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Integration of time of planting and insecticide application schedule to control sesame webworm and gall midge in Uganda

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ABSTRACT

Objectives: This study aimed to increase grain yield of sesame by protecting it against sesame webworm and gall midge. The specific objective was to determine the appropriate time and frequency of insecticide application (insecticide application schedule) and time of planting of sesame to control the pests.
Methodology and results: Time of planting sesame included at the onset of rains, and at 2 and 4 weeks after onset of rains (WAO). Seven insecticide application schedules of the contact liquid insecticide Cypercal P 720 EC ® were investigated. This insecticide contains two active ingredients, 120 g/l cypermethrin and 600 g/l profenofos. Application of the insecticide twice at 2 and 4 weeks after emergence (WAE) on sesame planted at the onset of rain resulted into the lowest incidence (0.5 larvae/10 plants) of sesame webworm and highest grain yield (1039 Kg ha $^{-1}$). This was statistically comparable to the outcome with weekly insecticide application (same incidence) and grain yield of 1161 Kg ha^{-1}. The contact insecticide did not significantly reduce incidence and capsule damage by the sesame gall midge. The sesame gall midge had the least incidence and capsule damage on sesame planted two weeks after the onset of rain.
Conclusion and application of findings: Planting sesame at the onset of rains combined with insecticide application twice at 2 and 4 WAE is the most effective strategy of controlling sesame webworm and achieving the highest sesame grain yield. It is important to monitor the dominance of either sesame webworm or gall midge during crop growth. Where sesame gall midge dominates, delaying planting by two weeks after the onset of rain is preferable. Research on the effect of insecticide application schedule on sesame gall midge using systemic insecticides is recommended.

Key words: Sesame, webworm, gall midge, insecticide application, time of planting

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 & Dharmalingam, 1999; Anonymous, 2000; Anonymous, 2005). The low yield is due to, among other factors, insect pests of which sesame webworm, *Antigastra catalaunalis* (DUP) (Lepidoptera; Pyralidae) and sesame gall midge, *Asphondylia sesami*, Felt (Diptera; Cecidomyidae) are the major ones in Uganda (Ssekabembe *et al*., 2006).

Previous studies with cow peas showed that a combination of appropriate time of planting and timely insecticide application is more effective against pests than applying insecticides without considering the time of planting (Karungi *et al*., 1999). Pest populations may vary during the growing season, and time of planting can be used to avoid peaks of pest populations (Nderitu *et al*., 1990; Smit & Matengo, 1995; Clinton & Marlin, 2001). Harvir and Yadava (1985) recommended early planting as a control measure against sesame gall midge and sesame webworm. Early planting may also help to increase yield because the crop benefits from a full season's rainfall and soil nitrate fluxes, and may suffer less from weed competition (Smit & Matengo, 1995; van den Berg & Nur, 1998).

The National Agricultural Research Organisation (NARO) recommends applying dimethoate, an insecticide, against sesame pests at 10 days interval starting at 38 days after crop emergence (Anonymous, 1994). However, the majority of peasant farmers may not be able to afford pesticides to apply throughout the growth period of sesame. Over application of pesticides may also result into harmful impacts on public health, the destruction of natural enemies and pollinators, and the development of pesticide resistance, among others (Pimentel, 2005).

Combining time of planting with an appropriate minimum insecticide application strategy is most likely going to achieve greater control of the major pests of sesame than relying on either strategy independently. The present study was designed to determine the possibility of combining time of planting and insecticide application schedule to control sesame webworm and gall midge.

MATERIALS AND METHODS

Experimental sites: 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 at an altitude of 1185 m above sea level; latitude 0º41'5N and longitude 34º10'52E (Anonymous, 2007). NaSARRI is situated in Soroti district, about 27 km to the south-west of Soroti town, at an altitude of 1140 m above sea level, latitude 01º50'N and longitude 33º40' (Anonymous, 2007).

Planting and insecticide timing: The experiment was conducted during the long (first season) and repeated in the short (second season) rains of 2005. Sesame variety 'Sesim II', obtained from NaSARRI was used. Time of planting sesame was at the onset of rains, and 2 and 4 weeks after the onset of rain (WAO). During the first season, first planting (at onset of rains) was done on 28th and 30th April at Tororo-DATIC and NaSARRI, respectively. In the second season, first planting was carried out on 29th and 31st August at Tororo-DATIC and NaSARRI, respectively. Application schedules of Cypercal P 720 EC®, a contact insecticide that contains 120 g/l cypermethrin and 600 g/l profenofos, included: (1) No application; (2) Once at two weeks after crop emergence (WAE); (3) Once at flowering; (4) Twice at 2 and 4 WAE; (5) Twice at 2 WAE and two weeks after 50% flowering; (6) Thrice at 2 WAE, 50% flowering and two weeks later and; (7) weekly. The pesticide was applied at a rate of 225 g a.i. ha^{-1}.

Trial layout: The treatments were laid out in a split plot design with time of planting as the main plot, and replicated three times. Each plot measured 3 x 6 m in size with 1m width in between plots 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. Counting started three weeks after crop emergence (WAE) when larvae were first detected. Monitoring continued on a fortnightly basis for a total of five times. Incidence of sesame gall midge was monitored starting 7 WAE, when galls first appeared on the capsules and continued on a fortnightly basis for a total of three times. Ten plants were randomly selected at each fortnightly visit and their capsules examined for gall midge larvae. Capsule damage due to gall midge infestation was assessed one week before crop harvest. This was computed as the proportion (%) of capsules with galls. Grain yield of sesame was measured from an area of one square meter ($1m^2$) and 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.

RESULTS AND DISCUSSION

The incidence of sesame webworm significantly ($P<0.001$) declined with delayed planting (Fig 1 & 2). A similar relationship between pod sucking bugs and defoliators with planting time of soybean was reported by Sastawa *et al*. (2003). These researchers however noted that the higher incidence of these pests on early sown soybean did not result in significant reduction in grain yield. There were significant interactions between time of planting and site ($P=0.007$); and between time of planting and season ($P<0.001$) regarding incidence of sesame webworm (Figures 1 & 2). The incidence was lower at NaSARRI than at Tororo-DATIC (figure 1) and in the first season than the second one (figure 2).

The factors affecting population dynamics of sesame webworm may be variable at the two sites. 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). In addition, the longer rainfall duration in the first season may not be favorable to the webworm.

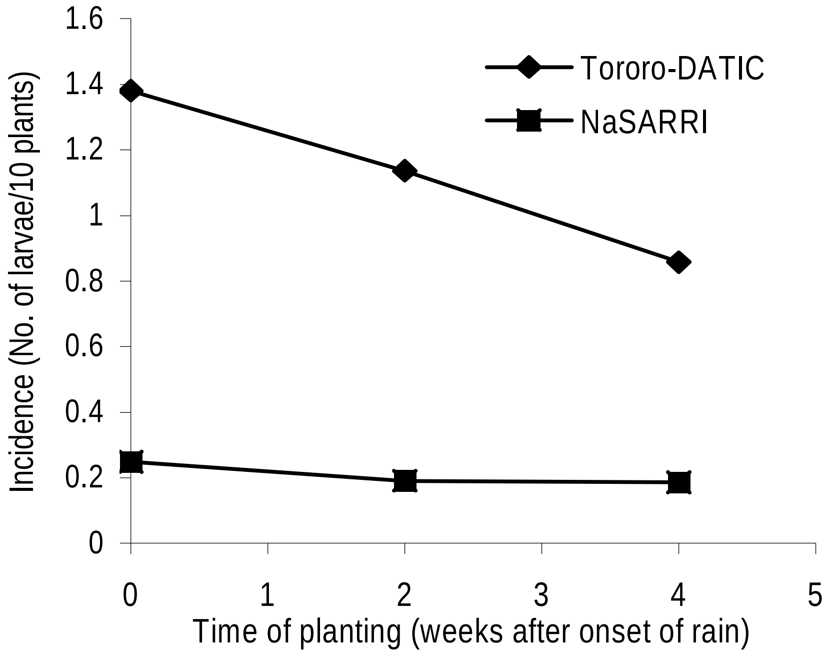


Figure 1: Effect of time of planting on incidence of sesame webworm as influenced by site.

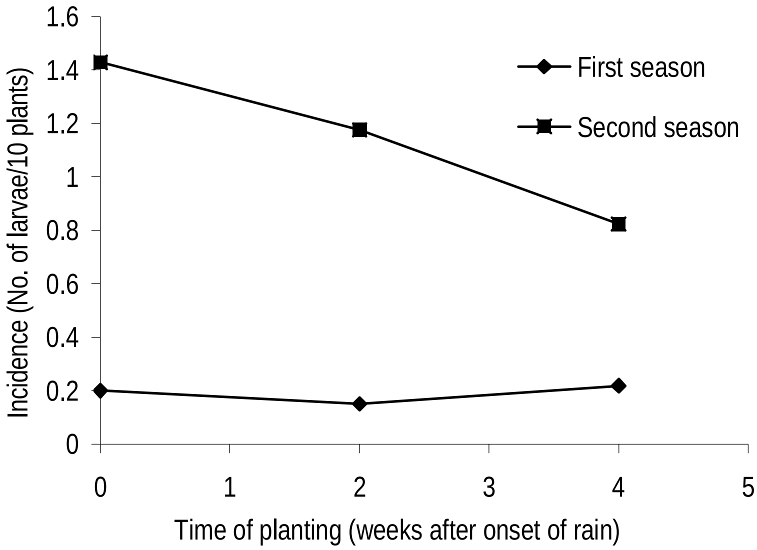


Figure 2: Effect of time of planting on incidence of sesame webworm as influenced by season.

Incidence of sesame gall midge was significantly (P<0.001) lowest on the crop planted two weeks after the onset of rain (figure 3). Capsule damage due to sesame gall midge was also significantly lowest (P=0.05) on sesame planted two weeks after the onset of rain (figure 4). These findings concur with the recommendation by Harvir and Yadava (1985) to plant sesame early to control the two major pests. The current study specified planting time in relation to the onset of rain.

There was a significant (P<0.001) interaction between time of planting and crop development stage regarding incidence of sesame gall midge (figure 3). At 9 and 11 weeks after planting, the highest incidence of sesame gall midge was recorded on the crop planted at the onset of rain and declined progressively with delay in planting. However, when the crop was observed at 13 weeks after planting, the lowest incidence was on sesame planted 2 weeks after the onset of rain; while the highest was on the crop planted at 4 weeks after the onset of rain. It could be that at 13 weeks after planting, the newly emerged gall midge adults also start reproducing and act as a source of new infestation for the crop planted 4 weeks after the onset of rain.

There was a significant (P=0.02) interaction between time of planting and site regarding capsule damage by sesame gall midge (figure 4). Whereas capsule damage decreased progressively with delay in planting at NaSARRI, it decreased with delay in planting by two weeks then rose sharply when planting was delayed by another two weeks at Tororo-DATIC. Unlike sesame webworm, sesame gall midge was more active at NaSARRI than the Tororo-DATIC site.

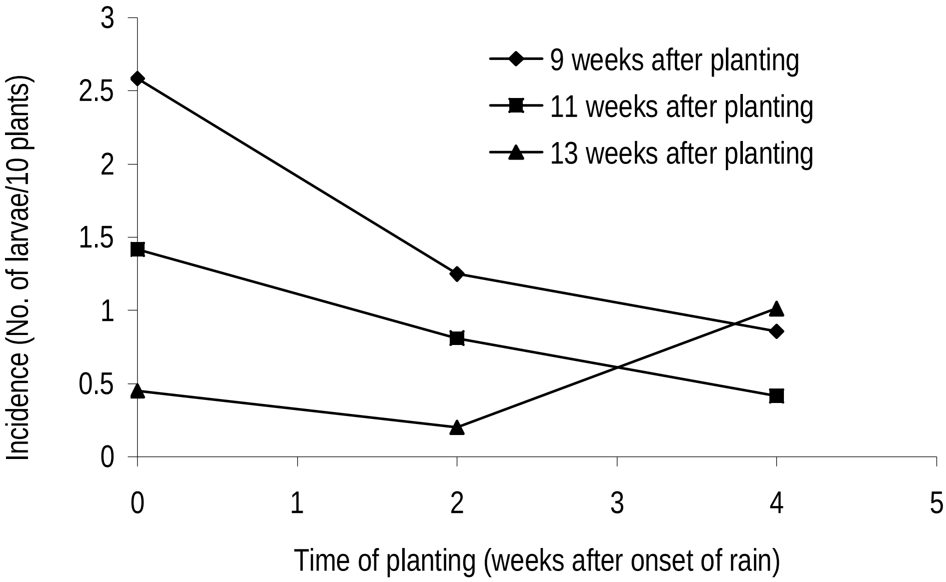


Figure 3: Effect of time of planting on incidence of sesame gall midge as influenced by crop development stage.

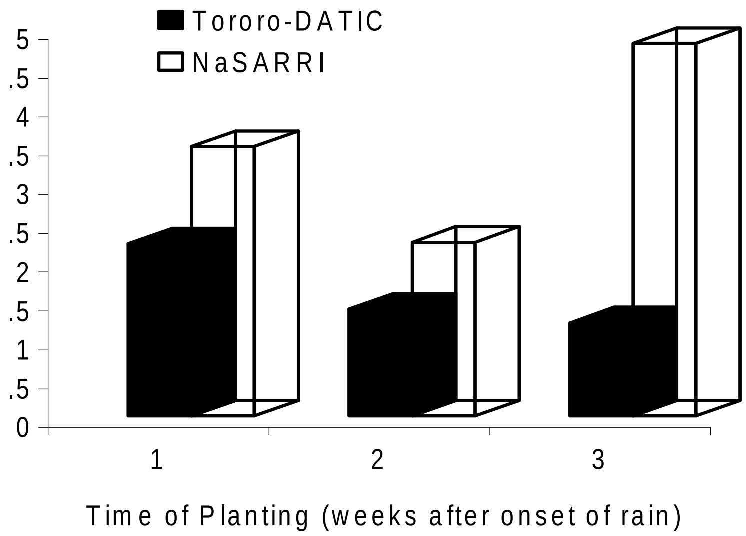


Figure 4: Effect of time of planting on capsule damage due to sesame gall midge as influenced by site.

Significantly ($P<0.001$) lower incidence of sesame webworm (0.5 larvae/10 plants) was recorded for the weekly insecticide applications, twice at 2 and 4 WAE, and once at 2 WAE compared to the other treatments (table 1). Correspondingly, significantly ($P<0.001$) higher grain yield of sesame planted at the onset of rain was realized for the weekly insecticide applications and twice at 2 and 4 WAE (table 2). Although Cypercal P 720 EC ® application once at 2 WAE significantly reduced incidence of sesame webworm, it did not result in a significant increase in grain yield. Considering the cost of applying pesticides, applying twice at 2 and 4 weeks after crop emergence would be more cost effective than weekly application, and it produced grain yield that was not significantly different from that of weekly application.

The sesame gall midge was not significantly affected by the application of Cypercal P 720 EC ®.

Since the larvae of the gall midge hide in the capsules, it may be difficult for the pesticide to get in contact with them. This therefore means that the increase in grain yield observed as a result of insecticide application was only due to the control of sesame webworm.

Application of Cypercal P 720 EC ® did not result in a significant effect on grain yield from late planted sesame (table 2). This could partly be explained by the fact that the webworm which was controlled by the insecticide was less prevalent on the late planted crop, and therefore, application of the insecticide on this crop was not necessary. It implies that the delay in planting reduces the incidence and damage by sesame webworm but at the expense of the benefits of early planting. By computation, the yield of late planted sesame that was not sprayed with the insecticide declined by 35 and 72%, when planted 2 and 4 weeks after the onset of rain, respectively.

Table 1: Effect of insecticide application schedule on incidence of sesame webworm

Insecticide application schedule	Mean incidence (larvae/10 plants)
None	0.8
Once at 2WAE	0.5
Once at flowering	0.9
Twice at 2 and 4WAE	0.5
Twice at 2WAE and 2 weeks after 50% flowering	0.8
Thrice at 2WAE, 50% flowering and 2 weeks later	0.6
Weekly	0.5
$LSD_{0.05}$	0.2

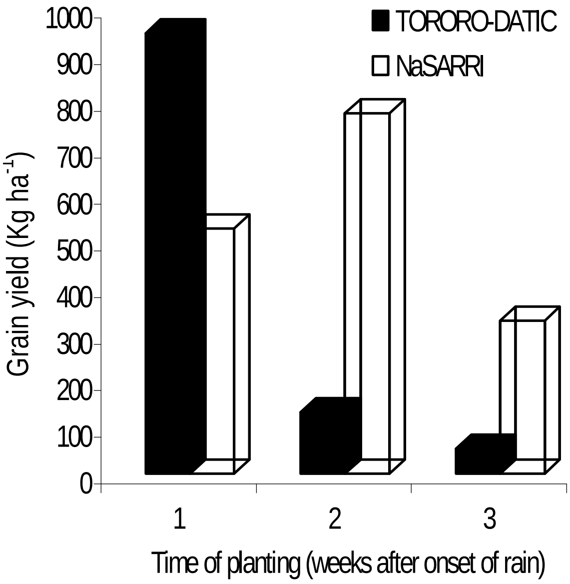
Table 2: Effect of insecticide application schedule on grain yield of sesame as influenced by time of planting (weeks after onset of rain (WAO))

Insecticide application schedule	Grain yield (Kg ha-1)		
	Onset of rain	2 WAO	4 WAO
None	616	399	175
Once at 2WAE	707	408	197
Once at flowering	503	494	137
Twice at 2 and 4WAE	1039	489	264
Twice at 2WAE and 2 weeks after 50% flowering	430	327	193
Thrice at 2WAE, 50% flowering and 2 weeks later	696	491	177
Weekly	1161	565	191
Mean	736	453.3	190.6

NB: $LSD_{0.05}=264.1$

There was a significant ($P<0.001$) interaction of time of planting sesame with site regarding grain yield. Sesame grain yield was highest on the crop planted at the onset of rain and 2 weeks later at Tororo-DATIC and NaSARRI, respectively (Figure 5). The lowest yields were recorded when the crop was planted 4 weeks after the onset of the rains at both sites. This could be partly because early planted crop benefits from a full season's rainfall and initial high soil nitrate levels that are available at the beginning of the rains while at the same time undrgoing less weed competition (Baumann *et al*., 2001). The site effects could be due to differences in the prevalence of the two pests. At NaSARRI, for example, the gall midge, which was the more prevalent pest, had the least incidence and capsule damage on sesame planted two weeks after the onset of rain, and consequently, grain yield was highest on this crop.

There was a significant ($P<0.001$) interaction of time of planting with season regarding grain yield of sesame. The yield was higher in the first season than the second one (figure 6). This may be due to the difference in the amount and duration of rainfall, being higher in the first season than in the second one. There was also a significant ($P<0.001$) interaction of insecticide application schedule with season regarding grain yield of sesame (figure 7). The effect of insecticide application was only significant during the first season.



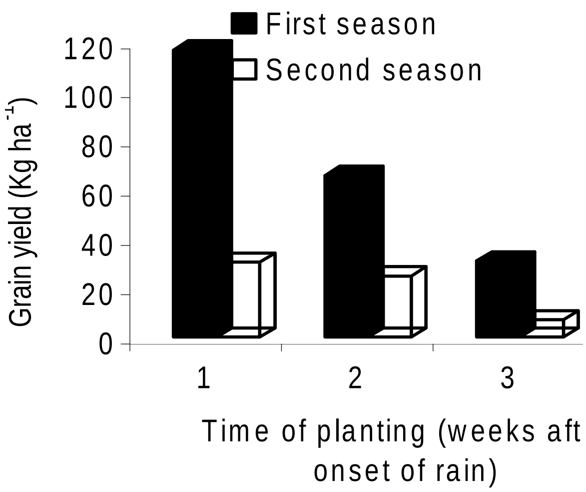


Figure 5 (left): Effect of time of planting on grain yield of sesame as influenced by site.
Figure 6(right): Effect of time of planting on grain yield of sesame as influenced by season.

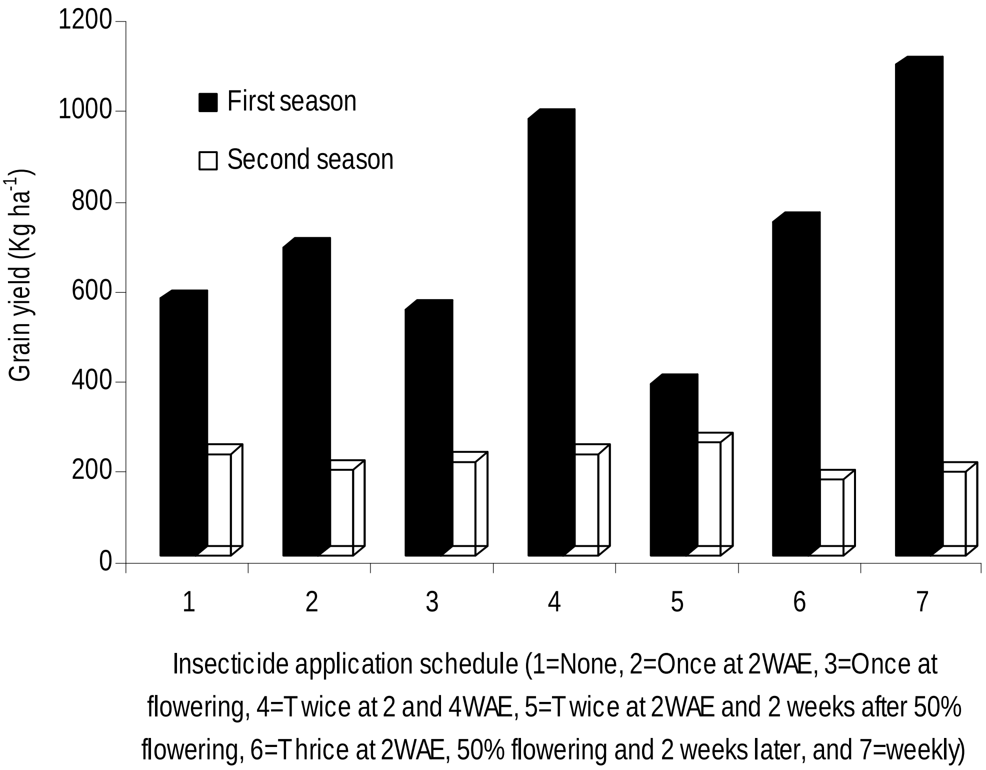


Figure 7: Effect of insecticide application schedule on grain yield of sesame as influenced by season.

Conclusion: Based on our findings, planting sesame at the onset of rain combined with application of Cypercal P 720 EC ® twice at 2 and 4 weeks after crop emergence is the most effective strategy of controlling sesame webworm and achieving the highest grain yield. Monitoring of the dominance of either sesame webworm or gall midge during the growth season is important. In areas dominated by sesame gall midge, delaying planting by two weeks after the onset of rain would be beneficial. Research on the effect of insecticide application schedules on sesame gall midge using systemic insecticides is recommended.

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