INTEGRATED PEST MANAGEMENT APPROACH IN COTTON AGRO-ECOSYSTEM IN UGANDA. 1- BASIC FIELD DATA.

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ABSTRACT

Integrated Pest Management (IPM) has recently been introduced in the cotton agro-ecosystem in Uganda. Modern pest management programmes cannot operate without accurate information and estimates of pests and natural enemies population densities. This study was conducted in the 1994/95 season and focused on collecting basic field data of cotton plant, pests and natural enemies, particularly the predators in untreated cotton fields. Work was conducted at three different geographical locations; Namulonge Agricultural and Animal Production Research Institute (NAARI) Mpigi-, Masindi- and Kasese districts representing major BPA (Bukalasa Pedigree Albar Uganda) areas of Uganda. Assessment of cotton plant phenology and visual counts of pests and associated predators were carried out weekly in each working site. Sex pheromone traps were used to monitor bollworms populations. The seasonal abundance of both the pests and the predators in the three locations were studied. In addition, natural percentages of infestation in the sheddings; squares, blooms and green bolls were also estimated. Obtained data established: the plant growth pattern of the cotton variety BPA,89, that *lygus* bugs, bollworms and stainers are the major cotton pests, and 8 species and/or groups of predators were recorded associated with several cotton pests throughout the season.

Key words: BPA, Cotton, IPM, Natural Enemies, Pests, Uganda,.

INTRODUCTION

Cotton is an important economic crop in world agriculture. Approximately 31 million hectares are grown in the world each year. In Uganda, about 300,000 hectares are grown annually. Cotton was the main export crop in the country prior to 1950 when it was overtaken by coffee. The need to revive the cotton industry to its former pre-eminence has recently been recognized and, as part of this effort, and in consideration of the environmental and public health concerns, the concept of Integrated Pest Management (IPM) was proposed.

Therefore, there are two ecologically distinguishable cotton growing zones in Uganda, the northern and eastern dry areas that grow the type SATU (approx. 40%) and the southern and western wet

areas that grow the BPA type (approx. 60%). Cotton in both zones is entirely rainfed (**Anon, 1991**).

In agro-ecosystems, there are usually a few major pest species and numerous minor ones. Modern pest management cannot operate without accurate estimates of pests and natural enemies population densities, or without reliable assessents of plant damage and its effect on yield. Many studies have shown that control based on systemic scouting and/or predicting pest population is worthwhile (**Lacewell and Masud,1989**).

Available literature revealed that for more than two decades (except **Sekamatte, 1994**), no studies have been conducted on cotton pest problems in Uganda. The latest ones were that of **Coaker, 1959 and Nyiira,1970**. Their studies focused mainly on the survey of cotton pests and their natural enemies.

The present study was conducted to generate basic field data of the cotton plant, pests and natural enemies as well as their seasonal abundance in untreated BPA fields. The data would constitute a basis for developing a sustainable IPM programme for the country.

MATERIALS AND METHODS

The experimental plots were located at Namulonge Agricultural and Animal Production Research Institute (NAARI) Mpigi, Masindi- and Kasese districts during the 1994/95 cotton season. The three represent the major growing areas of the type BPA in Uganda. Experimental plots, approximately one hectare each, were planted with the variety BPA, 89 at the recommended planting periods; by early July at NAARI and Masindi and by the end of August at Kasese. The plots were surrounded by conventional farming system crops, without interference mainly; maize, sorghum, beans and cassava. Regular cultural practices were conducted throughout the season. To avoid any possible interferences in the dynamics of insect populations and their predators no insecticides were applied in the experimental plots throughout the season.

Beginning 1-2 weeks after germination (WAG), designated 100 plants / sampling date / location were inspected weekly and visual counts of phenological cotton plant data, pests and their associated predators were taken up to harvesting. The stratified scouting technique was used (**Garcia et al.,1982 and Legaspi et al., 1989**).

Counts of thrips, aphids, whiteflies, and jassids were estimated according to the relative categories of infestation as follows: Low = <10, Medium = 11-25 and High= >26 individuals/leaf. By taking means of three leaves/plant, one each from top, middle and lower portions of the plant, percentage infestation was calculated from 300 leaves/100 plants. Actual numbers were visualy

counted for the cotton pests (Anon 1991, 1993); the *lygus* bugs, bollworms and stainers.

At the same time as the pest counts were taken, each designated plant was inspected and visual counts of common predators were also recorded. Counts of both immature and adults stages of common predaceous species were taken.

Sex pheromone traps were placed at the beginning of squareing period in each of the experimental plots for monitoring bollworms population. Trap catches were recorded twice a week.

Besides, natural percentage of infestation in the sheddings; squares, blooms and green bolls were estimated weekly at NAARI only. Causes of the damages in the green bolls were identified.

RESULTS AND DISCUSSION

I- Cotton Plant Data:

Cotton plant data were collected weekly from the three woking sites. Obtained data are illustrated in fig.(1). The figure dipicts the growth pattern of the type BPA.

Falcon, 1972 divided the cotton plant growth season into three stages; Plant establishment (PE) (from planting date to 1st square), Fruit Formation (FF) (from 1st square to 1st open boll) and Fruit Maturation (FM) (from 1st open boll to harvest). Falcon, 1972, Gonzalez and Wilson,1982 , and Williams et al., 1992 stated that these periods not only describe different phases of the cotton plant growth and development but also can provide a basis for pest control decisions made in IPM programmes because each of these stages has distinct morphological and physiological characteristics which in turn affects pests and natural enemies abundances.

As shown in fig (1), the square period started about 5-6, the blooms 7-9 and the green bolls 11-13 WAG, Thus the plant growth stages; PE, FF and FM lasted 6-7, 9-11 and 8-11 weeks, respectively, while the whole growing season lasted about 24-27 weeks.

II- Cotton Pests:

Dividing the crop season into growth stages focuses attention on the arthropod pest problems that are most likely to occur at a particular time of crop development. Therefore, the division made by Falcon, 1972 will be followed.

a- Early Season Pests (0-6 WAG):

During this PE stage, the plant establishes its root system, its branching pattern and sets leaves. The leaf sucking insect species; thrips, *Thrips* sp., aphids, *Aphis gossypii* Glov.,

whiteflies, *Bemesia tabaci* Genn. and jassids, *Empoasca* spp. were recorded as the common early season insect pests of cotton in the three districts. Aphids predominated the other species during this period (Fig. 2). Percentage infestation of aphids were relatively higher at NAARI, it reached a peak of 40 % at 5 WAG, but population mostly lied between category low and medium. Whiteflies and jassids ranked second behind the aphids and they were always at the low level. A maximum of 23 and 2 % infestation by the whiteflies and jassids was recorded at 5 WAG, respectively. Thrips incidence was relatively very low and it was found mostly when maize and/or sorghum are adjacent.

b- Mid-Season Pests (6-17 WAG):

During this FF stage, the plant sets 80 % or more of its entire boll carrying-capacity. This period is very critical because most of the pests attack occurs on squares, flower buds and flowers. Damage of these sensetive plant parts leads to reduction in boll formation or increases in fruit drop (Abul-Nasr et al, 1978). In both cases, crop yield is adversely effected.

During this stage, aphids population built up to raech category high most of the time with a peak of 93 % infestation at 15 WAG (Fig. 2), while that of whiteflies and jassids infestations continued at the low level. The *lygus* bug, *Taylorilygus vosselori* Popp., the American bollworm (ABW), *Helicoverpa armigera* Hb., the spiny bollworms (SBW), *Earias insulana* Boisd. and *E. piblaga* Wlk. and the stainers, *Dysdercus* spp. were recorded during this period. These species except the stainers are considered the major and most destructive insect pest species in cotton fields in Uganda during this period (Anon, 1991, 1993). As shown in Fig. (3), most of the recorded major species built up their populations rapidly during this stage. *Lygus* bugs numbers were relatively higher at Kasese followed by Masindi. They reached their maximum of 67, 85 and 35 bugs /100 plants at 17, 14 and 15 WAG at Kasese, Masindi and NAARI, respectively. Their damages to the leaves and squares were obviously observed during this stage. Among the bollworms, ABW population exceeded that of the SBW in all locations. Peaks of 27, 15 and 5 ABW larvae/100 plants were recorded at 14, 17 and 16 WAG at Masindi, NAARI and Kasese, respectively in corrospondence to 22, 9 and 8 SBW larvae /100 plants at 14, 13 and 11 WAG at the same loctions. Bollworms damages to the squares and blooms beside that of the SBW as tip borers were also observed during this period. Stainers population was found very low during this FF stage.

c- Late Season Pests (17-26 WAG):

The FM stage includes the entire period of fruit maturation. Most of the insect pest damage during this period is sustained on green bolls. This damage is particularly important because it leads to additional destruction of bolls through secondary invasion of fungi and bacteria.

Sucking pests, caterpillers and bugs species were all recorded during this stage. Aphids population declined to be mostly at category medium with a peak of 96 % infestation (Fig. 2) at 18 WAG, while that of whiteflies and jassids continued at the low levels. As shown in Fig. (3) *lygus* bugs and SBW numbers decreased during this period in correspodence to relative and sharp increase in ABW and stainers populations, respectively. Peaks of 208, 202 and 131 individuals/100 plants of stainers were recorded at 26, 23 and 23 WAG at NAARI, Masindi and Kasese, respectively. Some other species of stink bugs such as; *Nezara viridula* and *Dolycoris haccarum* L. were irregularly found but with less importance, while the cotton seed bug, *Ocycarenus hyalinipennis* (Costa) was observed in relatively considerable numbers associated with the cotton seeds in open bolls. Late of the season the pink bollworm (PBW), *Pectinophora gossypiella* Saunds and the false codling moth (FCM), *Cryptophlebia leucotrcta* Neyr. were also recorded but so far in relatively low numbers. PBW population increased apperantly in the opened and dry bolls in the last few weeks of the season. PBW population was relatively higher at Kasese than the other two locations.

III- Predators

Visual counts of common predatory species associated with the cotton pests were counted weekly on the disignated plants inspected for the pests. Counts of both predeceous immature and adult stages of several species and/or groups of predators were recorded. These were ; Lady beetles, coccinellids, *Cheilomenes* spp. and *Scymnus* spp., Lace-wings, chrysopids, *Chrysoperla carnea* Steph. and *Chrysopa* spp., Minute Pirate bugs, anthocorids, *Orius* spp., Rove beetles, staphilinids, *Padearus* sp., Earwigs, libidurids, *Diaperasticus* spp., Flower flies, syrphids, *Syrphus* sp., ants and true spiders.

Generally, highest total population of the predators was recorded at Kasese followed by Masindi and then NAARI (Fig. 4). It reached a peak of 662, 270 and 193 individuals /100 plants at 10, 13 and 15 WAG in the respective locations. Among the predator groups, percentage of representations of the most abundant species were calculated as follows: at Kasese; ants 61.1 and coccinellids 25 %, at Masindi; ants 43, true spiders 21.2 and coccinellids 15.4 %, and at NAARI; true spiders 27.2, ants 25.7, minute pirate bugs 15.7, and rove beetles 14.6 %.

Pheromone Trap Catches:

Pheromones are now being used throughout the world as monotiring tools and trapping systems for many key pests. Sex pheromone traps were used for the first time in the cotton fields in Uganda for monitoring bollworms populations throughout 1994/95 growing season. As shown in Fig. 5 the trend of ABW moth catches was almost similar at the three working sites except a slight increase at Kasese,

while that of SBW was recorded rarely and in unrepresentive numbers despite the pest larvae were counted regularly in the experimental plots for about five months. PBW catches increased drastically during the last month perior to harvesting and continued in very high numbers particularly at Kasese.

Percentage Damage in Sheddings:

This study was done only at NAARI and started relatively late from 10 WAG. AS shown in table (1) percentage infestation in different sheddings increased almost towards the end of the season. It reached a peak of about 94 % in squares and green bolls during January. Generally, infestation in the shedded blooms was the least among the other plant parts.

Table (1): Monthly percentages infestation in the shedded; squares, blooms and green bolls at NAARI in season 1994/95.

Month	Squares	Blooms	Green Bolls
Oct. (10-13 WAG)	56.0	5.6	32.4
Nov. (14-17 WAG)	71.0	6.0	58.2
Dec. (18-21 WAG)	80.7	6.5	73.8
Jan. (22-25 WAG)	93.8	4.5	93.7

Damage in the Green Bolls:

Rates of infestation and causes of the damages in the green bolls were recorded late in the season, starting 18 WAG. As shown in table (2) number of infested bolls increased gradually towards the end of the season. It reached a peak of 98 % at 25 WAG. Analysis of the causes of the damages in green bolls indicated that 18.8 and 61.1 % were injured by sucking pests; stainers, *lygus* and stink bugs, and bollworms, respectively.

CONCLUSION

Generally, it could be concluded that:

- Where cotton is not irrigated, the response to changes in rainfall and cloudiness can affect boll retention irrespective of pest infestation so use of a plant model is difficult (Matthews, 1989).

- Pest infestation perior to the start of flower-bud production (early season) with some exception, such as severe infestation of aphids, will normally only delay a crop, so emphasis on control measures in this vegetative growth phase is mainly on non-chemical methods. Also a moderate infestation during this period is acceptable because it attracts more natural enemies to the cotton fields.

Table (2): Weekly percentages of infestation and causes of damages in the cotton green bolls at NAARI in season 1994/95.

WAG	Causes of Damages		
	Sucking pests	Bollworms	Total
18	15	25	40
19	29	50	79
20	32	48	80
21	27	50	77
22	29	54	83
23	16	76	92
24	2	88	90
25	0	98	98
MEAN	18.8	61.1	79.9

- Mid-season is the most critical period of crop development especially about 10 weeks after the fruit flower buds have formed. During this period of rapid growth there is an increasing number of buds and then bolls which attract different insect pests, mainly *lygus* bugs and bollworms (ABW and SBW). During this period early and late season pests may also be present in considerable populations.

- Control of insect infestations during the late season (period of crop maturation) can be crucial also for several reasons. At the late stage in plant development, compensation for loss of buds and bolls is no longer possible, and the presence of certain pest species such as the stainers and PBW reduces lint quality as well as the yield of seed cotton. There is also the need to reduce the population of pests which are entering diapause or are migrating to alternative hosts so that infestations in the following season might be less severe. Most of the late season pests, initially arrive in the cotton crop earlier during mid-season, their populations being either suppressed or increasing depending on the control tactics used then.

- Although considerable incidence of several predator groups in cotton fields (Frisbie, 1983), their populations are often not adequate, especially at the time of peak flowering which frequently coincides with periods of rainfall. In consequence, yields are generally very low if farmers rely entirely on natural controls.

- Pheromone traps generally catch target pest species and can therefore be used qualitatively to provide an early warning of pest incidence. Pheromone traps type funnel were found more practical than the delta under the environmental conditions, particularly rainfall in Uganda.

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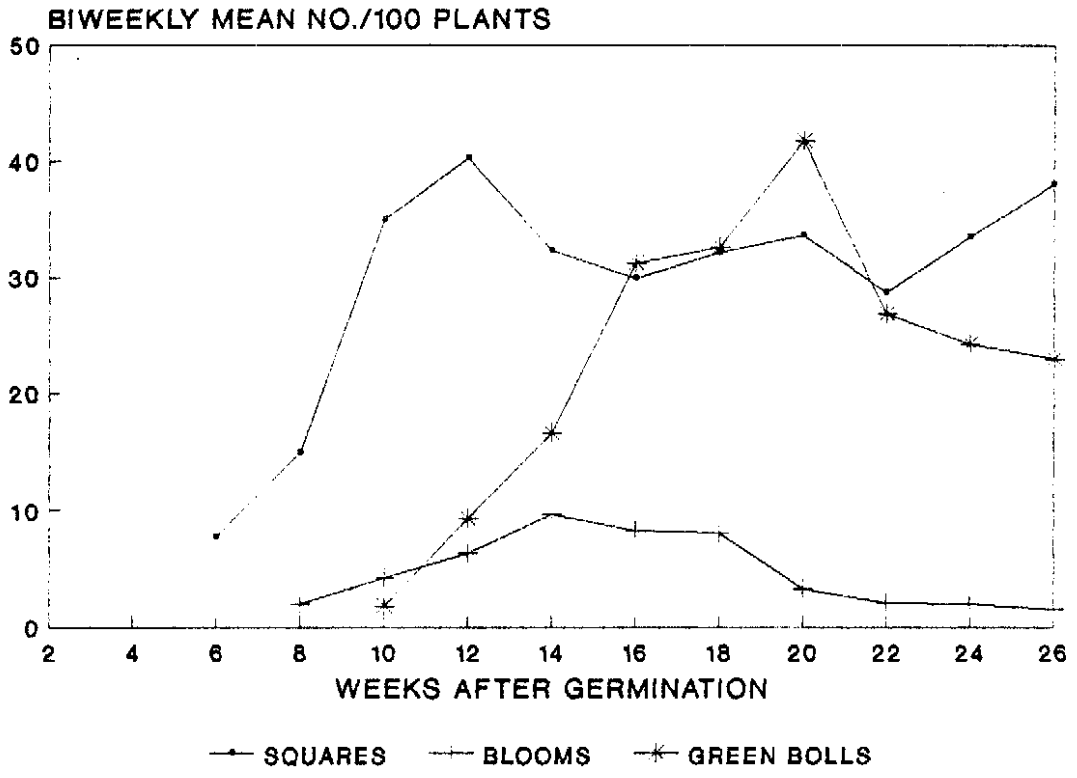


Fig. (1): Biweekly growth pattern of the cotton variety BPA,89 in the southern and western cotton regions of Uganda.

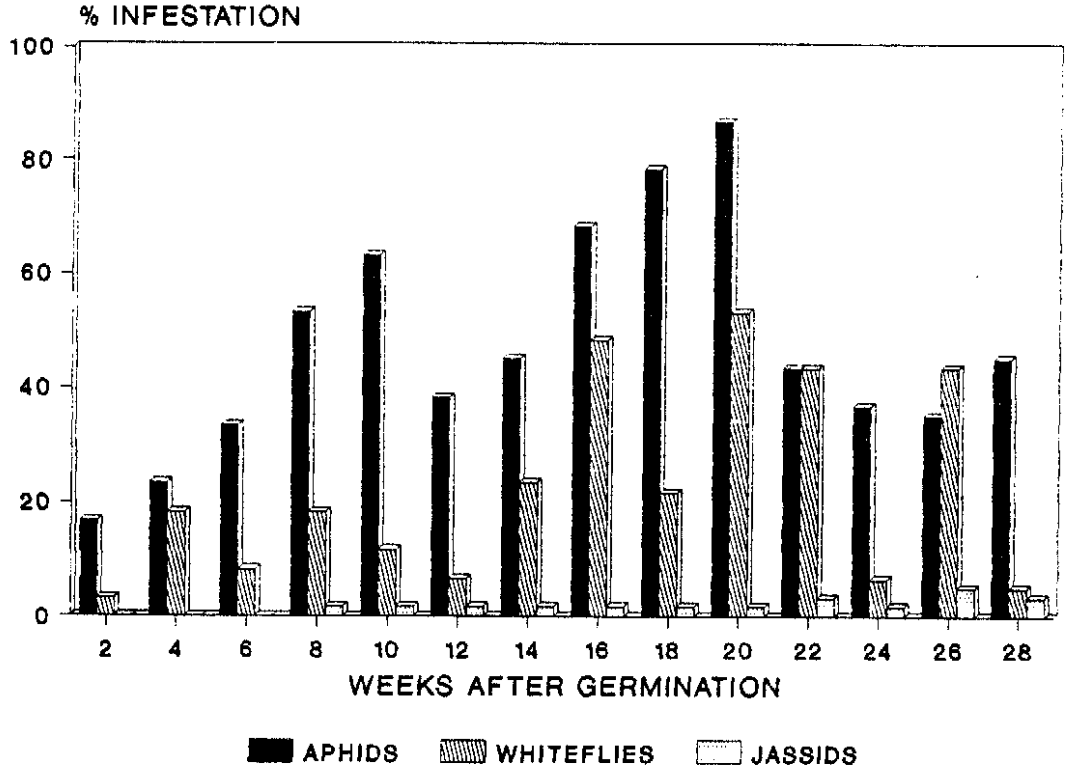
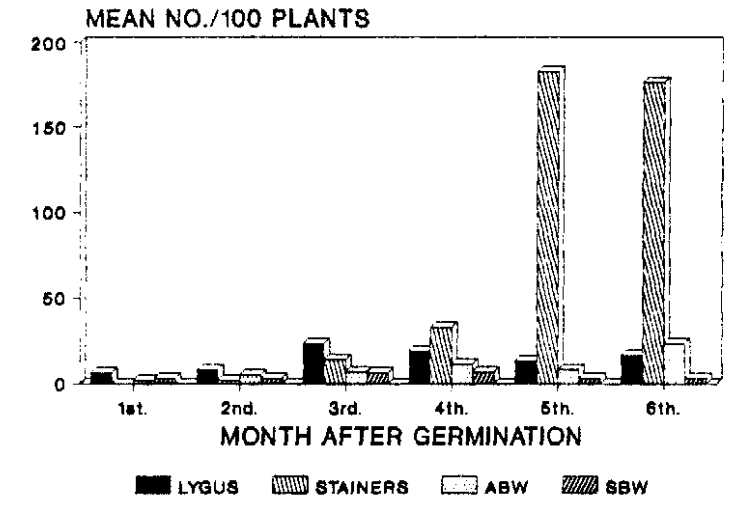
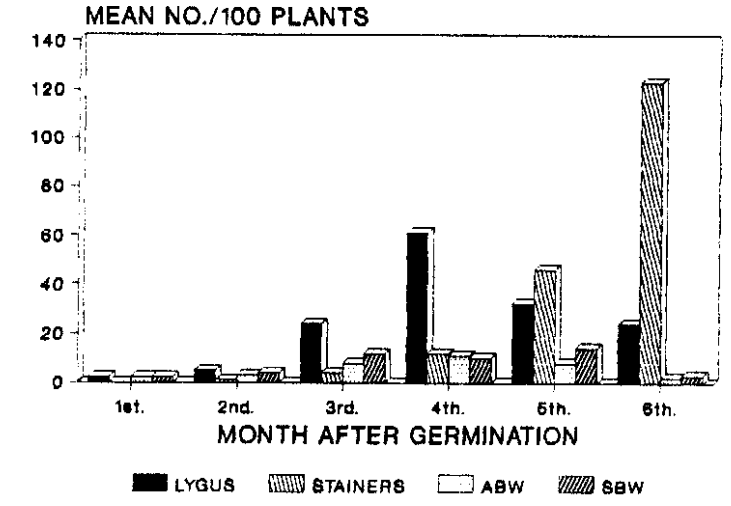


Fig. (2): Biweekly mean percentages infestation by the secondary cotton pests; aphids, whiteflies and jassids on the cotton variety BPA,89 at NAARI, Masindi and Kasese in season 1994/95.



NAARI,94



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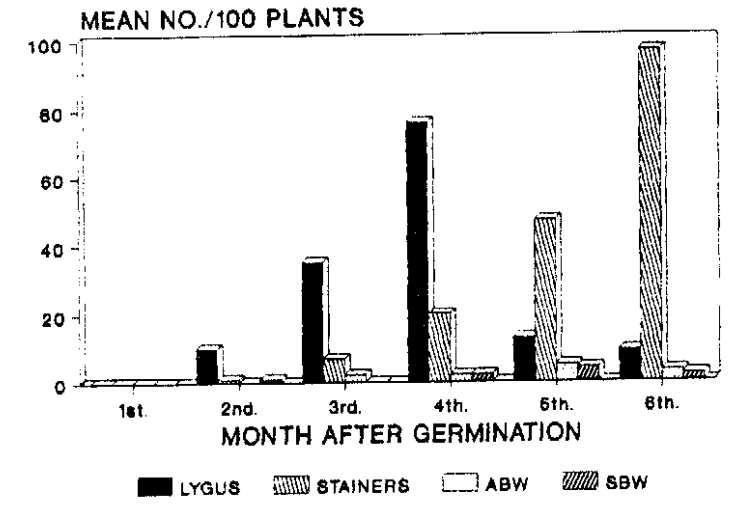


KASESE,94

Fig. (3): Monthly mean numbers of cotton primary pests /100 plants at NAARI, Masindi and Kasese in the cotton season 1994/95

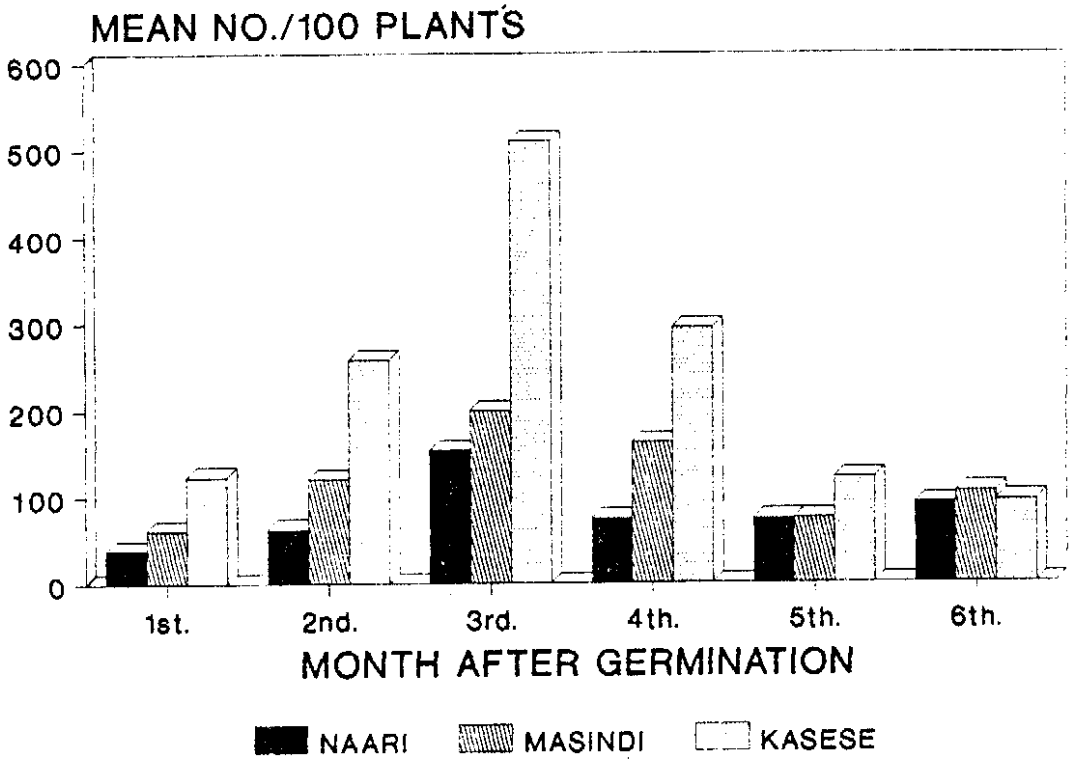
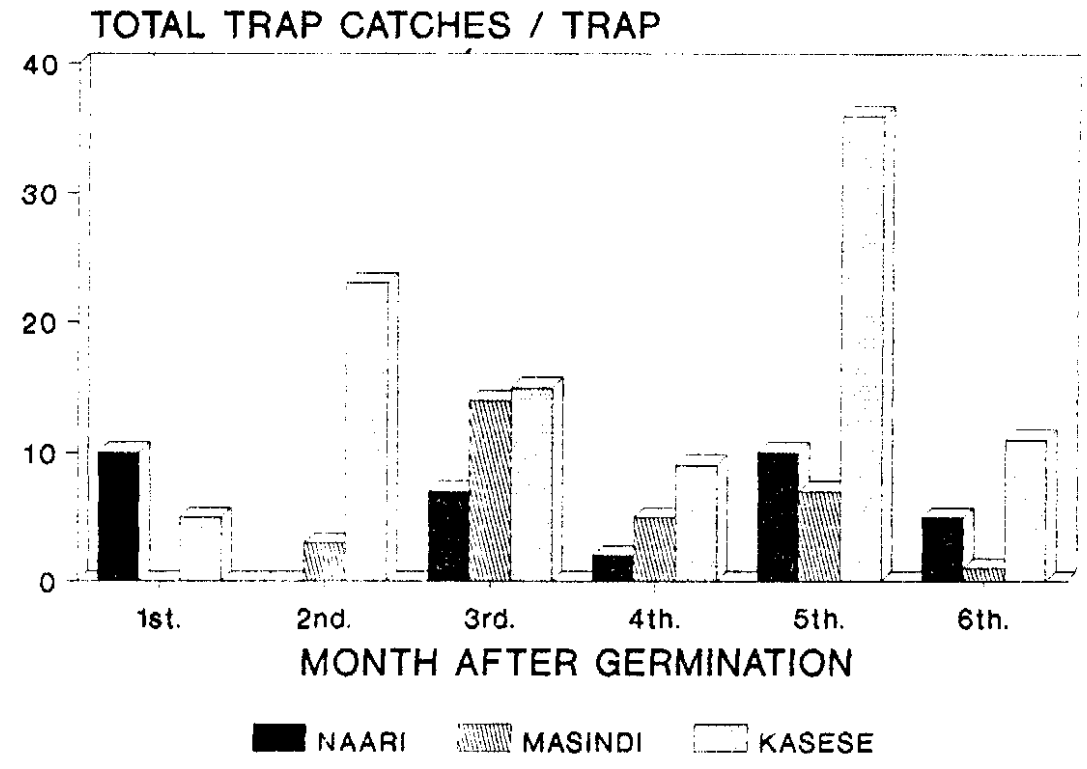
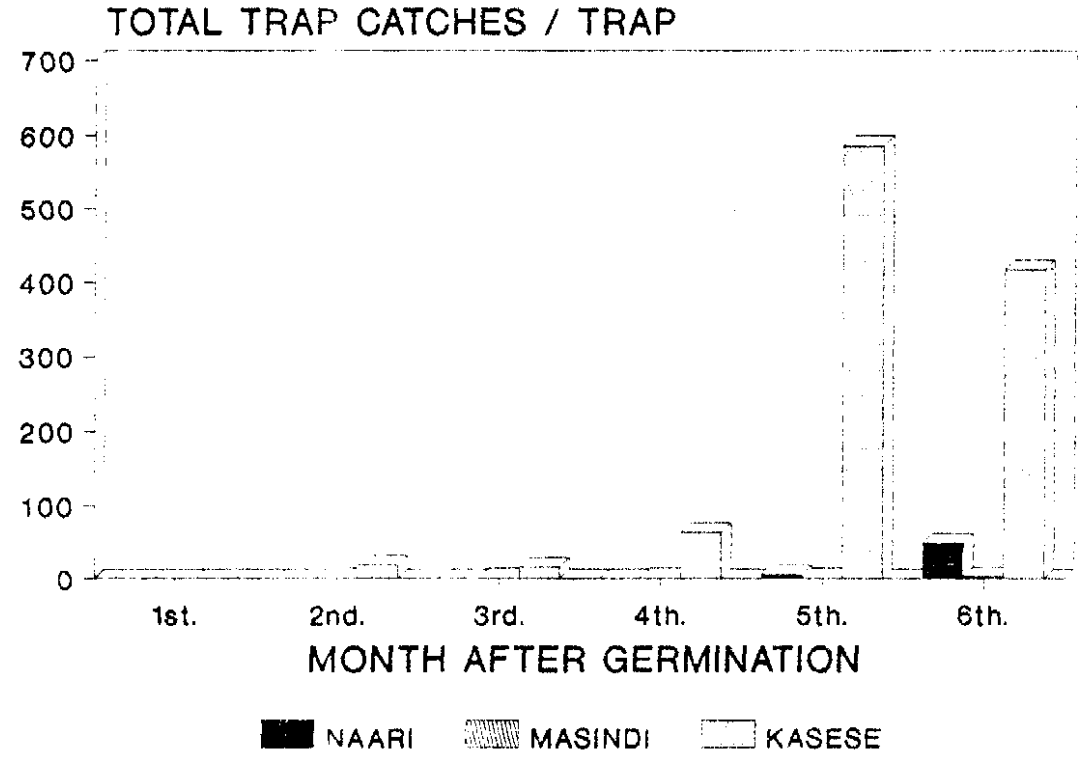


Fig. (4): Monthly mean numbers of common predators /100 plants associated with cotton pests at NAARi, Masindi and Kasese in the cotton season 1994/95.



ABW



PBW

Fig. (5): Monthly total sex pheromone trap catches of bollworms at NAARI, Masindi and Kasese in the cotton season 1994/95.