, the non-transformed data were subjected to an analysis of variance and Duncan's multiple range test to separate the significant means ($P=0.05$).

Results and discussion

Considering first of all the non-irrigated 1976 trial. All four insecticides tested gave an appreciable degree of control of *H. armigera*. Outstanding amongst them was decamethrin which, applied weekly at a rate of 25 g a.i./ha diminished the attack from 61.6% (untreated) to 0.1% of damaged fruits. The two products acephate and tetrachlorvinphos, with 8% and 5% of damage respectively would also be readily accepted locally as efficient insecticides.

In the 1977 non-irrigated trial, the decamethrin again gave the best results, but with a significant difference between weekly and two-weekly application.

Of the other insecticides tested, tetrachlorvinphos and acephate were not significantly different from decamethrin applied every two weeks, carbaryl came next, with a level of control which was still satisfactory.

Dichlorvos, with a higher mammalian toxicity than the other products was included because of its shorter persistence. At a dose of 750 g a.i./ha it gave unsatisfactory results but is perhaps worth testing again at a higher dosage rate.

Dimethoate was included in the trial because it is readily available locally and fairly cheap, rather than for its qualities in controlling Lepidoptera. It performed well in 1976 (17.9% damage). However, this performance is difficult to understand in relation to the 1977 results which, despite an increased dosage rate* showed a considerably higher percentage of damage (30.6%, non-irrigated trial). The results of the 1977 trial are, in fact more in line with those observed when dimethoate has been used on a field scale.

The seventh product tested, the biological insecticide, *B. thuringiensis*, is very safe from the point of view of mammalian toxicity and residues, and would be an ideal product for use locally. Results obtained under the conditions of the 1977 trials were somewhat disappointing, although the dosage used (800 g product/ha) was perhaps rather low. In addition it is known that several factors such as the variety and serotype of *B. thuringiensis* used, the Formulation of the product, the addition of various adjuvants, etc. can influence the effectiveness of this type of insecticide (Falcon 1971), thus the results obtained with this sole variety and a single dosage rate should not be interpreted too rigidly.

Irrigated trial 1977

Comparison of the results of the two 1977 trials shows broadly the same order of insecticidal activity in both trials. It is apparent, however, that the overhead irrigation has led to a reduction in the effectiveness of all the insecticides. The same effect would almost certainly be found on the farms where irrigated crops are grown, as these are watered at least once per day by means of watering-cans. A modified system of watering is being studied at the Centre, but it may be difficult to supplant the long-established traditional method.

Considering the trials as a whole, it is evident that the four best products were acephate, carbaryl, decamethrin and tetrachlorvinphos. Of these decamethrin showed the highest insecticidal activity. A weekly application of 15 g a.i./ha could probably be recommended where overhead irrigation is used, although this has only been tested in a single trial: where tomatoes are irrigated other than by overhead irrigation, an application rate of 25 g a.i./ha every two weeks would appear to be adequate.

The quantity of active ingredient involved in the decamethrin treatment is very small, and when distributed over the foliage of a tomato crop can probably be counted in parts per billion in terms of residue. This, in conjunction with a moderate mammalian toxicity probably makes decamethrin a candidate for consideration as an insecticide for use even during the period of harvest, and it has been authorised for use on vegetable crops in France with zero delay between treatment and harvest.

Acknowledgments

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● Chemical analysis of the dimethoate used in the 1977 trials showed no reduction in the percentage of active ingredient.