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## STUDIES OF THE FLORA IN ARABLE FIELD MARGINS



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# STUDIES OF THE FLORA IN ARABLE FIELD MARGINS
A Report to the Countryside Commission

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SUMMARY

A series of studies is in progress at Long Ashton (following the move from the Weed Research Organization, Oxford, in September 1985) supported by the Countryside Commission, MAFF and the Perry Foundation, examining the role and management of field margins. Field margins are a major landscape feature of lowland farmland in Britain. With intensification of agriculture, the field boundary has become under increasing pressure, both for removal and for change due to greater disturbance. A proper understanding of the interactions of the boundary with farmland should allow the adoption of suitable management, which in turn will ensure the survival of a useful farmland feature.

An interview survey of farmers was carried out at the 1985 Royal Agricultural Show in the Arable Section; 163 respondents answered questions on the management of their cereal field edges. Of these, 75% reported they farmed the crop edge as the rest of the field; 30% created a barrier strip of some sort between crop and hedgebottom. Surprisingly, 60% reported past or present use of herbicides in the hedgebottom. The overriding motivation for management was for weed control. The perception that weeds spread from field edges is common; the main threats were seen as sterile brome and cleavers, species which are common where the perennial flora has been destroyed.

Surveys of the floras of cereal fields and field margins has been carried out on three farms, the Boxworth EHF, Cambridge, the Manydown Estate, Hampshire (Game Conservancy Cereals & Gamebirds Research Project) and Bovingdon Hall, Essex (Countryside Commission Demonstration Farm). The collected data indicate the following major points:

- only a quarter of the plant species found within the hedgebottom are also found in the crop. Most hedge species are not weeds.
- some common field weeds may be found in the hedge and are capable of spreading into the field.
- there are indications that field edge structure does not affect field weed populations
- there may be a trend for increased plant species diversity in hedgebottoms adjacent to unsprayed crop edges

Although the origin of some common field weeds may be the hedgerow, only a small number of species are involved. The rate of spread of species requires further study so that the significance of any spread in maintaining field weed populations is assessed. Methods of field edge management will modify the flora and influence potential weed populations in the hedgebottom.

Pot and field experiments on controlling sterile brome by cutting or by the application of the flower-suppressing compound mefluidide have not given the desired result. The species is capable of recovery by increased tillering. Further work on the effects of cutting on brome and cleavers is planned.

An experiment on the movement of couch grass among perennial grass swards has been set up at Long Ashton. The establishment of a perennial grass sward

between the hedge and the crop will be studied in the field. The technique has the potential of minimising weed spread as well as providing a defined edge, which may reduce accidental fertiliser and spray inputs to the natural flora.

Plant populations will continue to be surveyed at Boxworth, Manydown and Bovingdon Hall, to assess the effects of reduced herbicide inputs on hedgebottom floras and to further confirm the patterns already found. Field experiments on cutting of hedgebottoms and establishing a grass strip are planned. Work on the dispersal of some species, particularly movement of seed by mechanical soil movement, may be initiated. The work supported by the Perry Foundation on the direct effects of chemicals on hedgebottom plants terminates at the begining of November 1986. By that time about 40 ground flora species and 5 shrub species will have been tested against a number of herbicides and growth regulators.

## INTRODUCTION

Field margins are a major landscape feature of farmland, particularly in lowland Britain. Their traditional role, that of containing stock, has largely gone from holdings that now grow arable crops. Arable farmers often view the field margin as a source of weeds, pests and disease. As a result of this, and improvements in mechanisation, the hedgerow is under pressure. Hedgerow removal to enlarge fields continues but at a slower pace than in past years. Nevertheless, field margins are the commonest feature of uncropped land on the farm and as such represent an important habitat for wildlife. If the farmer can be shown that field margins pose insignificant problems to crops, or are even of benefit, or that management can create floras that are desirable and innoffensive, then their future on farmland may be more assured.

The terms used to describe the areas and structures that make up field margins are diverse. Recently there have been moves to clarify the semantics to facilitate management advice (Greaves & Marshall, in press). It is suggested that the barrier structure, such as the hedge, fence, wall etc., and any associated bank or water course are referred to as the field boundary. Between the field boundary and the crop, there may be a boundary strip consisting of a track, a grass strip or a sterile strip. The crop edge, often loosely referred to as the headland, is also included under the term field margin.

A series of studies of field margin floras are in progress at Long Ashton supported by the Countryside Commission, the Ministry of Agriculture, Fisheries and Food and the Perry Foundation. The aims of the work are to i) assess the effects of agricultural operations, primarily herbicide applications, on field edge flora, ii) to examine the role of the field margin in influencing field weed populations, and iii) to develop and assess methods of managing field edge floras which satisfy agricultural and wildlife requirements. The role of the field edge needs critical examination to justify or refute the perceptions of farmers. Management techniques also need to be well founded scientifically.

The work may be divided into three areas:-

a). Surveys of field populations of plants on farms where varied herbicide treatments are being applied
b). Testing a range of hedgerow plants grown in pots against herbicides and plant growth regulators
c). Small plot experiments in the field to look at different forms of field edge management and at weed spread.

The work has concentrated on arable field edges, as these are perhaps under the greatest threat. In addition, most work has been associated with thorn hedges as these are the commonest structure. In the case of the monitoring exercises other field edge structures, e.g. woodland edges, grass banks, have also been studied. The surveying exercises have taken place on the Boxworth Experimental Husbandry Farm, Cambridge, the Manydown Estate, Hampshire and Bovingdon Hall, Essex. The Manydown Estate is the field site for the Game Conservancy's Cereals & Gamebirds Research Project. Bovingdon Hall is one of the sites for the Countryside Commission's Demonstration Farms Project. This report takes the form of a review of the results collected.

## FARMERS PERCEPTIONS OF FIELD MARGINS

An interview survey of farmers was carried out in the Arable Section at the 1985 Royal Agricultural Show at Stoneleigh. Details of crop edge, boundary strip edge and hedgerow management were sought from farmers growing cereals. 160 respondents, each growing at least some cereals, were questioned about their cereal field edges, including their flora. In response to the question "Do you farm the crop edge similarly to the rest of the field?", 75% said Yes. Approximately a quarter of farmers either drilled at double rate, sprayed extra agrochemicals or carried out other activities on the crop edge. Some 30% of the farmers reported they created a barrier strip between the crop and the hedgebottom. Where herbicides were applied to create a barrier, glyphosate and paraquat were the commonest to be used. Most farmers cultivate up to the hedge base.

When questioned about hedge management 60% of farmers said they had used herbicides in the hedgebottom. They did not differentiate between regular hedgebottom spraying and occasional nettle or thistle patch spraying. Nevertheless the practice of hedgebottom spraying appears to be more common than previously supposed. The overriding motivation for management at the cereal field edge was for weed control, occasionally to facilitate harvesting. It is generally perceived that field edges harbour weeds which spread into the field. The plant species which were thought to be the main threat were Bromus sterilis (sterile brome) and Galium aparine (cleavers), both of which have until recently been poorly controlled by herbicides in the field.

## THE BOXWORTH PROJECT, CAMBRIDGE

The multidisciplinary MAFF project on pest and disease control systems, based at the Boxworth Experimental Husbandry Farm, Cambridgeshire and known as the Boxworth Project, seeks to assess the economic and ecological consequences of different levels of pesticide use in commercially grown cereals (Stanley & Hardy, 1984). AFRC Weed Research Organization (now LARS Weed Research Division) became responsible in 1982 for advising on the use of herbicides and in 1983 for assessing the changes in the flora of both the fields and the field boundaries (M.A.F.F., 1982; 1983). The 120 ha study area is made up of 11 fields divided into three blocks receiving the following regimes:

1. Full Insurance - receiving pesticides on a prophylactic basis. A high, regular, but realistic, input is achieved.
2. Supervised - receiving pesticides only when pests achieve levels likely to affect yield. Decision thresholds are being used.
3. Integrated - receiving pesticides on the same basis as the Supervised area but husbandry and cultural operations are combined to further minimise pesticide use.

The treatment regimes were imposed for the 1984 harvest year and will continue to the 1988 harvest. Baseline data were collected in the 1983 harvest year. The data presented are a summary of some assessments taken over the initial and first two treatment years. Therefore only an interim picture is presented; major conclusions should not be drawn at this stage.

In terms of the herbicides applied, different numbers of treatments have been achieved in the different treatment areas, with most on Full Insurance and least on Integrated. Details of methods and some of the results are given in the folowing sections.

Extensive surveys

The field margins were surveyed in March, June and July at 50 pace survey points around the field perimeter. At each point an area of hedge 2 metres wide was studied. All species present in the hedge and a metre into the crop were recorded. The results from the three surveys have been collated, giving a species list for each field and the percentage occurrence of each species within the three treatment areas for each year.

The numbers of species recorded in each field and treatment area are given in Table 1 below with Margalef's index of diversity (Margalef, 1951). Most fields have shown an increase in species number and diversity over 1984, indicating that field treatments are perhaps not affecting edge floras overall as was at first indicated (Marshall, 1985b).

Table 1. Summaries of species occurrences in field boundaries at Boxworth EHF, 1983-85.

| Field | Number of sites | No. of species | | | No. of occurrences | | | Margalef's diversity score | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 83 | 84 | 85 | 83 | 84 | 85 | 83 | 84 | 85 |
| Integrated | | | | | | | | | | |
| Bushes & Pits | 21 | 51 | 63 | 64 | 232 | 339 | 377 | 9.2 | 10.6 | 10.6 |
| 11 Acre Extra | 22 | 46 | 63 | 64 | 196 | 356 | 374 | 8.5 | 10.6 | 10.6 |
| Extra Close E&W | 33 | 60 | 69 | 71 | 388 | 588 | 535 | 9.9 | 10.7 | 11.1 |
| Area | 76 | 81 | 87 | 95 | 816 | 1283 | 1286 | 11.9 | 12.0 | 13.1 |
| Supervised | | | | | | | | | | |
| Top Pavements | 17 | 35 | 50 | 56 | 181 | 303 | 337 | 6.5 | 8.6 | 9.5 |
| Thorofare | 26 | 52 | 65 | 63 | 318 | 458 | 432 | 8.9 | 10.5 | 10.2 |
| Knapwell | 45 | 81 | 70 | 81 | 617 | 790 | 786 | 12.5 | 10.3 | 12.0 |
| Area | 88 | 87 | 80 | 100 | 1116 | 1551 | 1555 | 12.3 | 10.8 | 13.5 |
| Full Insurance | | | | | | | | | | |
| Grange Piece | 24 | 56 | 64 | 67 | 283 | 404 | 369 | 9.7 | 10.5 | 11.2 |
| Shackles Aden | 21 | 55 | 55 | 68 | 329 | 386 | 412 | 9.3 | 9.1 | 11.1 |
| Backside | 32 | 63 | 65 | 72 | 403 | 534 | 526 | 10.3 | 10.2 | 11.3 |
| Pamplins | 18 | 41 | 45 | 50 | 187 | 256 | 230 | 7.7 | 7.9 | 9.0 |
| Area | 95 | 98 | 97 | 109 | 1202 | 1580 | 1537 | 13.7 | 13.0 | 14.7 |

In 1985 the situation was complicated by the presence of fields in oilseed rape. These fields tend to have a slightly different field edge flora from the winter wheat fields, e.g. *Papaver* sp. and *Capsella bursa-pastoris* occur more frequently in the rape field edges. The percentage occurrence of these species within a treatment area is affected by the number of oilseed rape fields, so individual fields should be examined not areas.

On balance, more species were found in 1985 than 1984. This partially reflects improved identification, e.g. new records of Elymus caninus (bearded couch). Some of the new species are trees that have recently been planted.

In 1984 Fallopia convolvulus had increased in numbers from 1983. In 1985 the level has fallen again from 49% to 12% in the Integrated Area, from 27% to 0% in the Supervised Area and from 47% to 19% in the Full Insurance Area. This would suggest the increase was not a permanent one in response to chemical treatment.

A list of the changes in occurrence from 1983 to 1985 of the most common species, excluding shrubs and trees, is given in Appendix 1. The levels of occurrence of Urtica dioica were higher in 1985 as were those for Arrhenatherum elatius in the Integrated and Supervised Areas. However in the Full Insurance Area A.elatius levels were lower. There was less Convolvulus arvensis in the Full Insurance Area compared with last year, and the incidence of Elymus repens and Poa trivialis was lower. In the Integrated Area the level of Heracleum sphondylium was lower than for last year. These changes may, of course, be unrelated to the field treatments.

Cluster analyses of the species compositions of each site indicated that structure affected the flora. Average-linkage analyses produced site groupings that followed the major field margin types, i.e. short hedge, woodland, track etc. There was no obvious difference in species composition between similar boundary types of different aspect.

Intensive study areas

In five of the fields there are intensive study areas which complement invertebrate and small mammal studies. These five sites are based on a fixed 50m length of hedgerow, extending 100m into the crop. Detailed records of field edge plant populations are taken in autumn, spring and summer and more intensive sampling of the field weed flora is made at these times.

The hedges in Extra Close East and Grange Piece are both short hawthorn hedges, the Thorofare study area borders a tall hedge and ditch. The Top Pavements site consists of a previously burned bank and ditch with mature trees and the site in Knapwell is a length of bank and ditch bordering a recently replanted area of woodland.

An example of the 5m transect data collected in Extra Close East in spring 1985 is shown in Table 2.

Table 2. Mean densities ($m^{-2}$) of plants (grass tillers) in eleven 5m transects traversing the Extra Close East field margin in March 1985. Data are given as densities within successive 0.5m lengths from the hedge. Mean distance to edge of cultivated ground = 0.6m.

| Quadrat distance (m) from hedgebottom | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0m |
|---|---|---|---|---|---|---|---|---|---|---|
| | Edge : Cultivated - crop drilled | | | | | | | | | |
| Species | Plant or tiller density ($m^{-2}$) | | | | | | | | | |
| Ranunculus repens | | 0.5 | | | | | | | | |
| Sinapis arvensis | | 1 | 1 | 0.5 | | | | | | |
| Stellaria media | | | | | | | 0.5 | | | |
| Geranium molle | | | | | | 0.5 | | 0.5 | | 0.5 |
| Rubus fruticosus | 5 | | | | | | | | | |
| Anthriscus sylvestris | 44 | 17 | 6 | 2 | | | 0.5 | | | |
| Conopodium majus | 2 | 0.5 | | | | | | | | |
| Aethusa cynapium | 4 | 0.5 | 0.5 | | | | | | | |
| Heracleum sphondylium | 9 | 5 | | | | | | | | |
| Polygonum sp. | 2 | | | 1 | | 0.5 | 0.5 | | 1 | |
| Urtica dioica | 4 | 0.5 | | | | | | | | |
| Kickxia sp. | | | | | | | | 0.5 | | |
| Veronica hederifolia | | | | | | | | | | 0.5 |
| Veronica persica | 2 | 1 | 2 | 6 | 8 | 8 | 8 | 5 | 7 | 7 |
| Galium aparine | 224 | 24 | 1 | 1 | | | 1 | | | 0.5 |
| Cirsium arvense | | | 0.5 | | | | | | | |
| Cirsium sp. | 2 | | | | | | | | | |
| Unidentified dicot. | 9 | 0.5 | 0.5 | 1 | 4 | 0.5 | | 1 | 1 | 0.5 |
| Poa sp. | 2 | 80 | 3 | 1 | | | | | | |
| Bromus sp. | 908 | 231 | 35 | 4 | 3 | 1 | | | | |
| Elymus repens | 40 | 28 | 22 | 0.5 | | | | | | |
| Arrhenatherum elatius | 49 | 10 | | | | | | | | |
| Agrostis stolonifera | 33 | 36 | | | | | | | | |
| Alopecurus myosuroides | | | 0.5 | | 0.5 | | | 0.5 | 1 | |

The distributions of G.aparine, Bromus spp. and E.repens indicate some ability to survive in the crop edge. Of these, G.aparine occurred further into the field than other species. A.myosuroides was not found in the hedge area.

The distances between fixed marker pegs at the hedge base and the edge of cultivation have altered each year (Table 3), illustrating the variable element of disturbance in the field margin caused by cultivations.

Table 3. Mean distance between the hedgebottom and either (A) cultivated ground or (B) the crop in intensive study sites.

| Year | 1983/84 | | 1984/85 | | 1985/86 | |
|---|---|---|---|---|---|---|
| Distance | A | B | A | B | A | B |
| Field | | | | | | |
| Grange Piece | 0.50 | 1.07 | 0.49 | 0.88 | 0.50 | 0.60 |
| Extra Close | 0.64 | 1.50 | 0.60 | 1.05 | 0.53 | 0.65 |
| Knapwell | 0.96 | 1.95 | 1.54 | 2.07 | 1.01 | 1.26 |
| Thorofare | 0.87 | 1.21 | 0.95 | Rape | 0.36 | 0.36 |
| Top Pavements | 1.00 | 1.94 | 0.75 | 1.02 | 0.25 | 0.4 |

In 1984/85 the edge area of Knapwell was deeper, while that of Top Pavements was shallower.

In the July 5m transect series, the vegetative frequency of species is recorded within the hedge, in the area from the hedgebase to the crop edge ("edge") and in the crop to 5m. Changes from year to year for the grasses in Extra Close East are shown in Table 4. Increases in frequencies of grasses in 1984 in the "edge" area were not repeated in 1985, with values returning to 1983 levels. The exception was the continued increase in B.commutatus. A.elatius has increased in the hedgebottom (cf. Extensive surveys) while A.myosuroides has declined over the three years.

Table 4. Changes in summer vegetative frequencies (%) of grasses in Extra Close East field 5m transects over three years. Boxworth EHF.

| Transect area | Hedge | | | Edge | | | Crop | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 83 | 84 | 85 | 83 | 84 | 85 | 83 | 84 | 85 |
| Poa annua | 0 | | | 1.7 | | | 0 | | |
| Poa trivialis | 0 | 0 | 1.8 | 20.9 | 15.1 | 21.6 | 0.6 | 0.7 | 0.2 |
| Dactylis glomerata | | 0 | 1.8 | | 1.2 | 1.7 | | 0 | 0 |
| Bromus sterilis | 0 | 10.9 | 63.6 | 74.8 | 94.5 | 75.9 | 4.9 | 5.4 | 21.9 |
| Bromus commutatus | | | 1.8 | 2.6 | 25.4 | 30.2 | 1.8 | 14.9 | 14.8 |
| Elymus repens | 2.2 | 14.5 | 21.8 | 36.5 | 66.7 | 44.0 | 8.9 | 4,4 | 8.8 |
| Avena fatua | | 8.2 | 5.5 | 16.5 | 30.3 | 11.2 | 0.3 | 4.7 | 1.6 |
| Arrhenatherum elatius | | | 12.7 | | 12.1 | 7.8 | | | 0.7 |
| Agrostis stolonifera | | | | 3.5 | | | 0.6 | | 0.2 |
| Alopecurus myosuroides | | | | 23.5 | 0.6 | 2.6 | 0.9 | 1.8 | 0.2 |
| Mean sample length (m) | 0.50 | 1.00 | 0.50 | 1.05 | 1.50 | 1.05 | 2.95 | 2.50 | 3.95 |

## Seed bank studies

Viable buried seed populations are being estimated from soil core samples taken from intensive study areas from within the hedge and at increasing distance into the crop. Seedlings are germinated in shallow clay pans from soil core samples and are identified and counted. So far only one sample has been fully examined (two year germination); the data form a baseline for further comparisons. A summary of the numbers of species in the seed bank recorded at different distances from the hedgebottom is given in Table 5.

Table 5. Numbers of species in the seed bank in three fields at different distances from the hedgebottom. Soil core samples taken in March 1984. Boxworth E.H.F.

| Distance (m) | 0 | 5 | 25 | 100 |
|---|---|---|---|---|
| Full Insurance | 17 | 5 | 3 | 4 |
| Supervised | 20 | 15 | 7 | 7 |
| Integrated | 28 | 4 | 4 | 7 |

The seed flora of the relatively undisturbed field margin consistently contained greater numbers of species than the field area. Examination of the composition of the seed floras indicated that patterns of dispersion, relative to the hedge, found previously in the above-ground flora were repeated (Marshall, 1985b). Soil samples from the crop contain few species, which are typically common field weeds.

## STUDIES ON THE MANYDOWN ESTATE, HAMPSHIRE

In 1984 and 1985 the flora of fields and field margins have been studied on the Manydown Estate, Hampshire. This is the site of field investigations by the Cereals & Gamebirds Research Project and different field edge treatments have been imposed on large areas of arable fields. In 1984 half the study fields received no agrochemicals on the outside 6m of the crop after New Year (NSS treatment). The treatment was achieved by turning off half of the 12m spray boom. In 1985 there was an added treatment (NS treatment) in that all sprays, from sowing to harvest, were kept off the outside 6m of crop in some fields. The remaining control fields received the full spray programme (FS treatment).

Work by the Game Conservancy has shown that the NSS treatment significantly increases partridge and pheasant chick survival and has implications for other wildlife (Rands, 1985; Sotherton et al., 1985). The treatments also provide an element of protection to the field edge flora by reducing likely agrochemical spray drift. This is the most practical method of achieving protection of field edges from sprays, so that we may investigate changes in the flora following cessation of field applications of chemicals. The fields also offer the opportunity to study plant distributions relative to the hedge in some detail.

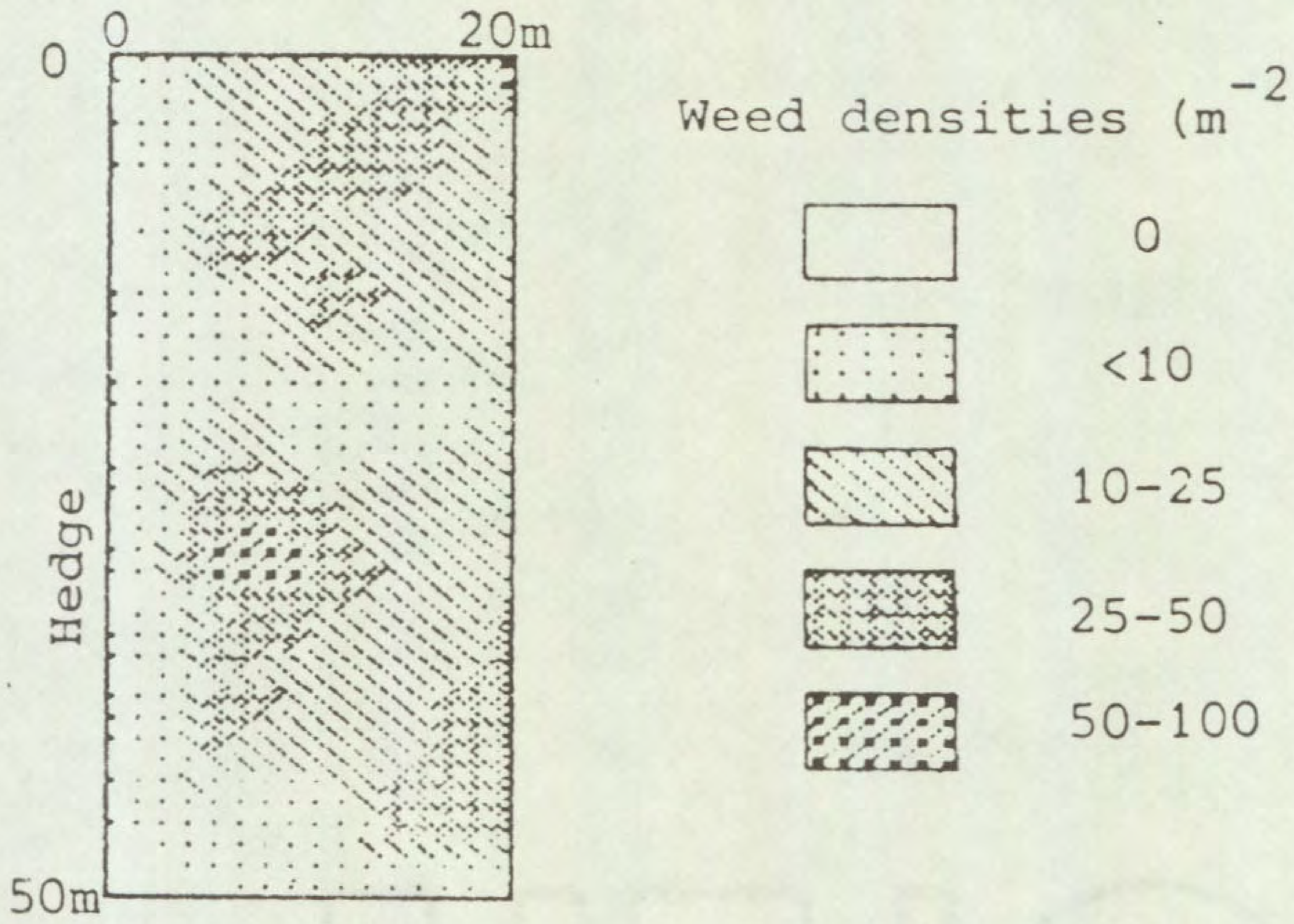
### Plant distributions

In 1984 quadrat surveys were made in summer in twelve fields (nine in 1985) at different distances into the crop and parallel to a 50m length of hedgerow in summer. Two quadrats were placed at random at sampling points every 5m parallel to the hedge, at 2.5, 5, 10, 15, and 20m from the hedge and within the hedgebottom. Occasional surveys were made at 50m and 100m from the hedge. Six fields of winter wheat and six fields of spring barley were chosen for study in 1984, three of each with the 6m crop edge unsprayed and three sprayed normally. Broad-leaved weeds were counted in 0.1 $m^2$ quadrats (22 in total at each distance, parallel to the 50m length) in April 1984. In June 1984 each broad leaved species was scored according to cover on a simple scale (0-3) with 1 = <1% cover, 2 = 1% to 10% cover and 3 = >10% cover. Scores were summed for each site to assess the effects of unsprayed and sprayed crop edges. Grass panicles were counted in 0.25$m^2$ quadrats in July. A computer mapping programme (Stent & Hanley, 1985) was used to produce maps of weed density out to 20m in the area adjacent to the 50m hedge length. The fields and their treatment histories, which changed from 1984 to 1985, are given in Table 6 below.

survive in the field area, seasonal soil disturbance being probably a major cause. Limited dispersal may also restrict their distribution. On the Manydown Estate about 75% of the species found in the hedge were not found in the field; variation from field to field gave a range of 52% to 83%.

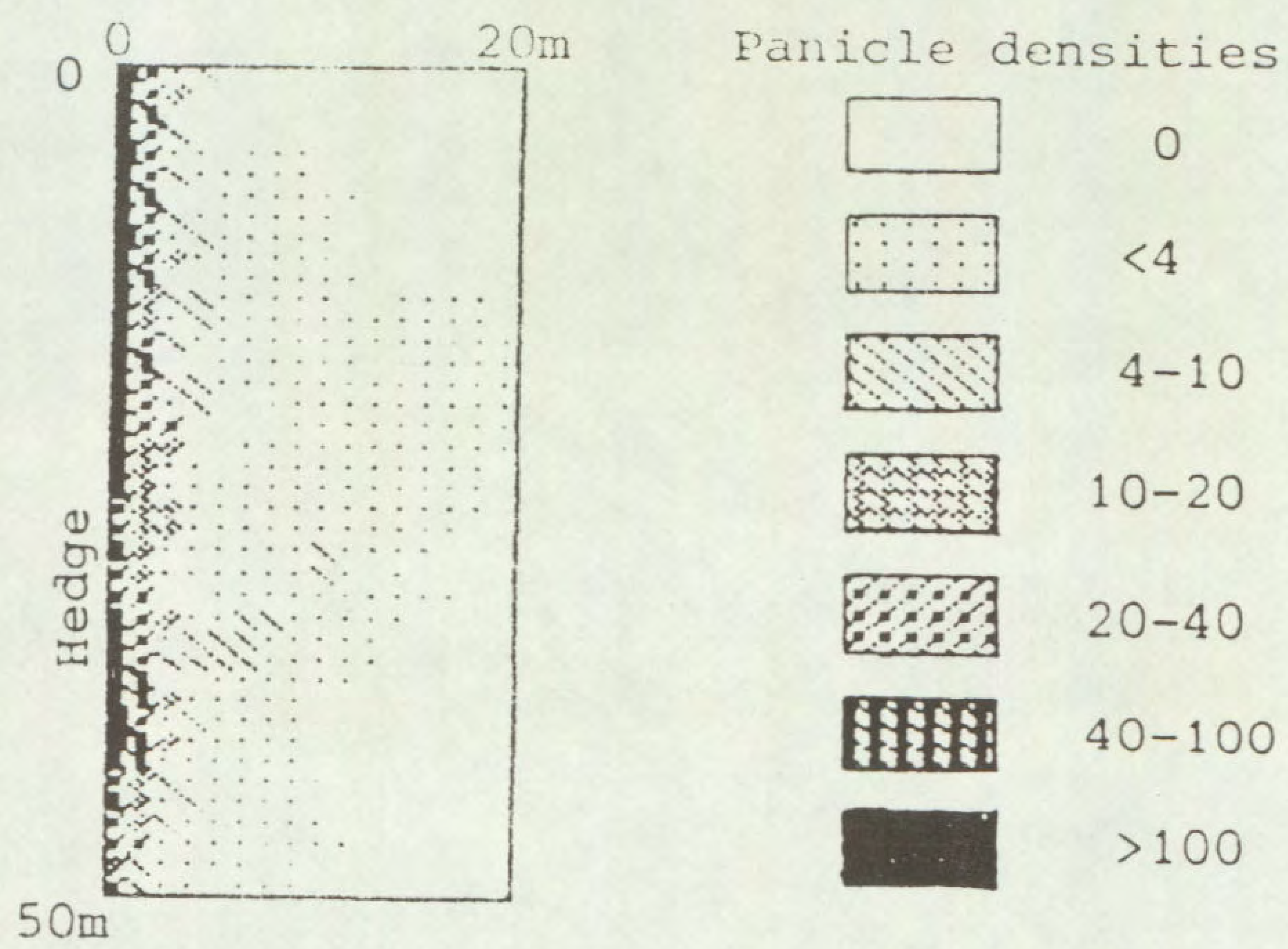
A number of species were limited to the cropped area (type II) including Polygonum aviculare, Sinapis arvensis and Aethusa cynapium. A representation of the increasing densities of Polygonum aviculare with distance is given in Fig 1.

Fig.1.
Map of plant densities of Polygonum aviculare in an area adjacent to 50m of hedgerow to a distance of 20m from the hedge in April 1984.



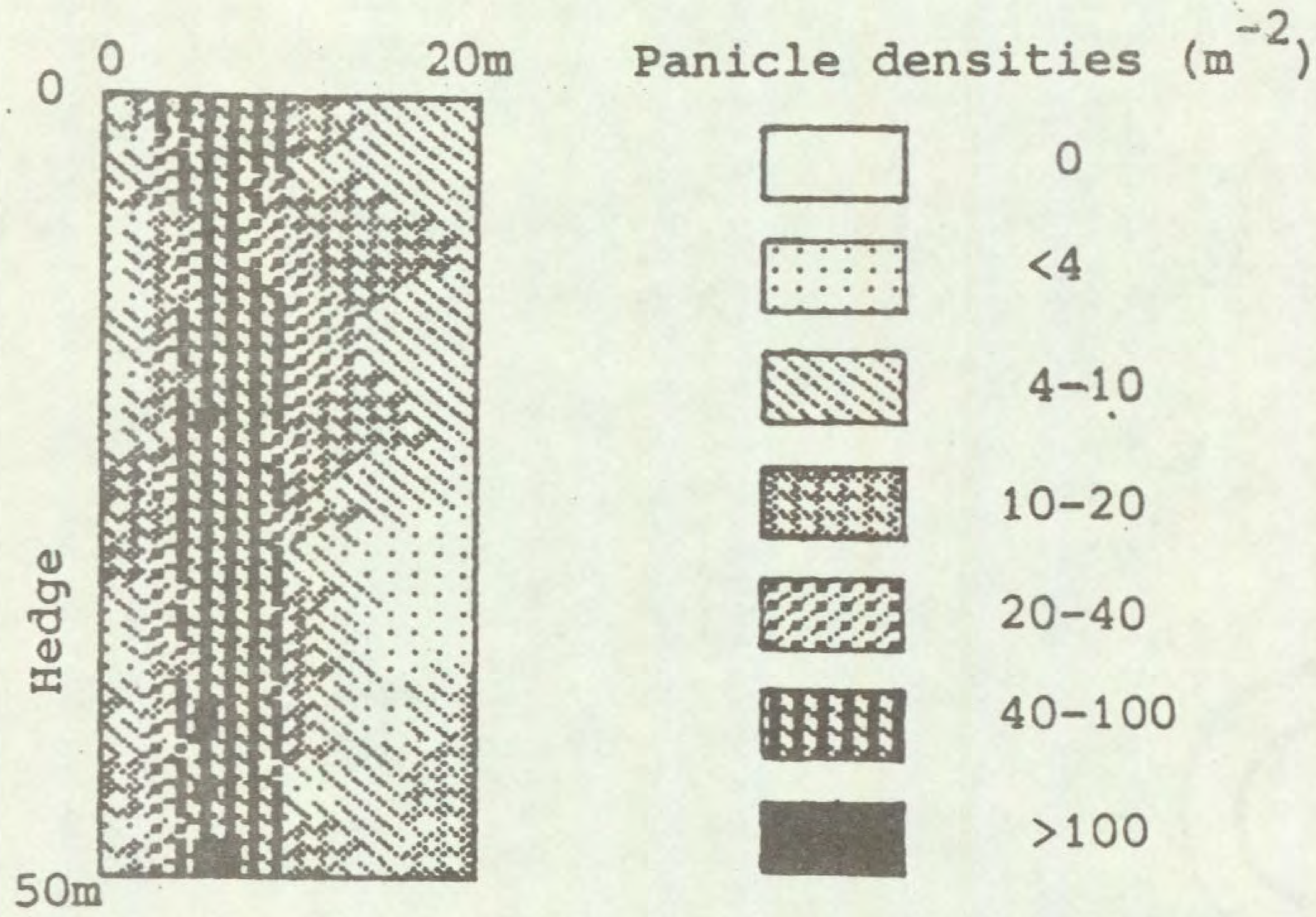

Type III distributions were found for many of the species common to hedge and field. A typical distribution pattern is given in Fig.2 for Poa trivialis. Such species are native to the field margin but capable of spreading into the field area. Several species common to hedge and field, except A.myosuroides, had this distribution of decreasing density with distance from the hedge (Tables 8 & 9).

Fig. 2.
Densities of Poa trivialis in an area 20m by 50m adjacent to a hedgerow. July 1984.



The fourth group of distribution patterns covers those not falling into previous categories. At present this is limited to the pattern shown by A.myosuroides (Fig.3). At Manydown this species appears to have a crop edge distribution with greatest densities in the area 5m from the field edge. It is found in the hedgebottom ground flora and as a field weed though the crop edge conditions are such to encourage the species. The crop edge is farmed differently to the rest of the field and receives greater compaction, more seed and may be affected in more subtle ways by the field margin. This crop edge distribution has been reported for other species, notably Phalaris paradoxa (Pers comm J Roebuck). In this case field invasion is apparently via the crop edge, and subsequently into both the field and the hedge bottom.

Fig. 3.
Densities of A.myosuroides in an area 20m by 50m adjacent to a hedgerow. July 1984.




As only a small number (9) of fields were sampled in 1985, some of the more spectacular effects of leaving off all sprays (NS treatment), seen on the ground as high densities of grass weeds, were not recorded. In general patterns found in 1985 were similar to those seen in 1984, with some species capable of spreading into the field. Differences in populations attributable to the crop edge treatments could be found, notably with highest cover of Polygonum aviculare on unsprayed spring barley fields (Battledown and Lonely Meadow). In addition, the highest panicle densities of Poa trivialis were recorded on unsprayed crop edges. However, with only nine fields sampled in 1985, the data need to be viewed with caution. The one surveyed unsprayed winter wheat field had no blackgrass, while another unsprayed field edge was seen with a severe blackgrass infestation. The 'crop edge' distribution of blackgrass noted in 1984 was evident on two fields, Farm Close and Great Woods East.

Hedgebottom flora

In the intensively studied sites (50m by 20m) the hedgebottom flora was recorded as percentage ground cover from two random quadrats at each 5m sample point. While a full replicated comparison of effects over two years has not been made (only 6 fields were surveyed in both years; 9 fields with one year's data), the available data indicate an interesting trend with increased numbers of species adjacent to unsprayed crop edges and reduced adjacent to sprayed (Table 7). Care should be taken in extrapolating these results; experience at Boxworth EHF shows that year-to-year variation can be large. In addition some species will have been missed in a single sampling survey.

Table 7. Numbers of non-shrub plant species in hedgebottoms in 1984 and 1985 on some fields of the Manydown Estate (1984 data: records from April)

| | 1984 | | | 1985 | | |
|---|---|---|---|---|---|---|
| Field | Crop | Crop edge treatment | No. species in hedge | Crop | Crop edge treatment | No. species in hedge |
| Hatchcroft | WW | NSS | 13 | WW | NS | 22 |
| Pack Lane | WW | NSS | 16 | WW | FS | 14 |
| Moores | WW | FS | 20 | SB | NS | 17 |
| Lonely Meadow | SB | NSS | 19 | SB | NS | 23 |
| Farm Close | SB | FS | 21 | SB | FS | 14 |
| Gt Woods East | SB | FS | 25 | SB | FS | 22 |
| Big Field | WW | NSS | 18 | | | |
| Scrapps Hill S | WW | FS | 17 | | | |
| Scrapps Hill N | WW | FS | 23 | | | |
| Teddys | SB | NSS | 15 | | | |
| Saltash | SB | FS | 23 | | | |
| Mothers East | SB | FS | 13 | | | |
| Hansfords | | - | | WW | NSS | 20 |
| Rooksdown | | - | | WB | FS | 20 |
| Battledown S | | - | | SB | NS | 32 |

(WW=Winter wheat; SB=Spring barley; FS=full spray; NSS=no Spring sprays; NS=no sprays on outside 6m)

## Boundary structure and field weeds

Data on the weed floras of fields at Manydown were collected at 3m and 50m into the crop in 1984 and 1985. Pricipal component analyses were made on the data. In April 1984 the first three components explained 63%, 23% and 8% of the variance respectively. The data, for 36 fields, were densities of grasses and dicotyledonous species and were unstandardised. Examination of the calculated latent vectors indicated that the most abundant species, *Polygonum aviculare* and *Veronica persica*, accounted for the most variance. Crop, boundary structure, crop edge treatment and aspect apparently had little influence on the weed flora. Data for 1985 were limited to 17 fields; analyses again indicated that populations of *Polygonum aviculare* and *V.persica* accounted for most variance.

June 1984 data were grass panicle densities and scores of broad leaved weeds and were analysed unstandardised. There was no evidence of boundary structure affecting weed floras. The abundant grasses accounted for most variance, notably *Poa trivialis* (winter wheat) and *A.myosuroides* (spring barley) at 3m.

## BOVINGDON HALL ESTATE, ESSEX

During the 1984/1985 season parts of the Bovingdon Hall Estate were treated in a similar fashion to the Manydown Estate in that some fields had the outside 7.5m unsprayed after New Year (NSS treatment) and others were sprayed as normal (FS). In July 1985 sections of 24 fields were surveyed, with quadrat samples taken at 5m and 50m into the crop and a record of cover abundance made for all plants found in a 50m length of adjacent field boundary. These data form a background against which to assess future changes in weeds and field edge floras.

The effects of the treatments on field weed floras were not statistically significant in this first season, perhaps because there was considerable field to field variation. However, the trend for increased grasses and dicotyledonous plant cover on unsprayed crop edges was obvious. The mean grass panicle densities at 5m and 50m of sprayed and unsprayed fields are compared in Table 8. Average percentage cover of dicotyledonous species are compared in Table 9.

Table 8. Average grass panicle densities ($m^{-2}$) of sprayed and unsprayed fields of two cereals at 5m and 50m from the hedge. Bovingdon Hall, 1985.

| | 5m | | | 50m | | |
|---|---|---|---|---|---|---|
| | Sprayed | | Unsprayed | Sprayed | | Unsprayed |
| Winter wheat (5 and 6 fields) | 4.00 | N.S. | 61.07 | 11.04 | N.S. | 26.00 |
| Winter barley (4 and 3 fields) | 5.40 | N.S. | 120.13 | 2.80 | N.S. | 10.53 |

The most abundant grass species was <u>Alopecurus myosuroides</u>, which achieved high densities in some unsprayed crop edges. As grass weeds can increase their populations rapidly, autumn herbicide applications will often be essential for grass control in the crop edge. As long as the herbicides used do not have a carry-over effect and reduce the survival of spring-germinating species, partridges, at least, should be unaffected by such treatments.

Table 9. Average % cover of dicotyledonous species of sprayed and unsprayed fields of two cereals at 5m and 50m from the hedge. Bovingdon Hall, 1985.

| | 5m | | | 50m | | |
|---|---|---|---|---|---|---|
| | Sprayed | | Unsprayed | Sprayed | | Unsprayed |
| Winter wheat (5 and 6 fields) | 1.84 | P=0.1 | 5.25 | 3.60 | N.S. | 5.65 |
| Winter barley (4 and 3 fields) | 2.10 | P=0.1 | 22.10 | 1.10 | N.S. | 12.00 |

A total of 110 ground flora and climbing plant species were recorded in the field boundaries, with an average of 23.5 species per 50m study site irrespective of crop edge treatment. Future changes may indicate the potential of not spraying the crop edge for protecting the field edge flora.

## SPECIES OCCURRENCE IN HEDGEBOTTOM AND FIELD

Data collected from the plant surveys from Boxworth, Manydown and Bovingdon Hall have been examined to find where different species are recorded. The average number of non-shrub species found in the hedgebottom, in the crop at 5m or beyond and in both situations are given in Table 10. Only ablout 25% of the hedgebottom species also occur in the field at 5m or further from the hedge.

Table 10. Average numbers of plant species in the hedge, the field 5m or more from the edge and in both locations on three farms.

| Site | Number of fields | Numbers of species In hedge | In field | Common to hedge and field |
|---|---|---|---|---|
| Cambridge | | | | |
| Boxworth 1984 | 5 | 24.6 | 14.2 | 5.2 |
| Boxworth 1985 | 5 | 23.2 | 15.6 | 7.0 |
| Hampshire | | | | |
| Manydown 1984 | 12 | 25.5 | 16.7 | 6.0 |
| Manydown 1985 | 9 | 19.8 | 10.7 | 2.1 |
| Essex | | | | |
| Bovingdon Hall | 24 | 23.5 | 7.0 | 3.5 |

Therefore only a limited number of hedgebottom plant species are likely to appear as field weeds in cereals.

At Manydown, 31 plant species were recorded in both the hedge and field. At Boxworth the number of species was 29. A number of these species were limited to the area close to the hedge; the number of species common to the field edge and found at 5m or more from the hedge was reduced to 24 at Manydown and 12 at Boxworth. Six of these species, the grasses A.myosuroides, E.repens and B.sterilis and the herbs G.aparine, C.arvense and F.convolvulus, were found on both farms. The few species which are consistently recorded in hedge and crop are listed in Table 11.

Table 11. Plant species found consistently on three farms both in the hedge and in the field beyond 5m. Data are the number of sampled fields where the species was common to both sites.

| | Boxworth EHF 1984 | Boxworth EHF 1985 | Manydown Estate 1984 | Manydown Estate 1985 | Bovingdon Hall 1985 |
|---|---|---|---|---|---|
| Number of study fields | 5 | 5 | 12 | 9 | 24 |
| Species | | | | | |
| Elymus repens | 4 | 4 | 5 | | 9 |
| Alopecurus myosuroides | 3 | | 6 | 2 | 13 |
| Poa trivialis | | | | 5 | |
| Bromus sterilis | 4 | 5 | 4 | | 3 |
| Galium aparine | 5 | 4 | 7 | 3 | 9 |
| Convolvulus arvensis | 2 | 2 | 1 | | 8 |
| Fallopia convolvulus | 1 | | 4 | 1 | 3 |
| Cirsium arvense | 1 | | 3 | | 2 |
| Veronica persica | | 2 | 5 | 1 | 6 |

The occurrences of known field weeds (cf. Froud-Williams & Chancellor, 1982; Chancellor & Froud-Williams, 1984) in only the hedgebottom flora has also be found from this data (Table 12).

Table 12. The percentage of fields where common weeds were recorded only in the hedgebottom or only in the crop. (Species in decreasing order of incidence in central Southern England).

| Species | No. fields recorded | Proportion of fields (%) | |
|---|---|---|---|
| | | In hedge only | In Crop only |
| Elymus repens | 52 | 50 | 2 |
| Avena fatua | 21 | 62 | 19 |
| Alopecurus myosuroides | 45 | 18 | 36 |
| Poa trivialis | 51 | 65 | 0 |
| Bromus sterilis | 44 | 59 | 0 |
| Galium aparine | 51 | 35 | 6 |
| Viola arvensis | 24 | 8 | 88 |
| Convolvulus arvensis | 42 | 55 | 14 |
| Myosotis arvensis | 30 | 40 | 30 |
| Stellaria media | 28 | 11 | 63 |
| Polygonum aviculare | 35 | 14 | 71 |
| Fallopia convolvulus | 32 | 0 | 38 |
| Rumex obtusifolius | 17 | 82 | 0 |
| Cirsium arvense | 35 | 77 | 3 |

Bromus sterilis is a hedgerow species that has become a field weed, particularly under minimum-cultivation techniques (Froud-Williams et al.,1980). The data show that in about 60% of fields where B.sterilis is found it is absent from the crop. It may therefore be reasonable to propose that hedgerow species are those with a 60% or greater occurrence only in hedgebottoms. These data may therefore indicate that the grasses P.trivialis and A.fatua are hedgerow species. Among the dicotyledonous species, R.obtusifolius and C.arvense are also probably hedgerow species that spread into the crop. While F.convolvulus (black bindweed) is commonly found in both crop and hedge (Table 11), it appears not to be a hedgerow species. G.aparine, thought to be a hedgerow species, occurred in hedges alone on only 18 fields (35%) out of 51 in which it was recorded. This would perhaps add weight to the hypothesis that there are differences between field and hedgerow populations of the species (Froud-Williams, 1985). Nevertheless these data may not portray the entire picture, in that species capable of highly efficient dispersal would not be expected to be recorded in the hedge alone.

Dispersal of plants from the hedgerow will occur by a variety of means. Vegetative spread will occur, e.g. by rhizome growth of E.repens. Seeds will drop from tall plants into the field edge. Wind will disperse some species into the field and the activity of insects, birds and mammals (man included) may move some seed into the field (e.g. Fenner, 1985). Once the plant or propagule has reached the crop, there are opportunities for further movement into the field by mechanical means. The combine harvester will move seed considerable distances. Soil cultivations may also move seed (Fogelfors, 1985). However, important questions remain as to how significant edge populations are in maintaining field populations of weeds, what conditions favour spread and how sympathetic management can limit economically significant spread?

## SUSCEPTIBILITY OF HEDGEROW PLANTS TO CHEMICALS

With the support of the Perry Foundation a pot experiment programme was chosen to provide basic information on the susceptibility of a wide range of hedgerow plant species to herbicides and plant growth regulators. 31 broad-leaved species and 11 grass species, representing 25 families, have been treated so far with seven herbicides (Appendix 4). Seven further herbicides and three plant growth regulators are presently being investigated. A further 5 shrubs, hawthorn, blackthorn, ash, elder, and beech, have also been treated. Most of the species are common field edge plants and they include plants which in certain situations are considered as weeds.

A single application has been made of each chemical at the recommended field rate. An example of an experiment already concluded is listed in Table 13. Each treatment was applied using a laboratory pot sprayer calibrated to deliver 200 litres $ha^{-1}$. Treatments were replicated twice. A field margin might be expected to receive a dose of herbicide from a field application ranging from zero up to field rate with accidental spraying. Pot-grown material which was unaffected by a treatment at field rate would not be expected to be affected under field conditions.

Table 13. Herbicide treatments applied to a range of field margin flora

| Herbicide | Product (Tradenames) | Rate kg (a.i.) $ha^{-1}$ | Formulation |
|---|---|---|---|
| mecoprop | Compitox Extra | 2.40 | K salt |
| ioxynil+bromoxynil | Deloxil | 0.76 | ester e.c. |
| chlorsulfuron | Glean DF20 | 0.02 | wettable powder |
| clopyralid | Format | 0.20* | amine salt |
| isoproturon | Arelon Liquid | 1.88 | dispersion liquid |
| diclofop-methyl | Hoegrass | 1.14 | e.c. |
| flamprop-M-isopropyl | Commando | 0.60 | e.c. |

*= kg (a.e.) $ha^{-1}$

Plants were either grown from field material or raised from seed. A permanent stockbed of the selected species has been set up to provide plant material for subsequent experiments.

The assessment adopted initially was a simple visual score of the vigour of treated plants compared to the untreated control plants (0=dead; 9=as control). This enabled plants with very different growth rates and habits to be compared equally, so that susceptibility and potential selectivities between species could be assessed. The assessments were carried out at weekly intervals following spraying, for six weeks for annuals and 15 weeks for perennials.

The results from one experiment (Appendix 5) are shown as vigour scores at 15 weeks after treatment. The most susceptible species are at the top of each column. Data from other experiments (Birnie, 1984, 1985) have shown effects on a further range of grasses and dicotyledonous species. A summary of species markedly affected by herbicides is given in Table 14.

Table 14. Species seriously affected by herbicides, as shown by a score rating of 0 - 4 at the end of the assessment period.

| Herbicide | Dicotyledonous species | Grasses |
| --- | --- | --- |
| mecoprop | Carduus acanthoides | Brachypodium sylvaticum |
| | Conium maculatum | Agrostis stolonifera |
| | Silene alba | |
| | Galium aparine | |
| | Sisymbrium officinale | |
| | Vicia tetrasperma | |
| | Urtica dioica | |
| | Plantago lanceolata | |
| | Alliaria petiolata | |
| | Rumex sanguineus | |
| | Ranunculus repens | |
| | Cirsium arvense | |
| ioxynil + bromoxynil | Carduus acanthoides | |
| | Conium maculatum | |
| | Veronica persica | |
| | Alliaria peteolata | |
| isoproturon | Achillea millefolium | Agrostis stolonifera |
| | Cirsium arvense | Arrhenatherum elatius |
| | Urtica dioica | Brachypodium sylvaticum |
| | Silene alba | Poa trivialis |
| | Conium maculatum | Poa pratensis |
| | Ranunculus repens | Lolium perenne |
| | Rumex sanguineus | |
| | Leucanthemum vulgare | |
| clopyralid | Achillea millefolium | |
| | Carduus acanthoides | |
| | Cirsium arvense | |
| | Trifolium repens | |
| | Vicia tetrasperma | |
| | Plantago lanceolata | |
| | Leucanthemum vulgare | |
| chlorsulfuron | Galium aparine | |
| | Sisymbrium officinale | |
| | Myosotis arvensis | |
| | Anthriscus sylvestris | |
| | Cirsium arvense | |
| | Achillea millefolium | |
| | Geranium pusillum | |
| diclofop-methyl | | Lolium perenne |
| | | Arrhenatherum elatius |
| | | Dactylis glomerata |
| | | Festuca rubra |
| flamprop-M-isopropyl | | Arrhenatherum elatius |
| | | Dactylis glomerata |

The results (Birnie, 1984, 1985; Marshall & Birnie, 1985) do not necessarily reflect the situation that would occur in the field, since herbicides, especially soil-acting compounds, may produce greater effects on pot- than field-grown material. It is probable, therefore, that plants which survived an application of a chemical at the doses used would survive similar applications in the field. The severity of any field effect will depend on factors such as dose of chemical received, growth stage of the plant, weather conditions at time of spraying and whether the plant is an annual or perennial species. Some perennial species recovered from the single application of chemical, e.g. Rumex species treated with ioxynil+bromoxynil. Those species which have an underground storage organ, e.g. rhizome or tap root, may recover from herbicide applications (Bailey, 1980), if the chemical used is not readily translocated throughout the whole plant. However, transient scorch or deformity may not be acceptable where the visual appearance of field edge plants is important. Annuals, even if they are susceptible, may survive to set viable seed. This will depend on the growth stage of the plants at the time of spraying.

## Broad-leaved weed herbicides

Of the chemicals tested so far, mecoprop damaged the greatest number of species. This chemical is widely used in agriculture, either in mixture with other herbicides or on its own. Incorrectly applied, mecoprop is also known to cause ear deformities in cereals (Leafe, 1956), and some cases of herbicide damage to broad-leaved crops, e.g. oilseed rape, are attributed to vapour drift of this herbicide (Eagle & Caverly, 1981). In the light of the number of species affected, drift and vapour drift of mecoprop may pose a significant threat to field margin floras.

The other herbicides tested which affect broad-leaved species, ioxynil+bromoxynil, clopyralid and chlorsulfuron, were more limited in the numbers of species they affected. Given that increased herbicidal activity usually occurs in pot experiments these results suggest that few species would be affected from accidental contamination in the field.

## Grass weed herbicides

With the exception of isoproturon, the grass weed herbicides were restricted in activity to the grass species. Of the species tested, B.sterilis and Elymus repens are the only grasses which were not significantly affected, compared to the untreated control by any of the herbicide treatments. Although few grass species actually died, several were restricted in growth, particularly by diclofop-methyl. This effect may be useful in a management situation where suppression of grass growth is desirable. The ability to manipulate grass growth could be a useful tool if competition between broad-leaved species and grasses is limiting diversity and growth.

The Perry Foundation programme terminates in November 1986, by which time 17 chemicals will have been examined on some 40 ground flora species. In addition five shrub species, hawthorn, blackthorn, ash, elder and beech, will have been tested.

## POT AND FIELD EXPERIMENTS

The possibility of using chemicals or physical management to modify species composition of the hedgebottom requires intensive study, particularly for those situations where disturbance has already created serious weed problems. The selective control of vigorous annual species such as *Bromus sterilis* and *Galium aparine*, might allow the development of a more desirable perennial ground flora. Two experiments have been carried out, one on the use of the flower-inhibiting chemical mefluidide and the other using a strimmer to cut hedgerow *B.sterilis*.

### Mefluidide on *B.sterilis*

*Bromus sterilis* L. is an annual grass that has become a field weed in the U.K. over recent years. The species is a prolific seed producer but the seed has almost no dormancy (Froud-Williams *et al.*, 1980). Under certain temperature and moisture conditions enforced dormancy may occur, though seed does not persist for more than one year in the soil (Thompson & Grime, 1979). Therefore the species relies for survival on recruitment from seed produced the previous year. The germination requirements for *B.sterilis* are simple; with sufficient moisture germination occurs over a wide temperature range. The light requirement is atypical in that far-red light is required for germination; bright sunlight inhibits germination (Hilton, 1982; Pollard, 1982).

As *B.sterilis* is perceived as a problem originating from the field margin, many farmers have applied herbicides to hedge bottoms. The elimination of the perennial species that were present has encouraged the dominance of annuals such as *B.sterilis*. A technique which controls this species in the hedgebottom and which encourages desirable species would be a useful tool in ameliorating such situations. A potential method of disrupting the reproductive cycle would be the prevention of seed formation. The growth retardant mefluidide inhibits flowering in a number of grass species (Field, 1983; Marshall, 1983). The effect of the compound is largely limited to grasses; dicotyledonous species may be encourgaged in treated grass swards (Marshall & Craine, 1984). Poor results on *B.sterilis* have been noted following a single application of mefluidide in April in the field (Pers.comm. F Pollard). Earlier application, different doses or repeated applications may give the desired suppression of flowering.

Seed of *B.sterilis*, collected in July 1983 and stored dry in the dark, was sown in 10cm pots of loam soil on 23 November 1984. After germination under glass, the seedlings were thinned to two per pot and placed outdoors for the remainder of the experiment.

Mefluidide, as the commercial formulation Mowchem and containing 240 g a.i. $l^{-1}$ as the diethanolamine salt, was applied on six dates at rates of 0.2, 0.4 and 0.8 kg a.i. $ha^{-1}$. Single applications were made once a month from December to May. A further series of plants was given a repeat application two or three months following the initial treatment (Table 15). Treatments were replicated six times, with six control pots per replicate.

Table 15. Details of mefluidide applications to B.sterilis

| Application date | 18/12/84 | 18/1/85 | 22/2/85 | 22/3/85 | 19/4/85 | 20/5/85 |
|---|---|---|---|---|---|---|
| Single application | | | | | | |
| | T1 | T2 | T3 | T4 | T5 | T6 |
| Growth stage at treatment | | | | | | |
| | 2 leaves | 1 tiller | 1+tiller | 3 tillers | 3+tillers | 4+tillers |

The plants were scored subjectively for vigour using a 0 - 9 scale based on that used by Birnie (1984). Scores were made in February, March and May. Tiller numbers per plant were counted in May and June. Panicles were counted in June and finally in August. Assessment data were analysed statistically using analysis of variance.

Assessments from May, June and August for plants treated with a single application are given in Table 16. In May, after all but the last application of mefluidide , significant reductions in vigour score were found for all treatments except at the lowest rate sprayed in December and March. Greatest reductions in vigour were found on two-leaved plants treated at 0.8 kg $ha^{-1}$ at the early application dates. Counts in May indicated significant reductions in tiller number compared to the controls with the higher rates of mefluidide in December and January (0.8 kg $ha^{-1}$ in February). Tillering was encouraged by rates of 0.4 and 0.8 kg $ha^{-1}$ following treatment of three-tillered plants in March. Some tiller death was observed on treated plants, particularly of the main stem.

In June and August tiller and panicle numbers were significantly greater on plants treated at 0.8 kg $ha^{-1}$ at the later dates. The only significant reductions in panicle numbers were for the highest mefluidide rate at the two earliest dates. A single application of mefluidide to pot-grown B.sterilis did not totally prevent flowering, even when applied early in the development of the plant at doses of 0.8 kg $ha^{-1}$, though significant reductions in tiller and panicle number per plant were achieved. However, plants sprayed at 0.8 kg $ha^{-1}$ during and after March (3+ tillers) produced greater numbers of panicles than controls. A single dose of 0.2 or 0.4 kg $ha^{-1}$ gave a temporary reduction in vigour but did not give lasting control of flowering. With several treatments there was obvious recovery between the May and June and the June and July assessments (Table 16). A late initial treatment, while controlling primary tillers, encouraged secondary tillering thus improving the probability of the survival of the species.

Table 16. Vigour, tiller and panicle numbers per plant of B. sterilis treated with a single dose of mefluidide at different times.

| Treatment Date | Rate (kg $ha^{-1}$) | 16/5/85 Vigour | 16/5/85 Tillers | 24/6/85 Tillers | 24/6/85 Panicles | 12/8/85 Panicles |
|---|---|---|---|---|---|---|
| Control | | 9.0 | 4.2 | 4.1 | 2.6 | 3.1 |
| 18/12/84 | 0.2 | 7.8 | 4.0 | 3.8 | 2.2 | 2.7 |
| | 0.4 | 6.3- | 2.5- | 3.4 | 1.7- | 2.5 |
| | 0.8 | 1.8- | 0.6- | 0.9- | 0.7- | 0.9- |
| 18/1/85 | 0.2 | 6.7- | 2.8- | 3.7 | 1.9 | 2.5 |
| | 0.4 | 6.7- | 2.7- | 4.4 | 2.2 | 3.1 |
| | 0.8 | 4.0- | 1.5- | 2.6- | 1.3- | 1.8- |
| 22/2/85 | 0.2 | 5.7- | 3.0 | 4.3 | 2.4 | 3.0 |
| | 0.4 | 6.0- | 3.6 | 4.8 | 3.2 | 3.5 |
| | 0.8 | 3.7- | 2.2- | 3.3 | 1.6- | 2.4 |
| 22/3/85 | 0.2 | 8.0 | 4.3 | 3.8 | 3.0 | 3.3 |
| | 0.4 | 7.3- | 6.3+ | 4.9 | 3.4 | 3.9 |
| | 0.8 | 7.0- | 6.9+ | 5.8+ | 4.0+ | 5.0+ |
| 19/4/85 | 0.2 | 7.5- | 3.9 | 4.5 | 2.7 | 3.1 |
| | 0.4 | 7.5- | 5.0 | 4.8 | 2.9 | 3.3 |
| | 0.8 | 7.2- | 5.0 | 6.1+ | 4.1+ | 5.3+ |
| 20/5/85 | 0.2 | 8.8 | 4.0 | 4.2 | 2.9 | 3.3 |
| | 0.4 | 8.8 | 4.3 | 4.5 | 3.2 | 3.5 |
| | 0.8 | 9.0 | 4.7 | 7.6+ | 3.6+ | 5.4+ |
| | SE | 0.48 | 0.44 | 0.49 | 0.31 | 0.37 |

- = significantly less than control; + = significantly greater than control

B.sterilis could be killed in pots with two applications of mefluidide at 0.8 kg $ha^{-1}$ over the winter. Two applications at 0.4 kg $ha^{-1}$ gave only a reduction in tillering with December+February and February+April treatments. Results were variable, though in general additive effects of two applications on panicle number were recorded. With initial applications in March, repeated rates of 0.4 and 0.8 kg $ha^{-1}$ gave increased numbers of panicles. This may have resulted from the death of the primary tiller and the loss of apical dominance allowing increased tillering, an effect reported in annual grasses following defoliation.

Counts of the numbers of spikelets per panicle and tests on the viability of seed produced were limited to a single replicate of the experiment. Counts of the numbers of seeds per spikelet were not made as some seeds had been shed by August, the final assessment date. The data, while limited, indicate that mefluidide treatment did not affect viability of the seeds lower in the spikelet. In general, the more panicles per plant, the lower the number of spikelets per panicle. Data on the estimated return of viable seed, assuming a constant 7 florets per spikelet, indicated only the early treatments gave reductions. Considerable quantities of viable seed were produced after a single mefluidide treatment at the lower doses. In addition, control or flower prevention of autumn and winter germinating B.sterilis seedlings would not necessarily reduce populations. Pollard (1982) noted that seeds at the base of the spikelet often persist on the previous season's plants into spring and are capable of germination and recruitment to the population. A second application in spring might therefore be required. A repeat application of mefluidide did not affect estimated seed return in this experiment. This technique therefore seems unlikely to be of practical use for managing B.sterilis in the field margin unless combined with other methods.

Cutting B.sterilis in the hedgebottom

A section of brome-infested hedgerow of SW aspect at Begbroke Hill Farm, Oxford was divided into 16 lengths of 7.5m. Three treatments (plus a control) were made; sections were cut with a strimmer on 18 April 1985 or 24 May 1985 and on both dates. Treatments were replicated four times. Panicles of B.sterilis were counted in the hedgebottom and at 1m and 5m into the crop in May and July after cutting. Brome seedlings were counted in December.

In July there were significant differences in panicle densities within the hedgebottom but not at 1m or 5m (Table 17).

Table 17. Panicle densities ($m^{-2}$) of Bromus sterilis in July within the hedgebottom, and 1m and 5m into the crop, following cutting in April and May.

| Cutting treatment | Hedgebottom | 1m | 5m |
|---|---|---|---|
| April | 68.8 | 44.0 | 15.2 |
| May | 63.4 | 43.0 | 17.4 |
| April + May | 27.0 | 18.8 | 9.4 |
| Uncut control | 21.4 | 38.0 | 12.6 |
| S.E. | (P=0.001) 6.78 | N.S. | N.S. |

The data indicate that compared to uncut controls flowering was promoted on plots cut once. There was considerable variability between blocks and plots. In December the density of B.sterilis seedlings in the hedgebottom was not significantly different across treatments, though in the first furrow differences were apparent (Table 18).

Table 18. Seedling densities of B.sterilis in the undisturbed hedgebottom and the first furrow in December 1985, after cutting treatments.

| Cutting treatment | Hedgebottom | First furrow |
|---|---|---|
| April | 995 | 853 |
| May | 653 | 393 |
| April + May | 575 | 428 |
| Uncut control | 698 | 456 |
| S.E. | N.S. | (P=0.004)100.4 |

The data indicate that one or two cuts are unlikely to ameliorate a serious infestation of brome.

## CONCLUSIONS AND FUTURE WORK

The main conclusions from this work are that some plant species in field margins appear capable of invading fields. As the observed patterns could conceivably have resulted from spread other than from the field edge, the surveys have been repeated in 1986 to follow changes in the distributions. Certain of the major weeds of cereals are found in field edges, though the number of species involved is small. Relatively few of the field edge plant species are potential weeds. Thus the implication for management is that should edge populations need to be controlled, selective treatments of the few significant species involved would be required. Further work, particularly on the biology and rates of dispersal of species, would be required to understand the conditions under which weed spread occurs.

Studies on the effects of chemicals on hedgerow plants is showing selectivites between species. Herbicides applied in the field may affect the hedgerow flora. Initial investigations of the control of Bromus sterilis using cutting and the chemical mefluidide have not been promising.

The surveys of plants at Boxworth EHF will continue to harvest in 1988, when five years of the three pesticide programmes will have been completed. The surveys on the Manydown Estate and at Bovingdon Hall should continue for one and at least two seasons respectively to observe changes in the hedgebottom flora. Changes in the flora brought about by reduced herbicide drift into the hedgebottom might be expected to be slow. The patterns of dispersal relative to the hedgerow found in these studies will be drawn together as a single report.

Studies on the dispersal of selected species and the role of mechanical movement of seed in the soil will be investigated. The work supported by the Perry Foundation on the direct effects of chemicals will continue to November 1986. About 40 ground flora species will have been tested against 16 chemicals by that time. In addition five shrub species will have been investigated.

Field experiments on the establishment, management and efficacy of barrier strips between hedgebottom and crops will be made. It may be within the scope of the programme to look at grass barrier strips. Further experiments on cutting brome and cleavers in the hedgebottom are in hand.

Further areas of investigation which could, with suitable support, be undertaken include the effects of fertilisers on hedgerow floras, the recreation of desirable ground floras in degraded hedgerows, weed control in establishing new hedges and in old hedges, mechanisms and significance of weed spread, interactions between invertebrates and hedgebottom plants and the effects of different hedge management techniques, especially coppicing, on the hedgerow flora and fauna.

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## Appendix 1

The commonest field edge species at Boxworth EHF expressed as number of 50 pace sites recorded in each field and percentage frequency for each study area.

| Year | Species | Area | Integrated | | | | Supervised | | | | Full Insurance | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Field number | 1 | 2 | 3 | % | 4 | 5 | 6 | % | 7 | 8 | 9 | 10 | % |
| | | Number of sites | 21 | 22 | 33 | | 17 | 26 | 45 | | 24 | 21 | 32 | 18 | |
| 1983 | Anthriscus sylvestris | | 12 | 14 | 27 | 70 | 13 | 17 | 28 | 66 | 10 | 12 | 15 | 11 | 50 |
| 84 | | | 15 | 19 | 30 | 84 | 17 | 21 | 31 | 78 | 14 | 13 | 16 | 11 | 56 |
| 85 | | | 17 | 18 | 30 | 86 | 16 | 23 | 31 | 80 | 14 | 14 | 15 | 13 | 59 |
| 1983 | Heracleum sphondylium | | 12 | 11 | 18 | 54 | 11 | 5 | 32 | 55 | 7 | 9 | 20 | 9 | 47 |
| 84 | | | 18 | 16 | 25 | 78 | 17 | 14 | 34 | 74 | 10 | 12 | 23 | 11 | 58 |
| 85 | | | 15 | 9 | 25 | 64 | 16 | 11 | 34 | 69 | 9 | 14 | 23 | 8 | 57 |
| 1983 | Fallopia convolulus | | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 3 | 0 | 0 | 2 | 0 | 2 |
| 84 | | | 12 | 6 | 19 | 49 | 5 | 10 | 9 | 27 | 13 | 12 | 23 | 5 | 55 |
| 85 | | | 3 | 0 | 6 | 12 | 0 | 0 | 0 | 0 | 9 | 2 | 4 | 1 | 17 |
| 1983 | Urtica dioica | | 13 | 16 | 23 | 68 | 5 | 1 | 41 | 65 | 20 | 11 | 25 | 9 | 68 |
| 84 | | | 13 | 19 | 24 | 74 | 9 | 13 | 43 | 74 | 20 | 12 | 28 | 12 | 75 |
| 85 | | | 19 | 22 | 25 | 87 | 13 | 15 | 46 | 84 | 23 | 13 | 30 | 8 | 78 |
| 1983 | Convolvulus arvensis | | 16 | 12 | 24 | 68 | 2 | 17 | 9 | 32 | 13 | 12 | 19 | 7 | 53 |
| 84 | | | 14 | 13 | 25 | 68 | 6 | 17 | 20 | 49 | 18 | 13 | 18 | 11 | 63 |
| 85 | | | 12 | 12 | 27 | 67 | 8 | 15 | 17 | 45 | 18 | 10 | 7 | 2 | 39 |
| 1983 | Poa trivialis | | 10 | 11 | 12 | 43 | 8 | 7 | 29 | 50 | 7 | 15 | 15 | 4 | 43 |
| 84 | | | 5 | 17 | 20 | 55 | 8 | 14 | 37 | 69 | 10 | 14 | 14 | 14 | 54 |
| 85 | | | 6 | 13 | 19 | 50 | 10 | 9 | 40 | 67 | 13 | 16 | 15 | 8 | 55 |
| 1983 | Bromus sterilis | | 13 | 10 | 31 | 71 | 15 | 22 | 40 | 88 | 16 | 20 | 29 | 14 | 82 |
| 84 | | | 20 | 21 | 33 | 97 | 17 | 24 | 37 | 89 | 23 | 21 | 32 | 18 | 98 |
| 85 | | | 21 | 22 | 23 | 87 | 17 | 26 | 45 | 100 | 20 | 21 | 30 | 18 | 94 |
| 1983 | Arrhenatherum elatius | | 7 | 4 | 13 | 32 | 5 | 8 | 8 | 24 | 7 | 11 | 10 | 3 | 32 |
| 84 | | | 6 | 9 | 18 | 43 | 3 | 12 | 19 | 39 | 6 | 13 | 16 | 5 | 42 |
| 85 | | | 8 | 12 | 21 | 54 | 13 | 17 | 17 | 54 | 8 | 10 | 6 | 5 | 31 |

## Appendix 2

The abundance of some dicotyledonous species at different distances from the hedge on the Manydown Estate, 1984 and 1985.

*Polygonum aviculare* - April 1984 (No. $m^{-2}$)

| Field | Hedge | 2.5m | 5m | 10m | 15m | 20m | 50m |
|---|---|---|---|---|---|---|---|
| Hatchcroft | 0 | 0.9 | 2.7 | 2.3 | 0.5 | 0.5 | 0.9 |
| Pack Lane | 0 | 9.1 | 5.9 | 4.1 | 8.6 | 13.2 | 6.4 |
| Big Field | 0 | 13.6 | 25.5 | 22.3 | 16.4 | 24.1 | 38.6 |
| Moores | 0 | 13.0 | 15.5 | 42.7 | 58.5 | 45.5 | 76.5 |
| Scrapps Hill N | 0 | 7.7 | 7.3 | 1.4 | 0.9 | 0.5 | 0 |
| Scrapps Hill S | 0 | 1.4 | 3.6 | 0.9 | 1.4 | 2.3 | 0 |
| Lonely Meadow | 0 | 78.2 | 246.8 | 147.3 | 231.4 | 170.5 | 323.6 |
| Teddys | 0 | 0 | 1.4 | 2.3 | 3.2 | 5.5 | 5.5 |
| Saltash | 0 | 12.0 | 4.0 | 15.0 | 21.5 | 53.0 | 57.0 |
| Farm Close | 0 | 0.9 | 4.1 | 1.4 | 1.8 | 1.4 | 0.5 |
| Gt Woods East | 0 | 3.0 | 2.5 | 1.5 | 1.0 | 2.0 | 18.5 |
| Mothers East | 0 | 1.8 | 0.5 | 2.7 | 1.8 | 11.4 | 3.2 |

*Polygonum aviculare* - July 1985 (% cover)

| Field | Hedge | 2.5m | 5m | 10m | 15m | 20m | 50m |
|---|---|---|---|---|---|---|---|
| Rooksdown | 0 | 0 | 0 | 0 | 0 | 0.1 | |
| Hatchcroft | 0 | 0.1 | 0 | 0.7 | 0 | 0.5 | |
| Pack Lane | 0 | 0 | 0.3 | 0.7 | 1.6 | 0.1 | |
| Hansfords | 0 | 0.3 | 0.4 | 0 | 0 | 0 | |
| Battledown S | 0 | 3.9 | 1.3 | 0.1 | 0 | 0.01 | |
| Moores | 0 | 1.2 | 3.8 | 0.2 | 0 | 0 | |
| Lonely Meadow | 0 | 3.0 | 6.4 | 0.8 | 0.1 | 0.1 | |
| Farm Close | 0 | 0 | 0 | 0 | 0 | 0 | |
| Gt Woods East | 0 | 0 | 0 | 0 | 0 | 0 | |

*Galium aparine* - June 1984 (mean cover score)

| Field | Hedge | 2.5m | 5m | 10m | 15m | 20m | 50m |
|---|---|---|---|---|---|---|---|
| Hatchcroft | 0.23 | 0 | 0 | 0 | 0 | 0.05 | 0.05 |
| Pack Lane | 0.36 | 0 | 0 | 0 | 0 | 0 | 0 |
| Big Field | 1.91 | 0.14 | 0.23 | 0.18 | 0.18 | 0.09 | 0.73 |
| Moores | 1.32 | 0.45 | 0.41 | 0 | 0 | 0.05 | 0 |
| Scrapps Hill N | 2.05 | 0.09 | 0 | 0 | 0 | 0.09 | 0 |
| Scrapps Hill S | 2.64 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lonely Meadow | 1.59 | 0.14 | 0.14 | 0 | 0 | 0 | 0 |
| Teddys | 1.05 | 0 | 0 | 0 | 0 | 0 | 0 |
| Saltash | 0.23 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Close | 0.68 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gt Woods East | 0.36 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mothers East | 1.82 | 0.23 | 0.18 | 0.05 | 0 | 0 | 0 |

| Field | Hedge | 2.5m | 5m | 10m | 15m | 20m | 50m |
|---|---|---|---|---|---|---|---|
| Cirsium arvense - June 1984 (mean cover score) | | | | | | | |
| Hatchcroft | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pack Lane | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Big Field | 0.09 | 0.09 | 0.14 | 0 | 0 | 0 | 0 |
| Moores | 0.73 | 0.09 | 0 | 0 | 0 | 0 | 0 |
| Scrapps Hill N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scrapps Hill S | 0.05 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lonely Meadow | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Teddys | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Saltash | 0.68 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Close | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gt Woods East | 0.09 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mothers East | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fallopia convolvulus - July 1985 (% cover) (=Polygonum convolvulus) | | | | | | | |
| Rooksdown | 0 | 0 | 0.1 | 0 | 0 | 0 | |
| Hatchcroft | 0 | 0 | 0 | 0 | 0 | 0 | |
| Pack Lane | 0.5 | 0 | 0 | 0.2 | 0 | 0 | |
| Hansfords | 0 | 0 | 1.8 | 0.6 | 0.1 | 0.6 | |
| Battledown S | 0 | 0 | 0.1 | 0 | 0 | 0 | |
| Moores | 0 | 0 | 0 | 0 | 0 | 0 | |
| Lonely Meadow | 0 | 1.2 | 0 | 0 | 0 | 0 | |
| Farm Close | 0 | 0 | 0 | 0 | 0 | 0 | |
| Gt Woods East | 0 | 0 | 0 | 0 | 0 | 0 | |

## Appendix 3

Mean panicle densities ($m^{-2}$) of four grass species at different distances from the hedge on the Manydown Estate, 1984 and 1985.

| Field | Hedge | 2.5m | 5m | 10m | 15m | 20m | 50m |
|---|---|---|---|---|---|---|---|
| **Alopecurus myosuroides - July 1984** | | | | | | | |
| Hatchcroft | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pack Lane | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Big Field | 0.4 | 18.4 | 12.9 | 7.5 | 6.2 | 4.2 | 2.0 |
| Moores | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scrapps Hill N | 0 | 1.5 | 0.9 | 0 | 0 | 0 | 0 |
| Scrapps Hill S | 0 | 0.7 | 0 | 1.3 | 0 | 0 | 0 |
| Lonely Meadow | 0 | 6.5 | 1.1 | 0 | 0.4 | 0.7 | 0 |
| Teddys | 34.1 | 102.9 | 136.0 | 77.3 | 38.4 | 8.9 | 20.5 |
| Saltash | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Close | 122.3 | 108.0 | 24.2 | 10.5 | 21.3 | 17.6 | 10.9 |
| Gt Woods East | 18.2 | 53.5 | 96.5 | 12.9 | 7.1 | 7.5 | 0.5 |
| Mothers East | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Alopecurus myosuroides - July 1985** | | | | | | | |
| Rooksdown | 0 | 0.5 | 1.4 | 0 | 0 | 0 | |
| Hatchcroft | 0 | 0 | 0 | 0 | 0 | 0 | |
| Pack Lane | 0 | 0 | 0 | 0 | 0 | 0 | |
| Hansfords | 4.6 | 0.8 | 0 | 0 | 0 | 0 | |
| Battledown S | 0 | 0 | 0 | 0 | 0 | 0 | |
| Moores | 0 | 0 | 0 | 0 | 0 | 0 | |
| Lonely Meadow | 0 | 0 | 0 | 0 | 0 | 0 | |
| Farm Close | 0.9 | 15.9 | 0 | 0 | 1.4 | 11.4 | |
| Gt Woods East | 0.9 | 21.8 | 4.1 | 0 | 0 | 0 | |
| **Elymus repens - July 1984** | | | | | | | |
| Hatchcroft | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pack Lane | 8.2 | 0.7 | 0 | 0 | 0 | 0 | 0 |
| Big Field | 101.3 | 8.4 | 1.5 | 0.5 | 0 | 0 | 0.9 |
| Moores | 42.9 | 0 | 0.4 | 0 | 0 | 0 | 0 |
| Scrapps Hill N | 0.4 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| Scrapps Hill S | 19.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lonely Meadow | 15.1 | 0 | 1.1 | 0 | 0 | 0 | 0 |
| Teddys | 7.1 | 1.6 | 0 | 0 | 0 | 0 | 0 |
| Saltash | 17.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Close | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 |
| Gt Woods East | 11.4 | 0 | 0 | 0 | 0.2 | 0 | 0 |
| Mothers East | 0 | 0 | 0 | 0 | 0.5 | 0 | 0.2 |
| **Elymus repens - July 1985** | | | | | | | |
| Rooksdown | 24.1 | 0 | 0 | 0 | 0 | 0 | |
| Hatchcroft | 2.3 | 0 | 0 | 0 | 0 | 0 | |
| Pack Lane | 0.9 | 0 | 0 | 0 | 0 | 0 | |
| Hansfords | 0 | 0 | 0 | 0 | 0 | 0 | |
| Battledown S | 0.5 | 0 | 0 | 0 | 0 | 0 | |
| Moores | 0.9 | 0 | 0 | 0 | 0 | 0 | |
| Lonely Meadow | 0 | 0 | 0 | 0 | 0 | 0 | |
| Farm Close | 0 | 0 | 0 | 0 | 0 | 0 | |
| Gt Woods East | 0 | 0 | 0 | 0 | 0 | 0 | |

| Field | Hedge | 2.5m | 5m | 10m | 15m | 20m | 50m |
|---|---|---|---|---|---|---|---|
| **Poa trivialis - July 1984** | | | | | | | |
| Hatchcroft | 285.0 | 6.0 | 3.0 | 45.0 | 1.0 | 3.0 | 0 |
| Pack Lane | 537.0 | 6.0 | 4.0 | 0 | 0 | 0 | 0 |
| Big Field | 14.9 | 0.2 | 0 | 0 | 0 | 0 | 0 |
| Moores | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scrapps Hill N | 28.2 | 0.7 | 1.6 | 0.2 | 0.5 | 0 | 0.4 |
| Scrapps Hill S | 0 | 0 | 2.5 | 8.5 | 0 | 0 | 0 |
| Lonely Meadow | 62.3 | 6.7 | 17.1 | 0 | 0 | 0 | 0 |
| Teddys | 285.9 | 0.7 | 2.0 | 0.7 | 0.2 | 0 | 0 |
| Saltash | 90.0 | 2.2 | 0.5 | 2.4 | 0.9 | 0 | 0 |
| Farm Close | 150.9 | 0.7 | 0.4 | 0 | 0 | 0 | 0 |
| Gt Woods East | 382.3 | 0.4 | 5.6 | 0 | 0.2 | 0.4 | 0 |
| Mothers East | 36.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Poa trivialis - July 1985** | | | | | | | |
| Rooksdown | 26.8 | 3.2 | 0 | 0 | 0 | 0 | |
| Hatchcroft | 86.8 | 160.8 | 230.9 | 2.3 | 2.3 | 0.5 | |
| Pack Lane | 13.6 | 0 | 1.8 | 4.1 | 4.6 | 2.7 | |
| Hansfords | 81.8 | 0.8 | 0 | 0 | 0 | 0 | |
| Battledown S | 17.3 | 0 | 0 | 0 | 0 | 0 | |
| Moores | 12.7 | 77.3 | 35.0 | 29.1 | 41.8 | 6.4 | |
| Lonely Meadow | 65.5 | 0 | 0 | 0 | 0 | 0 | |
| Farm Close | 100.1 | 0 | 0 | 0 | 0 | 2.3 | |
| Gt Woods East | 113.2 | 0 | 0 | 0 | 0 | 0 | |
| **Bromus sterilis - July 1984** | | | | | | | |
| Hatchcroft | 417.3 | 8.4 | 0.7 | 0 | 0 | 0 | 0 |
| Pack Lane | 3.6 | 0.4 | 0 | 0 | 0 | 0 | 0 |
| Big Field | 7.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| Moores | 80.9 | 2.0 | 0 | 0 | 0 | 0 | 0 |
| Scrapps Hill N | 168.0 | 0 | 0.9 | 0 | 0 | 0 | 0 |
| Scrapps Hill S | 114.2 | 0 | 0.4 | 0 | 0 | 0 | 0 |
| Lonely Meadow | 15.6 | 0.2 | 0 | 0 | 0 | 0 | 0 |
| Teddys Field | 69.3 | 0.2 | 0 | 0 | 0 | 0 | 0 |
| Saltash | 5.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Close | 804.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gt Woods East | 166.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mothers East | 880.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Bromus sterilis - July 1985** | | | | | | | |
| Rooksdown | 38.6 | 0 | 0 | 0 | 0 | 0 | |
| Hatchcroft | 94.1 | 0 | 0 | 0 | 0 | 0 | |
| Pack Lane | 26.4 | 0 | 0 | 0 | 0 | 0 | |
| Hansfords | 30.9 | 0 | 0 | 0 | 0 | 0 | |
| Battledown S | 59.1 | 0 | 0 | 0 | 0 | 0 | |
| Moores | 44.6 | 0 | 0 | 0 | 0 | 0 | |
| Lonely Meadow | 32.7 | 0 | 0 | 0 | 0 | 0 | |
| Farm Close | 233.2 | 0 | 0 | 0 | 0 | 0 | |
| Gt Woods East | 143.2 | 0 | 0 | 0 | 0 | 0 | |

## Appendix 4

Plant species which have been included in the pot experiments for the Perry Foundation.

| LATIN NAME | COMMON NAME |
|---|---|
| Achillea millefolium | Yarrow |
| Agrostis stolonifera | Creeping bent |
| Alliaria petiolata | Hedge garlic |
| Anthriscus sylvestris | Cow parsley |
| Arrhenatherum elatius | False oat grass |
| Arum maculatum | Lords and Ladies |
| Brachypodium sylvaticum | Slender false brome |
| Bromus erectus | Upright brome |
| Bromus sterilis | Sterile brome |
| Ballota nigra | Black horehound |
| Carduus acanthoides | Welted thistle |
| Centaurea scabiosa | Greater knapweed |
| Chrysanthemum leucanthemum | Ox-eye daisy |
| Cirsium arvense | Creeping thistle |
| Cirsium vulgare | Spear thistle |
| Conium maculatum | Hemlock |
| Convolvulus arvensis | Field bindweed |
| Dactylis glomerata | Cocksfoot |
| Digitalis purpurea | Foxglove |
| Elymus repens | Common couch |
| Epilobium montanum | Broad leaved willowherb |
| Festuca rubra | Red fescue |
| Galium aparine | Cleavers |
| Galium verum | Yellow bedstraw |
| Geranium molle | Doves foot cranesbill |
| Geranium pussilum | Small flowered cranesbill |
| Geum urbanum | Herb bennet |
| Hordeum murinum | Wall barley |
| Hypericum perforatum | Perforate St Johns Wort |
| Lamium album | White dead nettle |
| Lapsana communis | Nipplewort |
| Lathyrus pratensis | Meadow vetchling |
| Leontodon autumnalis | Autumnal hawkbit |
| Linaria vulgaris | Yellow toadflax |
| Lolium perenne | Perennial ryegrass |
| Malva moschata | Musk mallow |
| Malva sylvestris | Common mallow |
| Mercurialis perennis | Dog mercury |
| Myosotis arvensis | Forget-me-not |
| Plantago lanceolata | Ribwort plantain |
| Poa pratensis | Smooth meadowgrass |
| Poa trivials | Rough meadowgrass |
| Polygonum aviculare | Knotgrass |
| Potentilla reptans | Creeping cinquefoil |
| Primula vulgaris | Primrose |
| Primula veris | Cowslip |
| Ranunculus repens | Creeping buttercup |
| Rumex obtusifolius | Broad-leaved dock |
| Rumex sanguineus | Red-veined dock |
| Silene alba | White campion |

| | |
|---|---|
| Sisymbrium officinalis | Hedge mustard |
| Stachys sylvatica | Hedge woundwort |
| Stellaria holostea | Greater stitchwort |
| Tragopogon pratensis | Goatsbeard |
| Trifolium repens | Wild white clover |
| Veronica persica | Common speedwell |
| Vicia cracca | Tufted vetch |
| Vicia tetrasperma | Smooth tare |
| Viola riviniana | Dog violet |
| Viola reichenbachiana | Early dog violet |
| Urtica dioica | Stinging nettle |

## Appendix 5.

The susceptibility of field margin species to six herbicides at fifteen weeks after treatment.
Species in *italics* are significantly reduced in vigor compared to the unsprayed control.
Mean score values in parenthesis 9 = control 0 = complete kill.

| mecoprop | | ioxynil + bromoxynil | | isoproturon | | clopyralid | | diclofop-methyl | | chlorsulfuron | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *C.acanthoides* | (0.0) | *C.acanthoides* | (0.0) | *A.millefolium* | (0.0) | *A.millefolium* | (0.0) | S.alba | (5.5) | *A.sylvestris* | (1.0) |
| *C.maculatum* | (0.0) | *C.maculatum* | (1.5) | *C.arvense* | (0.0) | *C.acanthoides* | (0.0) | A.millefolium | (8.5) | *C.arvense* | (2.5) |
| *S.alba* | (0.0) | *V.tetrasperma* | (4.5) | *U.dioica* | (0.0) | *C.arvense* | (0.0) | C.maculatum | (8.5) | *A.millefolium* | (4.0) |
| *C.arvense* | (1.0) | *L.album* | (6.5) | *S.alba* | (1.5) | *T.repens* | (0.0) | H.perforatum | (8.5) | *U.dioica* | (5.0) |
| *V.tetrasperma* | (1.0) | *H.perforatum* | (7.0) | *C.maculatum* | (2.5) | *V.tetrasperma* | (0.0) | A.sylvestris | (9.0) | | |
| *U.dioica* | (3.0) | A.sylvestris | (8.0) | *R.sanguineus* | (3.0) | *C.maculatum* | (5.0) | C.arvense | (9.0) | | |
| *R.sanguineus* | (3.5) | A.millefolium | (9.0) | *H.perforatum* | (4.5) | *R.obtusifolius* | (5.5) | R.sanguineus | (9.0) | | |
| *C.arvensis* | (3.5) | C.arvense | (9.0) | A.sylvestris | (8.5) | *S.alba* | (5.5) | U.dioica | (9.0) | | |
| *A.millefolium* | (4.5) | R.sanguineus | (9.0) | V.tetrasperma | (8.5) | *U.dioica* | (5.5) | | | | |
| *A.sylvestris* | (6.5) | R.obtusifolius | (9.0) | | | *H.perforatum* | (6.0) | | | | |
| H.perforatum | (8.5) | S.alba | (9.0) | | | A.sylvestris | (8.0) | | | | |
| L.album | (8.5) | T.repens | (9.0) | | | R.sanguineus | (8.0) | | | | |
| R.obtusifolius | (9.0) | U.dioica | (9.0) | | | L.album | (8.0) | | | | |
| T.repens | (9.0) | | | | | | | | | | |

| | mecoprop | ioxynil + bromoxynil | isoproturon | clopyralid | diclofop-methyl | chlorsulfuron |
|---|---|---|---|---|---|---|
| L.S.D. treated x control | 1.84 | 1.42 | 2.52 | 1.45 | N.S. | 3.27 |
| L.S.D. between species | 5.16 | 5.11 | 4.02 | 5.24 | N.S. | N.S. |

N.S. = no significant difference.