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Cotton Integrated Pest Management in Central Sudan

A.A. Abdelrahman[1], A. Alsaffar[2], B. Munir[2] and P.A. Stam[2]

(1) Agricultural Research Corporation, Wad Medani, Sudan; (2) c/o FAO Representative, Khartoum, Sudan.

Abstract

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The Integrated Pest Management (IPM) for cotton was investigated during 1979-1992 in large scale trials conducted in the main cotton producing areas in Sudan: the Gezira and Rahad schemes. The main pests which require annual arial insecticide spraying are *Bemisia tabaci* (Genn), *Aphis gossypii* Glov, *Helicoverpa armigera* (Hb) and *Jacobiasca lybica* de Berg. Results showed that the indigenous natural enemies of *B. tabaci* and *A. gossypii* were capable of controlling the two pests effectively when chemical control of the other pests was delayed until the crop reached an advanced flowering stage. Commercial cotton varieties were found to compensate simulated 100% damage of bollworms. Field trials also revealed that the Economic Threshold Levels (ETLs) for the four pests could be considerably raised without significant effect on yield. Optimizing the cultural practices and not to initiate spraying against *H. armigera* before advanced flowering were found to be the prerequisite for the implementation of this IPM package.

General

Cotton in Sudan is produced mainly by gravity irrigation (80%). The commercial chemical control against cotton pests has started as early as 1947 against the jassid, *Jacobiasca lybica* de Berg, executed then by Tractors. Aerial spraying was first used experimentally in the Gezira in season 1950/51 and has been commercialized since then.

The number of sprays on cotton was only one during the fifties, increased to 3-5 sprays per season during the sixties due to resurgence of the whitefly, *Bemisia tabaci* and the bollworm *Helicoverpa armigera*. The number of sprays reached 8-9 sprays in the seventies due to the increasing severity of the former three pests in addition to *Aphis gossypii* which became an all-season pest since then. Despite this escalating number of sprays, cotton yields has remained, more or less, the same during all these decades (Table 1).

The integrated pest management (IPM) project entitled "Development and Application of Integrated Pest Management in Cotton and Rotational Food Crops" was initiated in 1979 and terminated in 1996. The project underwent four phases; the first three were devoted mostly to cotton. The fourth phase was devoted to vegetable IPM. The four phases were generously sponsored by the Government of the Netherlands and executed by FAO and the Agricultural Research Corporation (ARC) of the Sudan.

Cotton IPM

In the first phase of the IPM project, most of the activities were devoted to the study of the seasonal occurrence of the main pests as well as their natural enemies. The effect of the important agronomic practices on the population densities of the key pests were also studied. Cotton breeding by ARC and project staff for resistance to the major pest species resulted in releasing Sudac-K variety (4) a whitefly resistant super- okra glabrous *G. hirsutum*.

Table 1. Number of sprays and cotton yields in the Gezira Scheme during 1978-1996 (Source: Sudan Gezira Board).

Season	No. of sprays	Yield (kant/fed)
1978/79	9.25	3.27
1979/80	8.87	2.66
1980/81	8.61	2.31
1981/82	6.78	3.76
1982/83	5.22	4.70
1983/84	5.45	4.93
1984/85	4.14	5.22
1985/86	8.60	3.30
1986/87	5.20	4.93
1987/88	5.67	4.57
1988/89	5.27	5.20
1989/90	4.34	4.14
1990/91	3.72	3.72
1991/92	4.75	4.70
1992/93	4.93	2.90
1993/94	3.02	3.84
1994/95	2.80	3.30
1995/96	4.00	4.04

During the second phase a large scale trial was conducted in the commercial cotton fields of the Gezira scheme. An area of 333 ha of cotton was left completely unsprayed throughout the season 1986/87. This trial showed the conditions which were prevailing in the Gezira before the introduction of insecticide applications. The basic insect problems of cotton

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were thus illuminated and the impact of the insecticides was convincingly demonstrated. The key pest of cotton in the unsprayed cotton fields was again found to be the jassid. Both the whitefly, *Bemisia tabaci* and the bollworm *Helicoverpa armigera* were created by the continuous use of insecticides. The most important finding was that, in the absence of insecticides the indigenous natural enemies were capable of suppressing both whitefly and aphids below the economic threshold levels throughout the season (1).

The most common natural enemies of cotton pests are:

(a) Predators:

Chrisopidae
- *Chrysoperla carnea*
- *Chrysoperla pudica*
- *Chrysoperla zastrowi*

Coccinellidae
- *Hippodamia variegata*
- *Cydonia* spp.
- *Scymnus* spp.

Nabidae
- *Nabis* spp.
- *Tropiconabis capsiforms*

Myridae
- *Campylomma* spp.

Anthocoridae
- *Orius* spp.

Syrphidae
- *Ischiodon aegypticus*

Spiders

(b) Parasitoids:

Aphilinidae
- *Encarsia lutea* (whitefly)
- *Eretmoserus mundus* (whitefly)
- *Aphelinus sudanensis* (aphids)

Braconidae
- *Apanteles rufricus* (*H. armigera*)
- *Chelonus* spp. (*H. armigera*)
- *Microbracon kirkpatrickiy* (*H. armigera*)

Eulophidae
- *Euplectrus* spp. (*H. armigera*)

The importance of delaying the first insecticide application which was suggested by Eveleens and Abdelrahman (3) was verified. As a result, during the third phase (1985-1992) a series of trials to raise the ETLs for the four pests were conducted in different localities (5). Another series of experiments were also conducted to reveal the maximum age of the cotton plant at which it can still fully compensate simulated 100 % damage of bollworms in the Gezira environment. It was found that all the commercial cotton varieties could compensate 100 % of such damage up to four weeks after the initiation of the flowering (2). The newly proposed higher ETLs were accepted by the National pests and Diseases Committee and were released for all cotton growing areas. These new ETLs, which were fully adopted in all cotton areas in the Sudan since the 1993/94 season are shown in Table 2.

The early cotton pests which might pose a difficulty when the first application of insecticides is delayed are *H. armigera* and *J. lybica*. For the former species, the egg parasitoid, *Trichogramma pretiosum* Riley was introduced from Texas, USA; mass bred in Holland and released in cotton field at Rahad, Gezira and New Halfa during 1988-1990. The species became established and is regularly recovered since then. Nevertheless, the chemical control is still needed because the incidence of parasitism is rather low. The cotton jassid can be effectively controlled by a selective single insecticide treatment if the need arises.

Table 2. Newly recommended ETLs for cotton pests

Pest	Former ETL	New ETL
Bemisia tabica	200 adults/ 100 leaves	600 adults/100 leaves
Jacobiasca Lybica	50 nymphs/ 100 leaves	70 nymphs/100 leaves in *G. hirsutum* and 100 nymphs/100 leaves *G.barbadense*
Aphis gossypii	20% infested plants	40% infested plants
Hclicoverpa armigera	10 eggs and/or larvae	30 eggs or 10 larvae per 100 plants. No insecticide spraying before advanced flowering

At the end of the three phases of research and validation of cotton IPM it was possible to reduce the use of the insecticides on cotton from av. six to av. four sprays in all IPM experimental areas. This was achieved by:

(a) Delaying the first application of insecticides to permit the establishment of the local natural enemies in the cotton canopy.
(b) Raising the Economic Treatment Levels for the four important pests.
(c) Introduction and successful colonization of the egg parasitoid, *Trichogramma pretiosum* to control *H. armigera* which appeared early in the season and required early spraying upsetting natural biological control.
(d) Optimizing cultural practices, e.g. timely sowing; regular irrigation and good weed control.
(e) Intensive extension and training programmes on the recognition of hazards of insecticides.

The Economic Impact

Since 1993/94 season in which the new ETLs have been adopted in all cotton areas in Sudan two sprays have been annually saved. The mean cost of pesticide + application per one spray is about 12.8 US Dollars per feddan (calculated from the records of Gezira of the last 15 years). The monetary value of saving two sprays in 500.000 feddans of cotton is 12.8 million US $ annually.

The cotton quality has also improved as judged by the increase in the percentage of the higher lint grades which mean

higher prices for the farmer. The lint stickiness, which is one of the major factors affecting the prices of the sudanese cotton, has significantly dropped in the last few years, particularly in season 1994/95. Lint stickiness is caused by the honeydew secreted by the whitefly and the aphids.

The reduction of insecticide applications on cotton must have had a positive impact on the promotion of the role of the natural enemies in the cotton-based agroecosystem in the Rahad and Gezira schemes. This impact is evaluated now through comprehensive studies in both schemes. There are at present some indications to this positive impact. The wheat crop which is part of the rotation in both schemes is usually given two sprays per season against aphids. The number of sprays on wheat has dropped in the Gezira during the last three seasons. Wheat in Rahad received no spraying since its introduction in the rotation in season 1992/93. This coincided with the adoption of the IPM package of cotton in Rahad scheme.

In phase IV (1993/94) the project introduced the Farmers Field Schools (FFSs) approach to develop and promote vegetable IPM. Sudan has been the first country in Africa to adopt this system. The success of FFSs approach in addressing the problems of vegetable production (and at a later stage all the field crops) has won widespread recognition among both farmers and policy makers. The idea of FFS is now adopted and declared as the sole extension approach in the Gezira scheme, Rahad scheme and Gezira State. At present there are about 300 FFSs operating in Sudan.

Perhaps the most prominent and significant achievement of the IPM project is its dissemination and promotion of the IPM philosophy and approach among all those who are involved in agricultural production in Sudan. This will be an effective tool for the sustainability of IPM in sudanese agricultural policies.

الملخص

عبد الرحمن، عاصم، أ. الصفار، ب. منير وب.أ. ستام. 1998. المكافحة المتكاملة لآفات القطن في السودان. مجلة وقاية النبات العربية. 16(1): 52-54.

تم بحث المكافحة المتكاملة في الفترة من 1979-92 في تجارب موسعة نفذت في المناطق الرئيسة لإنتاج القطن في السودان (مشروعي الجزيرة والرهد). ومن الحشرات الرئيسة التي تكافح برش مبيدات الحشرات بوساطة الطائرات، الذباب الأبيض (*Bemisia tabaci*) ومنّ القطن (*Aphis gossypii*) ودودة اللوز (*Gelicoverpa armigera*) ونطاط الأوراق (*Jacobiasca lybica*). أظهرت النتائج أن بمقدرة الأعداء الطبيعية المحلية للذباب الأبيض ومنّ القطن السيطرة على هاتين الآفتين بفعالية شريطة تأجيل المكافحة الكيميائية لحين وصول النبات إلى مرحلة متقدمة من طور الإزهار. وجد أن الأصناف التجارية للقطن تستطيع تعويض 100% من أضرار ديدان اللوز. وأظهرت التجارب الحقلية أنه يمكن رفع مستوى العتبات الإقتصادية للآفات الأربعة دون تأثيرات معنوية في الغلة. ووجد أن تنفيذ الممارسات الزراعية على النحو الامثل، وعدم البدء برش ديدان اللوز قبل مراحل متقدمة من الإزهار هي من الأمور الأساسية لتطبيق هذا البرنامج بنجاح.

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