FARMERS' KNOWLEDGE AND PERCEPTIONS OF COTTON INSECT PESTS AND THEIR CONTROL PRACTICES IN GHANA

M. Abudulai, L. Abatania and A.B. Salifu
CSIR-Savanna Agricultural Research Institute,
P.O. Box 52,
Tamale

ABSTRACT

A survey of 337 cotton farmers in the three northern regions of Ghana was conducted between November 2002 and March 2003 with the objectives of assessing farmers' knowledge and perceptions of cotton insect pests and examining their control practices. The survey revealed that between 69 and 86% of the farmers were illiterate. Farmers' age average 42 years and had an average of 9 years of cotton farming experience. Farmers were familiar with cotton insect pests, especially those whose feeding caused obvious symptoms in the field such as bollworms, leafrollers and cotton stainers. Farmers relied on chemical insecticides supplied by their contract cotton companies to control insect pests on their fields. Insecticides from three classes namely organochlorines (e.g. endosulfan), pyrethroids (e.g. Lambda-cyhalothrin), organophosphates (e.g. Chlorpyrifos) or their mixtures were used. An average of five applications were made during the season. Farmers indicated that the control practice was largely ineffective against the pests, and attributed the cause to the use of expired and inadequate quantities of chemicals. The study showed that only 28% of the respondents had some knowledge of alternative pest control measures. It is important to improve farmers' knowledge and management skills of cotton insect pests through participatory research and training in integrated pest management (IPM). IPM training through farmer field schools will help farmers to acquire the requisite knowledge and skills to improve their management of insect pests on their fields.

Keywords: *cotton, farmer knowledge and perception, insect pest control, Ghana.*

INTRODUCTION

Cotton is one of the most important industrial crops in Ghana. It is grown primarily for fibre which is an important raw material in the textile and ferment industry. The seed is also an important source of cooking oil and a high quality protein source for animal feed (CABI Biosicnece 2000).

Cotton is grown in Ghana in the Northern, Upper East and Upper West Regions by farmers who are often contracted by cotton companies to produce seed cotton to feed their ginneries. The companies provide inputs (seeds, fertilizers and insecticides) to their contract farmers and then boy off the seed cotton produced at the end of the growing season. Cotton production is therefore a commercial venture and an important source of income to farmers and cotton companies. It is also an important foreign exchange earner for the country (Poulton, 1998).

Despite its importance, cotton production in Ghana faces many constrains most important of which is the problem of insect pests. The most common insects include the bollworm complex comprising the Sudan bollworm (*Diparopsis watersi* [Roths.]), American bollworm (*Helicoverpa armigera* Hubner), pink bollworm (*Pectinophora gossypiella* Saund), spiny bollworm (*Earias* spp.) and false codling moth (*Cryptophelebia leucotreta* Meyr.*);* cotton stainers (*Dysdercus* spp.); aphids (*Aphis gossypii* Glov.); and leafhoppers (*Jacobiella (Empoasca) fascialis* [Jacobi] (Salifu, 1996). Losses due to these insects can be as high as 100% in unprotected fields. Farmers rely solely on use of synthetic insecticides that are provided by cotton companies for control of insect pests. Notwithstanding the over reliance on chemical control, seed cotton yields are low averaging between 500-800 kg/ha compared with the world average of 1667 kg/ha (FAO, 1998). The low yields may be due partly to poor or inefficient pest management practices by farmers, as yields greater than 1600 kg/ha have been obtained from on-station trials in Ghana (Salifu, 1996). Low yields are not only a disincentive to farmers but also the quantity of seed cotton available to cotton companies for ginning and the lint supplied to textile and garment industries are reduced.

There is dearth of information on farmers' knowledge of insect pests of cotton and their control practices in Ghana. Ochou *et al.* (1998) reported that farmers in enighbouring Côte d'Ivoire identified very well large

insects such as bollworms and cotton stainers as pests on cotton and that small bodied insects like aphids were least identified. However, apart from probable differences in farmer circumstances between Côte d'Ivoire and ghana, their study was limited as they did not investigate pest control practices of farmers. It is important to assess farmers' knowledge and perceptions of cotton insect pests and their control practices as a prelude to design a strategy to empower them as independent decision makers of their farm operations (Dilts, 1990; Gallagher, 1990; Ochou *et al.,* 1998). This is because pest management extension will be more rebust when farmers' perceptions and practices are taken into account (Heong *et al.,* 2002).

This paper documents farmers' knowledge and perceptions of cotton insect pests and their control practices in Ghana. It also highlights farmers' opinions regarding constraints to cotton pest management. The information obtained will form the basis of a holistic approach for managing insect pests on cotton in the context of integrated pest management (IPM).

MATERIALS AND METHODS

The study was conducted between November 2002 and March 2003 in the northern savanna zone of Northern, Upper East and Upper West Regions of Ghana. The study area lies between latitudes 8^0 00^1 and 11^02^1N and longitudes 0^0 30^1 E and 2^0 5^1 W. The rainfall pattern of the area is monomodal and ranges between 600 and 1253mm per annum, while the mean annual temperature ranges between 26^0 C and 29^0 C (Kasei, 1990).

A total of 337 cotton farmers were selected across the cotton producing zones and/or compnaies (Nulux Plantations Ltd. Ghana Cotton Company Ltd. Agrostar Ltd, BAFCOT Company Ltd, Juni Agro Ltd. and Plantations Development Ltd.) in the three northern regions through multi-stage random sampling techniques (Gomez and Gomez 1984). Twelve districts or zones and on avarage three villages in each zone were selected at random from important cotton producing districts and villages for the study. The districts and/or zones and villages selected in the Northern Region were: 1), Tolon/Kumbungu district: (i) Tolon, Chirifoyili, Wantugu, (ii) Nyankpala, Kumbungu, Dalun; 2) Savelugu/Nanton district - Savelugu, Zokuga, Nanton; 3) Karaga district - Karaga, Galwei, Pishigu; 4) East Gonja district - Salaga, Gidanturu, Kpembe; 5) West and East Mamprusi districts - Kukua, Gambaga, Bunbuna; 6) Saboba/Cherikpeni district - Wapuli, Ugando, Nasoni. In the Upper East Region, the districts and villages were 7) Bawku West district - Zebila, Tanga; 8) Kassina/Nankana district - Banyono, Navrongo; 9) Sandema district-Wiaga. Finally, the districts and villages selected in the Upper West Region were: 10) Sissala district - Kupulma, Sorbelle, Chinchang, Dimanjan, Bujan; 11) Wa district; (i) Sagu, Boli, Chaggu, Kpalwogu; 12) Jirapa/Lambusie district - Sabuli, Ullo, Gbari. Subsequently, 5-10 farmers were selected, also at random, from each of the selected villages for the interview. Farmers were interviewed individually in the appropriate local languages using structured questionnaires. The questionnaire was pre-tested and the necessary revisions made before the actual interview was conducted. Each interview lasted about 30 min. Questions focused first on farmer's age, level of education, farm size, history of cotton cultivation and objectives. Subsequently, ques-tions bordered on tests of farmers' knowledge of cotton insect pests, their damage to cotton, control measures employed and constraints. Farmers were also asked to rank the various insect pests according to their relative importance. Because the interview was conducted during the off season (after harvest), colour photographs of the various insect pests of cotton and symptoms of their damage were shown to farmers. Finally, farmers were asked whether they knew and/or used any indigenous pest control practices in cotton. The data collected were encoded and subjected to descriptive analysis of simple proportions and percentages using SPSS statistical software (SPSS Inc., 1999). Also chi-square analysis were used to test for independence of farmers' responses on region (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Farmers' Background and Objectives

The survey revealed that farmers' age ranged between 19 and 94 years with an overall mean of 42 years. Years of experience in cotton cultivation also averaged 9.5 (range 1-40) and acreage 1.6 (range 1-20) across the regions. Between 69 and 84% of the farmers were illiterate as they had no formal education. Majority (96%) of the respondents across the three regions said they cultivated cotton for cash benefits from sale of seed cotton to cotton companies. Some 2.5-4.7% of them also said they cultivated cotton for other benefits such as getting inputs such as fertilizer or tractor plough services for their food crops from cotton companies that contracted them.

Farmers' Knowledge of cotton insect pests

Several insect pests were identified by the farmers in all three locations (Table 1). However, the levels of identification of the different insects varied significantly among farmers and locations (χ^2 = 51.6; df = 12, P < 0.0001). Farmers in the Northern and Upper East Regions were more knowledgeable of cotton insects than their counterparts in the Upper West Region. Among well known insects were bollworms, leafrollers and cotton stainers, which are commonly found insect pests of cotton. These pests were identified by over 80% of farmers interviewed. Ochou *et al.* (1998) reported similar findings from a survey conducted in Côte d'Ivoire that bollworms, leafrollers and cotton stainers were among well known insect species by farmers. Farmers identified insects by generic or descriptive names in the local languages, example in Dagbani 'zunzuya' was used to refer to caterpillars and 'merring' (meaning easily crashed) for aphids, in reference to their soft bodies. Leafhoppers were among the least identified insect pests, apparently because of their cryptic nature of feeding under the leaf surface and less obvious sucking feeding damage.

Table 1: Insect pests mentioned and identified by farmers as damaging their cotton Crop in northern Ghana[1]

Insect	Northern %	Upper East %	Upper West %	Mean %
Aphids	70.4	46.4	47.5	54.8
Leafhoppers	9.0	28.6	22.5	20.0
Leafrollers	92.6	100.0	75	89.2
Bollworms	95.8	100.0	59.2	85.0
Cotton stainers	93.1	92.9	34.2	73.4
Beetles	54.0	39.3	38.3	43.9
Grasshoppers	51.3	42.9	8.3	34.2

[1]Northern, n=189; Upper East, n=28; Upper West, n=120. %=percentage of farmers identifying pests. Farmers' knowledge of insect pests varied among regions (P<0.0001)

Farmers' perception of insect pest damage and their relative importance

Farmers demonstrated a good understanding of the crop ecosystem and the constraints that limit production. More than 90% of respondents said insect pests were the most important constraint in cotton production. Farmers also generally knew the damage caused by insect pests on cotton (Table 2). However, farmers knowledge of pest damage varied significantly among regions (χ^2=32.0; df = 12, P = 0.0014). Farmers in the Northern and Upper East Regions demonstrated better knowledge of insect pest damage on cotton than those in the Upper West Region. The majority (77%) of farmers correctly identified the damage caused by bollworms, leafrollers and cotton stainers, apparently because of their obvious feeding damage on cotton. Damage caused by sucking insects such as leafhoppers was least identified by farmers. Thus, there is the need for more farmer education on damage caused by insects, in particular sucking insect pests, as some of them also transmit diseases to plants (Munro, 1987).

Across the three regions, bollworms were ranked by farmers as the most damaging insect pest of cotton (Table 2). Other workers (e.g. Salifu, 1996; Martin *et al.*, 2002; Torres-Vila *et al.*, 2002) have reported that bollworms are the most important insect pests of cotton. Leafrollers and cotton stainers were ranked respectively, as the next most important pests. Grasshoppers and leafhoppers were ranked as the least important insect pests.

Farmers' perception of pest control methods

Farmers used insecticides from different chemical classes to control insect pests on cotton. Some products had the same active ingredient (a.i) but were marketed under different trade names (Table 3). The type of insecticide used was dependent on region (χ^2 = 379.4; df = 22, P < 0.0001). Organochlorine insecticides such as Callisulfan and Endosulfan were those commonly used in the Northern and Upper East Regions whereas farmers in the Upper West Region generally used Organophosphates such as Dursban

(Chlorpyrifos) and Pyrethroids such as Karate (Lambda-cyhalothrin) as well as insecticide mixtures such as Novabol (profenofos + cypermethrin) (Table 3). The insecticides were used either as emulsifiable concentrates (EC) or ultra low volume (ULV) concentrations. Majority of the farmers in the Northern and Upper West Regions applied 5 sprays while those in the Upper East Region applied 4 sprays during the season (Table 4). Control practices generally started at the vegetative (50.6% of farmers reporting) and squaring (36.9% of farmers reporting) stages. Majority of farmers in the Northern (43.9%) and Upper West (79.2%) Regions started control practices at the vegetative stage while those in the Upper East Region (67.9%) started control at the squaring stage. Applying insecticides at the vegetative stage is generally unnecessary as damage at this stage often does not result in yield reduction (Greene *et al.,* 2001). Such early sprays also negatively affect the build up of natural enemies of insect pests (Salifu, 1990; Javaid *et al*., 1998; Greence *et al.,* 2001).

Table 2: Farmers' knowledge of insect pests' damage and relative importance[1]

Insect	Nature of damage	Northern		Upper East		Upper West	
		%	Rank	%	Rank	%	Rank
Aphids	Suck sap from leaves and soft stems	70.9	4	46.4	7	32.4	5
Leafhoppers	Such sap from leaves	28.6	7	35.7	5	6.7	6
Bollworms	Roll and feed on leaves	92.6	2	100.0	3	55.8	2
Bollworms	Feed on squares and bolls causing them to drop	89.9	1	96.4	1	45.0	1
Cotton stainers	Feed on developing seed and also stain lint	82.0	3	92.9	2	33.3	4
Beetles	Feed on flowers and bolls	37.6	5	50.0	4	13.3	3
Grasshoppers	Feed on leaves	50.8	6	42.9	6	43.3	7

[1]Northern, n=189; Upper East, n=28; Upper West, n=120. % = Percentage of farmers correctly identifying damage. Insects were ranked in ascending order of importance with 1 = most important and 7 = least important. Farmers' knowledge of insect pest damage varied among regions ($P = 0.0014$).

Table 3: Insecticides employed by cotton farmers in northern Ghana[1]

Chemical Formulation	Active Ingredients	Northern Region % (n = 189)	Upper East Region % (n = 28)	Upper West Region % (n = 120)
Dursban	Chlorpyrifos	0.5(1)	-	28.3 (34)
Karate	Lambdacyhalothrin	-	-	21.7 (26)
Cypercal	Profenofos + Cypermethrin	7.4 (14)	-	9.2 (11)
Polytrin C	Cypermethrin + Profenofos	9.5 (18)	10.7 (3)	-
Novabol	Cypermethrin + Profenofos	-	-	12.5 (15)
Indolfen	-	-	-	12.5 (15)
Lambdacal	Chlorpyrifos + Lambdacyhalothrin	0.5 (1)	-	8.3 (10)
Endosulfan	Endosulfan	10.6 (20)	-	-
Thionex	Endosulfan	1.6 (3)	50.0 (14)	-
Endocotton	-	-	35.7 (10)	-
Callisulfan	Endosulfan	25.9 (49)	-	-
Pyrical	Chlorpyrifos	8.5 (16)	-	-

[1]Figures in parenthesis represent actual numbers of farmers reporting. A dash (-) means no farmers reported or active ingredient of chemical could not be ascertained. Percent reporting did not always add up to 100% because some of the respondent farmers could not tell us the chemicals they used. The type of insecticide used was dependent on region ($P < 0.0001$)

Table 4: Frequency of Insecticide application in cotton by farmers in northern Ghana

Frequency	Northern	Upper East	Upper West	Mean
Zero	0	0	4.2	1.4
Once	0.5	0	1.7	0.7
2 times	5.3	0	0.8	2.0
3 times	12.2	39.3	8.3	19.9
4 times	38.1	57.1	30.0	41.7
5 times	42.9	3.6	53.3	33.3
6 times	1.1	0	1.7	0.9

[1]*Northern, n=189; Upper East, n=28; Upper West, n=120. % = percentage of farmers reporting*

More than 60% of the respondents said they received advice from cotton extension agents on the use of insecticides. However, between 28 to 49% of the farmers said the chemicals they applied were not effective against the insect pests on their fields, because according to them most squares (flower buds) aborted after spraying. They also said that the insect pests were not killed several days after spraying. They indicated that some of the chemicals supplied to them by the cotton companies had expired and that lower dosages were used. Apart from the poor control, applying sublethal doses of an insecticide results in acquired resistance. Already, pyrethroid resistance in field populations of the cotton bollworm, *H. armigera* has been reported in neighbouring Côte d'Ivoire (Vassal *et al*., 1997; Martin *et al*., 2000, 2002).

Only about 28% of respondents knew of alternative pest management strategies to chemical control, but none of them used those strategies in cotton pest management. Some of the alternative (indigenous) pest management strategies mentioned by farmers include the use of botanicals such as neem extracts, tobacco extracts and wood as ash, which they use to control pests in food such as cowpea. Apparently, the botanical insecticides were not used on cotton because of the supply of synthetic chemicals to farmers by contract cotton companies. A few of the farmers, however, indicated their willingness to extend this control strategy to cotton. However, full implementation of control with botanicals by farmers may require the support of contract cotton companies. About 45% of the farmers interviewed said they would accept any control strategy that will increase their yields.

CONCLUSIONS AND RECOMMENDATIONS

The study has shown that insect pests are problematic to cotton production in Ghana. Farmers have good knowledge of these pests especially those whose feeding caused obvious symptoms in the field e.g. bollworms, leafrollers and cotton stainers. This was demonstrated by the large majority of farmers who readily identified insects and their damage. However, the current pest management practices that rely on chemical control are not effective in some cases. Among others, the use of expired chemicals and the application of sublethal doses of chemicals are largely responsible for the ineffectiveness of chemical pest management. Under the current arrangement for cotton production in Ghana, neither do farmers have an influence on the choice of chemical to use nor the quantity to apply. Chemicals are provided by cotton producing companies in the country at cost to farmers. Indigenous pest management strategies which are based on botanical extracts exist in the study area. However, these strategies are exclusively used in food crop production.

The opportunity exists to try out alternative pest management strategies in cotton production in Ghana. Given that indigenous pest control strategies exist for food crops, these strategies should form the basis for alternative pest management for cotton. The indigenous strategies which are largely based on botanicals such as neem extracts have been found to be effective and economical in controlling major cotton pests (Gahukar, 2000). Botanical insecticides are also less harmful to humans, natural enemies of insect pests and to the environment than synthetic chemical insecticides (Abudulai and Shepard, 2003; Abudulai *et al*., 2004).

It is recommended that extension officers of cotton companies and Ministry of Food and Agriculture

(MoFA) as well as cotton farmers be given education on proper use of pesticides to address the problem of use of expired and inadequate doses of chemicals in cotton pest management. Also, alternative pest management to chemical insecticides for cotton should be developed around botanicals such as neem extracts. Integrating these controls with other proven pest management strategies such as pest souting and good farm sanitation, among others, would result in effective management of cotton pests (Matthews 1996). The farmer field school concept, which is a holistic approach to pest management, should therefore be adopted as the paradigm to train farmers in integrated management of cotton pests. The farmer training should be preceded by training of extension officers from cotton companies and MoFA who will act as facilitators to farmer learning in and outside of the farmer field school.

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