Crop Protection 28 (2009) 968–973

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Sequential pegboard to support small farmers in cotton pest control decision-making in Cameroon

T. Brévault[a,b,*], L. Couston[a,b], A. Bertrand[a,b], M. Thézé[c], S. Nibouche[d], M. Vaissayre[b]

[a] IRAD, PRASAC-ARDESAC, Cotton Unit, Garoua, Cameroon
[b] CIRAD, UPR Systèmes de cultures annuels, Montpellier F-34398, France
[c] SODECOTON, Direction de la Production Agricole, Garoua, Cameroon
[d] CIRAD, UMR PVBMT, Saint-Pierre, La Réunion F-97410, France

ARTICLE INFO

Article history:
Received 3 February 2009
Received in revised form
9 July 2009
Accepted 13 July 2009

Keywords:
Cotton
Bollworms
Spraying threshold
Sampling
Cameroon
Dissemination

ABSTRACT

A method (SPID) based on sequential plan for individual decision with a pegboard was tested over the 2006 and 2007 cropping seasons in 15 cotton producing villages in Cameroon – covering almost 700 farmers and 2000 ha to help farmers decide on when to spray their cotton crops against bollworms. This method was promoted through training sessions, from researchers to farmers through the technical staff of the cotton company (SODECOTON). This innovation led to a significant reduction in the number of sprays in 5 village-years out of 17 (total number of villages for 2006 and 2007). The number of sprays was larger than in the calendar-based programme in nine village-years, mainly due to poorly controlled infestations of *Diparopsis watersi* (Rothschild). However, this larger number of sprays led to a greater (seven village-years) or equal (two village-years) seed-cotton yield than that obtained with the calendar-based programme. When the number of sprays was equal or smaller, seed-cotton yield was greater (two village-years) or equal (six village-years) to LPD. Lastly, income increased proportionally to seed-cotton yield. An analysis of decisions made by farmers using the pegboard, as well as an *a posteriori* evaluation test, showed that users successfully learned the method and were confident in its diagnosis. This new method is not hampered by the constraints experienced with the former LEC ('targeted staggered control') spraying decision method – sequential sampling reduces the number of plants to be monitored, spraying decisions are made for individual plots, income rises and the role of supervisors is reduced. However, large-scale dissemination of this innovation is being hampered by the collective management of cotton production and the need to train a large number of farmers.

1. Introduction

In many sub-Saharan areas, cotton cultivation is a driving force behind technical change and rural development. In northern Cameroon, cotton is grown in association with food crops in small-scale farming systems (mean 0.6 ha/farm). Most farmers (90%) grow cotton, representing one-third of the cultivated area and contributing 60% of farm income (Mbétid-Bessane et al., 2006). The Société de Développement du Coton du Cameroun (SODECOTON) coordinates the development of cotton production in this country, and provides farmer access to inputs and farm machinery. Besides persistent harsh climatic conditions, soil fertility degradation and the rising cost of inputs, cotton farmers now have to cope with increased pest damage. The bollworm complex including *Helicoverpa armigera* (Hübner), *Diparopsis watersi* (Rothschild), and *Earias* spp., is a major threat for cotton production. Bollworm management relies basically on chemical control, but the repeated use of pyrethroids by the late 1970s resulted in resistance in field populations of *H. armigera* (Brévault and Achaleke, 2005; Brévault et al., 2008). The recommended insect control programme used by cotton farmers in Cameroon involves chemical predetermined control (LPD), whereby insecticides are sprayed fortnightly from 45 days after seedling emergence. Pyrethroid use is restricted, and replaced by alternative compounds such as indoxacarb or endosulfan for some periods, in order to hamper the development of pyrethroid resistance. Spraying ends when more than half of the cotton plants bear at least one open boll. Accordingly, the number of sprays carried out under LPD ranges from four to seven for the whole season (SODÉCOTON, 2008). However, the recent increase in insecticide costs related to the introduction of new compounds to replace pyrethroids, and the fact that some farmers wish to decide

* Corresponding author. CIRAD, UPR Systèmes de cultures annuels, Avenue Agropolis, 34398 Montpellier cedex 5, France.
E-mail address: thierry.brevault@cirad.fr (T. Brévault).

0261-2194/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cropro.2009.07.004

on the level of protection for their fields, led West African research institutions to promote alternative ways of managing cotton pests. These new priorities give way to threshold-based interventions that take bollworm population densities into account, notably because bollworm infestations are highly variable between years and sites. Rational crop protection thus has to be planned weekly on the basis of field observations (Matthews, 1996), rather than on a calendar basis for large cotton areas, which was, for practical reasons, the general strategy in West Africa since the 1960s.

Threshold-based practices were developed more or less successfully in various cotton producing countries throughout the world (Matthews and Tunstall, 1968; Gower and Matthews, 1971; Ingram and Green, 1972; Sterling, 1976; Burgess, 1983; Kabissa, 1989; Nyambo, 1989; Javaid, 1990; Deguine et al., 1993; Silvie and Sognigbe, 1993; Stam et al., 1994; Matthews, 1996; Ochou et al., 1998; Nibouche et al., 1998). An example was the 'targeted staggered control' (LEC) concept that was introduced in the 1990s (Silvie et al., 2001). In Cameroon, this programme was used, with a first level of protection obtained by spraying a half dose of insecticide according to the calendar-based programme a calendar basis, while a complementary half dose was applied when observations made on the same day reported a pest density above the action threshold. On the other hand, LEC was collectively developed and was mandatory for all farmers in a LEC-oriented village, regardless of their production objectives and intensification level. A total of 25 randomly chosen plants were monitored on the basis of a 0.25 ha plot (quarter plot). Scouts had to record the number of bollworm larvae, leaf-eating caterpillars and leaves infested by aphids. The spraying threshold was 20 bollworms (irrespective of the bollworm species represented) for 100 plants (Deguine et al., 1993). Scouts were trained and paid by the cotton company, with the cost of the whole scouting process being reported on farmers' account at the end of the season. This method was rather quickly and widely adopted in more than 70% of the cotton area in 1994. Nevertheless, its use steadily decreased from 90 000 ha in 1994 to only 304 ha in 2007 (SODÉCOTON, 2008). Farmers progressively abandoned LEC due to the bad quality of observations made by scouts (most time not members of farmer communities where they were operating), and the quantity of paperwork required (Nibouche et al., 2003).

A threshold-based spraying approach (locally called SPID = sequential plan for individual decision) was tested in some villages in 2006, and adopted by 15 farmers' communities in 2007. As in Mali (Michel et al., 2000) or Burkina Faso (Nibouche et al., 1998) where LEC was implemented, farmers monitored pests themselves and only made decisions for their own fields only. The sampling plan was defined by Beyo et al. (2004), based on the distribution probability in cotton fields of all three cotton bollworm species considered together. For the sampling and decision process, a pegboard-like device (Beeden, 1972; Matthews, 1996) was designed according to a sequential decision plan (Ingram and Green, 1972; Sterling, 1976; Vaissayre, 1976). The farmer moves a wooden peg along the board according to the number of plants observed and the number of bollworms found (Fig. 1). This tool designed by Beyo et al. (2004) reduces the time devoted to scouting when pest pressure is low, and full monitoring of 25 plants is only required when the pest density is close to the intervention threshold. In addition, individual farmers can scout their own plots and obtain a locality-based estimate of pest numbers.

The aim of the present study was therefore: (1) to evaluate the level of adoption of the SPID programme by end-users, (2) to compare SPID and LPD programmes in terms of the number of sprays, cotton yield and farmers' income, and (3) to evaluate the feasibility of using a sequential pegboard for decision-making by small farmers in Cameroon.

2. Materials and methods

2.1. Principles

Farmers freely agreed to participate in this experiment. Plots managed according to the LPD or SPID programme thus coexisted within the same cotton field. Sampling was done on a weekly basis by choosing plants at random along a diagonal line crossing the 0.25 ha sampling plot. Farmers examined squares, flower buds and bolls individually and the total number of the three bollworm species was recorded. A full dose of insecticide was applied when the threshold was exceeded. By sequential sampling, spraying decisions were taken following a variable number of observed plants (Fig. 1), based on two thresholds: (1) a threshold of 0.3 bollworms per plant corresponding to the bollworm density above which spraying is economically warranted, and (2) a threshold of 0.1 bollworms per plant corresponding to the bollworm density below which spraying is not required. The threshold values were chosen according to expert knowledge (empirical data derived from experience). The risks chosen were: (1) a 20% α risk of inappropriate spraying when the bollworm infestation level was at the low threshold, and (2) a 10% β risk of not spraying when the upper threshold was attained. According to Beyo et al. (2004), it was decided to control β rather than α, as the success of the SPID programme would have been more affected by yield losses consecutive to missed sprays than by unnecessary sprays. When the peg remained inside the indecision zone after 25 plants had been sampled, farmers were advised to wait for 1 week before repeating pest scouting. For a given farmer, the results obtained on the sampling unit (quarter plot) could be extrapolated to his whole

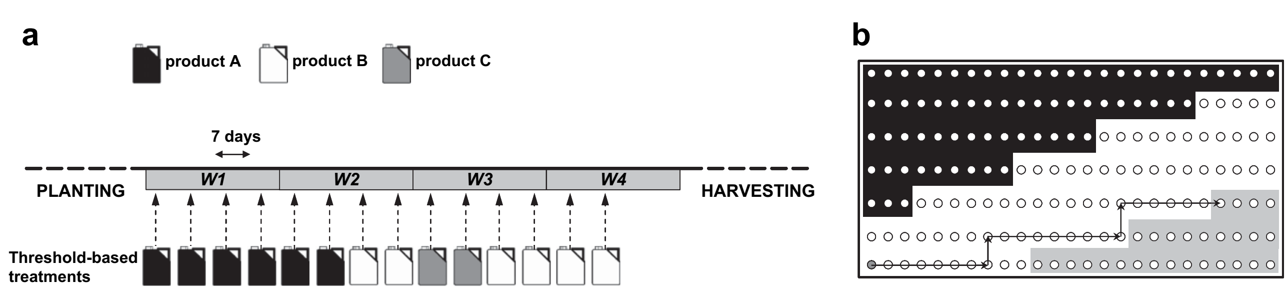

Fig. 1. Principle of the sequential plan for individual decision (SPID) with a pegboard. The peg is moved right at each observed plant and is moved up at each observed caterpillar. Grey area: 'do not spray'. Black area: 'spray'. Between these two areas: 'continue sampling'. Example: (1) Absence of larva on the first 7 observed plants, the peg is thus only moved right, (2) 1 larva is detected on the 8th plant, the peg is moved right and up, (3) no larva is detected from the 9th to the 15th plant, the peg is moved 7 places right, (4) 1 larva is detected on the 16th plant, the peg is moved right and up, (5) no larva from the 17th to the 22th plant, the peg is moved 6 places right and enters the grey area. Sampling ends and the final decision is 'do not spray'.