RESULTS OF PRELIMINARY PITFALL TRAPPING TRIALS FOR POTENTIAL ARTHROPOD PREDATORS OF *ELDANA SACCHARINA* WALKER (LEPIDOPTERA: PYRALIDAE)

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Abstract

On the La Mercy Field Station of the South African Sugar Association Experiment Station (SASEX), epigeal arthropod fauna were monitored over a seven month period using pitfall traps. The site comprised rows of sugarcane alternating with either a row of maize or a row of sorghum, and control plots of a mixed grass roadway and a commercial sugarcane field. The largest arthropod populations were trapped in intercropped cane, maize and sorghum rows. The most common groups of arthropods caught were beetles of the family Scarabaeidae, ants of the genera *Pheidole* and *Myrmecaria*, and lycosid spiders. The number of insect groups collected from each site varied between 11 and 16. However, numbers of individuals of each group trapped in pure sugarcane plots were five times lower than those caught in the intercrop sites. These very preliminary trials have shown that, among the arthropods caught, there were potential predators which could be monitored in sugarcane fields. The more diverse the habitat, the greater the number of potential predators found.

Introduction

There is a growing awareness of the importance of predacious insects in biocontrol of insect pests, particularly in short term or disturbed environments (Ehler, 1990). Predators need to consume more than one individual host (prey) in order to reach maturity. A larval predator, for example, will need to consume many individuals of a prey species during its lifetime, whereas a larval parasitoid will consume only one. As a result, De Bach (1964), in his review of biocontrol agents, suggested that predators are more efficient control agents than parasitoids at high host densities (e.g. the *Eldana saccharina* population in drought years) while parasitoids must be more efficient at low host densities. Some of the most spectacularly successful examples of biological control have been achieved using predacious species, e.g. control of cottony-cushion scale by the vedalia beetle (De Bach, 1964) and citrus scale insects by *Chilocorus nigritus* (Samways, 1989). In addition, Leslie (1986) showed that greater predation occurred where *E. saccharina* was more abundant, and that parasitism by parasitoids introduced into sugarcane was more effective at lower host densities (SASEX Annual Progress Reports, 1984-).

This paper examines the abundance of epigeal arthropods, including potential predators, found in an intercropping situation in sugarcane. It is the first report of a study which is aimed at enhancing the efficacy of indigenous predators in southern African sugarcane.

Materials and methods

Preliminary field surveys were conducted using pitfall traps (Donnelly and Giliomee, 1985), to determine the incidence of naturally occurring epigeal predators between and within sugarcane, maize and sorghum rows (i.e. intercrop habitat), and in a commercial sugarcane field and an adjacent mowed grass break (control).

Site description

Intercrop habitat. Sampling took place on the SASEX Field Station at La Mercy, KwaZulu-Natal (29°36'S; 31°05'E), in a field set out to assess resistance of selected sugarcane varieties to *E. saccharina* (Field 215, Trial ERF 1/93). The varieties were planted in rows in four replicated plots. Rows of sorghum and maize alternated with the rows of sugarcane. Planting of sugarcane varieties took place from 13 to 16 August 1993, and maize and sorghum were planted on 7 and 8 December 1993.

Control habitats. A four metre roadway adjacent to the above plots, comprising a mixed grass sward which was regularly mowed, provided one control. A commercial sugarcane field opposite the trials, on the other side of the roadway, was the other control.

Sampling

Intercrop habitat. To establish the effect of habitat diversity on the epigeal arthropod fauna, as caused by intercropping sugarcane with maize and sorghum, a series of three pitfall traps, one metre apart, were placed in each of the four replicated plots in the following positions:

- a sugarcane row
- a maize row
- a sorghum row
- an interrow between sorghum and sugarcane
- an interrow between maize and sugarcane.

Each of the replicate plots was divided into blocks, and the blocks were numbered for plant breeding purposes. These numbers formed a grid. Random numbers were generated, and those corresponding with numbers on the grid were used to position the series of pitfall traps in the above positions in each plot.

Control habitats. A series of three pitfall traps were positioned two metres into the adjacent grass roadway (midway); two opposite two of the replicates of the intercrop habitat, and one opposite an adjacent pesticide trial.

Another series of three pitfall traps were placed in the adjacent commercial sugarcane field, in line with the series in the grass roadway. They were positioned in the third interrow from the roadway.

Trap construction. Traps were constructed as described by Samways (1983). The trap proper was an 18 × 150 mm glass test tube containing two to three mℓ of a mixture of 70% denol and glycerol (7:3). Each trap was placed in a 200 mm length of black irrigation piping which was permanently sunk into the ground, and corked when not in use. This system limited habitat disturbance to the time the pitfall trap case was placed in position (Samways, 1983).

When in operation, a test tube was dropped into the uncorked pipe, with the lip of the test tube flush with the soil surface. Sampling was for a continuous period of 98 hours (Jensen and Metz (1979) and Samways (1983) considered 72 continuous hours as sufficient for maximum capture). A

Table 1

Range and abundance of epigeal arthropod groups caught in pitfall traps (arthropod number corresponds with numbers in relevant tables presented).

Arthropod group number	Arthropod group (order: family: genus/species)	% contribution to total arthropods found
1	Mixed Dermaptera	0,50
2	Orthoptera: Gryllidae	0,81
3	Orthoptera: Acrididae	0,11
4	Mixed Diptera	0,93
5	Hymenoptera: Scoliidae	0,03
6	Hymenoptera: Eurytomidae	0,24
7	Hymenoptera: Bethylidae	0,02
8	Hymenoptera: Pteromalidae	0,01
9	Hymenoptera: Ichneumonidae	0,02
10	Hymenoptera: Pompilidae	0,02
11	Hymenoptera: Ceraphronidae	0,01
12	Hymenoptera: Chalcididae	0,01
13	Hymenoptera: Multillidae	0
14	Hymenoptera: Formicidae: *Myrmecaria* sp.	3,75
15	Hymenoptera: Formicidae: *Pheidole megacephela*	27,90
16	Hymenoptera: Formicidae: Unknown spp.	0,35
17	Blattodea: Blattidae	0,01
18	Neuroptera: Myrmeleontidae	0
19	Mixed Hemiptera	0,35
20	Mixed Heteroptera	0,06
21	Araneida: Lycosidae	4,34
22	Araneida: Clubionidae	0
23	Araneida: Thomisidae	0
24	Araneida: Unknown spp.	0,03
25	Coleoptera: Scarabaeidae	57,80
26	Coleoptera: Staphylinidae	0,28
27	Coleoptera: Carabidae	0,84
28	Coleoptera: Other families	1,40
29	Coleoptera: Coccinellidae	0,13
30	Mantodea: Mantidae	0,02
31	Mixed Collembola	0,37
32	Unknown arthropods	0,06

period of 28 days elapsed between sampling, which allowed a rest period when no epigeic arthropods were removed from the habitat.

Trapping took place from February 1994 to September 1994. In all cases, sampling was terminated when the cane was harvested.

Results

Dominant groups of epigeal arthropods found

Table 1 shows the range (by name) and relative abundance of arthropods found.

Two groups comprised 86% of individuals found. Adult Scarabaeidae (group 25) were most abundant (57,80%). The ant *Pheidole megacephela* (group 15) was most abundant (27,90%). Lycosid spiders (group 21) followed, although these comprised only 4,34% of total individuals caught. All other groups varied in abundance, with none exceeding 3,75%.

Effect of habitat on epigeal arthropods

Figure 1 shows the relative abundance of total arthropods caught in the different habitats provided on the ground in the intercrop field.

The habitat with the greatest proportion of arthropods was the mowed roadway with mixed grass cover (22%), and that with the least was the commercial sugarcane field (8%). In the intercrop field itself, arthropods caught in the interrows between sugarcane and the two other crops comprised 13% of the total catch; those caught in sorghum rows 14%, and those in maize rows 11%. Most arthropods (17%) were caught in the sugarcane rows of this field. Table 2 shows the different arthropod groups caught in the actual intercrop, the commercial sugarcane and the grassed roadway.

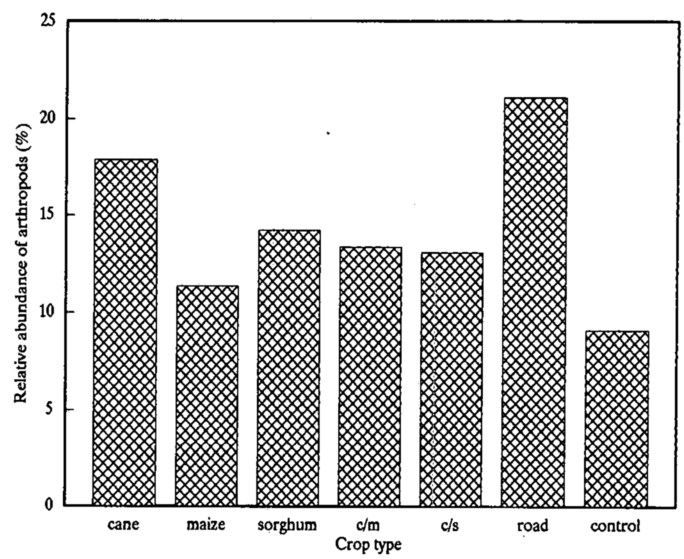

FIGURE 1 Relative abundance of arthropods caught in pitfall traps in different habitats provided by the sugarcane-sorghum-maize intercrop and control plots (c/m = cane/maize interrow; c/s = cane/sorghum interrow).

Again, two groups dominated, the Scarabaeidae (group 25) and *Pheidole megacephela* (group 15). The intercrop situation contained significantly more scarabs (41%) and *P. megacephela* (17%) when compared with the other two habitats. This habitat also had greater proportions of *Myrmecaria* sp. (group 14, 3,5%), lycosid spiders (group 21, 4%), various Coleoptera (group 28, 1,0%), predatory carabids (group 27, 0,65%), and various Diptera (group 4, 0,7%) than the other

Table 2

Relative abundance (%) of arthropod groups caught in all pitfall traps placed in the sugarcane-sorghum-maize intercrop and the two control plots. Arthropod group numbers as in Table 1.

Arthropod by group number	Total of intercrop habitats	Sugarcane control	Grass roadway control
1	0,03	0,01	0,10
2	0,30	0,41	0,10
3	0,08	0,02	0,01
4	0,70	0,17	0,05
5	0,01	0	0,02
6	0,21	0,03	0,01
7	0,02	0	0
8	0	0,01	0
9	0,02	0	0,01
10	0,02	0	0,01
11	0	0,01	0,01
12	0,01	0	0
13	0	0	0
14	3,53	0,03	0,20
15	16,95	4,56	6,43
16	0,27	0,01	0,08
17	0,01	0	0
18	0	0	0
19	0,23	0,9	0,03
20	0,06	0	0
21	4,01	0,16	0,16
22	0	0	0
23	0	0	0
24	0	0,01	0,02
25	41,06	3,39	13,40
26	0,20	0	0,08
27	0,65	0,09	0,10
28	1,24	0,06	0,10
29	0,10	0,01	0,01
30	0,01	0	0,01
31	0,07	0,05	0,25
32	0,05	0,01	0,01

habitats. The commercial sugarcane habitat was poorest in all arthropod groups other than gryllids (group 2, 0,4%).

The specific foraging sites of the 12 most abundant arthoropod groups in the intercrop (crop rows vs interrows) is shown in Table 3.

In all cases, there were more individuals of all listed arthropod groups in crop rows than in interrows.

To determine which crop supported most arthropods, the relative abundance of groups in each crop and in interrows of different crops was compared (Table 4).

Predators such as lycosid spiders (group 21) were most common in sorghum rows, and least common in the interrows. *P. megacephala* (group 15) was most common in sorghum and sugarcane rows and least common in maize rows.

Table 3

Relative abundance (%) of arthropod groups in rows and interrows of the intercrop plot. Arthropod group numbers as in Table 1.

Common arthropod groups by number	Crop rows	Crop interrows
2	0,16	0,14
4	0,50	0,20
6	0,12	0,09
14	2,60	0,92
15	10,54	6,41
16	0,19	0,09
19	0,13	0,10
21	3,17	0,85
25	24,32	16,74
26	0,14	0,06
27	0,35	0,30
28	0,89	0,35

Discussion

Lack of diversity in the sugarcane habitat is exacerbated by weed control practices, and a reluctance to intercrop sugarcane with other crops. This is agronomically correct practice for optimum sugarcane growth, but is questionable if one needs to control possible pests. The establishment of a pest in such a crop may cause losses that outweigh the yield increase gained from good weed control, lack of intercropping and other agronomic practices promoting a monoculture. The current *E. saccharina* infestation in southern African sugarcane could fall into this category.

This study showed that predators which were small enough to attack eggs and young larvae of *E. saccharina* in sugarcane (*P. megacephela* (group 15), lycosid spiders (group 21), carabid and staphylinid beetles (groups 27 and 26 respectively), and *Myrmecaria* sp. (group 14)) formed a very small percentage of the total arthropods caught over the sampling period (37,13%). If *P. megacephala* were excluded, potential predators of *E. saccharina* would comprise only 9,17% of the arthropods caught.

Literature supports the view that increased plant diversity increases natural enemy efficiency in agroecosystems. In his review of this subject, van Emden (1990) cites many examples of the type of diversity that has been created, and increased natural enemy activity that has followed. This paper

Table 4

Relative abundance of arthropod groups in rows of each crop in the intercrop habitat compared with interrows between the crops. Arthropod group numbers as in Table 1.

Arthropod group by number	Cane row	Maize row	Sorghum row	Cane/maize interrow	Cane/sorghum interrow
2	0,07	0,03	0,05	0,08	0,06
4	0,17	0,11	0,23	0,10	0,09
6	0,04	0,02	0,06	0,06	0,03
14	2,23	0,23	0,14	0,77	0,15
15	4,83	1,22	4,49	2,92	3,50
16	0,01	0,05	0,12	0,03	0,06
19	0,03	0,05	0,05	0,05	0,06
21	0,93	0,54	1,70	0,49	0,35
25	9,16	8,38	6,78	8,39	8,35
26	0,06	0,03	0,06	0,03	0,03
27	0,08	0,15	0,13	0,15	0,14
28	0,17	0,42	0,31	0,20	0,15

provides a further example of increased arthropod diversity and populations caused by intercropping sugarcane with two other graminaceous crops (maize and sorghum), when compared with impoverished arthropod communities in a commercial sugarcane field. It also indicates that further investigations into increasing the habitat diversity in sugarcane fields may have merit (Ali and Reagan, 1985).

Ways of increasing this diversity, both within and outside crops, are as follows:

Within crops. A low intercrop (e.g. grain legumes between maize, or weeds within a crop) may change the crop background both visually and olfactorily to arriving insects. The intercrop may provide flowers as adult feeding sources for parasitoids or predators, or provide shelter and more humid conditions near the ground for epigeal predators. This is the situation provided in part by the sugarcane/sorghum/maize intercrop of the present study. Increased diversity in vegetation increased the number of prey insects for predatory arthropods. In addition, arthropods used the greater amount of litter cover, provided in this situation by sugarcane, for shelter.

Plant diversity outside the crop. Plants outside the crop may influence natural enemy efficacy within the crop in a number of ways. They provide sources of adult food, e.g. flowers; alternative prey at times of prey scarcity within the crop (natural enemies may depend for their survival on prey living on plants outside the crop once the latter is harvested. This will however, allow natural enemies to colonise the crop earlier and in larger numbers than would otherwise be the case); and shelter for overwintering or in unfavourable crop conditions. The mowed grass break sampled during this study provided an important refuge for a number of arthropod groups, as shown by the larger numbers of arthropods found therein during the study.

The above section discusses some attributes which may be necessary for natural enemies to be effective in a crop. In this situation, as van Lenteren (1987) points out, the insect habitat may lack only certain key requisites, and addition of these may make natural enemies more effective. The introduction of sorghum to the sugarcane habitat, for example, increased the presence of lycosid spiders and staphylinid beetles. The variation in habitats provided by the intercrop, in addition, retained and increased foraging arthropod predators.

Van Lenteren (1987) does, however, warn that before habitat manipulation can be applied with success, it is of fundamental importance that the structure, functions and economics of agroecosystems are well understood. Only if the cause and effect pathways in agroecosystems are known before and after manipulation, will one be able to objectively determine whether improved natural enemy action through manipulation has led to any result. This paper thus reports only on the very early investigatory approaches to this long term control strategy. It provides an inventory of arthropods found in one intercrop option, in one sampling season at one locality in the southern African sugar belt.

Conclusion

Intercropping sugarcane with sorghum and maize increased groups and numbers of arthropods, including potential predators, compared with those found in a commercial sugarcane monoculture. Observations made in this study suggest that manipulation of the sugarcane habitat may be used as a tool to increase predator efficacy. However, much investigatory work needs to be completed on the predatory potential of dominant arthropods against *Eldana* and on different intercrop options, so that maximum benefit may be obtained.

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