THE MANAGEMENT OF HOUSE MICE IN AGRICULTURAL LANDSCAPES USING FARM MANAGEMENT PRACTICES: AN AUSTRALIAN PERSPECTIVE

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ABSTRACT: During 1995 to 1997, the efficacy of early tactical management of mouse populations in a project based on grain-growing farms in Victoria, Australia was examined. Farmers modified their management practices of crops (at sowing, harvest, and land preparation), and managed habitats on the boundary of cropped land (such as fencelines) and around farm buildings. One management practice examined was the effect on mouse populations of controlling weeds along margins of crops. On sites where farmers slashed or sprayed weeds in early spring, there was a comparative reduction in the abundance of mice in late summer compared to untreated sites.

KEY WORDS: House mouse, control, Australia, management, ecologically-based pest management

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INTRODUCTION

Populations of the introduced house mouse (*Mus domesticus*) periodically outbreak and cause severe damage to crops in agricultural areas of Australia (Singleton and Redhead 1989; Mutze 1991; Caughley et al. 1994). Farmers use rodenticides, such as strychnine or zinc phosphide when mouse densities are high (this is called "crisis management"). In recent years, governments have provided temporary registration for such rodenticides, but often too late to prevent significant damage to crops (Mutze 1989, 1993b; Brown et al. 1997). In 1995, 250,000 ha of cropping land were aerially baited with strychnine (Fisher 1996).

An alternative to crisis management is to take early preventive management through modifying farming practices. The aim is to slow the rate of growth of mouse populations so that densities are maintained below levels which cause significant economic hardship to farmers (this is called "tactical management").

Farming systems in the grain belt of Australia have changed markedly in the past 15 years. This is in response to the need for greater efficiency, the falling real value of farm produce, the wider cropping options available to the industry, and the desire for farmers to manage their land for a more sustainable future. "Conservation farming" techniques aim to prevent soil erosion, minimize use of water and labor while being a more economically viable and environmentally benign system. Modifications to traditional farming systems incorporate an increased frequency of cropping, a more diverse range of crops, extended cropping seasons, stubble retention, minimum tillage, and direct drilling. These factors, however, provide favorable conditions for mice through providing high quality food for longer periods and less disturbance of nesting sites (Mutze 1993a; Griffiths 1993). It is likely that these practices are responsible for an increase in the frequency of mouse plagues since 1980 (Singleton and Brown 1998).

In Australia, particular habitats (such as the uncropped zone beside fences) have been identified as important for the survival and breeding of mice in agricultural regions (Newsome 1969; Singleton 1989; Mutze 1991; Chambers et al. 1996). However, little has been done to examine the effects of modifying habitats on mouse abundance. Indeed, there has been only one large-scale manipulative study in which Whisson (1996) examined the effect of habitat change on the population dynamics of the canefield rat (*Rattus sordidus*) in sugarcane crops of northern Queensland. Comparisons were made between areas where minimum tillage and conventional practices (pre-harvest burning of sugarcane and intensive cultivation) were conducted. In the two treatments there were differences in survivorship and breeding performance of the rats, but not in the level of crop damage (Whisson 1996).

Research over the past decade has provided a good understanding of how mouse plagues develop in the cereal-growing regions of southeastern Australia (see Singleton 1997 for review). During 1995 to 1997, the efficacy and practicality of early tactical management of mouse populations in cereal-growing regions in Victoria, Australia was examined, by combining the knowledge of scientists and farmers. The scientists provided knowledge of the biology and habitat use of mice and the farmers provided practical recommendations on possible farm management actions that could modify how mice use the agricultural landscape. A project advisory panel was also formed, consisting of farmers and government agricultural officers, that identified the degree of mouse control required, when and where to best implement control, and provided advice on extension of results (Singleton and Brown 1998).

In this paper the effect of one of the farm management practices is reported; controlling plant growth along fences in early spring by spraying or slashing grassy weeds before they set seed. Fencelines

are considered a significant habitat for mice because they provide an undisturbed habitat which is not cultivated and where growth of weed species occurs. The effects of this treatment were assessed by monitoring mouse populations in the following summer.

METHODS

Two regions from the cereal growing area of northwestern Victoria, Australia were used for this project (Mallee and Wimmera). Both regions have a Mediterranean climate, with hot summers and predominantly winter rainfall. The topography is flat to gently undulating. The mean annual rainfall is 452 mm in the Wimmera and 336 mm in the Mallee. Crops are only grown in winter and spring, and are mainly cereals (wheat, barley, oats, and rye), grain pulses (chickpeas, field peas, lentils, and lupin) and oilseed (canola). Farmers in the Wimmera implement a continuous cropping cycle (cereal-legume-cereal or cereal-oilseed-cereal), whereas farmers in the Mallee implement a three year crop rotation which consists of a winter cereal/pulse crop, pasture, and bare fallow.

Wimmera

Twenty-five fencelines from four farms were selected. Each fenceline used in the study was 200 m in length and was separated by at least 200 m. The amount of available plant cover and food supply for mice was reduced along treatment fencelines (n=13). This was achieved by farmers either slashing plant-growth within two meters of the fences using a mechanical slasher attached to a tractor, or by spraying plant growth within two meters of fences with herbicides to prevent seed-set of weed species. Treatments were applied in early spring (September 1996; n=9) or late spring (October 1996; n=4). Vegetation along untreated fencelines (n=12) was allowed to grow unhindered.

Mouse abundance (number of mice caught per 100 trap nights, adjusted using the frequency-density transformation [Caughley 1977]) was assessed by setting 20 traps, each spaced 10 m apart along each fenceline for two consecutive nights. Trapping was conducted in October 1996 (Spring) and in February 1997 (Summer).

Plant biomass samples were taken from five quadrats (0.1 m^2) along each fenceline. Quadrats were positioned every 45 m, 0 to 200 mm from the base of the fence. All species of plants in each quadrat were recorded, harvested using grass shears, placed in paper bags and oven dried at 40°C for three days. Plant biomass was collected at the same times that trapping was conducted. The availability of seed was not measured.

Mallee

Twenty-four fencelines from four farms were selected. Each fenceline used in the study was 200 m in length and was approximately 200 m apart from each other. Fencelines were visually assessed according to plant biomass (high or low). Fencelines with high plant biomass had vegetation >150 mm in height, with >80% ground cover (n=13), whereas fencelines with low plant biomass had vegetation <150 mm in height, with sparse ground cover and included chemical (spraying) or mechanical (slashing) treatment (n=11). The methods for trapping and assessment of plant biomass were the same as those used in the Wimmera.

Statistical Analysis

After log transforming mouse abundance (to improve the validity of the constant variance assumption), a residual maximum likelihood (REML) analysis was conducted using biomass and the spring mouse abundance as a covariates using the statistical software, Genstat 5, Release 3.2 (Lawes Agricultural Trust, Rothamstead Experimental Station, England). Least Significance Difference (LSD) tests were then performed (using approximate "t" tests).

RESULTS

Wimmera

There were significantly fewer mice caught along sprayed fencelines that along unsprayed fencelines (approximate $t = 1.29$; d.f. = 20; $P < 0.05$) (Figure 1). The timing of spraying was not important. The abundance of mice along fencelines that were sprayed early was significantly different to untreated fencelines ($t = 1.44$; d.f. = 19; $P < 0.05$), similarly for late sprayed and untreated fencelines ($t = 0.91$; d.f. = 19; $P < 0.05$). Neither biomass nor spring mouse abundance were significant factors in the covariance and were excluded from the analysis.

Mallee

There was no apparent relationship between the height of biomass in spring and the abundance of mice in summer ($t = 0.52$; d.f. = 22; $P < 0.05$) (Figure 1).

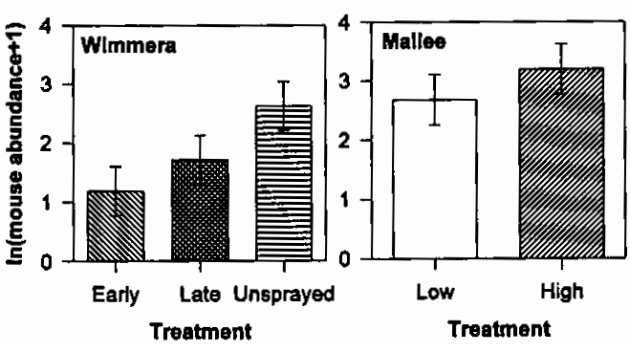

Figure 1. Mean mouse abundance (logarithm of adjusted trap success, ± standard error) in summer for each fenceline treatment for the Wimmera and Mallee.

DISCUSSION

Spraying of plant growth along fencelines in early spring in the Wimmera significantly reduced the abundance of mice in late summer. Weed species along fencelines provide a high quality food source to mice and can trigger breeding in early spring (Bomford 1987; Tann et al. 1991). Spraying reduces seed-set of weed species, and may delay the start of the breeding season of mice.

Further work is required to examine the effect of fenceline management on the damage caused in adjacent crops the following year.

In the Mallee, height of biomass was examined rather than how the vegetation was treated. Based on the findings, it was not recommended that farmers slash or spray their fencelines. However, it may be that small plants, although providing sparse ground cover, still produce high quality seeds that may be important for breeding of mice. Future research needs to examine the effect of spraying and slashing on seed production by grasses, and the subsequent response of mouse populations.

The lack of cover of weed species on areas either sprayed or slashed along fencelines may increase the vulnerability of mice to predation. The presence of avian predators can regulate the growth of mouse populations when they are in low numbers (Sinclair et al. 1991), but this relationship requires further study.

A potential problem of slashing or spraying weed species along fencelines in spring is the likely increase in germination and growth of noxious summer weeds. The removal of winter grasses reduces competition for resources for summer weeds. If this is the case, farmers may need to spray or slash in early spring and again in summer, or use a combination of slashing and spraying at different times. The benefit-cost of this strategy needs to be examined.

The management of plant growth along fencelines is just one action farmers can take to reduce the impact of mice. Other actions have been suggested for different growth stages of crops (sowing, growing, and harvest) and for different types of management (routine, preventive, and crisis) (Singleton and Brown 1998). These actions include livestock grazing immediately after harvest, smoothing the ground at sowing (to cover furrows which then makes it more difficult for mice to locate sown seed) and baiting at key times of the year (at the onset of breeding in early spring).

The present study examined one set of actions for managing mice for specific farm systems. Different responses by mice to these actions were found for the two farming regions. Further research is required to determine which management actions for mice are appropriate for particular farming systems. One interesting system would be the irrigated summer cropping areas, where channel banks provide good mouse habitat and there is little grazing by stock of stubbles.

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