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THE POTENTIAL OF LUMBRICIDE CHEMICALS FOR USE IN AIRFIELD BIRD CONTROL

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ABSTRACT

At the 20th meeting of BSCE, Allan and Watson (1990) presented data on the first phase of a two part study designed to investigate the potential of lumbricide (worm killing) chemicals to reduce food supply available to birds from areas of airfield grassland where conventional long grass could not be grown. The second phase of the study is now complete, and full details will be published elsewhere. This paper summarises the findings of the whole study and discusses the potential benefits and drawbacks of the use of lumbricides to control bird numbers on airfields.

The data suggest that lumbricide chemicals may have a limited potential for use in bird control on airfields in the treatment of areas where the grass is kept short for operational reasons. Larger scale treatment is likely to result in a number of difficulties in terms of the effective application of the chemical on long grass swards, the possibility of short term attraction of birds to the sprayed areas, the long term destabilisation of the invertebrate communities and the possible increased pesticide loading to the bird population on the airfield.

ACKNOWLEDGEMENT

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1. INTRODUCTION

Almost all European airfields have significant areas of grassland which attract birds to feed and/or roost. In the UK the management of the grass sward to produce a thick growth of about 200mm in height is regarded as the most effective management technique to deter birds (Mead & Carter, 1973, Brough & Brigeman, 1980, CAA, 1990). This 'airfield long grass' is thought to deter feeding birds by making the detection of food items more difficult and to deter both roosting and feeding individuals by impeding their movement and by reducing their view of the surrounding area thus hampering detection of approaching predators. Good long grass is therefore particularly effective against birds which find food by sight in open grassland and also those species which rely on vigilance and flocking behaviours to avoid predators.

The bird species considered most hazardous to aircraft because of their body weight and flocking behaviour fall into the above category and are the 'priority group' of any aerodrome bird control programme (Milsom, 1990).

The most problematic birds in the priority group in the UK are gulls (*Larus sp.*) 36% of all birdstrikes and lapwings (*Vanellus vanellus*) 21% of all birdstrikes.

An alternative approach to habitat management of grassland in the aircraft movement area is to remove the food supply by applying pesticides. As earthworms comprise an important part of the diets of the most troublesome species, gulls and lapwings, there has been considerable interest in the potential of lumbricides, to reduce earthworm populations.

In the UK MAFF experimented with the insecticide chlordane during the 1960's. This is an organochlorine insecticide which kills earthworms. The results of the trials on airfield grassland were inconclusive in terms of bird control and highlighted the problem of pesticide residue persistence in the earthworms and on grass (Wright, 1968). It was suggested that less persistent alternatives, such as carbaryl might be employed. Chlordane is no longer approved for use as a lumbricide in the UK.

Other lumbricides have been tested on grassland on airfields overseas. In New Zealand, Caithness (1986) experimented with liquid and granular preparations containing endosulfan, while benomyl was tested at airfields in Canada and Finland (Tomlin & Spencer, 1976, Helkamo & Stenman, 1990). All these trials were successful, but neither of the active ingredients is approved for use as a lumbricide in the UK.

Of the two approaches, long grass cultivation or lumbricide treatment, long grass is currently preferred in the UK. The long grass technique deters a broad range of species, including those most hazardous to aircraft and crucially, it affects both feeding and resting individuals. Herbicides are occasionally applied to control weeds but otherwise pesticide inputs are relatively small. In contrast, lumbricides are more restricted in their scope. They will only reduce the food supply of those species which feed on earthworms and other soil invertebrates and have no effect on loafing and roosting birds. Moreover, there may be problems with the accumulation of pesticides or their

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In the light of the foregoing, there can be little justification for applying lumbricides over entire airfields. There are, however areas of airfields where the quality of long grass is poor because access for specialist cutting machinery is restricted, and other areas where the grass needs to be cut short for operational reasons (eg., around ILS installations or along runway margins). Such areas may be particularly attractive to birds, and in the case of runway margins, the presence of birds close to aircraft may be especially dangerous. A further problem encountered along runway margins is that of earthworms moving onto runways and taxiways in wet weather. Supplementary habitat management techniques may therefore be appropriate for use in these areas and, since most of the priority group species take earthworms as a major part of their diet (Cramp & Simmons, 1983), a habitat management technique which reduces the numbers of worms in areas of poor long grass or short grass was considered the most appropriate to test for this purpose.

Airfield grassland is defined as amenity grassland for the purpose of pesticide usage approvals in the UK. Two active ingredients were approved for use against earthworms in amenity grassland at the time of the experiment (MAFF, 1990). They were the organochlorine gamma HCH (also known as Lindane) combined with thiophanate-methyl and the carbamate carbaryl. Both of these chemicals are also broad spectrum insecticides and are therefore also likely to reduce the numbers of other invertebrates which form part of the diets of priority group species on airfields (Cramp & Simmons, 1983).

It was decided to test each of the available chemicals, one on grass which had been cut short by gang-mower and then allowed to grow to around 150mm to determine whether this technique would improve bird control on areas where proper long grass could not be grown, and one on short grass to simulate treatment of runway margins and areas around aircraft navigation aids.

The objectives of the study were as follows: Firstly, to determine how effective lumbricide chemicals are in reducing the numbers of worms in turf. Secondly, to determine how the changes in invertebrate numbers affected the number of birds which attempted to use the treated areas. Thirdly, to assess the impact of the lumbricide on other invertebrates. Fourthly, to determine how long invertebrate populations took to recover from the treatment and whether proximity to the edge of the treated area had any effect on this process.

2. METHODS

The study was conducted at British Aerospace Military Aircraft Division's airfield at Samlesbury, Lancashire UK. This airfield contained large expanses of short grass in the aircraft movement area which attracted very large numbers of birds. The combined densities of gulls, lapwings and golden plover *Pluvialis apricaria* were so high that the likelihood of being able to detect effects of the lumbricides was good. The airfield had other advantages as a study site. It was secure and, as flying had ceased recently there was no bird control. The experiments were carried out in autumn and winter when bird numbers were highest.

In the first phase in 1989/90 a commercially available lumbricide containing gamma HCH plus thiophanate-methyl was applied by back-pack sprayer to three 1ha plots with a grass sward of 150mm. The grass on the airfield had previously been cut short twice with a gang-mower that year thus producing the kind of patchy sward which might occur on areas where the specialist machinery needed

to maintain proper long grass could not gain access. The three sprayed areas were compared with three adjacent 1ha plots which were unsprayed but otherwise managed identically.

The second phase of the study in 1990/91 was conducted using a lumbricide containing carbaryl applied by mechanical sprayer. A second set of plots was laid out in an identical way to that in the first phase, except that the grass on the plots was cut short two weeks prior to the application of the chemical in order to simulate the conditions around runway edges, ILS installations etc. The remainder of the airfield carried a similar sward to that in the first phase of the study.

The precise methodology for the sampling of invertebrate numbers and recording of bird numbers and behaviour for the first phase of the study has already been described (Allan and Watson 1990). The methodology for the second stage was identical with the exception of the change in chemical and the grass cutting regime on the experimental plots. In both cases bird and invertebrate numbers were monitored on the treated and untreated areas for 150 days after application of the chemical.

3. RESULTS

Detailed results for the first phase of the study were presented at the 20th meeting of the BSCE (Allan & Watson 1990), and the full data set for the entire experiment will be published elsewhere in due course.

This paper therefore, offers only a summary of the results obtained from both phases of the study, and concentrates on the feasibility of using lumbricides to aid aerodrome bird control.

3.1 The Impact of Lumbricide Treatment on Worm Populations

The treatment with gamma HCH in 1989/90 produced no discernible reduction in worm numbers in the treated area throughout the 150 days of the trial. This was thought to be because the chemical did not penetrate the longer grass cover effectively and did not reach the soil layer in sufficient quantity to be effective. Other workers have also encountered this problem, and Caithness (1986) overcame it by the use of a slow release granular preparation containing Endosulfan. Endosulfan is not approved for use as a lumbricide in the U.K., however (MAFF, 1990) and granular preparations of the two approved chemicals are not readily available.

The carbaryl treatment applied to short grass in 1990/91 produced a measurable reduction in worm numbers in the treated areas after 20 days which persisted to the end of the trial. This suggests that liquid lumbricides are likely to be most effective if applied to short grass areas.

3.2 The Impact of Lumbricide Treatment on Bird Numbers and Behaviour

Although there was some reduction in the number of birds using the treated areas of the plots in the first phase of the trial using gamma HCH on long grass, The number of birds using the experimental plots was low in this phase of the study and insufficient data were collected to allow statistical comparison.

The trial with carbaryl on short grass did show significant and potentially important effects of both the lumbricide and the grass cutting regime on bird behaviour.

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Firstly, the act of cutting the grass short attracted large numbers of birds to the experimental areas both to feed and roost. At times, 80 to 90% of the 1500 to 2000 birds present on the airfield were concentrated on the short grass plots, compared to an expected value of 8% if the birds had distributed themselves evenly across the airfield. Feeding birds showed a greater preference for the short grass areas than did resting individuals. As the study progressed the proportion of the airfield population favouring the short grass areas fell.

Secondly, the chemical treatment significantly affected the food intake rate of lapwings feeding on the treated areas. Immediately after the chemical was applied, the rate of pray capture on the treated areas almost doubled as birds fed on moribund worms and other invertebrates which had come to the surface as a result of the pesticide application. At the same time, the proportion of feeding birds on the experimental areas which fed on the treated plots increased slightly, but this increase did not achieve statistical significance. Later in the study, the feeding rate of birds foraging on the treated plots fell to around half that of birds feeding on the treated plots and the proportion of birds occupying the treated areas also declined, but again not by a statistically significant amount.

3.3 The Impact of Lumbricide Treatment on Soil Surface Invertebrate Populations

Both of the treatments produced significant effects on the soil surface invertebrate communities, although there were some differences which may prove important in terms of bird control.

The gamma HCH treatment on long grass significantly reduced the numbers of all those invertebrate groups that were trapped in sufficient numbers to allow analysis. Numbers of adult beetles, beetle larvae and collembolans (springtails) fell after spraying, but recovered to their former levels after around 150 days. Spider numbers were also significantly depleted, but showed no sign of recovery throughout the period of the experiment. Large (over 3mm) and small (under 3mm) dipteran flies were both significantly reduced in numbers, but by the end of the experiment had recovered to the extent that they were more abundant in the treated areas in comparison to the control plots than was the case before the treatment was applied.

The carbaryl trial on short grass produced a similar reaction from beetles and collembolans, but the reduction in spider numbers was much less pronounced and the population had begun to recover by the end of the trial. Dipteran fly numbers were depressed initially by the treatment but their recovery was less marked than with the gamma HCH treatment, and numbers did not rise to levels greater than those before the treatment was applied.

Some studies (eg., Duffield & Baker (1990)) have shown that the rate of recovery of an invertebrate population is influenced by the distance to the nearest untreated area from which individuals might move. Comparison of the rates of recovery of invertebrate numbers for areas close to the edge of the plots with those at the centre showed no significant difference. This suggests that immigration of invertebrates from the untreated areas around the plots does not significantly influence the rates of population recovery in this case. Small areas of short grass, and particularly runway margins have a much higher ratio of untreated edge per unit area than does a large square plot and in these cases recovery may be speeded up by immigration of invertebrates from the surrounding long grass.

The effects of the two lumbricide treatments are summarised in tables 1 and 2.

4. DISCUSSION

The data show that lumbricide chemicals can be effective in reducing the number of available food items for birds of the 'priority group' in airfield grassland, but they did not produce a corresponding reduction in bird numbers under the conditions of this experiment. They also highlight a number of significant difficulties likely to be encountered if large scale treatment or treatment of long grass is attempted.

4.1 Possible uses for Lumbricides on Airfields

The fact that the lumbricide failed to penetrate even a moderately dense sward of 150mm suggests that the only situation in which it is likely to be effective is when applied to short grass areas. The only time that airfield grassland should be cut short in the UK is during the bottoming-out process in March or if a silage or hay crop is taken no later than early July (CAA, 1990). If the lumbricide is applied at these times, it is likely that recovery of the invertebrate populations will be well under way by the time of maximum bird infestation in late autumn and early winter, although this obviously depends on such factors as the timing of reproduction of the invertebrate species concerned (Den Boer & Den Boer-Daanje, 1990). The foregoing, combined with the cost and environmental considerations, emphasise the fact that lumbricides are not a viable substitute for long grass in airfield bird control.

The lack of effectiveness when applied to a 150mm sward suggests that lumbricides are also unlikely to significantly improve the repellent properties of areas where proper grass cannot be grown.

If lumbricides are not to be considered for large scale use on long grass areas or for use on areas of poor quality grass, they may still be effective if applied to areas where the grass must be kept short for operational reasons such as runway margins or the areas around ILS installations. When applied to short grass, the lumbricide effectively reduced the numbers of worms in the soil, and should, therefore, also help to reduce the problems caused by worms moving onto tarmac areas during periods of wet weather.

Although this study showed no increase in the rate of invertebrate population recovery close to the edges of the treated plots, other workers have shown that invertebrate populations in areas close to the edge of a treated area recover more quickly from insecticide treatments due to immigration from the surrounding untreated habitat (Duffield & Baker, 1990). Runway margins have a particularly high ratio of untreated edge per unit area. For example, a 1km length of 2m wide runway margin has five times as much untreated edge per square metre than does an equivalent square area, even after allowing for the fact that the runway margin has tarmac on one side. It is therefore possible that recolonisation of small sprayed areas by invertebrates from surrounding unsprayed regions could reduce then effectiveness of lumbricide treatments. Although prey capture rate in the treated half of the plots fell in the latter stages of the trial, the proportion of birds using the treated areas did not show a significant decrease. This suggests that foraging on treated short grass is still sufficiently profitable to be worthwhile to the birds (improved predator detection may also influence the choice of feeding site). Further studies would be required to quantify the long term effectiveness of treating runway margins with lumbricides.

4.2 Possible problems resulting from Lumbricide use

It is important to note the practical implications of a temporary increase in food availability to the birds which resulted from the presence of large numbers of dead or dying invertebrates caused by the application of the chemical to short grass areas. If lumbricides are applied to short grass areas close to runways, it may be difficult to deploy the necessary extra scaring effort needed to deter birds from such an easily available food supply.

Consideration should also be given to the ecological implications of the use of lumbricides on short grass areas. The fact that the prey capture rate of lapwings almost doubled on the treated areas after the application of the chemical suggests that the birds may be receiving an unacceptably high pesticide loading as a result of feeding on moribund invertebrates. Although an increased scaring effort should reduce this intake, and the size of short grass areas is likely to be small, there is the potential for the delivery of sub-lethal doses to, or even poisoning of, non-target species. It is also possible that birds which have received a sub-lethal dose of pesticide may be less able to avoid aircraft and thus more prone to cause birdstrikes.

A further problem which may result from the routine use of lumbricides is the accumulation of pesticides or their residues in the soil. Although gamma HCH is regarded as one of the least persistent organochlorines (Anon, 1988) residues are still present in soil up to one year later and accumulation may result if annual applications are used (Leber, 1976). In what is an increasingly environmentally conscious society, consideration should be given to both the desirability and public relations implications of all pesticide treatments before they are applied.

4.3 The Effect of Lumbricides on other Invertebrates

The application of a lumbricide to both types of sward was effective in reducing the numbers of a wide variety of soil surface invertebrates. These invertebrates form a significant part of the diet of many of the 'priority group' species. Some airfield operators may be tempted to apply these or similar chemicals to long grass as a routine measure both to reduce the numbers of invertebrates available in the grass sward and to prevent the emergence of flying insects such as crane flies (*Tipulidae*) which can attract aerial feeding birds to forage above the airfield grassland. Such routine to applications of pesticides may do as much harm as good, however, since the natural predator prey balances in the invertebrate community may well be disrupted.

For example, in the gamma HCH trail on a 150mm sward, the numbers of spiders were significantly reduced throughout the period of the experiment and the numbers of dipteran flies, one of the principal food items of the spiders (Currey, 1987), recovered to levels in excess of those present before the spray was applied. In the second phase of the trial, using carbaryl on short grass, spider numbers recovered quickly and dipteran fly numbers did not overshoot their original levels. Spiders may consume up to 50% of emerging dipterans in grassland (Currey, 1987), which suggests that the higher numbers of spiders may have kept the dipteran fly numbers in check. Duffield and Baker (1990) found a similar interaction between carabid beetles and collembolans, when the recovery of the collembolan population after insecticide treatment was restricted by the presence of the predatory beetles. It is not possible to determine the cause of the different effect of the two chemicals on the spider populations. Carbaryl has a much shorter half life in soil than does gamma HCH (7 days compared to 4-6 weeks (Hotchkiss et al, (1989)), and this may have contributed to the more rapid recovery of the spider population in the second phase of the trial.

It should also be borne in mind that the different grass cutting regimes and any difference in weather patterns between the two years may also have contributed to the differing results of the chemical applications. The results are, therefore, not conclusive evidence that the two chemicals have fundementally different effects.

5. RECOMMENDATIONS

a) The Aviation Bird Unit at the Central Science Laboratory will continue to recommend a full long grass policy as the best management technique for deterring birds from airfield grassland.

b) The use of lumbricide chemicals may be appropriate on grass areas which are routinely cut short for operational reasons, particularly if problems are encountered with worms moving onto runways in wet weather. On no account, however, should grass be cut short solely to apply a lumbricide treatment.

c) If lumbricides are applied, care should be taken to ensure that birds which may be attracted to the area to feed on dead or dying invertebrates are adequately dispersed, both to reduce the consequent birdstrike risk and to reduce the pesticide intake of the birds.

d) The routine application of pesticides to airfield grassland as an 'insurance' against the appearance of large numbers of temporarily abundant species should be discouraged.

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TABLE 1

Summary of the effects on the bird and invertebrate fauna of airfield grassland resulting from the treatment of poor quality long grass areas with gamma HCH plus thiophannate-methyl

Species Group	Response
Earthworms	No reduction, probably due to lack of penetration to the soil layer.
Overall bird distribution and behaviour	Insufficient data.
Beetles	Numbers reduced, adult numbers recovered after 150 days.
Springtails	Numbers reduced, some recovery after 150 days.
Spiders	Numbers reduced, no recovery.
Dipteran flies	Numbers reduced, recovery to higher than previous levels.

TABLE 2

Summary of the effects on the bird and invertebrate fauna of airfield grassland resulting from the treatment of short grass areas with carbaryl

Species Group	Response
Earthworms	Numbers reduced.
Overall bird distribution	Birds concentrated on short grass.
Distribution of birds on plots	Some concentration on sprayed areas for first 14 days after spraying.
Lapwing feeding rates	Almost doubled on treated areas for 14 days after spraying then declined.
Beetles	Numbers reduced, little recovery.
Springtails	Numbers reduced, little recovery.
Spiders	Numbers reduced, rapid recovery.
Dipteran flies	Numbers reduced, recovery after 60 days.