Procedures, Advantages and Constraints of Staggered Targeted Control Programmes on Cotton in West Africa

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ABSTRACT

In the last decade, two main types of staggered targeted control (STC) have been designed by CIRAD in francophone Africa in collaboration with national research institutions. In the first in Benin, Cameroon and Guinea, spray calendars are used with five or six applications at fortnightly intervals. Formulations and doses depend on the pests present during scouting on the day before spraying. In the second in Burkina Faso pre-1996, Mali and Togo, the basic calendar programme is applied with a pyrethroid-organophosphate mixture at half the usual dosage and scouting six days after spraying. Further spraying is performed on the next day if a threshold is passed. Special procedures depend on the country (phytosanitary ecoregions, risk of a particular pest related to the growing season, sampling procedure, plant organs or pests observed). Decision-making procedures, spraying thresholds and products and doses may vary according to these features, and STC programmes match country pest conditions. Ecological and economic benefits include a 40-50% reduction in chemical control, lowering costs by CFAF 10,000 to 15,000 per ha. Better knowledge of pest biology and damage and better crop monitoring give 100-200 kg/ha seed-cotton where STC is applied. Many identified constraints remain, including problems of the status and payment of specialized scouts among growers. The real cost of products may form a serious constraint for single active substance formulations.

Introduction

The main pests found on cotton crops of Sub-Saharan belong to four main groups: bollworms, leaf eating caterpillars, honeydew secreting sucking insects and mites. A calendar spraying programme is recommended in the francophone Sub-Saharan countries (Cauquil, 1990).

In the face of crop extension problems related to economic conditions (devaluation of the CFA franc and the halting of subsidies for inputs), the withdrawal of extension services and the risk of the development of resistance to the active substances applied, new protection programmes have been designed in recent years (Cauquil and Vaissayre, 1997a, 1997b).

The general principles of STC programmes and specific procedures

In the STC programme, the decision on the one or more active substances and the quantity applied depend on the pests actually present in the field and observed just before spraying. These principles have led to the name 'staggered targeted control' (staggered with regard to the doses used and targeted with regard to the pest).

Two main types of STC programmes have been designed in recent years.

In the first category ('D-1' programmes), the number of sprayings is the same as that of pre-established recommended calendar programmes, that is to say five or six sprays at fortnightly intervals, depending on the region, starting at flowering. Scouting observations are made the day before spraying. The countries concerned are Benin (Vodounnon, 1995), Cameroon (Deguine *et al.*, 1993; Deguine and Ekukole, 1994) and Guinea.

In the second case ('D+7' programmes), the programme performed is based on the recommended programme with the use of a pyrethroid-acaricide organophosphate mixture applied at half-dosage with or without prior observations. However, scouting is performed 6 days after the calendar spraying dates and, if necessary, complementary spraying is performed the next day with a half or full dose (the case for aphids) of a single active substance. Mali and Togo are involved in using this method (Sognigbe, 1995).

The active substances are applied using very low volume (VLV) spraying technique with a water-based preparation sprayed at 10 l/ha.

Depending on the pest groups, use is made of pyrethroids aimed mainly at bollworms, organophosphates with an acaricide effect (isoxathion, chlorpyriphos-ethyl, profenofos and triazophos) that are generally effective on bollworms or that have a significant aphicidal effect (dimethoate and omethoate). The latter are sometimes replaced by carbamates when the effect is considered to be inadequate.

When the cotton zone is located in a country with different types of climate in the north and south and with one and two rainy seasons (Benin and Togo), the

pest complexes are different and a special STC programme may be set up in each region.

The risk related to the period of the protection cycle for a given pest may result in a change in the dosage during the cycle for a certain active ingredient. It may also lead to a change in the threshold levels for certain pests, as was the case in Cameroon (Deguine *et al.*, 1993).

The dosage specified can be larger when the risk of pest damage is high, for example, in the case of acariosis at the beginning of the cycle. It is possible to define periods of lesser risk with regard to each pest and to apply the appropriate active substance at a lower dose (Vodounnon, 1995).

Observation and decision-making procedures

The sampling procedure and the setting of spraying thresholds vary according to the country. In Cameroon, sampling is performed on a quarter of a hectare for each hectare grown. When large cropping blocks are concerned (50 to 150 ha), 15% of the total area can be sampled.

When the cotton plant stand is homogeneous, a single sampling operation is generally performed in a cultivated field with a maximum area of 5 ha. The number of plants observed can range from 60 in Benin to 25 in the other countries. The plants are selected 'at random' along the field diagonals. The number of leaves observed for aphid infestation may be 5 x 60 plants, i.e. 300 leaves (Benin), 5 x 25 plants (125) or 4 x 25 plants, i.e. 100 leaves (Togo) per field.

The pests, the damage observed and the scouting procedures can vary. Whitefly are recorded in Cameroon. Mites are counted on leaves in Cameroon but plants with typical acariosis symptoms are recorded in Benin and in Togo. 'Aphid thresholds' are established using the number of infested leaves or plants depending on the sampling procedure used.

Ongoing studies concern the best compromise between ease of performance of the sampling method, the time required for this and the risks run according to the pests present (Gozé and Deguine, 1998; Gozé, *et al.*, 1998).

Decision-making procedures in Cameroon consist of the grouping of field results by cropping block. An average is calculated and then the figure is compared with the threshold values for each pest (Deguine and Ekukolé, 1994). This system may result in the spraying of one or more fields in which the threshold has not been attained.

Advantages and constraints involved in the implementation of STC programmes

The differences between the yields obtained with use of the recommended programme and with normal farmers' practices and the STC programme were analyzed. A 40 to 50% saving in products was achieved with STC, varying between countries. The annual protection cost per hectare thus varied from CFAF 10,000 to 15,000 ($US20 to 30) according to the country and the year. However, in some specific cases there may have been no reduction in cost in some fields.

In addition to the gain resulting from a reduction in the use of insecticides, there is a 100 to 200 kg/ha increase in seed cotton production. This gain is probably related to better overall crop management. STC has a cost in the payment of scouts, estimated to total CFAF57 million in Cameroon.

The frequency used with the 'D-1' programme means that the farmers do not have to go into the fields to scout every week. The disadvantage is that it results in poor monitoring of the sanitary condition of the cotton plants and of caterpillar attacks.

The advantage of the 'D+7' programme is that it enables better management of certain types of infestation, such as that of the bollworm *Helicoverpa armigera*. Complementary spraying with the binary formulations makes it possible to avoid the problem of existing recommended ordering special inputs (single component insecticides) and the management of insecticide stocks.

Some advantages are difficult to evaluate in terms of cost such as the reduced impact on the environment or the reduced risk of resistance development.

Different types of constraint have been recorded. For example, in the dry zones in the north, where *H. armigera* attacks are serious, the adoption of 'D+7' programmes makes it possible to provide better protection of the plants. Special option are envisaged in Mali: if the 'bollworm' threshold is reached in the first six plants observed, a further spraying is performed two days later. In ecological zones with two rainy seasons, the presence of the lepidopteran *Cryptophlebia leucotreta* and *Pectinophora gossypiella*, whose larvae are difficult to detect with the naked eye and the coincidence of maize and cotton requires a programme designed for these particular conditions.

The development of sampling methods suited to large cultivation blocks remains to be undertaken. The training and extension requirements led researchers to develop extension aids such as pest and pest damage identification booklets (in French or in the national languages) and pegboards to facilitate field observations. Pest species are associated with colours corresponding to those of the labels on the insecticide drums. This improves farmer understanding of the link between the pest and the appropriate control product. However, the extension of STC programmes also requires substantial training of technical staff at farmers' organizations.

There are also problems of the organization of field spraying operations, taking account of the sowing dates. It is important to take the time constraint into

account in the 'D+7' programmes for which the farmer (or scout) must be available every week.

Good management of inputs is essential (carry-over of stocks, orders, storage), with a proper inventory at the end of the season and a good forecast for the following year. Procedures for credit and supplies need to be well defined.

Economic constraints are the final factor that slows the development of this type of programme. If scouts are employed, the way in which they are to be paid must be fixed on a case by case basis, with farmers' approval. A 'management advice' type of approach may make operations easier, together with a post-harvest technical and economic evaluation using surveys performed among users of STC methods.

With the increase in non-subsidized prices, especially for single products, it should be possible to judge farmers' real interest in the new methods.

State of the development of STC programmes in francophone Africa and current trends

The general principles appropriate for the situation in each country have led to a measure of heterogeneity in the programmes. With the exception of Cameroon and Mali where an extension of the areas to 15,000 ha is planned in 1998, these methods have remained at the pre-extension stage in West Africa (Table 1). This may be partly explained by lack of supervision of the cotton growing in some countries. In Benin, a project funded by the *Agence Française de Développement* (French Development Agency) should enhance the extension of this type of programme to 50,000 ha in 5 years. The project includes degressive funding of scouting and supervision of training operations.

The present trend is for the simplification of this type of programme to enhance its implementation. This means that studies on sampling and thresholds should be continued. In Cameroon**,** only bollworms are counted (threshold of six bollworms per 25 planting holes). Aphids are observed only in July and August (threshold of 13 planting holes infested out of 25 observed) and there is no longer any variation in threshold according to the period. In Guinea, thresholds are only defined for non-boll caterpillars. A systemic insecticide (imidacloprid) is applied at sowing for sucking pest control.

Another trend is for the abandoning of certain substances like dimethoate that are no longer considered to be effective aphicides (Cameroon and Mali) or for ignoring aphids when making spraying decisions.

Conclusions

In the present economic context of real prices and the privatization of national cotton companies, withdrawal of state and agricultural sub sector from supervision of cotton growing, the STC programmes proposed can achieve the optimal management of the pest problems encountered while limiting risks insecticide resistance.

The results are encouraging but a number of constraints should be removed. In particular, the training in the identification of pests and their damage is required. The cost of crop protection observed when these methods are used is among the lowest in the world. They have undoubted advantages with regard to the environment, although these are difficult to quantify. Experimental studies on sampling and thresholds still need to be in parallel with the development of farmers' knowledge. These processes will require the approval and participation of all supervisory structures in the region.

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Table 1. Areas (in ha) protected by STC programmes.

Year	Cameroon	Mali	Benin	Burkina Faso	Togo	Guinea
1994	92,640	105	102	1,000	-	-
1995		260	606		100	-
1996	76,000	2,120	1,270	500	1,200	40
1997		5,310	730	-	3,000	150