EFFECTS OF PRE-TRASHING SUGARCANE ON OVIPOSITION, AND ON PREDATION OF EGGS AND MOTHS OF *ELDANA SACCHARINA* (LEPIDOPTERA: PYRALIDAE)

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Abstract

The influence of the agronomic practice termed pre-trashing on the survival of eggs and adults of the sugarcane borer *Eldana saccharina* Walker was studied. Moths labelled with the radio-isotope phosphorus-32 were released into field cages, and a Geiger counter was used to find egg batches laid by the females. The position and extent of predation on egg batches were recorded. In pre-trashed sugarcane nearly half the recovered egg batches were found in the litter layer. In sugarcane not pre-trashed most batches were recovered from the dry leaf material on stalks, and only 9% of batches came from the litter layer. A greater number of batches and a higher percentage of eggs were attacked by predators in pre-trashed sugarcane. However, predation on adults seemed to have been greater in sugarcane not pre-trashed.

Introduction

The practice termed pre-trashing has been shown to decrease numbers of *Eldana saccharina* in sugarcane (Carnegie and Smaill[2]). It is a simple but labour-intensive procedure; much of the dead leaf material associated with stalks is manually removed and deposited at the base of the stool and in the inter-row. How pre-trashing influences the survival of *E.saccharina* is not clearly understood, and the present study was conducted to investigate the hypothesis that pre-trashing increases predation on eggs and adults.

A further objective was to identify the oviposition sites selected by females in sugarcane and to provide an estimate of batch size and position for subsequent ecological studies of mortality factors.

Because of the dense, tangled nature of the sugarcane habitat, direct searching for eggs is a laborious and inefficient procedure. Accordingly, use was made of the radio-isotope phosphorus-32 to label *E.saccharina* adults. Any eggs laid by labelled females would themselves be radioactive and so subject to detection in the field by means of a portable Geiger counter.

Materials and methods

Labelling E.saccharina *adults with phosphorus-32*

Larvae, visually assessed to be third or fourth instar, were labelled with ^{32}p by feeding them on an artificial diet containing the radio-isotope. The diet was that developed by Atkinson[1], except that cellulose was replaced by a larger volume (120 g/l diet) of dried, crushed sugarcane.

The radio-isotope was received in 4 ml quantities with an activity of 1 mCi/ml. This entire volume was added to 4 l of warm, liquid diet and thoroughly mixed to give a final concentration of 1 μ Ci ^{32}p/ml. Before the diet cooled, the pH was adjusted with NaOH to between pH 7 and pH 8.

After cooling the labelled diet was dispensed, 10 ml at a time, into individual glass vials. Larvae were then introduced into the diet, one larva per vial, and the vials sealed. The vials were examined regularly and adults that emerged were collected, mated and released into field cages.

Preparation of field cages and the release of adults

Field cages were prepared in pairs; one cage of a pair enclosed pre-trashed sugarcane, while the other enclosed sugarcane that was not pre-trashed. The cages comprised a metal 2 m × 1 m × 2 m frame which was covered with shadecloth of a sufficiently fine mesh (40% shade) to prevent the escape of released moths. As a further precaution against their escape, soil was banked up around the perimeter of the cage. Over the period November 1987 to June 1988 fifteen pairs of such cages were prepared. Moths were mated (2 males for every female) overnight in the laboratory and released into the field cages the following day. Between 7 and 10 females were released into each cage of a pair.

Sampling field cages

Cages had to be sampled before the eclosion of any eggs laid by released females, but not before remaining *in situ* long enough for predation to resemble that experienced by feral eggs. To determine the best sampling date, newly laid eggs from the main laboratory culture of *E.saccharina* were placed in the field at the same time as moths were released into the cages. When placed eggs turned dark orange or black, (as *E.saccharina* eggs do just before eclosion), the cages were sampled.

Sampling consisted of the scanning of all material enclosed by the cage, which was done by means of a portable Geiger counter, the detector head of which could be placed within 5 mm of any surface in the cage. When a batch was detected it was collected and its position and height recorded. The degree of predation and batch size were determined in the laboratory.

Results

Tests were made to assess the effect of the radio-isotope on *E.saccharina* adults. These showed that ^{32}p-labelled and control females laid 236 ± 39,8 and 246 ± 62,7 eggs respectively. Recovery of adults from labelled and control cultures was 81% ± 5,6 and 92% ±9,1 respectively. At the dose used in this study and at a distance of 50 mm from the detector of the Geiger counter, adults gave counts of 100 ± 60 c/s.

Data presented in Tables 1 and 2 show the influence of pre-trashing on oviposition and on predation of eggs and adults. A greater proportion of both batches and eggs in a batch were attacked by predators in pre-trashed sugarcane (Table 1) than in non pre-trashed sugarcane (Table 2), but the differences were not statistically significant. A greater percentage of released females was recovered alive from pre-trashed sugarcane (29% compared with 19%).

Table 1

The recovery of egg batches and adults from pre-trashed sugarcane

Trial Number	Number of females			Number of batches recovered	Egg predation		Percentage of eggs eaten
	Released	Recovered			Number and (%) of batches attacked		
		Alive	Dead				
1.1	10	3	0	40	13	(33)	4
2.1	5	0	0	14	7	(50)	4
3.1	5	3	0	18	10	(56)	8
4.1	4	2	0	14	8	(57)	19
5.1	7	1	0	44	16	(36)	8
6.1	7	1	2	34	14	(41)	5
7.1	7	0	0	24	12	(50)	18
8.1	8	2	1	55	23	(42)	6
9.1	9	2	2	45	17	(38)	3
10.1	6	5	0	48	27	(56)	11
11.1	8	3	2	33	20	(61)	13
12.1	9	1	2	47	28	(61)	10
13.1	9	1	0	32	16	(50)	8
14.1	9	4	2	42	32	(74)	22
15.1	9	4	2	26	13	(50)	7
Totals	112	32	13	516	256		
				x̄=34,4 SD=13,0	x̄=17,1 SD= 7,5	x̄=50,3 SD=11,1	x̄= 9,7 SD= 5,9

Table 2

The recovery of egg batches and adults from sugarcane not pre-trashed

Trial Number	Number of females			Number of batches recovered	Egg predation		Percentage of eggs eaten
	Released	Recovered			Number and (%) of batches attacked		
		Alive	Dead				
1.2	7	1	2	23	11	(48)	6
2.2	6	0	0	17	6	(35)	8
3.2	5	0	1	11	2	(18)	1
4.2	4	1	1	11	3	(27)	2
5.2	7	1	1	25	1	(4)	1
6.2	6	0	4	20	6	(30)	2
7.2	7	0	3	20	8	(40)	6
8.2	8	2	1	45	17	(38)	6
9.2	9	2	0	35	10	(29)	11
10.2	7	3	1	50	23	(46)	11
11.2	8	4	1	61	20	(33)	11
12.2	9	1	2	45	23	(51)	12
13.2	9	0	0	20	12	(60)	15
14.2	9	4	3	36	12	(33)	15
15.2	9	2	1	23	12	(52)	5
Totals	110	21	21	442	166		
				x̄=29,5 SD=15,1	x̄=11,1 SD= 7,1	x̄=36,3 SD=14,3	x̄= 7,5 SD= 4,8

Table 3

The sites from which egg batches were recovered in pre-trashed sugarcane

Pre-trashed sugarcane

Position of Batch			Trial Number 1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	9.1	10.1	11.1	12.1	13.1	14.1	15.1	% of batches at the various positions
On Mature Stalks	Dry leaf sheaths	Behind leaf sheaths	13	5	8	8	9	8	4	11	20	1	1	1	1			25
		Behind leaf sheath fragments	1	1	1	1			1		4	1		1	1			
		Curled/folded edges of leaf sheaths	5				3	3	1	2	1	1						
		Space between vascular bundles in leaf sheath	1	2	2			2			1							
	Dry leaf blades	Curled edges of leaf blades	2		1	1	1		2	8		2	1			3	1	22
		Curled tip of leaf blades	3	1			14	9	8	16	6	1	1	3			2	
		Fold of leaf blades	3		1	4	3			11								
		Behind the leaf collars	1			1				2	1							
	Green leaf blades	Between the leaf blades							3	3								
	Living stalks	stubble			1								4					
		Cracks/splits in stalk	2	1			1											
	Dead stalks	In folds of longitudinally collapsed internodes		1														
		Behind leaf sheath	1															
On dead shoots	Dry leaf sheaths	Behind leaf sheath		1	1													2
		Curled edge of leaf sheath		1														
	Dry leaf blade	Curled leaf blade	2		1		4											
On the ground		Plant debris not connected with stalks	5	1	4	2	8	7	4	2	12	42	25	36	27	36	23	45
Miscellaneous		Wild grasses												3				
		Frame/mesh of cages	1															
Totals			40	14	18	14	44	34	24	55	45	48	33	47	32	42	26	

Table 4

The sites from which egg batches were recovered in sugarcane not pre-trashed

Sugarcane not pre-trashed

Position of Batch			Trial Number 1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2	14.2	15.2	% of batches at the various positions
On Mature Stalks	Dry leaf sheaths	Behind leaf sheaths	13	10	7	9	5	6	1	5	8	20	22	8	3	8	3	35
		Behind leaf sheath fragments	3	1														
		Curled/folded edges of leaf sheaths	1		1				1			3	1	8	1	2		
		Space between vascular bundles in leaf sheath		2	1	1												
	Dry leaf blades	Curled edges of leaf blades		1			11		2	2	1	6	17	10	3	2	3	34
		Curled tip of leaf blades					3	4	7	16	6	1			1			
		Fold of leaf blades					1	5	3	13	6	3		6	2		2	
		Behind the leaf collars	2				1	1			4	1	4					
	Green leaf blades	Between the leaf blades								4			1	2				
	Living stalks	stubble																
		Cracks/splits in stalk			1													
	Dead stalks	In folds of longitudinally collapsed internodes		1														
		Behind leaf sheath																
On dead shoots	Dry leaf sheaths	Behind leaf sheath										1	8	5	2	10	3	18
		Curled edge of leaf sheath		2														
	Dry leaf blade	Curled leaf blade	2				2	1	4	2	7	11	6	6	1	6	1	
On the ground		Plant debris not connected with stalks	2		1			2	2	3	1	4	2		7	8	6	9
Miscellaneous		Wild grasses					2				2							
		Frame/mesh of cages						1										
Totals			23	17	11	11	25	20	20	45	35	50	61	45	20	36	23	

The sites from which batches were recovered are given in Tables 3 and 4. Oviposition sites in both pre-trashed and non-pretrashed cane were common behind dead leaf sheaths or blades or fragments of these materials associated with the stalks. Litter, however, formed an important site in pre-trashed sugarcane, while dead shoots were frequent oviposition sites in sugarcane not pre-trashed.

The heights at which batches were recovered are plotted in Figure 1. In pre-trashed sugarcane nearly half of the batches were recovered from the litter and in non pre-trashed sugarcane 54% of batches were recorded from within 400 mm of the ground. Figure 2 shows the frequency distribution of the size of the recovered batches. There was no marked difference in batch size between pre-trashed and not pre-trashed sugarcane. In both situations approximately 70% of the batches recovered comprised 60 or fewer eggs.

Discussion

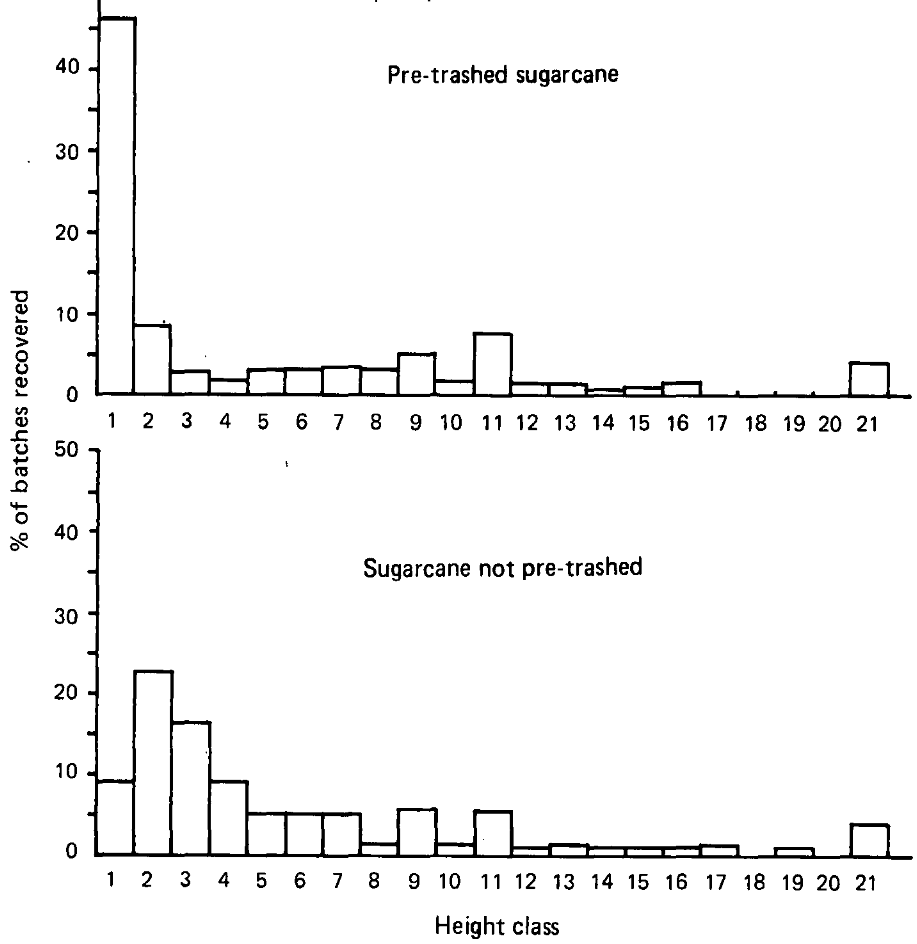
This study was conducted to assess the influence of pre-trashing on egg and moth predation, choice of oviposition site and egg batch size.

Concealment was a common feature of all oviposition sites in both pre-trashed and non pre-trashed sugarcane (Tables 3 and 4). However, in the former habitat most batches were recovered from the litter layer (Figure 1). In sugarcane not pre-trashed, 54% of batches were recovered within 400 mm of the ground, which interestingly is a zone where the many dead shoots in mature stools form a dense tangle of dead leaves closely resembling the litter layer of pre-trashed sugarcane. Similarly, van Leerdam *et al*,[6] have shown *Eoreuma loftini*, (a pyralid borer of sugarcane in Texas) to lay 96% of its eggs preferentially on dead leaf material, mostly within 800 mm of the ground; dead shoots were frequently selected. As in the present study, there was considerable preference for the dense, tangled mass of leaves. Pre-trashing had little influence on egg batch size (Figure 2). Most batches comprised between 11 and 40 eggs, which shows that females tend to lay several small batches rather than a few large batches.

The results suggest that there is greater predation of eggs in pre-trashed than in non-pre-trashed sugarcane. However, differences were small and predation was low, irrespective of habitat type. Egg predation may have been greater in pre-trashed sugarcane because of a shortage of suitable oviposition sites, so enforcing the selection by female moths of more exposed sites. Leslie[5] found that eggs placed in exposed positions were severely attacked by predators, whereas concealed eggs were less severely attacked.

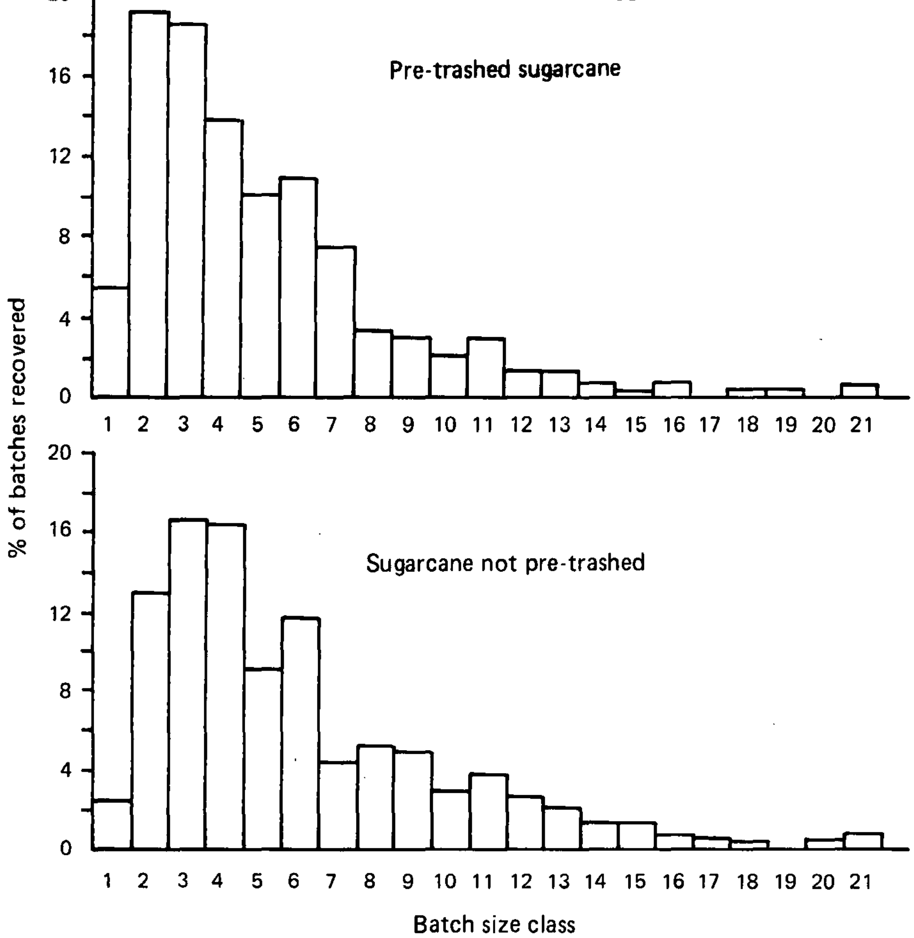
The results suggest also that predation on female moths was greater in sugarcane not pre-trashed. However, this has not been confirmed by current (unpublished) observations

FIGURE 1 Frequency distribution of the height of recovered batches.



Height class	Height range (mm)
1	Litter on ground
2	10–100
3	110–200
4	210–300
5	310–400
6	410–500
7	510–600
8	610–700
9	710–800
10	810–900
11	910–1000
12	1010–1100
13	1110–1200
14	1210–1300
15	1310–1400
16	1410–1500
17	1510–1600
18	1610–1700
19	1710–1800
20	1810–1900
21	1910–2000

FIGURE 2 Frequency distribution of egg batch size.



Batch size class	Batch size range
1	1–10
2	11–20
3	21–30
4	31–40
5	41–50
6	51–60
7	61–70
8	71–80
9	81–90
10	91–100
11	101–110
12	111–120
13	121–130
14	131–140
15	141–150
16	151–160
17	161–170
18	171–180
19	181–190
20	191–200
21	200+

on predation of females over the three days after mating (shown by Girling[4] to be the period over which most eggs are laid). Here pre-trashing appeared to have no effect on predation of moths; predation of gravid females is evidently low and not greatly influenced by pre-trashing.

The effect of mortality factors other than predation on eggs is not clear. No parasitoids (Conlong and Hastings[3]) or pathogens have been recovered from feral eggs, and it seems likely that many survive to hatch. Consequently, there must be significant mortality at some other stage in the life cycle of *E. saccharina*. The most likely stage for this is the short period before the young larvae penetrate the stalk. Probably neonate larvae, while dispersing from the point of eclosion, may encounter predators or die from desiccation. Whether the movement of young larvae towards the cane stalk is more hazardous from the litter layer in pre-trashed sugarcane than from dead material attached to the stool is not clear. If it were more hazardous it could help explain the benefits of pre-trashing.

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