British Beet Research Organisation Project 03/13: Report A

The value of the sugar beet crop for birds and the farm environment

[Report A – uncropped headlands]

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Summary

This project examined the plant and invertebrate composition of sugar beet crops and uncropped headlands and recorded the consequent use of these by birds. It was carried out in summer and autumn of 2003 and 2004, studying a total of 16 sites (eight in each year) in East Anglia.

The densities of bird species were higher on headlands than in crops and on average the presence of a headland increased the 'value' of a field to birds by introducing a new habitat in which to forage. Of the birds recorded, some such as thrushes, finches and buntings were probably foraging whilst others, such as Skylarks or Grey Partridge, may have nested within the margins. The increased use of the headlands in late summer and autumn by birds, emphasised the late-season value of the headlands as a food resource, though more for seed-eating finches and buntings than for insectivorous species such as Dunnock, thrushes and wagtails.

Higher bird densities occurred in cropped areas with adjacent headlands compared to cropped areas without adjacent headlands. This difference was likely to have been due to the crops proximity to the headland rather than any tangible difference in the food quality of the cropped areas as a consequence of being next to the headland (i.e. due to weed ingress from the headland). There was an increase in bird densities with increasing weed-seed densities in headlands but this was not significant in cropped areas. When the three sites with game crops adjacent to the headlands were excluded from the analysis, this led to a weaker correlation between headland bird densities and adjacent crop bird densities.

The lack of association between birds and invertebrates is likely to be due to a range of factors including the density of foliage in the headland and the crop and the presence of large mobile beetles which can move around freely in crops (and were caught in larger numbers in the crop than the headlands) but less freely in the headlands. Weed numbers, species, cover and seed production varied greatly between the headlands but were much less variable in the beet crop. The general trend for the headlands to attract birds to the field and into the crop suggests that the use of non-cropped headlands in beet will be particularly beneficial for birds that inhabit farm environments.

OBJECTIVES

1. To survey headland set-aside as used in beet fields for both invertebrate and plant compositions and bird use.
2. To identify the major invertebrate and plant constituents of the set-aside headlands that are important resources for birds.
3. To record presence of any rare plant species in the headlands.
4. To evaluate the practicalities, and crop and whole farm cost implications, of improvements to the headlands.

METHODS

Site selection

Fields of sugar beet (crop) with set-aside headlands (headland) were chosen from a list of growers compiled by Broom's Barn staff. Farms were offered via personal contacts or as the result of a request for volunteers through the Broom's Barn Bulletin. All the beet crops were conventionally managed and the farmers treated the set-aside according to their normal practice. Weed control in the set-aside was either by cutting or herbicide (usually glyphosate) but some were not treated. Sixteen sites in total were surveyed:- eight in 2003 and eight in 2004. Five farms participated in both years although different fields were surveyed in each year. The sites were in Cambridgeshire, Norfolk and Suffolk.

Sites were chosen with set-aside headlands (as opposed to stewardship strips), and were favoured if the headlands were 20 m wide or more, if they were formed from natural regeneration or sown with grasses and if they were not close to woodland. Due to a relatively small pool of offers some were nearer to woodland than desirable, although not completely surrounded by it.

The location and details of sites are given in Table 1.

Sampling positions for weeds and invertebrates

Sampling points were established on 5 transects per field spread along the margin, at least 30 m apart. Three samples per transect were taken in the headland (15) and three samples per transect in the crop (15) on each sampling occasion. Sampling locations were sited with measurements from the margin of the set-aside headland and were spaced evenly, forming a mirror image in the crop and the set-aside. The distance between samples depended on the width of the headland. Samples on narrow headlands were taken at 3, 6 and 9 m from the margin and on wide margins were taken at 5, 10 and 15m from the edge. Distances in the crop matched those.

Weed sampling

Weeds were counted and cover was estimated monthly in 50 x 50cm quadrats at each sampling point between crop emergence and harvest (June to September in 2002 and May to August in 2003) (see Appendix Table 1A for details of assessment dates). Seed rain traps (each 10cm in diameter) were set in the field at each sampling point and collected monthly when the plant counts were taken between June and September. In the laboratory, seeds were identified to species and tested for viability using the squeeze test. At the last assessment of the season weed biomass was collected from the sample quadrats. All plant material above ground was collected, bagged and taken to the laboratory where it was separated by species. Once separated, the material was dried for 24 hours at 80°C and weighed once dry. Dicotyledon, monocotyledon and weed species of food value to birds (Appendix Table 2A) were analysed separately.

Invertebrate sampling (pitfall sampling)

Pitfalls were also collected from emergence to harvest. Traps measuring 7.5 cm diameter and 10 cm depth were placed into the ground, supported by standard plastic drain pipe, the lip of the trap was level with the soil. A lid allowing beetles to crawl under, but keeping rainwater out, was then placed over the trap. Each trap contained 100 ml of ethylene glycol 50% and distilled water 50 %. Traps were set for two weeks in each of the months June, July and August, after which they were collected, filtered and the collected specimens stored in alcohol in a cold room at 7ºC until identified. Invertebrates were identified to various levels, depending on the organisms – e.g. to family for insects, to Order for slugs. Carabid beetles were identified to species from a sub-sample of traps in 2003 (when numbers were very high), and from every trap in 2004.

Bird fieldwork for headland sites

The bird data were collected from one visit per month to each site, from June to October inclusive in both 2003 and 2004. At each site 30-minute static watches were carried out from a vantage point to record bird movements and distribution into the beet crop, headlands or associated boundary habitats. The observer then walked a transect line around the perimeter of each field, recording on a map, the location and activity of all birds seen or heard. Birds were recorded in association with five habitat categories of interest: (i) the headland margin itself, (ii) the adjacent boundary to the headland margin, (iii) the up to 30 m into the crop adjacent to the headland strip, (iv) the field boundaries without an adjacent headland margin and (v) up to 30 m into the crop along boundaries without a headland margin. The calculated area of each of these categories allowed bird densities to be compared between habitats, to assess the influence of headlands on the use of the adjacent crop by birds. Other recorded details included: crop height, adjacent crop content and boundary characteristics.

Analyses

Invertebrate and weed data were analysed by analysis of variance using Genstat VI.

The analysis combined species into five groups of interest (Appendix Table 3A). They included: (1) Nine of the 19 species that occur on the Government's Quality of Life indicator for farmland birds: Grey Partridge, Yellow Wagtail, Whitethroat, Greenfinch, Goldfinch, Linnet, Yellowhammer, Reed Bunting and Corn Bunting; (2) Species of high conservation concern, and subject to national Biodiversity Action Plans ('BAP' species): Grey Partridge, Song Thrush, Bullfinch, Linnet and all bunting species; (3) Insectivorous passerines: Yellow and Pied Wagtail, Dunnock, Mistle Thrush, Song Thrush, Blackbird and Whitethroat; and (4) Seed-eating passerines: Tree Sparrow, Finches and Buntings. Group (5) includes only Skylark, which was analysed separately from groups (1) and (2) because of its very different ecology as a field-nesting species. Bird count data was analysed statistically, by using Generalised Linear Models with Poisson error terms, adjusted for over or under dispersion using "deviance/degrees of freedom". Habitats area (field habitats) or length (boundary habitats) were included as offset variables to give relative estimates of bird density. Average bird densities from within these species groups were also analysed in relation to weed-seed and invertebrate densities obtained from headland and crops areas.

Table 1. Details of sites studied

	Year	Type of headland	Date established	Location	Boundaries/ Landscape features	Neighbouring crops
H1	2003	Regeneration	2002	Barrow, Suffolk	Railway, woodland, river and road	Winter wheat all sides
H2	2003	Regeneration from winter wheat	2002	Newmarket, Cambs	Hedges, road, woodland belt, adjacent to setaside wild bird option and maize strip	Sugar beet and winter wheat
H3	2003	Regeneration from barley stubble	2002	Littleport, Cambs	Drains on 2 sides, trees and hedge and trunk road	Setaside on two sides, grass and sugar beet
H4	2003	Regenerated after wheat	2002	Benwick, Cambs	Ditches and farm tracks	Wheat and potatoes
H5	2003	Regenerated after wheat	2001	Baston Fen, Cambs	Dry dykes on 2 sides, river and a grass bank	Wheat
H6	2003	Sown wild bird cover	2003	Doddington, Cambs	Bounded by woodland on 1 side and farm roads on 2 others	Winter wheat on all sides
H7	2003	Regeneration after barley	2002	Lyng, Norfolk	Road on three sides	Beans on 2 sides, oilseed rape and setaside
H8	2003	Regeneration after wheat	1999	Wallington, Norfolk	Ditch and hedge 3 sides, drain	
H9	2004	Regeneration		Barrow, Suffolk	Wood, 1 side sown wild bird cover	
H10	2004	Regeneration after winter barley	2003	Newmarket, Suffolk	Woods at 2 sides, hedge all round	Spring barley, winter barley, spring wheat, triticale and grass
H11	2004	Natural regeneration	2003	Otley, Suffolk	Hedge on 3 sides (1 side plus ditch) and woodland with game cover 1 side	Barley and wheat
H12	2004	Grass and regeneration	2000	Wallington, Norfolk	Woods on 1 side, rides on 2 sides, track on 1 side	Wheat and potatoes
H13	2004	Regeneration after winter wheat	2003	Ashill, Norfolk	Ditches 3 sides, hedge 2 sides	Wheat and sugar beet
H14	2004	Grass		Stowmarket, Suffolk	Green lane on 1 side, trees on others	Sugar beet
H15	2004			Doddington, Cambs		
H16	2004	Natural regeneration in 2001		Baston Fen, Norfolk	Dykes, farm track	Sugar beet, wheat and linseed

RESULTS

There was a large variation in the total weed seed produced during the season as seed rain in the headlands (Table 2). Similar variation was also noted for weed biomass on the headlands (Table 3). The main effects were the agronomy and species sown (e.g. at site H11natural regeneration after barley compared to site H6 with sown bird cover). Figures 1 and 2 show that headlands are a potential major source of food for birds.

Table 2. Seed rain by site for headlands (seeds m^{-2})

		Viable dicot.	Non viable dicot.	Viable monocot.	Non viable monocot.	Bird food group	Season total
H1	2003	41796	6035	12011	18199	26178	53366
H2	2003	4928	3370	3818	1956	11269	14072
H3	2003	1456	2735	10050	13572	4352	27813
H4	2003	1719	474	85	356	2303	2633
H5	2003	5182	3175	57091	35128	24731	100576
H6	2003	206180	21370	169	203	226712	227931
H7	2003	115841	45889	17941	6748	176191	186419
H8	2003	5817	1482	18661	21480	4047	47363
H9	2004	17467	5275	872	364	22335	23978
H10	2004	68	279	161	161	508	669
H11	2004	8	51	0	0	59	59
H12	2004	8	0	2379	2515	330	4902
H13	2004	10727	3598	10719	3962	28677	29007
H14	2004	85	8	25	754	17	872
H15	2004	17	17	8670	21395	127	30099
H16	2004	398	119	16485	16061	533	33062

Table 3. Weed biomass by site for headlands (g DM m^{-2})

		Dead material	Vegetative material	Reproductive material	Total biomass
H1	2003	383.9	6.2	3.2	393.3
H2	2003	286.1	7.3	19.9	313.4
H3	2003	204.4	121.5	10.1	336.1
H4	2003	396.5	19.8	20.4	436.7
H5	2003	402.3	53.0	34.7	490.0
H6	2003	145.7	26.5	409.3	581.5
H7	2003	145.5	4.6	308.5	458.5
H8	2003	352.2	17.7	9.4	379.3
H9	2004	133.1	21.2	38.6	193.0
H10	2004	191.8	0.5	0.0	192.3
H11	2004	1.4	3.9	3.3	8.6
H12	2004	71.0	236.7	30.2	337.9
H13	2004	32.5	25.5	168.9	226.9
H14	2004	9.3	227.0	0.8	237.1
H15	2004	288.7	262.9	114.1	665.8
H16	2004	220.2	238.1	121.7	580.0

Seed rain in the crop (Table 4) was lower and tended to be less variable compared to the headland. Again, seedrain tended to mirror biomass (Table 5).

Table 4. Seed rain by site for crop (seeds m^{-2})

		Viable dicot.	Non viable dicot.	Viable monocot.	Non viable monocot.	Bird food group	Season total
H1	2003	2411	1418	8	17	3752	3854
H2	2003	491	483	25	0	821	991
H3	2003	195	93	34	51	229	373
H4	2003	152	229	169	34	576	584
H5	2003	11777	1304	93	25	13157	13200
H6	2003	14453	3641	76	8	18136	18178
H7	2003	136	237	93	34	500	533
H8	2003	85	93	0	0	169	178
H9	2004	1168	643	0	0	1770	1812
H10	2004	25	85	0	0	93	110
H11	2004	0	0	0	0	0	0
H12	2004	0	34	85	34	34	152
H13	2004	93	262	42	42	432	440
H14	2004	34	203	0	0	229	237
H15	2004	0	8	17	178	8	203
H16	2004	51	356	17	152	398	576

Table 5. Weed biomass by site for crop (g DM m^{-2})

		Dead material	Vegetative material	Reproductive material	Total biomass
H1	2003	0.7	2.7	39.4	42.8
H2	2003	0.0	0.1	7.5	7.6
H3	2003	0.8	0.0	1.9	2.7
H4	2003	0.5	3.2	2.1	5.7
H5	2003	0.4	2.9	98.8	102.1
H6	2003	5.5	2.6	46.4	54.5
H7	2003	0.1	0.0	0.3	0.5
H8	2003	0.0	0.0	0.0	0.0
H9	2004	0.0	0.2	1.6	1.8
H10	2004	0.0	0.1	2.0	2.1
H11	2004	0.0	0.0	0.0	0.0
H12	2004	0.0	1.1	0.2	1.3
H13	2004	0.0	0.3	7.9	8.3
H14	2004	0.0	0.0	2.9	2.9
H15	2004	19.2	20.5	7.8	47.6
H16	2004	0.0	0.0	4.5	4.5

Figure 1. Comparison of seed rain on headlands and cropped land (mean of 16 sites)

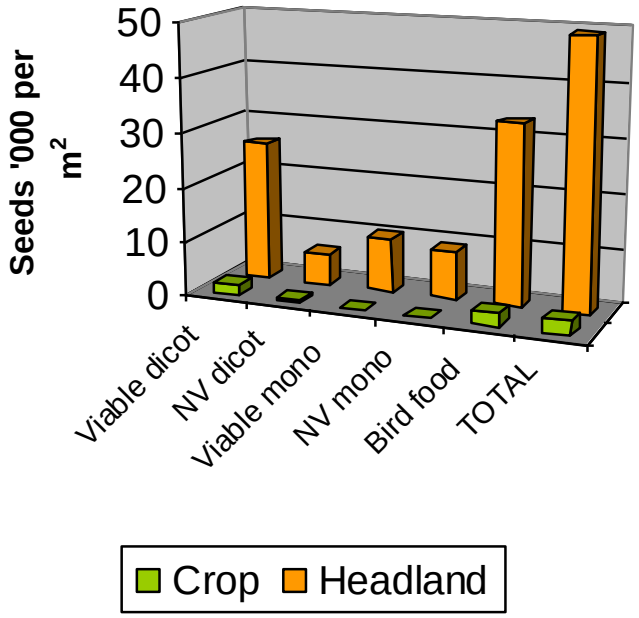
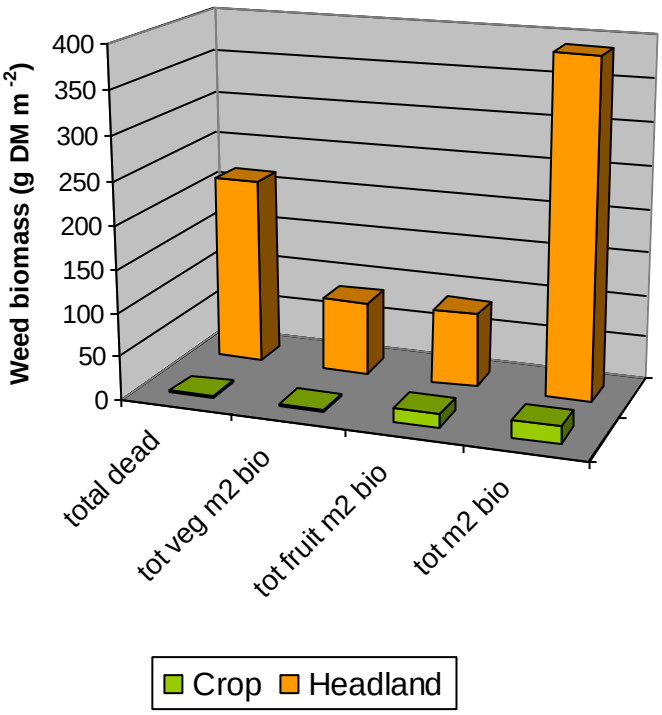


Figure 2. Comparison of biomass on headlands and cropped land (mean of 16 sites)



There was a range of weed species present across the sites (see Appendix Tables 4a-4p) but generally a more diverse spectrum in the set-aside compared to the crop.

Ground cover varied across the sites as well (Table 6); no site had less than 37% average cover for the season (lowest = H2 and H11) but some had more than 90% cover (H12, 14, 15, 16)

Table 6. Seasonal average ground cover on headland (%) and season total weed seed rain (seeds m^{-2}). Highlighting showing sites with low ground cover (<60%) or high seed production (>50,000 m^{-2}). Sites to right hand side of table were excluded from the analysis as having game cover crops.

				Sites without game cover			Sites with game cover		
Site	Site	Farmer	Year	Season average cover	Season total seed rain	Bird density	Season average cover	Season total seed rain	Bird density
H1	Barrow	Haylock	2003	59	53366	1.691			
H2	Stetchworth	Gabain	2003	37	14072	1.387			
H3	Littleport	Martin	2003	65	27813	0.778			
H4	Benwick	Burton	2003	55	2633	0.283			
H5	Baston Fen	Ward	2003	86	100576	0.375			
H6	Doddington	Boughton	2003				70	227931	2.253
H7	Lyng	Brigham	2003	59	186419	0.906			
H8	Kings Lynn	Holmes	2003	77	47363	0.199			
H9	Barrow	Haylock	2004	53	23978	0.065			
H10	Stetchworth	Gabain	2004				44	669	0.492
H11	Otley	Creasey	2004	37	59	0.087			
H12	Wallington	Luddington	2004	96	4902	0.009			
H13	Ashill	Sears	2004	41	29007	1.204			
H14	Stowmarket	Forrest	2004				94	872	0.113
H15	Doddington	Boughton	2004	96	30099	0.571			
H16	Baston Fen	Ward	2004	95	33062	0.171			

Invertebrate data

Over the two years of study, there were significantly more invertebrates (about 2.5 fold) in the pitfall traps in 2003 than in 2004, probably due to the much warmer weather in the former year, which increased their activity (Appendix Tables 5A and 5B). There was no difference between the crop and the headland in any month or overall three months, nor was there any interaction between year and environment. The majority of invertebrates caught were carabid beetles, followed by surface active collembola, spiders, flies and staphylinid beetles. However, the total numbers mask considerable variation within invertebrate groups.

Over the two years and all months sampled there were significantly more carabid and staphylinid beetles in June and July in 2003 than in 2004 (Appendix Tables 6A and 7A), which contributed most to the results for total invertebrates. There were significantly more parasitoids in 2004 than in 2003 in all three months studied (Appendix Tables 5B, 6B, 7B, 8B). There were no differences between years with most other groups except for 'other coleoptera' and flies in July (Appendix Tables 6A and 6B), and spiders (Appendix Table 7A) in August; in the latter case more were found in 2004 than in 2003.

Most differences were between the headland and crop, and there were very few interactions between year and environment, except for total hymenoptera in June (Appendix Table 6B) and carabids in July (Appendix Table 6A).

Some invertebrates were more numerous in the crop, and some more numerous in the headland, which explains why differences in the overall numbers between the two were negligible. For example, there were 68% more carabids overall in the crop than in headlands, mostly due to greater activity in July and August (Appendix Tables 5A, 7A and 8A). However, many other groups were more abundant in the headland than in the crop, including collembola, woodlice, snails, slugs, total hymenoptera, aphids and total homoptera (Appendix Tables 6A and 6B). Groups that were equally common in both environments, included adult staphylinids, flies, spiders, harvestmen, parasitoids and aphid predators (ladybird adults and larvae, syrphid and lacewing larvae and earwigs) (Tables 5A and 5B).

Over the season, the number of invertebrates was about the same in each of the three months studied, though whether they were all available as bird food is debatable. For example, the many species of most numerous group, carabids, are nocturnal feeders, which might preclude their being available to daytime feeding birds; slugs and snails also tend to be nocturnal, precisely to avoid predation by birds. The variability of food resources in headlands was much greater than in the crop, which might be expected to attract more species of birds to feed there. The major food resources in the crop were carabid beetles.

Bird data

A summary of the species groups used in the analysis of birds that were associated with sugar beet headlands are shown in Table 7.

Interaction with weeds and invertebrates

Total bird densities (all species) were correlated with total abundance of monocotyledon and dicotyledon weed-seed abundance in headlands (**Spearmans *rho* = 0.60; *P*<0.04, n=16**) but not in the adjacent crops (*rho*= -0.24, *P*<0.32, n=16). Bird densities on crops and headlands combined were related to combined total abundance of monocotyledon and dicotyledon seed, as measured in September (General Linear Models (dev/df=1.34), Likelihood ratio: $\chi^2_1 = 46.5$, *P*<0.001), or during the whole summer season combined (LR: $\chi^2_1 = 19.8$, *P*<0.001).

In this study, the densities of birds in headlands were not correlated with any of target invertebrates groups except that, in August, there was a negative correlation with earthworm density (*rho* = -0.51, *P*<0.052, n=**16**: probably related to sward composition). In the same month, bird densities and total weed-seed availability was significantly and positively correlated on headlands (*rho* = 0.57, *P*<0.05, n=**16**) but not in adjacent crops (*rho* = -0.28, *P*<0.30, n=**16**). Seed densities therefore appear to have been a stronger associate of bird abundance than invertebrate densities, and seed-eating species showed the strongest spatial and temporal response within and between headlands.

Determinants of bird densities

There were significant differences in the bird densities recorded on the three field categories: ‘headland’, ‘crop adjacent to headland’ and ‘Crop without headland’, for all analytical groups (Table 8A) with significant differences between farm sites (General Linear Models (dev/df=1.34), Likelihood ratio: $\chi^2_{15} = 77.1$, *P*<0.001) and visit dates (LR: $\chi^2_1 = 23.3$, *P*<0.001). but not years (LR: $\chi^2_1 = 1.1$, *P*<0.13). The highest bird

Table 7. A summary of the species groups used in the analysis of birds that were associated with sugar beet headlands.

Species name	Species status			
	UK farmland bird index	Biodiversity Action Plan	Insectivorous group	Seed-eating group
Kestrel	Yes			
Lapwing	Yes	Yes		
Grey Partridge	Yes	Yes		
Barn Owl		Yes		
Turtle Dove	Yes	Yes		
Stock Dove	Yes			
Woodpigeon	Yes			
Skylark	Yes	Yes		
Yellow Wagtail	Yes	Yes	Yes	
Pied Wagtail			Yes	
Meadow Pipit			Yes	
Whitethroat	Yes		Yes	
Dunnock			Yes	
Blackbird			Yes	
Song Thrush		Yes	Yes	
Jackdaw	Yes			
Rook	Yes			
Starling	Yes	Yes	Yes	
House Sparrow				Yes
Tree sparrow	Yes	Yes		Yes
Chaffinch				Yes
Goldfinch	Yes			Yes
Linnet	Yes	Yes		Yes
Greenfinch	Yes			Yes
Bullfinch	Yes	Yes		Yes
Reed Bunting	Yes	Yes		Yes
Yellowhammer	Yes	Yes		Yes
Corn Bunting	Yes	Yes		Yes

densities were consistently recorded on the headland rather than the crop, with a significant seasonal increase in density during September and October (Fig. 3). For the bird indicator group and for the seed-eating passerines group, there were significantly higher mean densities of birds on the beet crop adjacent to the headland when compared to the beet crop without headland nearby (Table 8A). For insectivorous passerines the difference was not statistically significant and the difference between the two areas of crop was less pronounced when the three game crop sites were omitted from the analysis (Table 8A). The seasonal effect of the headland was less pronounced for insectivorous species than for seed-eating species but there was still a significant increase in the use of adjacent crops to headlands during August and September by insectivorous birds (Fig. 3). The majority of bird species recorded on headlands were non-native gamebeirds (Red-legged Partridge and Ring-necked Pheasant), Pigeons

(mainly Woodpigeon, and to a lesser extent Stock Dove) and granivorous passerines particularly in late summer (Fig. 4).

Boundaries adjacent to headlands also supported the highest linear densities of seed-eating passerines throughout the summer and especially in autumn. There was no significant difference in the densities of insectivorous species between boundary types (Table 8B).

Tables 8A and 8B. Differences in the densities of bird groups between late May and October on: (A) headland or beet crops or (B) the adjacent boundaries, from 16 beet fields during 2003 and 2004 combined.

(A) Fields: Densities per ha

	With game crops			Without game crops		
Bird group	**A. Headland**	**B. Crop adjacent to headland**	**C. Crop without a headland**	**A. Headland**	**B. Crop adjacent to headland**	**C. Crop without a headland**
Farmland indicator species	0.85*†	0.69†	0.07	0.78*†	0.24†	0.08
BAP species	0.46*†	0.30†	0.05	0.38*†	0.09†	0.04
Seed-eating passerines	0.60*†	0.45†	0.05	0.55*†	0.10†	0.03
Insectivorous passerines	0.12*†	0.06	0.04	0.13*†	0.05	0.02
Skylarks	0.56*†	0.01†	0.33			

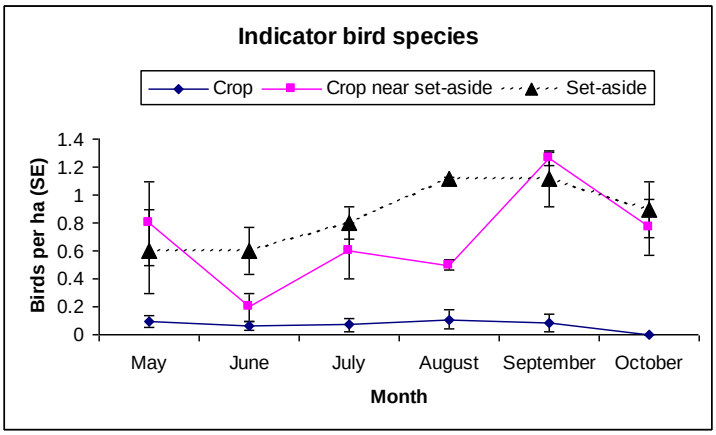
Likelihood ratio (LR) χ^2 : *significant difference (P<0.05) with B; † significant difference (P<0.05) with C.
Range of over/under dispersion ("deviance"): 0.71 to 2.83.

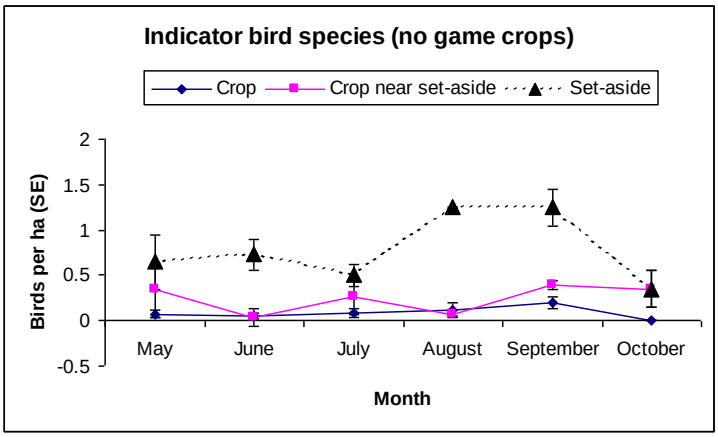
(B) Boundaries: Relative linear densities per 100m

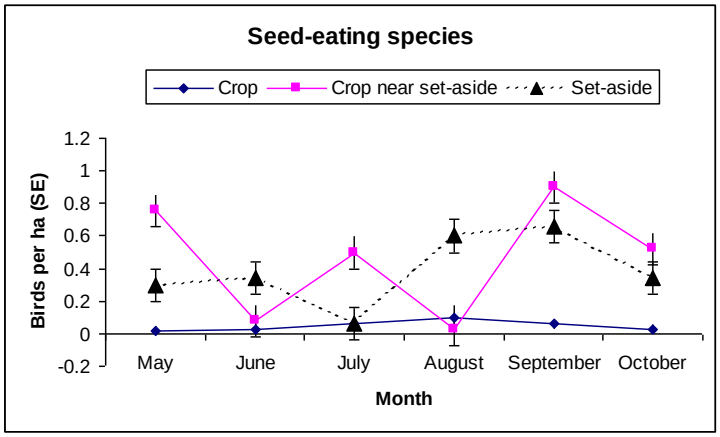
	Summer		Autumn	
Bird group	**Adjacent to headland**	**Boundary without a headland**	**Adjacent to headland**	**Boundary without a headland**
Farmland indicator species	2.3*	1.7	2.8*	1.2
BAP species	1.4	1.2	2.3*	1.0
Seed-eating passerines	2.6*	2.0	3.5**	1.5
Insectivorous passerines	2.1	2.3	2.2	2.1

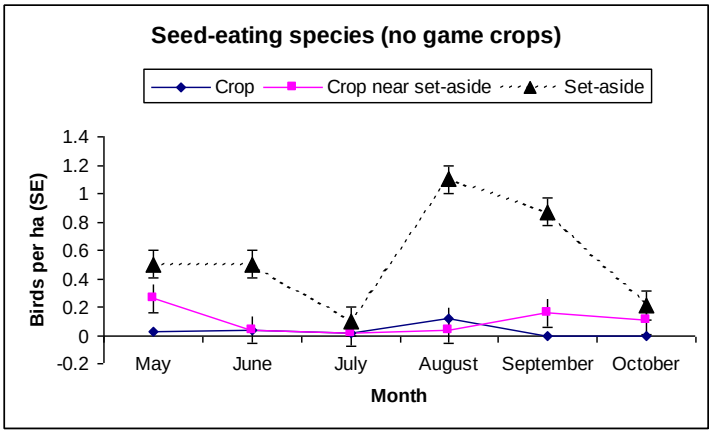
Likelihood ratio (LR) χ^2 : *significant difference (P<0.05). Range of over/under dispersion ("deviance"): 0.92 to 1.84.

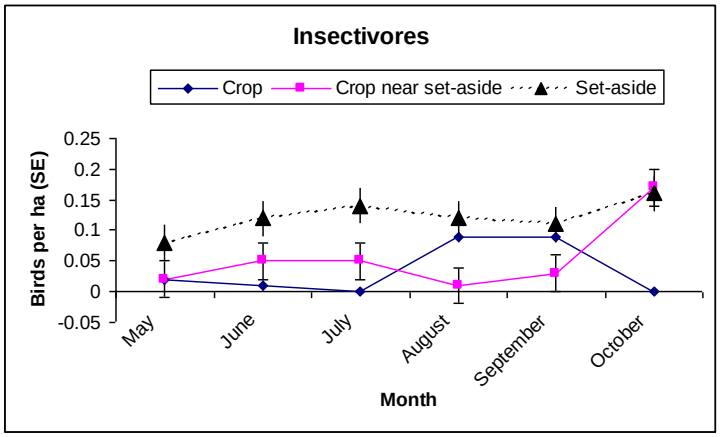
Figure 3. Trends in bird densities for four amalgamated groups of species between late May and October on headlands ("set-aside"), the 30m strip of crop adjacent to the headland ("Crop near set-aside") and on the 30m strip of crop without an adjacent headland ("Crop"). Three farms sites had margins with game-cover crops present and these are removed in some of the analyses (ie, "no gamecrops"). "Indicator species" are nine recorded birds species (excluding Woodpigeon) that contribute to the Government's farmland bird index; "BAP species" are species subject to national Biodiversity Action Plans, Seed-eating species are Tree Sparrow, finches and buntings; "Insectivorous species" are Meadow Pipit, wagtails, thrushes, Dunnock and Whitethroat.











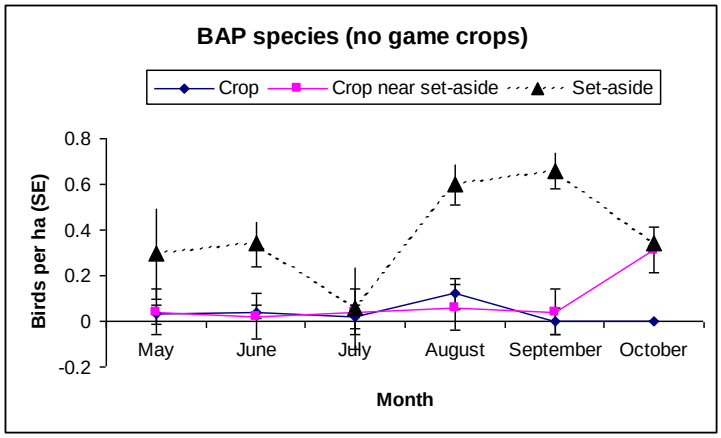
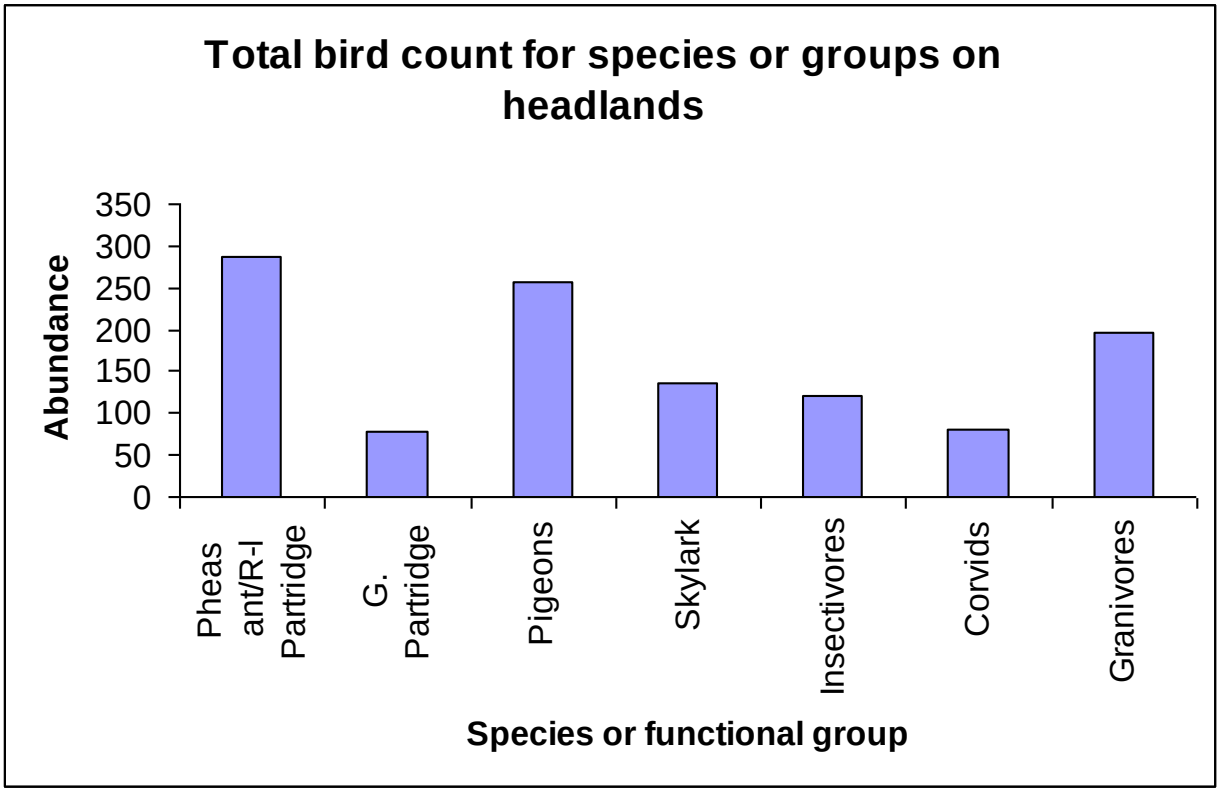


Figure 4. A summary of the total summer count of (the commonest) selected species or species groups using headlands by sugar beet fields. Gamebirds, pigeons (mainly Woodpigeon) and granivorous passerines (sparrows, finches and buntings) were the three most abundant groups.



Discussion

The use of pitfall traps to measure the availability of food for birds is controversial. On the one hand they operate for 24 hours per day and catch those organisms that are active on the soil surface (where many birds would be looking for them), but catch size is dependent on activity as well as abundance, and the former can be affected by the density of the foliage around the traps, and the propensity of potential prey to walk on the soil. It was certainly true that foliage density was much greater in the headlands than in the crop where sugar beet is grown in rows 50 cm apart allowing extensive corridors under the canopy for the most active creatures to move. This probably partially explains the significant increase in carabid numbers within the crop compared to the headland. However, another major reason for the greater carabid numbers is the dominance of one large species, *Pterostichus melanarius*, in the crop habitat compared to the headland habitat which was much more diverse (see Appendix for species lists). *P. melanarius* comprised over 75% of the total carabids caught in these and other field trials conducted in sugar beet in recent years (Dewar *et al*, 2003). Unfortunately for birds, this species is usually nocturnal, and thus avoids predation from daytime feeders. So having a large population of these beetles in fields does not necessarily counteract the otherwise detrimental effect of cropping on the other invertebrates used as food sources by most bird species. Lapwings and stone curlews might be the exception, as they have larger eyes and greater ability to see in low light levels.

The densities of bird species were higher on headlands than in crops and on average the presence of a headland increased the bird abundance 'value' of a field by introducing a new habitat in which to forage. Most of the birds recorded in headlands (thrushes, finches and buntings) were probably foraging there. Some species, such as Skylarks or Grey Partridge, may have nested within the margins, especially the Skylarks in headlands that were in an open location. A predicted increased use, however, of the headlands in late summer and autumn by birds, emphasised the late-season value of the headlands as a food resource, though more for seed-eating finches and buntings than for insectivorous species such as Dunnock, thrushes and wagtails.

Higher bird densities occurred in cropped areas with adjacent headlands compared to cropped areas without adjacent headlands. This difference was likely to have been due to the crop's proximity to the headland rather than any tangible difference in the food quality of the cropped areas as a consequence of being next to the headland (i.e. due to weed ingress from the headland). The association between bird densities and weed-seed densities was not significant in cropped areas, only in headlands. Also, when three sites with game crops adjacent to the headlands were excluded from the analysis, this led to a weaker correlation between headland bird densities and adjacent crop bird densities.

There was a strong difference in bird densities on headlands between sites (fields) and even sites within the same farm. Site location, whole-farm management practices and headland sward-management would all have contributed to habitat suitability, especially as a foraging habitat for birds. Factors that allow birds access to food (patchy sward) and encourage an abundance of food (e.g. weed seeds) are those most likely to have improved the value of headlands for birds.

Weed numbers, species, cover and seed production varied greatly between the headlands but were much less variable in the beet crop. Unfortunately, in this project it was not possible to evaluate the different forms of headlands separately owing to the small

replication that would provide. However, the general trend for the headlands to attract birds to the field and into the crop suggests that the use of non-cropped headlands in beet will be particularly beneficial for birds that inhabit farm environments.

Acknowledgments

We would like to thank the following individuals and organisations for their input into the project:

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Appendix

Table 1a. Weed assessment dates

	Weed counts and weed cover				Weed seed rain			Biomass
H1	12.6.03	16.7.03	20.8.03	24.9.03	16.7.03	20.8.03	24.9.03	24.9.03
H2	19.6.03	17.7.03	19.8.03	1.10.03	17.7.03	19.8.03	1.10.03	1.10.03
H3	10.6.03	17.7.03	19.8.03		17.7.03	19.8.03	1.9.03	1.9.03
H4	10.6.03	15.7.03	18.8.03		15.7.03	18.8.03	1.9.03	1.9.03
H5	23.6.03	18.7.03	22.8.03		18.7.03	22.8.03	21.9.03	2.9.03
H6	10.6.03	15.7.03	18.8.03	30.9.03	15.7.03	18.8.03	30.9.03	30.10.03
H7	24.6.03	24.7.03	21.8.03	23.9.03	24.7.03	21.8.03	23.9.03	23.9.03
H8	27.6.03	21.7.03	20.8.03	25.9.03	21.7.03	20.8.03	25.9.03	25.9.03
H9	18.5.04	15.6.04	13.7.04	11.8.04	15.6.04	13.7.04	11.8.04	11.8.04
H10	18.5.04	15.6.04	13.7.04	11.8.04	15.6.04	13.7.04	11.8.04	11.8.04
H11	17.5.04	16.6.04	14.7.04	9.8.04	16.6.04	14.7.04	9.8.04	9.8.04
H12	9.6.04	5.7.04	10.8.04		5.7.04	4.8.04		10.8.04
H13	20.5.04	16.6.04	14.7.04	18.8.04	16.6.04	14.7.04	10.8.04	18.8.04
H14	17.5.04	16.6.04	14.7.04	9.8.04	16.6.04	14.7.04	9.8.04	9.8.04
H15	9.6.04	5.7.04	3.8.04		5.7.04	3.8.04		3.8.04
H16	3.6.04	8.7.04	2.8.04		8.7.04	2.8.04		2.8.04

Appendix Table 2A. Species of value to birds (as used to compile the bird food group)

Species		**Present**
Shepherd's purse	*Capsella bursa-pastoris*	Y
Fat hen	*Chenopodium album*	Y
Fig leaved goosefoot	*Chenopodium ficifolia*	Y
Many seeded goosefoot	*Chenopodium polyspermum*	Y
Quinoa	*Chenopodium quinoa*	Y
Creeping thistle	*Cirsium arvense*	Y
Spear thistle	*Cirsium vulgare*	N
Hawksbeard spp.	*Crepis* spp.	N
Blackbindweed	*Fallopia convulvulus*	Y
Fumitory	*Fumaria officinalis*	N
Cats-ears	*Hypochoeris* spp.	N
Hawkbits	*Leontodon* spp.	N
Redshank	*Persicaria maculosa*	Y
Annual meadow grass	*Poa annua*	Y
Knotgrass	*Polygonum aviculare*	Y
Curled dock	*Rumex crispus*	Y
Groundsel	*Senecio vulgaris*	Y
Campion spp.	*Silene* spp.	N
Charlock	*Sinapis arvensis*	Y
Perennial sowthistle	*Sonchus arvensis*	Y
Prickly sowthistle	*Sonchus asper*	Y
Smooth sowthistle	*Sonchus oleraceus*	Y
Sowthistle spp.	*Sonchus spp.*	Y
Common field chickweed	*Stellaria media*	Y
Dandelion	*Taraxacum officinale*	N
Clovers	*Trifolium* spp.	N
Scentless mayweed	*Tripleurospermum inodorum*	Y
Vetches	*Vicia* spp.	N
Field pansy	*Viola arvensis*	Y

Table 4a. A summary of weeds in set-aside and adjacent crop 2003

H1 - Barrow, Suffolk

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Grass weeds			
Blackgrass	*Alopecurus myosuroides*	*	
Barren brome	*Anisantha sterilis*	*	
Common couch	*Elytrigia repens*	*	*
Italian ryegrass	*Lolium multiflorum*	*	*
Annual meadow grass	*Poa annua*	*	*
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Scarlet pimpernel	*Anagallis arvensis*	*	
Mugwort	*Artemisia vulgaris*	*	
Common orache	*Atriplex patula*		*
Fat hen	*Chenopodium album*	*	*
Figleaved goosefoot	*Chenopodium ficifolia*		*
Creeping thistle	*Cirsium arvense*	*	*
Spear thistle	*Cirsium vulgare*	*	
Willowherb	*Epilobium* spp.	*	*
Black-bindweed	*Fallopia convolvulus*		*
Fumitory	*Fumaria officinale*		*
Cleavers	*Galium aparine*		*
Doves foot cranesbill	*Geranium molle*		*
Mayweed sp.	*Matricaria* spp.		*
Redshank	*Persicaria maculosa*		*
Plantain	*Plantago major*		*
Knotgrass	*Polygonum aviculare*	*	*
Groundsel	*Senecio vulgaris*	*	*
Prickly sowthistle	*Sonchus asper*	*	
Sowthistle sp.	*Sonchus* spp.	*	
Common chickweed	*Stellaria media*	*	
Scentless mayweed	*Tripleurospermum inodorum*		*
Small nettle	*Urtica urens*	*	
Ivy-leaved speedwell	*Veronica hederifolia*	*	
Common field speedwell	*Veronica persica*	*	*
Field pansy	*Viola arvensis*	*	*

Table 4b. A summary of weeds in set-aside and adjacent crop 2003

H2 Newmarket, Suffolk

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	*
Grass weeds			
Barren brome	*Anisantha sterilis*	*	*
Common couch	*Elytrigia repens*	*	
Annual meadow grass	*Poa annua*	*	*
Broad-leaved weeds			
Common orache	*Atriplex patula*		*
Shepherds purse	*Capsella bursa-pastoris*	*	*
Fat hen	*Chenopodium album*	*	*
Creeping thistle	*Cirsium arvense*	*	*
Willowherb	*Epilobium* spp.	*	*
Canadian fleabane	*Erigeron canadensis*	*	
Black-bindweed	*Fallopia convolvulus*		*
Cleavers	*Galium aparine*	*	
Redshank	*Persicaria maculosa*		*
Knotgrass	*Polygonum aviculare*		*
Groundsel	*Senecio vulgaris*	*	*
Black nightshade	*Solanum nigrum*	*	
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*	*	*
Common nettle	*Urtica dioica*	*	*
Common field speedwell	*Veronica persica*	*	*
Field pansy	*Viola arvensis*	*	*

Table 4c. A summary of weeds in set-aside and adjacent crop 2003

H3 Waterbeach, Cambridgeshire

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	*
Grass weeds			
Blackgrass	*Alopecurus myosuroides*	*	*
Barren brome	*Anisantha sterilis*	*	*
Soft brome	*Bromus mollis*	*	*
Common couch	*Elytrigia repens*	*	*
Perennial ryegrass	*Lolium perenne*	*	
Annual meadow grass	*Poa annua*	*	*
Rough meadow grass	*Poa trivialis*	*	*
Broad-leaved weeds			
Fat hen	*Chenopodium album*	*	*
Creeping thistle	*Cirsium arvense*	*	*
Spear thistle	*Cirsium vulgare*	*	
Rough hawksbeard	*Crepis biennis*	*	
Willowherb	*Epilobium* spp.	*	*
Cleavers	*Galium aparine*	*	*
Cut leaved cranesbill	*Geranium dissectum*	*	
Ground ivy	*Glechoma hederifolia*	*	
Cats ear	*Hypochoeris radicata*	*	
Mayweed sp.	*Matricaria* spp.		*
Knotgrass	*Polygonum aviculare*	*	
Dock sp.	*Rumex* spp.	*	*
Groundsel	*Senecio vulgaris*	*	*
Prickly sowthistle	*Sonchus asper*	*	
Sowthistle sp.	*Sonchus* spp.	*	*
Common field speedwell	*Veronica persica*	*	*
Field pansy	*Viola arvensis*	*	*
Thyme leaved speedwell	*Veronica serpyllifolia*	*	

Table 4d. A summary of weeds in set-aside and adjacent crop 2003

H4 Benwick, Cambridgeshire

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Potato	*Solanum tuberosum*	*	
Wheat	*Triticum aestivum*	*	
Grass weeds			
Barren brome	*Anisantha sterilis*	*	
Wall barley	*Hordeum murinum*	*	
Perennial ryegrass	*Lolium perenne*	*	*
Annual meadow grass	*Poa annua*	*	*
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Common orache	*Atriplex patula*	*	
Fat hen	*Chenopodium album*	*	
Creeping thistle	*Cirsium arvense*	*	
Black-bindweed	*Fallopia convolvulus*	*	*
Cleavers	*Galium aparine*	*	*
Mallow	*Malva sylvestris*	*	
Bristly oxtongue	*Picris echioides*		*
Knotgrass	*Polygonum arvense*	*	*
Dock	*Rumex* spp.	*	
Groundsel	*Senecio vulgaris*	*	*
Charlock	*Sinapis arvense*	*	*
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*	*	*
Scentless mayweed	*Tripleurospermum inodorum*	*	
Common field speedwell	*Veronica persica*	*	*
Field pansy	*Viola arvensis*	*	

Table 4e. A summary of weeds in set-aside and adjacent crop 2003

H5 Baston Fen, Cambridgeshire

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Wheat	*Triticum aestivum*	*	
Grass weeds			
Black bent	*Agrostis gigantea*	*	
Barren brome	*Anisantha sterilis*	*	*
False oat grass	*Arrhenatherum elatius*	*	*
Soft brome	*Bromus mollis*	*	
Cocksfoot	*Dactylis glomerata*	*	*
Common couch	*Elytrigia repens*	*	
Red fescue	*Festuca rubra*	*	
Yorkshire Fog	*Holcus lanata*	*	
Wall barley	*Hordeum murinum*	*	
Perennial ryegrass	*Lolium perenne*	*	*
Timothy	*Phleum pretense*	*	
Annual meadow grass	*Poa annua*	*	*
Smooth meadow grass	*Poa pretense*	*	
Rough meadow grass	*Poa trivialis*	*	*
Broad-leaved weeds			
Sycamore	*Acer platyphyllos*	*	
Common orache	*Atriplex patula*		*
Fat hen	*Chenopodium album*		*
Fig leaved goosefoot	*Chenopodium ficifolia*		*
Many seeded goosefoot	*Chenopodium polyspermum*		*
Creeping thistle	*Cirsium arvense*	*	*
Field bindweed	*Convolvulus arvense*	*	
Willowherb	*Epilobium* spp.	*	
Black-bindweed	*Fallopia convolvulus*		*
Cleavers	*Galium aparine*	*	*
Red dead nettle	*Lamium purpureum*		*
Pale persicaria	*Persicaria lapathifolia*		*
Redshank	*Persicaria maculosa*		*
Knotgrass	*Polygonum aviculare*		*
Creeping buttercup	*Ranunculus repens*	*	
Dock	*Rumex* spp.	*	
Ragwort	*Senecio jacobea*	*	
Groundsel	*Senecio vulgaris*	*	*
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*		*
Dandelion	*Taraxacum officinale*	*	
Scentless mayweed	*Tripleurospermum inodorum*	*	
Common field speedwell	*Veronica persica*		*
Field pansy	*Viola arvensis*		*

Table 4f. A summary of weeds in set-aside and adjacent crop 2003

H6 Doddington, Cambrigeshire

Species		Setaside	Crop
Crop volunteers			
Potato	*Solanum tuberosum*	*	*
Grass weeds			
False oat grass	*Arrhenatherum elatius*	*	
Common couch	*Elytrigia repens*	*	*
Perennial ryegrass	*Lolium perenne*	*	
Annual meadow grass	*Poa annua*	*	*
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Shepherds purse	*Capsella bursa-pastoris*	*	
Fat hen	*Chenopodium album*	*	*
Fig leaved goosefoot	*Chenopodium ficifolia*	*	*
Quinoa S	*Chenopodium quinoa*	*	
Creeping thistle	*Cirsium arvense*	*	
Field bindweed	*Convolvulus arvense*	*	
Swinecress	*Coronopus squamatus*	*	
Willowherb	*Epilobium* spp.	*	
Black-bindweed	*Fallopia convolvulus*	*	*
Buckwheat S	*Fagopyrum esculentum*	*	
Cut leaved cranesbill	*Geranium dissectum*		*
Sunflower S	*Helianthus annuus*	*	
Cats ear	*Hypochoeris radicata*	*	
Pineappleweed	*Matricaria discoidea*	*	
Red dead nettle	*Lamium purpureum*	*	*
Linseed S	*Linum usitatissimum*	*	
Mayweed sp.	*Matricaria* spp.	*	
White millet S	*Panicum miliaceum*	*	
Pale persicaria	*Persicaria lapathifolia*	*	
Redshank	*Persicaria maculosa*	*	*
Bristly ox-tongue	*Picris echioidea*	*	
Plantain	*Plantago nigrum*	*	
Knotgrass	*Polygonum aviculare*	*	*
Groundsel	*Senecio vulgaris*	*	
White mustard S	*Sinapis alba*	*	
Charlock	*Sinapis arvensis*	*	
Black nightshade	*Solanum nigrum*	*	*
Sowthistle sp.	*Sonchus* spp.	*	
Common chickweed	*Stellaria media*	*	
Scentless mayweed	*Tripleurospermum inodorum*	*	
Small nettle	*Urtica urens*	*	
Common field speedwell	*Veronica persica*	*	
Vetch sp. S	*Vicia* spp.	*	
Field pansy	*Viola arvensis*	*	*
Maize S	*Zea mays*	*	

S – sown game cover species

Table 4g. A summary of weeds in set-aside and adjacent crop 2003

H7 Lyng, Norfolk

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Grass weeds			
Blackgrass	*Alopecurus myosuroides*	*	
False oatgrass	*Arrhenatherum elatius*	*	
Wild oat	*Avena fatua*	*	
Common couch	*Elytrigia repens*	*	
Perennial ryegrass	*Lolium perenne*	*	
Annual meadow grass	*Poa annua*	*	*
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Scarlet pimpernel	*Anagallis arvense*	*	
Common orache	*Atriplex patula*	*	
Shepherds purse	*Capsella bursa-pastoris*		*
Fat hen	*Chenopodium album*	*	*
Fig leaved goosefoot	*Chenopodium ficifolia*	*	
Creeping thistle	*Cirsium arvense*	*	
Field bindweed	*Convolvulus arvense*	*	
Willowherb	*Epilobium* spp.	*	
Canadian fleabane	*Erigeron Canadensis*	*	
Sun spurge	*Euphorbia helioscopa*	*	
Black-bindweed	*Fallopia convolvulus*	*	*
Cleavers	*Galium aparine*	*	
Cut leaved cranesbill	*Geranium dissectum*	*	
Nipplewort	*Lapsana communis*	*	
Mayweed sp.	*Matricaria* spp.	*	*
Poppy	*Papaver rhoeas*	*	
Redshank	*Persicaria maculosa*	*	
Plantain	*Plantago major*	*	
Knotgrass	*Polygonum aviculare*	*	*
Buttercup	*Ranunculus repens*	*	
Groundsel	*Senecio vulgaris*	*	*
Prickly sowthistle	*Sonchus asper*	*	
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*	*	
Dandelion	*Taraxacum officinale*	*	
Scentless mayweed	*Tripleurospermum inodorum*	*	*
Small nettle	*Urtica urens*	*	
Common field speedwell	*Veronica persica*		*
Field pansy	*Viola arvensis*	*	

Table 4h. A summary of weeds in set-aside and adjacent crop 2003

H8 Wallington, Norfolk

Species		Setaside	Crop
Grass weeds			
Black bent	*Agrostis gigantea*	*	
Barren brome	*Anisantha sterilis*	*	
False oatgrass	*Arrhenatherum elatius*	*	
Soft brome	*Bromus hordaceus*	*	
Cocksfoot	*Dactylis glomerata*	*	
Common couch	*Elytrigia repens*	*	*
Red fescue	*Festuca rubra*	*	
Yorkshire fog	*Holcus lanatus*	*	
Perennial ryegrass	*Lolium perenne*	*	
Annual meadow grass	*Poa annua*	*	
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Scarlet pimpernel	*Anagallis arvense*	*	
Creeping thistle	*Cirsium arvense*	*	
Hawksbeard	*Crepis biennis*	*	
Willowherb	*Epilobium* spp.	*	
Canadian fleabane	*Erigeron canadensis*	*	
Black-bindweed	*Fallopia convolvulus*	*	
Cleavers	*Galium aparine*	*	
Doves foot cranesbill	*Geranium molle*	*	
Cats ear	*Hypochoeris radicata*	*	
Pineappleweed	*Matricaria discoidea*	*	
Corn mint	*Mentha arvensis*	*	
Forget-me-not	*Myosotis arvensis*	*	
Redshank	*Persicaria maculosa*		*
Bristly ox-tongue	*Picris echioidea*	*	
Plantain	*Plantago major*	*	
Knotgrass	*Polygonum aviculare*	*	*
Groundsel	*Senecio vulgaris*	*	*
Madder	*Sherardia arvensis*	*	
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*	*	*
Dandelion	*Taraxacum officinale*	*	
Scentless mayweed	*Tripleurospermum inodorum*	*	
Coltsfoot	*Tussilago farfara*	*	
Common field speedwell	*Veronica persica*	*	
Field pansy	*Viola arvensis*		*
Thyme leaved speedwell	*Veronica serpyllifolia*	*	

Table 4i. A summary of weeds in set-aside and adjacent crop 2004

H9 Barrow, Suffolk

Species		Setaside	Crop
Crop volunteers			
Weed beet	*Beta vulgaris*		*
Barley	*Hordeum distichon*	*	
Wheat	*Triticum aestivum*	*	
Grass weeds			
Wild oat	*Avena fatua*	*	
Common couch	*Elytrigia repens*	*	
Annual meadow grass	*Poa annua*	*	
Smooth meadow grass	*Poa pretense*		*
Broad-leaved weeds			
Common orache	*Atriplex patula*	*	*
Shepherd's purse	*Capsella bursa-pastoris*	*	
Fat hen	*Chenopodium album*	*	*
Fig leaved goosefoot	*Chenopodium ficifolia*	*	
Creeping thistle	*Cirsium arvense*	*	
Field bindweed	*Convolvulus arvense*	*	
Willowherb	*Epilobium* spp.	*	
Canadian fleabane	*Erigeron canadensis*	*	
Sun spurge	*Euphorbia helioscopa*	*	
Cleavers	*Galium aparine*	*	
Mayweed sp.	*Matricaria* spp.	*	
Annual mercury	*Mercurialis annua*	*	*
Redshank	*Persicaria maculosa*	*	
Bristley oxtongue	*Picris echioidea*	*	
Knotgrass	*Polygonum aviculare*	*	
Ragwort	*Senecio jacobea*	*	
Groundsel	*Senecio vulgaris*	*	*
White campion	*Silene album*	*	
Prickly sowthistle	*Sonchus asper*	*	*
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*	*	*
Scentless mayweed	*Tripleurospermum inodorum*	*	
Common field speedwell	*Veronica persica*	*	
Field pansy	*Viola arvensis*	*	*

Table 4j. A summary of weeds in set-aside and adjacent crop 2004

H10 Newmarket, Suffolk

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Grass weeds			
Barren brome	*Anisantha sterilis*	*	
Annual meadow grass	*Poa annua*	*	
Broad-leaved weeds			
Fat hen	*Chenopodium album*	*	*
Fig leaved goosefoot	*Chenopodium ficifolia*	*	
Creeping thistle	*Cirsium arvense*	*	
Black-bindweed	*Fallopia convolvulus*	*	*
Mayweed sp.	*Matricaria* spp.	*	
Knotgrass	*Polygonum aviculare*	*	
Groundsel	*Senecio vulgaris*	*	*
White campion	*Silene album*		*
Sowthistle sp.	*Sonchus* spp.	*	*
Dandelion	*Taraxacum officinale*	*	
Common field speedwell	*Veronica persica*	*	*
Field pansy	*Viola arvensis*	*	*

Table 4k. A summary of weeds in set-aside and adjacent crop 2004

H11 Otley, Suffolk

Species		Setaside	Crop
Crop volunteers			
Oilseed rape	*Brassica napus*		*
Wheat	*Triticum aestivum*	*	
Grass weeds			
Barren brome	*Anisantha sterilis*	*	
Soft brome	*Bromus hordaceus*	*	
Common couch	*Elytrigia repens*	*	*
Broad-leaved weeds			
Spear thistle	*Cirsium vulgare*	*	
Hawthorn	*Crateagus monogyna*	*	
Cherry sp.	*Prunus* spp.	*	
Wild radish	*Raphanus raphanistrum*	*	
Radish	*Raphanus sativus*	*	
Groundsel	*Senecio vulgaris*	*	
Charlock	*Sinapis arvensis*	*	
Hedge mustard	*Sisymbrium officinale*	*	
Prickly sowthistle	*Sonchus asper*	*	
Sowthistle sp.	*Sonchus* spp.	*	
Common chickweed	*Stellaria media*	*	

Table 4l. A summary of weeds in set-aside and adjacent crop 2004

H12 Wallington, Norfolk

Species		Setaside	Crop
Grass weeds			
Cocksfoot	*Dactylis glomerata*	*	
Common couch	*Elytrigia repens*		*
Yorkshire fog	*Holcus lanatus*	*	
Perennial ryegrass	*Lolium perenne*	*	*
Annual meadow grass	*Poa annua*	*	*
Smooth meadow grass	*Poa pratense*	*	
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Scarlet pimpernel	*Anagallis arvense*		*
Common orache	*Atriplex patula*		*
Fat hen	*Chenopodium album*		*
Creeping thistle	*Cirsium arvense*	*	
Spear thistle	*Cirsium vulgare*	*	
Black medic	*Medicago sativa*	*	*
Pineappleweed	*Matricaria discoidea*		*
Broad leaved plantain	*Plantago major*	*	
Oak	*Quercus* spp.	*	
Creeping buttercup	*Ranunculus repens*	*	
Curled dock	*Rumex crispus*	*	
Dandelion	*Taraxacum officinale*	*	
White clover	*Trifolium repens*	*	

Table 4m. A summary of weeds in set-aside and adjacent crop 2004

H13 Ashill, Norfolk

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Wheat	*Triticum aestivum*	*	
Grass weeds			
Blackgrass	*Alopecurus myosuroides*	*	
Common couch	*Elytrigia repens*	*	
Sheeps fescue	*Festuca ovina*	*	
Italian ryegrass	*Lolium multiflorum*	*	
Perennial ryegrass	*Lolium perenne*	*	
Timothy	*Phleum pretense*	*	
Annual meadow grass	*Poa annua*	*	*
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Common orache	*Atriplex patula*	*	
Fat hen	*Chenopodium album*	*	*
Rough hawksbeard	*Crepis biennis*	*	
Willowherb	*Epilobium* spp.	*	
Black-bindweed	*Fallopia convolvulus*	*	
Mayweed sp.	*Matricaria* spp.	*	
Poppy	*Papaver rhoeas*	*	
Pale persicaria	*Persicaria lapathifolia*	*	
Redshank	*Persicaria maculosa*	*	*
Plantain	*Plantago major*	*	*
Knotgrass	*Polygonum aviculare*	*	
Groundsel	*Senecio vulgaris*	*	*
Prickly sowthistle	*Sonchus asper*	*	
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*	*	
Scentless mayweed	*Tripleurospermum inodorum*	*	
Field pansy	*Viola arvensis*		*

Table 4n. A summary of weeds in set-aside and adjacent crop 2004

H14 Stowmarket, Suffolk

Species		Setaside	Crop
Grass weeds			
Common bent	*Agrostis gigantea*	*	
Blackgrass	*Alopecurus myosuroides*		*
Barren brome	*Anisantha sterilis*	*	
False oat grass	*Arrhenatherum elatius*	*	
Soft brome	*Bromus hordaceus*	*	
Crested dogs tail	*Cynosurus cristata*	*	
Cocksfoot	*Dactylis glomerata*	*	
Common Couch	*Elytrigia repens*	*	
Sheeps fescue	*Festuca ovina*	*	
Meadow fescue	*Festuca pratense*	*	
Perennial ryegrass	*Lolium perenne*	*	
Timothy	*Phleum pratense*	*	
Smooth meadow grass	*Poa pratense*	*	
Rough meadow grass	*Poa trivialis*	*	
Broad-leaved weeds			
Scarlet pimpernel	*Anagallis arvense*		*
Common orache	*Atriplex patula*		*
Shepherds purse	*Capsella bursa-pastoris*	*	
Common mouse ear	*Cerastium fontanum*	*	
Fat hen	*Chenopodium album*	*	
Creeping thistle	*Cirsium arvense*	*	
Hawthorn	*Crateagus monogyna*	*	
Ash	*Fraxinus excelsior*	*	
Cleavers	*Galium aparine*	*	
Fluellen	*Kickxia spuria*		*
Prickly lettuce	*Lactuca serriola*	*	
Mayweed sp.	*Matricaria* spp.	*	
Plantain	*Plantago major*	*	
Blackberry	*Rubus fruticosus*	*	
Dock	*Rumex* spp.	*	
Groundsel	*Senecio vulgaris*	*	
Sowthistle sp.	*Sonchus* spp.	*	
Rowan	*Sorbus aucuparia*	*	
Corn Spurrey	*Spergula arvensis*	*	
Dandelion	*Taraxacum officinale*	*	
Common field speedwell	*Veronica persica*	*	
Field pansy	*Viola arvensis*		*

Table 4o. A summary of weeds in set-aside and adjacent crop 2004

H15 Doddington, Cambridgeshire

Species		Setaside	Crop
Crop volunteers			
Potato	*Solanum tuberosum*		*
Wheat	*Triticum aestivum*	*	
Grass weeds			
Bearded couch	*Agropyron caninum*	*	
Blackgrass	*Alopecurus myosuroides*		*
Barren brome	*Anisantha sterilis*	*	
False oat grass	*Arrhenatherum elatius*	*	
Soft brome	*Bromus hordaceus*	*	
Sedge sp.	*Carex* spp.	*	
Cocksfoot	*Dactlyis glomerata*	*	*
Common couch	*Elytrigia repens*		*
Hybrid fescue	*Festulolium loliaceum*	*	
Sheeps fescue	*Festuca ovina*	*	
Yorkshire fog	*Holcus lanatus*	*	
Italian ryegrass	*Lolium multiflorum*	*	
Perennial ryegrass	*Lolium perenne*	*	*
Annual meadow grass	*Poa annua*	*	
Rough meadow grass	*Poa trivialis*	*	*
Broad-leaved weeds			
Scarlet pimpernel	*Anagallis arvense*		*
Fat hen	*Chenopodium album*		*
Spear thistle	*Cirsium vulgare*	*	
Black-bindweed	*Fallopia convolvulus*		*
Cleavers	*Galium aparine*	*	
Red dead nettle	*Lamium purpureum*		*
Mayweed sp.	*Matricaria* spp.	*	*
Redshank	*Persicaria maculosa*		*
Knotgrass	*Polygonum aviculare*		*
Groundsel	*Senecio vulgaris*	*	
Scentless mayweed	*Tripleurospermum inodorum*	*	
Small nettle	*Urtica urens*	*	*
Field pansy	*Viola arvensis*	*	

Table 4p. A summary of weeds in set-aside and adjacent crop 2004

H16 Baston Fen, Cambridgeshire

Species		Setaside	Crop
Crop volunteers			
Barley	*Hordeum distichon*	*	
Wheat	*Triticum aestivum*	*	
Grass weeds			
Blackgrass	*Alopecurus myosuroides*	*	
Barren brome	*Anisantha sterilis*	*	
False oat grass	*Arrhenatherum elatius*	*	*
Soft brome	*Bromus hordaceus*	*	
Cocksfoot	*Dactylis glomerata*	*	*
Common couch	*Elytrigia repens*	*	
Fescue sp.	*Festuca* spp.	*	
Yorkshire Fog	*Holcus lanatus*	*	*
Wall barley	*Hordeum murinum*	*	
Perennial ryegrass	*Lolium perenne*	*	
Annual meadow grass	*Poa annua*	*	
Flattened meadow grass	*Poa compressa*	*	
Rough meadow grass	*Poa trivialis*	*	*
Broad-leaved weeds			
Fat hen	*Chenopodium album*		*
Creeping thistle	*Cirsium arvense*	*	
Rough hawksbeard	*Crepis biennis*	*	
Willowherb	*Epilobium* spp.	*	
Black-bindweed	*Fallopia convolvulus*		*
Cleavers	*Galium aparine*	*	*
Cut leaved cranesbill	*Geranium dissectum*	*	
Red dead nettle	*Lamium purpureum*		*
Nipplewort	*Lapsana communis*	*	
Black medic	*Medicago lupulina*		*
Redshank	*Persicaria maculosa*		*
Knotgrass	*Polygonum aviculare*		*
Curled dock	*Rumex crispus*	*	
Groundsel	*Senecio vulgaris*		*
Sowthistle sp.	*Sonchus* spp.	*	*
Common chickweed	*Stellaria media*		*
Dandelion	*Taraxacum officinale*	*	
Coltsfoot	*Tussilago farfara*	*	
Common field speedwell	*Veronica persica*		*
Field pansy	*Viola arvensis*		*

Appendix Table 5A . Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: year totals

	Carabid adults	Carabid larvae	Staphs adults	Staphs larvae	Other Coleop	Collem-bola	Diptera adults	Spiders	Har'men	Wood-lice	Snails	Slugs
2003												
Headland	219	0.28	8.2	0.19	3.1	77.4	13.1	24.0	2.1	4.4	0.6	1.9
Crop	371	0.08	6.9	0.04	4.2	25.2	12.8	21.8	3.1	0.2	0.1	0.1
2004												
Headland	49	0.20	3.2	0.08	3.7	44.6	10.6	28.8	0.6	8.6	0.7	3.5
Crop	80	0.09	1.5	0.02	6.2	24.7	8.4	23.6	2.1	0.1	0.1	1.0
Mean for both years												
Headland	**134**	**0.24**	**5.7**	**0.13**	**3.4**	**61.0**	**11.9**	**26.4**	**1.3**	**6.5**	**0.6**	**2.7**
Crop	**225**	**0.08**	**4.2**	**0.03**	**5.2**	**24.9**	**10.6**	**22.7**	**2.6**	**0.1**	**0.1**	**0.6**
SED year 14 d.f.	86.0	0.059	1.61	0.050	1.05	11.63	2.53	5.69	2.04	1.67	0.21	0.88
SED env'ment 14 d.f.	32.5	0.063	0.94	0.044	0.70	11.12	1.97	3.55	0.70	1.67	0.23	0.56
SED interaction 14 d.f.	45.9	0.087	1.33	0.063	0.99	15.72	2.78	5.02	1.00	2.37	0.31	0.79
LSD year	184.5 P=0.018	0.127 NS	3.45 P=0.006	0.11 NS	2.25 NS	24.95 NS	5.42 NS	12.20 NS	4.37 NS	3.62 NS	0.45 NS	1.88 NS
LSD env'ment	69.7 P=0.014	0.135 P=0.025	2.02 NS	0.10 P=0.037	1.50 P=0.024	23.84 P=0.006	4.22 NS	7.62 NS	1.51 NS	3.59 P=0.002	0.50 P=0.043	1.19 P=0.002
LSD interaction	98.5 NS	0.190 NS	2.86 NS	0.13 NS	2.11 NS	33.72 NS	5.97 NS	10.77 NS	2.13 NS	5.08 NS	0.70 NS	1.69 NS
CV%	51	109	54	155	46	73	50	41	102	143	178	97

NS = not significant

Appendix Table 5B . Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: year totals

	Parasitoids	Total Hymenoptera	Aphids	Total Homoptera	Aphid Predators	Total inverts
2003						
Headland	3.1	7.2	3.0	4.3	0.4	371
Crop	1.2	2.0	0.3	0.4	0.3	451
2004						
Headland	6.6	8.1	3.1	4.1	0.4	169
Crop	7.1	7.1	1.1	1.2	0	158
Mean of both years						
Headland	**4.9**	**7.7**	**3.1**	**4.2**	**0.4**	**270**
Crop	**4.1**	**4.6**	**0.7**	**0.8**	**0.2**	**304**
SED year 14 d.f.	1.70	1.64	0.82	0.89	0.10	94.0
SED env'ment 14 d.f.	1.10	1.36	0.83	0.92	0.14	25.1
SED interaction 14 d.f.	1.56	1.92	1.18	1.30	0.20	97.3
LSD year	3.65 P=0.015	3.51 NS	NS	1.92 NS	0.22 NS	201.5 P=0.020
LSD env'ment	2.36 NS	2.91 P=0.037	P=0.013	1.97 P=0.002	0.31 NS	53.9 NS
LSD interaction	3.34 NS	4.12 NS	NS	2.79 NS	0.44 NS	206.2 NS
CV%	69	63		104	144	25

NS = not significant

Appendix Table 6A. Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: June

	Carabid adults	Carabid larvae	Staphs adults	Staphs larvae	Other Coleop	Collem-bola	Diptera adults	Spiders	Har'men	Wood-lice	Snails	Slugs
2003												
Headland	75.0	0.1	2.4	0.1	1.1	20.1	3.8	9.8	0.5	0.7	0.4	0.5
Crop	80.7	0	1.8	0	1.6	9.7	3.7	11.1	1.5	0.1	0	0
2004												
Headland	16.3	0.1	0.8	0	1.2	16.3	2.1	10.0	0.1	1.1	0.1	0.4
Crop	14.0	0	0.4	0	1.5	10.4	2.6	9.6	0.1	0	0	0
Mean for both years												
Headland	**45.6**	**0.1**	**1.6**	**0**	**1.2**	**18.2**	**3.0**	**9.9**	**0.3**	**0.9**	**0.2**	**0.4**
Crop	**47.3**	**0.1**	**1.1**	**0**	**1.6**	**10.1**	**3.1**	**10.3**	**0.8**	**0**	**0**	**0**
SED year 14 d.f.	24.34	0.03	0.43	0.02	0.47	4.76	1.09	4.42	0.82	0.39	0.13	0.18
SED env'ment 14 d.f.	8.57	0.03	0.25	0.02	0.31	2.88	0.45	3.16	0.55	0.38	0.13	0.18
SED interaction 14 d.f.	12.12	0.05	0.35	0.03	0.43	4.08	0.64	4.47	0.78	0.53	0.18	0.26
LSD year	52.21 P=0.022	0.07 NS	0.92 P=0.004	0.05 P=0.023	1.00 NS	10.21 NS	2.34 NS	9.49 NS	1.77 NS	0.84 NS	0.28 NS	0.39 NS
LSD env'ment	18.38 NS	0.07 P=0.029	0.54 P=0.058	0.04 NS	0.66 NS	6.18 P=0.014	0.97 NS	6.78 NS	1.18 NS	0.81 P=0.036	0.28 NS	0.39 P=0.053
LSD interaction	26.00 NS	0.10 NS	0.76 NS	0.06 NS	0.93 NS	8.75 NS	1.37 NS	9.58 NS	1.66 NS	1.14 NS	0.39 NS	0.55 NS
CV%	52	165	53	197	64	58	42	88	289	231	334	247

NS = not significant

Appendix Table 6B. Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: June

	Parasitoids	Total Hymenoptera	Aphids	Total Homoptera	Aphid Predators	Total inverts
2003						
Headland	1.1	3.4	1.0	1.3	0.2	122.2
Crop	0.2	0.7	0.1	0.2	0	113.3
2004						
Headland	2.1	2.2	0.6	0.8	0.2	52.7
Crop	4.3	4.3	0.5	0.5	0	43.7
Mean for both years						
Headland	**1.6**	**2.8**	**0.8**	**1.1**	**0.2**	**87.5**
Crop	**2.2**	**2.5**	**0.3**	**0.3**	**0**	**78.5**
SED year 14 d.f.	1.21	1.28	0.30	0.36	0.08	27.05
SED env'ment 14 d.f.	0.98	1.08	0.30	0.35	0.08	11.13
SED interaction 14 d.f.	1.38	1.53	0.43	0.49	0.11	15.74
LSD year	2.60 P=0.050	2.75 NS	0.65 NS	0.76 NS	0.17 NS	58.01 P=0.022
LSD env'ment	2.10 NS	2.32 NS	0.64 NS	0.75 P=0.056	0.18 NS	23.87 NS
LSD interaction	2.97 NS	3.28 P=0.040	0.91 NS	1.06 NS	0.25 NS	33.76 NS
CV%	146	116	162	142	243	38

NS = not significant

Appendix Table 7A. Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: July

	Carabid adults	Carabid larvae	Staphs adults	Staphs larvae	Other Coleop	Collem-bola	Diptera adults	Spiders	Har'men	Wood-lice	Snails	Slugs
2003												
Headland	85.1	0.1	3.3	0.1	1.4	27.1	5.2	9.5	1.1	2.5	0.1	0.5
Crop	162.4	0	2.0	0	1.1	11.2	4.8	6.7	0.9	0.1	0	0
2004												
Headland	11.5	0.1	0.9	0.1	1.1	18.3	3.6	9.2	0.1	5.8	0.4	1.0
Crop	18.7	0	0.5	0	3.7	9.7	1.5	8.9	0.7	0.1	0	0.1
Mean for both years												
Headland	**48.3**	**0.1**	**2.1**	**0.1**	**1.2**	**22.7**	**4.4**	**9.4**	**0.6**	**4.2**	**0.2**	**0.8**
Crop	**90.6**	**0**	**1.2**	**0**	**2.4**	**14.0**	**3.2**	**7.8**	**0.8**	**0.1**	**0**	**0.1**
SED year 14 d.f.	40.97	0.02	0.69	0.05	0.54	5.11	1.15	1.86	0.81	1.54	0.11	0.27
SED env'ment 14 d.f.	15.83	0.02	0.48	0.04	0.43	3.94	1.04	1.62	0.25	1.54	0.12	0.24
SED interaction 14 d.f.	22.38	0.03	0.67	0.06	0.61	5.48	1.48	2.29	0.36	2.17	0.17	0.34
LSD year	87.88 P=0.019	0.05 NS	1.48 P=0.015	0.11 NS	1.16 P=0.059	10.96 NS	2.46 P=0.052	3.99 NS	1.73 NS	3.30 NS	0.25 NS	0.57 NS
LSD env'ment	33.95 P=0.018	0.05 P=0.004	1.02 NS	0.09 NS	0.93 P=0.020	8.46 P=0.008	2.24 NS	3.47 NS	0.54 NS	P=3.29 0.018	0.25 NS	0.52 P=0.011
LSD interaction	48.01 P=0.044	0.06 NS	1.44 NS	0.13 NS	1.32 P=0.005	11.96 NS	3.18 NS	4.90 NS	0.77 NS	4.65 NS	0.36 NS	0.73 NS
CV%	65	123	81	265	68	67	78	53	102	207	261	159

NS = not significant

Appendix Table 7B. Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: July

	Parasitoids	Total Hymenoptera	Aphids	Total Homoptera	Aphid Predators	Total inverts
2003						
Headland	1.3	2.6	1.1	1.7	0.2	141.3
Crop	0.2	0.5	0.2	0.2	0.2	190.4
2004						
Headland	2.6	2.9	2.5	2.9	0.2	59.0
Crop	1.5	1.5	0.6	0.6	0	46.5
Mean for both years						
Headland	**1.9**	**2.7**	**1.8**	**2.3**	**0.2**	**100.2**
Crop	**0.8**	**1.0**	**0.4**	**0.4**	**0.1**	**118.5**
SED year 14 d.f.	0.46	0.61	0.48	0.49	0.09	40.92
SED env'ment 14 d.f.	0.35	0.40	0.49	0.50	0.09	15.75
SED interaction 14 d.f.	0.50	0.57	0.69	0.70	0.13	22.28
LSD year	0.99 P=0.017	1.30 NS	1.03 NS	1.06 NS	0.20 NS	87.77 P=0.015
LSD env'ment	0.75 P=0.008	0.86 P<0.001	1.05 P=0.011	1.07 P=0.002	0.19 NS	33.79 NS
LSD interaction	1.07 NS	1.21 NS	1.48 NS	1.51 NS	0.27 NS	47.78 NS
CV%	72	61	125	104	187	41

NS = not significant

Appendix Table 8A. Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: August

	Carabid adults	Carabid larvae	Staphs adults	Staphs larvae	Other Coleop	Collem-bola	Diptera adults	Spiders	Har'men	Wood-lice	Snails	Slugs
2003												
Headland	59	0	2.6	0	0.6	30.2	4.1	4.7	0.5	1.3	0.1	0.9
Crop	128	0.1	3.1	0	1.5	4.3	4.4	4.0	0.7	0	0.1	0
2004												
Headland	21	0.1	1.5	0	1.4	10.0	4.9	9.6	0.4	1.7	0.3	2.2
Crop	47	0.1	0.7	0	1.0	4.6	4.3	5.2	1.3	0.1	0.1	0.9
Mean for both years												
Headland	**40**	**0.1**	**2.0**	**0**	**1.0**	**20.1**	**4.5**	**7.1**	**0.5**	**1.5**	**0.2**	**1.5**
Crop	**88**	**0.1**	**1.9**	**0**	**1.3**	**4.4**	**4.3**	**4.6**	**1.0**	**0.1**	**0.1**	**0.5**
SED year 14 d.f.	32.4	0.04	0.92		0.33	5.66	1.47	1.24	0.49	0.47	0.07	0.70
SED env'ment 14 d.f.	20.4	0.03	0.54		0.33	5.85	1.21	1.19	0.24	0.46	0.09	0.28
SED interaction 14 d.f.	28.9	0.04	0.77		0.47	8.27	1.71	1.68	0.34	0.65	0.12	0.40
LSD year	69.4 NS	0.09 NS	1.96 NS	NS	0.70 NS	12.14 NS	3.15 NS	2.67 P=0.029	1.01 NS	1.00 NS	0.16 NS	1.49 NS
LSD env'ment	43.8 P=0.036	0.06 NS	1.16 NS	NS	0.71 NS	12.54 P=0.018	2.59 NS	2.55 P=0.048	0.51 NS	0.98 P=0.008	0.19 NS	0.60 P=0.002
LSD interaction	62.0 NS	0.08 NS	1.65 NS	NS	1.01 NS	17.73 NS	3.67 NS	3.61 NS	0.73 NS	1.39 NS	0.26 NS	0.86 NS
CV%	91	141	78		83	135	78	58	94	170	184	81

NS = not significant

Appendix Table 8B. Numbers of invertebrates per pitfall trap in sugar beet and surrounding headlands, 2003-2004: August

	Parasitoids	Total Hymenoptera	Aphids	Total Homoptera	Aphid Predators	Total inverts
2003						
Headland	0.8	1.3	1.0	1.3	0.1	107.2
Crop	0.7	0.8	0	0.1	0.1	147.0
2004						
Headland	2.0	3.1	0	0.5	0	57.7
Crop	1.4	1.4	0	0	0	67.6
Mean years						
Headland	**1.4**	**2.2**	**0.5**	**0.9**	**0.05**	**82.5**
Crop	**1.1**	**1.1**	**0**	**0.1**	**0.05**	**107.3**
SED year 14 d.f.	0.33	0.51	0.49	0.57	0.04	36.88
SED env'ment 14 d.f.	0.27	0.57	0.49	0.58	0.04	17.05
SED interaction 14 d.f.	0.38	0.80	0.69	0.82	0.06	24.11
LSD year	0.70 P=0.014	1.10 P=0.037	1.04 NS	1.22 NS	0.10 NS	79.09 NS
LSD env'ment	0.57 NS	1.22 NS	1.05 NS	1.24 NS	0.10 NS	36.56 NS
LSD interaction	0.81 NS	1.72 NS	1.49 NS	1.76 NS	0.14 NS	51.71 NS
CV%	63	98	528	359	254	51

NS = not significant