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Natural enemies of sesame webworm and the effect of additive intercropping on its incidence in Uganda

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ABSTRACT

Objectives: This study aimed to increase the grain yield of sesame by protecting it against sesame webworm. The specific objectives were to determine the effect of additive intercropping on incidence of sesame webworm and the occurrence of natural enemies with potential to biologically control the pest.
Methodology and results: Five plant population densities of sesame incorporated mid-way between finger millet rows spaced at 45 X 7.5 cm were 44444, 55556, 74074, 111111 and 222222 plants/ha. The control was sole sesame at a population density of 333333 plants/ha. The treatments were laid out in a completely randomised block design, with four replicates. Data were collected on incidence of sesame webworm and sesame grain yield. Webworm larvae recovered from this trial were reared and monitored for emergence of natural enemies. Additive intercropping had no significant effect on the incidence of sesame webworm. Sesame webworm larvae recovered from sole sesame had higher mortality (63.1%) than those from intercrops with 49.2%. Two natural enemies of the sesame webworm, *Hemipimpla* sp. and a nematode of the Order Mermithid, were discovered.
Conclusion and application of findings: Additive intercropping of sesame with finger millet has no benefit towards controlling sesame webworm and yet intercropping results into a significant (P=0.02) reduction in sesame grain yield. Mortality of sesame webworm larvae recovered from sole sesame was higher than for those from sesame + finger millet intercrop. Therefore, sole cropping of sesame is recommended for its high yields. Two natural enemies of sesame webworm namely *Hemipimpla* sp. and a Mermithid nematode exist in Uganda. An evaluation of these natural enemies for efficacy in the control of sesame webworm is recommended. Sesame webworm larvae died due to unknown factors, besides the two named natural enemies. These factors need to be identified.

Key words: Sesame webworm, additive intercropping, *Hemipimpla* sp, Mermithid nematode

INTRODUCTION

Sesame is a leading non-traditional oil export crop in Uganda (Anonymous, 2006). In addition to foreign exchange, sesame contributes to a relatively balanced diet of the people in northern and eastern Uganda (Anyanga & Obongo, 2001). Unfortunately, its grain yield under peasant farmers' practices was estimated at only 601 Kg ha^{-1} in 2005, yet up to 2500 Kg ha^{-1} can be achieved (Kathiresan & Damalingam, 1999; MAAIF & UBOS, 2000; Anonymous, 2005). The low yield is attributed to damage caused by insect pests of which sesame webworm, *Antigastra catalaunalis*, (DUP) (Lepidoptera; Pyralidae) is key (Ssekabembe *et al.,* 2006). The larvae of sesame webworm are the damaging stage in the life cycle of this moth. They spin silken webs around terminal leaves, eat the foliage and bore stems and pods, causing substantial damage to grains inside (Plate 1). Direct grain yield loss of 10-70% by this pest has been reported (Singh & Kalorn, 1985, Sexana & Jackmola, 1993).

Plate 1: The tip of a sesame plant damaged by sesame webworm.

The sesame webworm is reported to be attacked by a hymenopterous parasitoid, *Trathala flavo-orbitalis* Cam. A single larva of the webworm was found to harbour 6-8 larvae of the parasitoid (Murali & Thangavelu, 1989). There is no record of natural enemies of sesame webworm in Uganda. High plant population density of sesame (333333 plants/ha) has been reported to reduce incidence of sesame webworm (Ssekabembe *et al.,* 2006). Crop mixtures are also reported to have insect pest control benefits. Ssekabembe *et al* (2006) reported significant differences (P<0.05) in the incidence of sesame webworm in replacement mixtures of sesame with finger millet, sorghum and maize. According to them, the highest incidence occurred in the sesame + finger millet mixture and the least was in sesame + sorghum mixture. The effect of sesame + finger millet additive mixture on the incidence and damage caused by sesame webworm, however, is not known.

This method of intercropping sesame with finger millet is more appropriate for the people of northern and eastern Uganda who attach greater value to finger millet, which is their staple food (Ssekabembe *et al.*, 2001). The present study was therefore designed to determine the effect of additive intercropping of sesame with finger millet on incidence of sesame webworm and its relationship to sesame grain yield. In addition, the study sought to determine the occurrence of natural enemies of sesame webworm with potential for biological control of this pest. The effect of additive intercropping on these natural enemies was also investigated, since intercropping is reported to favour natural enemies of insect pests in general (Kyamanywa & Tukahirwa, 1988; Ogenga-Latigo *et al.,* 1993; Abate *et al.*, 2000).

MATERIALS AND METHODS

I. Effect of additive intercropping on incidence of sesame webworm

Trial site: The experiment was conducted at Tororo District Agricultural Training and Information Centre (Tororo-DATIC) and the National Semi-Arid Resources Research Institute (NaSARRI), in eastern Uganda. These sites were chosen mainly because they fall within the sesame growing areas of Uganda and intercropping sesame with finger millet is commonly practiced (Ssekabembe *et al.,* 2001). Tororo-DATIC is situated in Tororo municipality, about 6 km along the Tororo-Malaba Road. It is found at an altitude of 1185 m above sea level, latitude 0°41'5N and longitude 34°10'52E (Anonymous, 2007). NaSARRI is situated in Soroti district, about 27 km to the south-west of Soroti town. It is found at an altitude of 1140 m above sea level, latitude 01°50'N and longitude 33°40'E (Anonymous, 2007).

The experiment was conducted during the long (first season) and short (second season) rains of 2005. Sesame variety, "Sesim II" and finger millet variety, "Seremi II", both obtained from NaSARRI were used. During the first season, planting was done on 28th and 30th April at Tororo-DATIC and NaSARRI, respectively. Second season planting was carried out on 29th and 31st August at Tororo-DATIC and NaSARRI, respectively.

Trial layout: The five plant populations of sesame incorporated into finger millet were 44444, 55556, 74074, 111111 and 222222 plants/ha. The control was sole sesame with a population of 333333 plants/ha. The respective populations in the additive mixture were attained by intra-row spacing of sesame at 50, 40, 30, 20 and 10 cm mid-way between finger millet rows planted at 45 X 7.5 cm (296296 plants/ha). The plant population of sole sesame was attained using a spacing of 30 X 10 cm. The spacing of finger millet and sesame was attained by first drilling seeds in furrows and then thinning to the required spacing, two weeks after crop emergence. The treatments were laid out in a randomised complete block design (RCBD), with four replications. Each plot measured 3 x 6 m in size with 1m width in between to serve as walk ways. The crop was kept weed-free by hand weeding using a hoe twice at 3 and 8 weeks after planting.

Data recording: Incidence of sesame webworm was monitored by counting *in situ*, the larvae recovered from a random sample of ten plants, starting three weeks after crop emergence, when larvae were first detected. Monitoring continued on a fortnightly basis for a total of five times. Grain yield of sesame was measured from one square meter ($1m^2$) sample and later converted into kilograms per hectare (Kg ha^{-1}). Data were subjected to analysis of variance (ANOVA) using GenStat computer program (Anonymous, 2003) to generate means and least significant differences (LSD) at 5% level.

II. Occurrence of natural enemies of sesame webworm: Larvae of sesame webworm recovered from the treatments described above were collected and reared in labeled glass vials with perforated lids under ambient room conditions for two weeks (Plate 2). The larvae were fed on sesame leaves picked from the field.

Plate 2: Larvae of sesame webworm being reared in glass vials in the laboratory.

They were monitored daily for emergence of natural enemies and mortality. Upon reaching adult stage, insect natural enemies were preserved in 75% ethanol and delivered to the identification laboratory. The nematodes on the other hand were placed in sterile water and kept in a fridge at 4°C until they were identified. The number of the larvae that matured and those that died during rearing was recorded. Dead larvae were categorised according to the cause of their death. Natural enemies from the larvae were identified at the National Agricultural Laboratories Research Institute (NALRI), Kawanda and the Department of Crop Science, Makerere University. The investigation into natural enemies did not focus on microscopic ones.

RESULTS AND DISCUSSION

Effect of additive intercropping on incidence of sesame webworm and sesame grain yield: Additive intercropping of sesame into finger millet had no significant effect on incidence of sesame webworm (Table 1). These results are in agreement with Ssekabembe *et al.* (2006) who reported no significant difference in sesame webworm incidence between sole sesame and sesame mixed with finger millet in a replacement intercropping pattern. They however reported a significant difference in incidence of sesame webworm between sole sesame and sesame mixed with maize or sorghum.

Intercropping sesame with finger millet in an additive manner resulted into a significantly (P=0.02) lower sesame grain yield (ranging from 95.9-123.3 Kg ha^{-1}) compared to sole sesame with 254.5 Kg ha^{-1} (Table 1). The reduction in grain yield as a result of intercropping could be due to the lower population of sesame in the millet mixture in which finger millet had the highest population. In addition, the lower sesame yield in the sesame + finger millet mixture could be due to competition for resources between the crops (Baumann *et al.,* 2001). Intercropping has also been reported to reduce grain yield of maize and beans, when grown in mixtures (Fisher, 1977; Niringiye *et al.,* 2005).

Table 1: Effect of additive intercropping of sesame with finger millet on sesame webworm incidence and sesame grain yield.

Sesame population in sesame + finger millet additive mixture and sole sesame (Plants/ha)	Incidence of sesame webworm (Larvae/10 plants)	Sesame grain yield (Kg/ha)
44444	0.81	107.7
55556	0.70	95.9
74074	0.69	112.1
111111	0.54	123.3
222222	0.63	105.5
333333*	0.69	254.5
$LSD_{0.05}$	NS	42

*sole sesame

Natural enemies of sesame webworm: Two natural enemies were recovered from sesame webworm larvae during rearing (table 2). These natural enemies occurred at both study sites. One of them was a hymenopterous wasp of the family ichenumonidae and genus Hemipimpla (*Hemipimpla* sp.). One or two larvae of the wasp emerged and remained attached to the affected sesame webworm larva, which eventually died. The larvae of the wasp were white and approximately 0.5cm long during emergence. These larvae developed white leathery cocoons one day after their emergence to form pupae. The pupal stage lasted seven days and thereafter, an adult wasp emerged from the cocoon. The wasp occurred in both seasons, but was more prevalent in the second one. It was more prevalent at NaSARRI than Tororo-DATIC.

The other natural enemy recovered from sesame webworm larvae was an entomophagous nematode of the Order Mermithid. Two to fourteen threadlike white nematodes about 5-15 cm long emerged from each affected sesame webworm larva. The emergence of the nematodes started immediately the larvae were brought from the field and was completed within five days. The nematodes emerged from numerous holes causing their host to ooze out its abdominal fluid until it flattened out and died. The nematode only occurred in the first season, and it was more prevalent at Tororo-DATIC than NaSARRI. The occurrence of the Mermithid only during the first season could be due to the higher rainfall realized compared to the second season. Pre-parasites of most terrestrial mermithids hatch from eggs in the soil and migrate to the surface in search of a suitable host, and this migration usually occurs during periods of rain or heavy dew (Cuthbert, 1968).

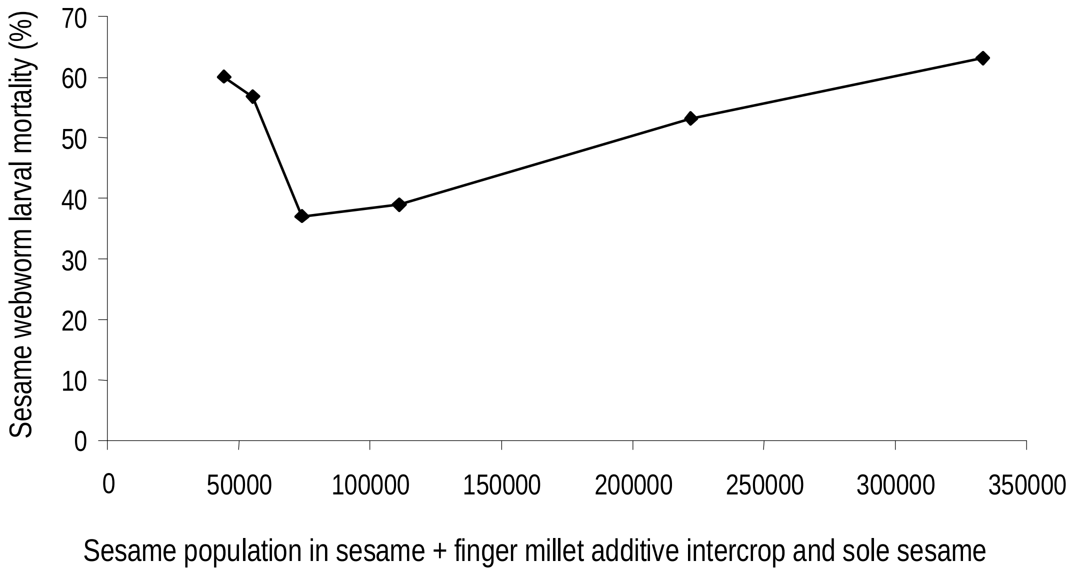
During rearing, there was also death of sesame webworm larvae due to factors other than the two natural enemies, but these were not verified during this study. Under natural conditions, the populations of most pest species are kept under check by a number of natural enemies (predators, parasitoids, and pathogens) and adverse weather conditions (Bonhof *et al* 1997, Conlong 1997, Polaszek 1997, Yitaferu & Walker, 1997). It is probable that there were microscopic pathogens that caused the death of the webworm larvae but were not investigated.

Effect of additive intercropping on mortality of sesame webworm larvae: Mortality of larvae of sesame webworm recovered from sole sesame was highest compared to those from the sesame + finger millet additive mixtures (figure 1). This contradicts the perception that the micro-climatic conditions in crop mixtures are unfavourable to pests but to natural enemies (Root, 1973; Abate 1997, Donald 1997). The death of more webworm larvae from the sole sesame could be due to factors other than natural enemies (Root, 1973).

The mortality of sesame webworm larvae from sesame + finger millet mixtures decreased progressively with increase in sesame population up to 74074 plants/ha and started to rise again (figure 1). It is not clear why larval mortality was higher in sesame populations lower than 74074 plants/ha. However, the trend after this population agrees with low incidence of sesame webworm on high plant population, as reported by Ssekabembe *et al.* (2006).

Table 2: Mortality of sesame webworm larvae caused by *Hemipimpla* sp, a Mermithid nematode and unknown factors.

Mortality factor	Percentage of larvae killed			
	Tororo-DATIC		NaSARRI	
	2005a	2005b	2005a	2005b
Hemipimpla sp	0	1.2	1.4	20
Mermithid nematode	20.2	0	8.3	0
Unknown	42.9	40.2	60.5	32.6
Total mortality	63.1	41.4	70.2	52.6



NB: sole sesame had the highest population of 333333 plants/ha

Figure 1: Effect of plant population in sesame + finger millet additive intercrop and sole sesame on mortality of sesame webworm larvae reared in the laboratory.

Conclusion: There was no significant effect of additive intercropping of sesame into finger millet on incidence of sesame webworm and yet intercropping resulted in a significant (P=0.02) reduction in sesame grain yield. A high sesame population results into higher mortality of sesame webworm larvae. Therefore, sole cropping of sesame at the optimum population of 333333 plants/ha, which was recommended by earlier researchers, is encouraged for high yields. Two natural enemies of sesame webworm namely the *Hemipimpla* sp. and a Mermithid nematode were identified. This is the first inventory of natural enemies of this pest in Uganda. An evaluation of these natural enemies for efficacy in the control of sesame webworm is recommended.

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