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INTEGRATED PEST MANAGEMENT APPROACH IN COTTON AGRO-ECOSYSTEM IN UGANDA. 2- ESTABLISHMENT OF CONTROL ACTION THRESHOLD LEVELS

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ABSTRACT

Field trials to establish control Action Threshold Levels (ATLs) for major insect pests in cotton fields in Uganda, mainly *lygus* bugs and bollworms were conducted at Kigumba, Masindi district and Namulonge Agricultural and Animal Production Research Institute (NAARI), Mpigi district during 1993/94 and 1994/95 seasons, respectively. Several ATLs were tested in the two locations. Leaf damage score and sweep-net catches techniques were used for *lygus*, while the visual count was used for both the bollworms and associated predators. Yields seed cotton were also estimated. Obtained data were statisticaly analysed. ATLs tested in the second season were more reliable. A maximum of two sprays were required to maintain the pests population around the tested ATLs. Negative impact from insecticide applications on predators population (up to 70 % reduction) was recorded. Statistical analysis showed no significant differences in the seed yield between the plots sprayed twice (ATL plots) and that ones sprayed four times (recommended calendered spray regime). High yields were obtained from the ATL plots, particularly in the second season.

Key Words: Action Threshold Levels, Cotton, Pests, Uganda.

INTRODUCTION

Efforts to make the use of insecticides totally compatible with the aims of Integrated Pest Management (IPM) must seek to reduce frequency of applications. To achieve such reduction on important crops such as cotton, the pest management specialist must move toward replacement of preventive routine treatment schedules with treat-when-necessary schedules based on appropriate techniques of monitoring major pest populations and crop development.

A critical problem in successful pest management is the proper timing of insectcide treatment and the concept of Control Action Threshold Level (ATL), which defined as" the density at which control measures should be applied to prevent an increasing pest population from reaching the economic injury level" (Stern, et al., 1959), has been adopted as an option for farmers to wise-use of insecticide applications. This however, requires that appropriate control thresholds for key pests are determined.

Insect pests as well as inadequate cultural practices constitute major limiting factors to cotton production in Uganda. Pest control regime has largely depended on callendar applications of insecticides (Anon, 1991 and 1993).

Available literature revealed that no studies have been done on ATL in cotton fields in Uganda. Recently, however some efforts have started to manipulate cotton problems in the country to implement the IPM system in the cotton growing zones (Sekamatte and Ajibo 1992; EL-Heneidy et al., 1996, EL-Heneidy and Sekamatte, 1996; and Sekamatte et al., 1996).

The present study was carried out under the IFAD / WORLD BANK Project " Smallholder Cotton Rehabilitation Project (SCRP) in Uganda". This study focused on establishing and developing action ATLs for major cotton pests in cotton agro-ecosystem in the country namely; the *Lygus* bug and the bollworms., (Anon, 1991 and 1993, and EL-Heneidy et al., 1996).

MATERIALS AND METHODS

Experiments to test control Action Threshold Levels (ATLs) for the *lygus* bug, *Taylorilygus vosselori* Papp. and the major cotton bollworms; American Bollworm (ABW), *Helicoverpa armigera* Hb.,Spiny Bollworms (SBW), *Earias insulana* Hb. and *E. biplaga*, and Pink Bollworm (PBW), *Pectinophora gossypiella* Saund. in cotton fields in Uganda were established at Kigumba experimental farm, district of Masindi and Namulonge Agricultural and Animal Production Research Institute (NAARI), district of Mpigi on 2.5 and 2.5 hectares plots, respectively in the 1993/94 and 1994/95 seasons.

During the first season, 1993/94 a simple non-replicated trial was planted at Kigumba. The plot was divided into three 2 acre sub-plots and treatments assigned as follows: sub-plot A was sprayed four times beginning 35 days (5 weeks after germination (WAG)) and subsequent sprays at 14 days intervals (which is the current recommendation for pest control in cotton fields in Uganda), sub-plot B was used to test two theoretical ATL values namely 10-15 larvae of bollworms per 50 plants and/or a mean leaf damage score of 2.0 for *lygus*. Sub-plot C was left without any sprays throughout the season to serve as control. Sampling for bollworms was done by systematic random examination of 50 plants (Garcia et al., 1982). To assess the extent of cotton leaf damage by *lygus* bugs, four top-most fully open leaves of each of the 50 plants used for bollworms sampling were examined at two weeks intervals and damage rated using a standard scale of 1-4 where 1 = no apparent damage and 4 = severe damage (Dineur, 1959). The control plot was scouted in the same manner.

During the second season, 1994/95 the experiment was repeated at NAARI with some modifications. Three 2 acre plots were respectively assigned to *lygus*, bollworms and control. Each plot was further sub-divided into six sub-plots each approximately 0.33 acre. Three ATL values 10,15 and 20 *lygus* bugs/50 sweep-net strokes/sub-plot (Garcia et al., 1982) and 5-6, 7-9 and >10 young larvae of bollworms /100 plants were tested. Two replicates for each ATL value were used. These values were designated low, medium and high. *Lygus* damage to leaves was also assessed as described in the first season (Dineur, 1959). Visual counts of larvae were used in the bollworms and control plots. Sampling was done weekly and repeated within 2-3 days before decision to apply the chemicals could be taken. Two types of insecticides were used: a pyrethroid, Sherpa DL (50g/L cypermethrin + 300 g/L dicofol) and an organo-phosphate, Salut (222g/L Dimethoate + 278g/L Chlorpyrifos) at a rate of 1.0 L/ha. On each sampling ocassions, the number of various predatory species associated with cotton pests on the 100 plants examined for bollworms in each sub-plot was also recorded. Three pheromone traps one for each of the major bollworms; ABW,SBW and PBW were placed in the experimental plot at NAARI by mid-season and catches were recorded twice a week. At harvesting, cotton was picked seperately from each sub-plot and later bulked for different treatments. Obtained data were statisticly analysed.

RESULTS AND DISCUSSION

Incidence and Status of Pests

Lygus:

During the 1993/94 season at Kigumba, the leaf damage score in the sprayed plots A and B maintained around category 1.0 throughout the growing season (Fig. 1a). In the unsprayed plot however, *lygus* damage scores rose significantly between September and November (5 - 13 WAG) to an average of 2.0. This result suggests therefore that the two insecticide regimes were equally effective against the pest despite the fewer number of sprays applied in plot B.

As shown in figure (1b) leaf damage scores in season 1994/95 increased by the end of September and October (11 - 15 WAG) to peak at 1.6, 1.7 and 1.8 in the low, medium and high ATL sub-plots of the *lygus* plot. A similar trend was obtained using data from sweep-net catches. *Lygus* population hit a peak of 25 bugs/50 sweep-net strokes at the third week of October (14 WAG) (Fig.1c). During this period two sprays were applied in each of the sub-plots A and B at 10 and 13 WAG and only single spray was requested in sub-plot C at 14 WAG (Table 1). Afterwards, 17 WAG *lygus* population declined sharply from November up to the end of the season (Fig.1b). In the bollworms and control plots, population of *lygus* bugs reached its peaks in November (17 - 21 WAG), about one month later than in the *lygus* plot.

Table (1): Number of sprays and chemical groups applied in cotton ATL tested plots at Kigumba and NAARI in 1993/94 and 1994/95 seasons.

1993/94			1994/95				
Main plot	No. sprays	Chemical group	Main plot	Sub-plot	ET Level	No. sprays	Chemical group
				A	Low	2	Py
A	4	Py	*Lygus*	B	Med.	2	Op
				C	High	1	Op
				A	Low	2	Py
B	2	Py	Bollworm	B	Med.	1	Py
				C	High	1	Py
				A	Low	0	--
C	0	-	Control	B	Med.	0	--
				C	High	0	--

Bollworms:

Bollworms incidence was relatively very high during the first season 1993/94. Fourteen days after the first insecticide application in plot A (7 WAG), all plots had equally high population (14 bollworm larvae/50 plants), mostly ABW (Fig. 2a). Bollworms infestation rapidly declined to below 5 per 50 plants in plot A after 11 WAG (end of October) after which the infestation sharply increased. During the same period, bollworms infestation in plots B and C ranged between 10-20 larvae per 50 plants. According to the tested ATL values, insecticide treatments in plot B were applied at 7 WAG when the larval population built up from 4 to 13 and again at 11 WAG when it reached 14 per 50 plants. Consequently this plot was sprayed only twice. As shown in figure (2a) infestation in the sprayed plots increased rapidly two weeks after the last application, at 11 WAG of the recommended regime. Generally, the lowest population of bollworms was found in plot A because it was sprayed four times while the highest was recorded in plot C, where no insecticides were used.

In the second season 1994/95, bollworms population was also high despite the difference in locations. It was noted however that like the case in Kigumba, the ABW was the dominant bollworm species (about 68 % at NAARI). Highest peaks of 31 and 21 ABW larvae/100 plants were recorded in November (19 WAG) in both bollworms and control plots, respectively in correspondence to 9 and 12 larvae of SBW in the same plots, respectively. SBW reached a peak of 13 larvae/100 plants one month later in December (21 WAG) in the control plot. There was a noticeable differences among the three tested ATL values in bollworms plot. In general, slightly more larvae were recorded in lowest ATL than in the higher ones, therefore, sub-plot A was the only one sprayed twice at 16 and 18 WAG, when all the sub-plots were sprayed including sub-plots B and C (Fig. 2b and c) and Table (1). The general means of ABW larvae per 100 plants in the bollworms and control plots ranged between 3 - 4 and 2 - 3.7, respectively. Statistical analysis indicated that no significant differences among bollworm infestation levels were found between the sub-plots sprayed once and those sprayed twice (Table 1). Generally, PBW seems to be a minor pest during the growing season. Its population increased rapidly at the end of the season and continued high in the dry bolls.

Predators:

Overall, the lady beetles (coccinellids) predominated all other predator species or groups such as; true spiders, syrphid larvae, earwigs and ants counted at Kigumba in season 1993/94. During this season significantly (P=0.05) more predators were recorded in the unsprayed plot (Plot C), a peak of 35 individuals/50 plants was recorded (Fig.3a). Similarly, for most part of the growing season, plot B had a greater predator population than plot A, 20 and 10 individuals/50 plants were recorded in plots B and A, respectively, because plot B received half of the chemicals sprayed in plot A.

At NAARI, in season 1994/95 nine species and/or groups of common predators were recorded throughout the season associated with cotton pests (Table 2) (**EL-Heneidy et al., 1996 and EL-Heneidy and Sekamatte, 1996**). As shown in the table, ants and rove beetles were the most abundant predatory species, followed by the coccinellids, *Orius* and true spiders. Except the month of October, the greater predator population was always recorded in the control plot, where no insecticides were used (Fig. 3b). Generally, highest population of predators was found in October (13 - 17 WAG), when it reached 242 and 190 /100 plants, in the bollworms and control plots, respectively.

Pheromone Trap Catches:

Obtained data illustrated in figure (4) indicated that ABW moth catches built up from September (9 - 11 WAG) to reach a peak of 20 moths/trap in November (17 - 19 WAG) to coincide with the highest population recorded by visual counts in the same weeks and then declined to below 5 in December and January (21 - 27 WAG). Uninterrpretted data were noticed in case of SBW when no moths were caught until January (25 - 27 WAG) despite the recorded infestations of pest larvae all over the season. PBW catches were first found in December (21 WAG) and then increased rapidly in January (25 - 27 WAG), it is clear that the PBW is a late season pest in cotton fields at NAARI and it was found numerously in the dry bolls collected by the end of the season in a diapause stage.

Yield of Seed Cotton:

Seed cotton yields obtained at Kigumba were generally very low compared to those obtained from NAARI (Fig.5). Apart from other reasons this result probably suggests that the AT levels used at Kigumba in the first season were too high. When the tested ATLs

Table (2): Mean number of predatory species/50 sweep-net strokes in cotton ATL tested plots at NAARI in season 1994/95.

Predator species	Experimental plots			
	Lygus	Bollworms	Control	LSD (p= 0.05)
Cheilomenes	0.43b	0.77b	3.77a	1.07
Scymnus	0.91b	2.00ab	5.77a	0.59
Lacewing	0.72a	0.46a	0.31a	0.38
Earwig	0.18a	0.23a	0.23a	0.37
Orius	1.80a	2.85a	3.16a	2.98
Rove beetle	1.46b	2.23b	7.15a	1.23
Ants	5.85b	5.86b	11.33a	4.15
Spiders	3.37a	2.00a	3.69a	1.97
Syrphus	0.17a	0.08a	0.23a	0.36

were reduced in the second year at NAARI,more yields were obtained. Yield difference between plot A and B in the first season was statisticaly not significant (P= 0.05; t= 37.5), while significant differences were found between plot C and each of them.

In the second season, highly significant differences (P= 0.01) were found between the yields obtained from the *lygus* plot (1959.5 K.g./ha) and that from each of the bollworms (909.2 K.g./ha) and control (1137.3 K.g./ha) plots, while no significance between the yields of the later two plots was found. It is however, notable that all tha values of yields obtained during this season were above 800 K.g./ha, the average seed cotton yield in Uganda. This suggests that the ATL values tested at NAARI were almost suitable to the pests populations in the area.

CONCLUSION

Obtained results of the two seasons showed that:

- Week after germination (WAG) was used as a parameter of the plant age to compare the results of the seasons, because the same cotton variety, BPA,89 was used in the two working sites.

- The ATL values tested in the first season at Kigumba were obviously high, particularly for bollworms. Two weeks interval for sampling is relatively long. Thus, lower values and weekly sampling were considered in the second season at NAARI.

- Insecticide applications were required to suppress pests populations and to maintain them below the tested ATLs, but the timing of the applications depending on scouting or predicting of pest populations was a critical factor for effective suppression and for minimizing the number of sprays needed.

- Statistical analysis indicated that two effective and well-timed applications give no significant difference compared to the four calendered sprays tested in the first season.

- On the other hand, insecticide applications had negative influence on the predator populations (up to 70% reduction) in the two seasons, when the control plots were compared with the sprayed ones.

- Relatively high yields were obtained in the second season because lower ATL values were used. This will create a basis to results. During the same season, lowest yield was obtained from the boll-worms plot which seem to suggest that the ATL values tested were still relativaly high, particularly for ABW, the dominant among the bollworms. Further studies are therefore required to develop more practical ATLs.

We understand that the ATL values are variable from one area to another and season to season depending on pest and natural enemies status and interactions in the area. Thus, threshold based control is only advisable in cases where accurate sampling methods are available and control actions can be taken quickly and effectively in response to the scouting.

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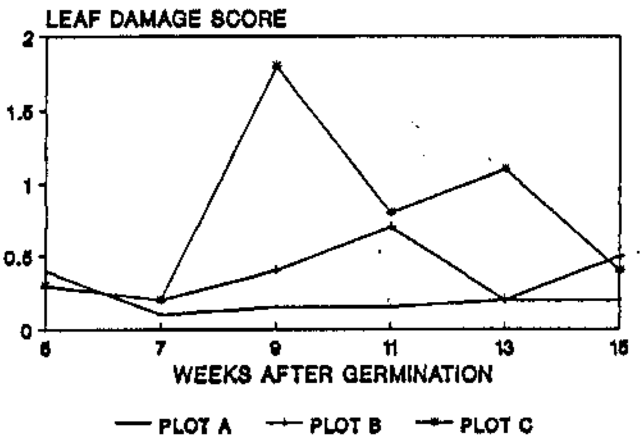
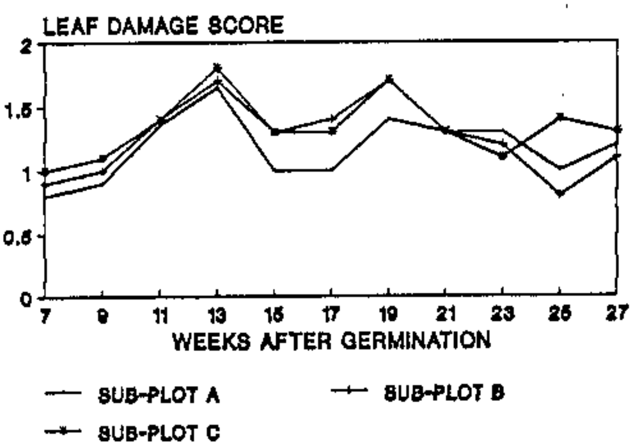
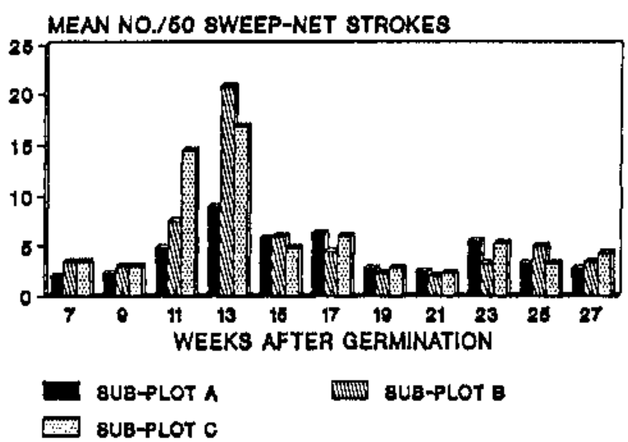


(1a)

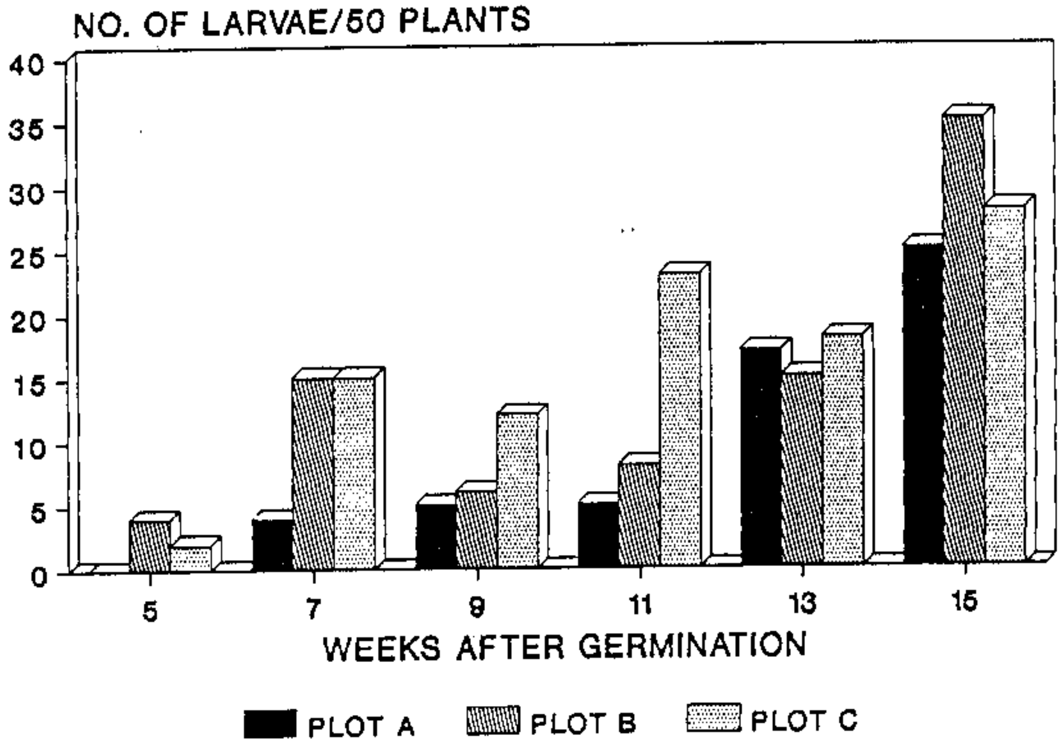


(1b)

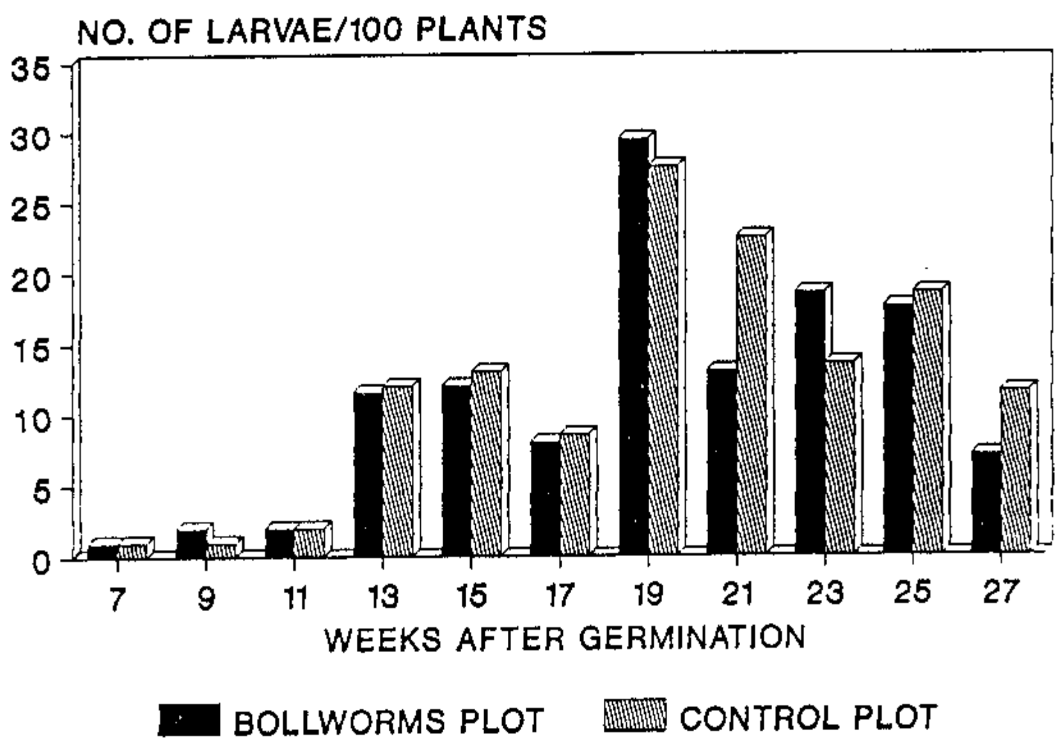


(1c)

Fig. (1): Lygus leaf damage scores and sweep-net catches/50 strokes in cotton ETL plots at:
(1a) Kigumba experimental farm in 1993/94 season,
(1b) and (1c) NAARI in 1994/95 season.

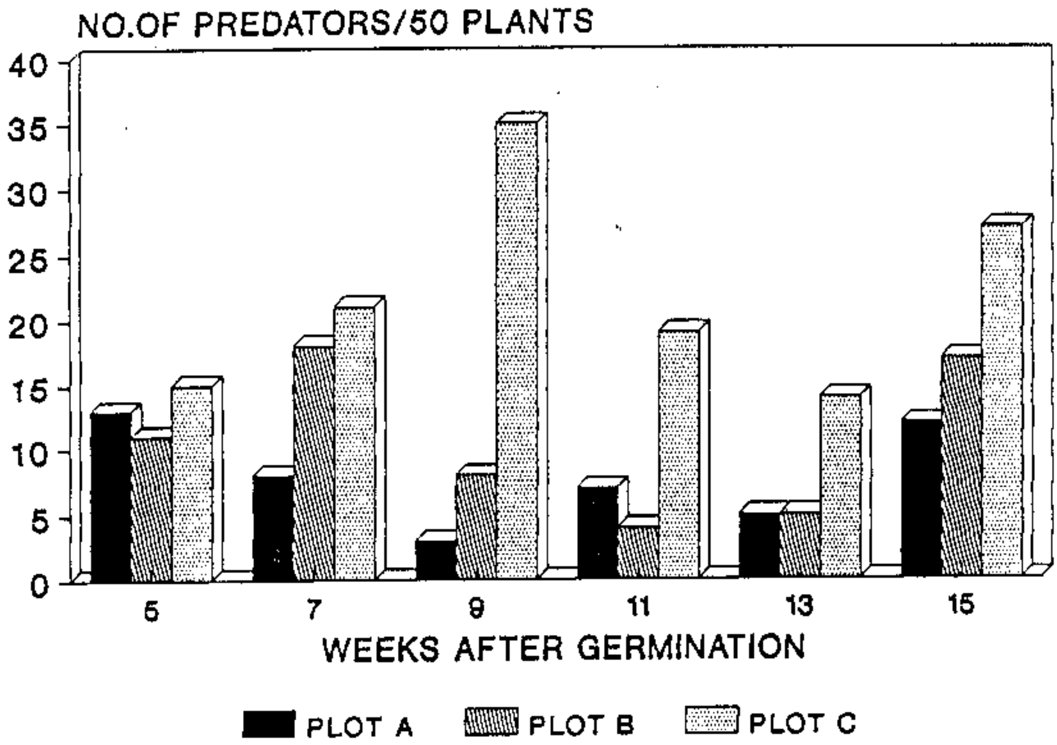


(2a)

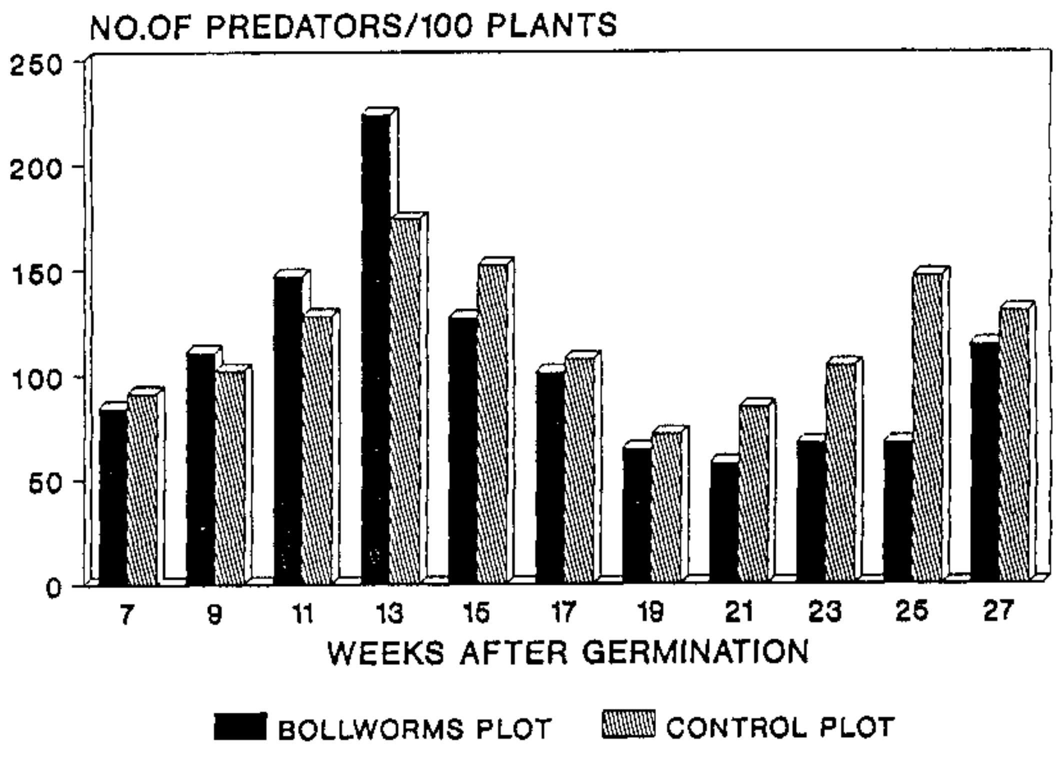


(2b)

Fig. (2): Mean numbers of bollworms larvae in cotton ETL plots at:



(3a)



(3b)

Fig. (3). Mean numbers of predators in cotton ETL plots at:

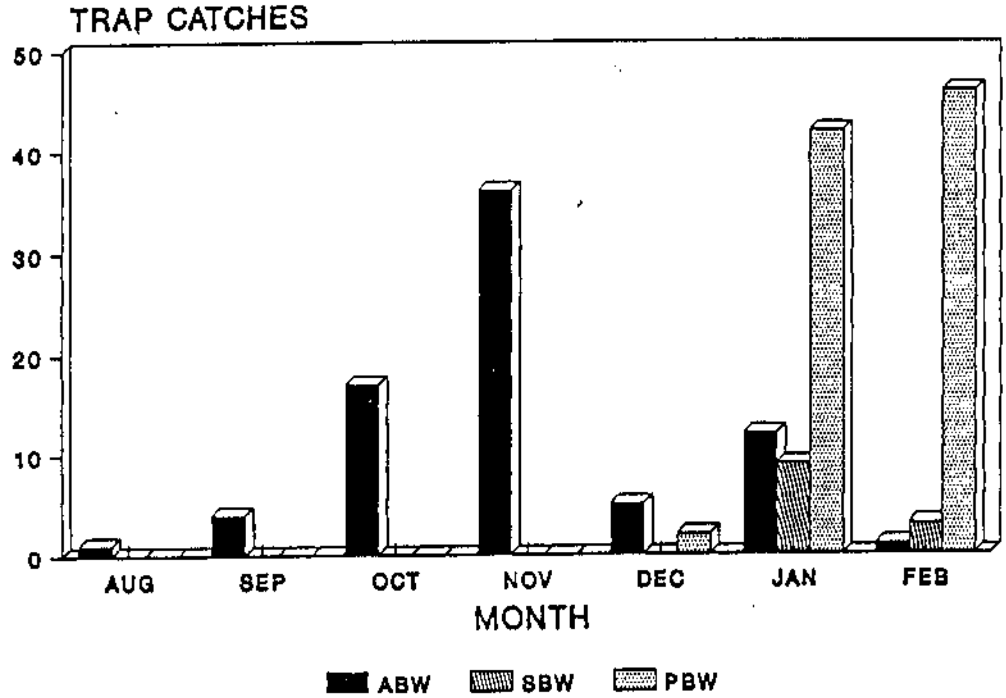


Fig. (4): Monthly total numbers of pheromone trap catches of bollworms' moths in cotton ETL plots at NAARI in 1994/95 season

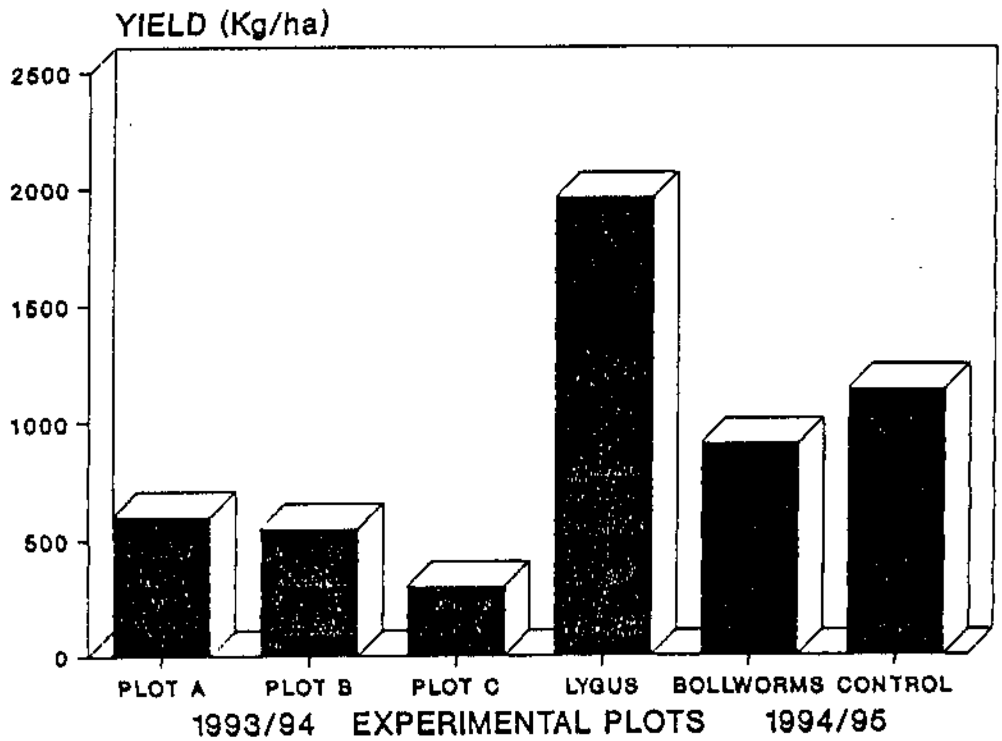


Fig. (5): Mean yield of seed cotton from cotton ETL plots at Kigumba experimental farm and NAARI in 1993/94 and 1994/95 seasons, respectively.