THE EFFECTS OF SIX INSECTICIDES USED IN UK CEREAL FIELDS ON SAWFLY LARVAE (HYMENOPTERA: TENTHREDINIDAE)

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ABSTRACT

A semi-field, manipulative experiment was carried out in June 1990 in southern England whereby batches of sawfly larvae (Hymenoptera: Tenthredinidae) were caged onto areas of spring wheat sprayed two hours earlier with either water or solutions of six insecticides at recommended field rates. These included two recently approved synthetic pyrethroids. This family of insects are important in the diet of wild gamebird chicks and are thought to be susceptible to broad-spectrum insecticides.

Pirimicarb proved to be the least toxic compound (32% mortality after 6 days) whereas the organophosphate compounds and the pyrethroids produced mortality rates of between 89% and 100%.

INTRODUCTION

The use of insecticides to control aphids in UK cereal fields in the summer has increased over recent years (Rands *et al.*, 1988). In a recent survey of UK cereal farmers conducted in 1988 by The Game Conservancy and the Department of Biology at Southampton University, over 55% of the 115,000 ha surveyed were treated with aphicides in the summer (Wratten & Mann, 1988). Over 60% of the treated area was sprayed with broad-spectrum organophosphate compounds often at levels of aphid infestation below ADAS damage thresholds. In 1988/89 the area of UK cereals treated with foliar insecticides (autumn and summer applications) increased by 87.2% over the previous year (Anon, 1990).

In 1982 the UK Advisory Committee on Pesticides recommended a moratorium on the summer use of pyrethroid insecticides because of a lack of data on the spectrum of activity of such compounds against a range of non-target invertebrates and because of fears about the toxicity of such compounds in the aquatic environment. Concern was also expressed about the potential wide scale use of such broad-spectrum products on a major UK field crop. Finally, such a restriction was thought necessary because of fears about cross-resistance potential with currently used organophosphate products. In 1990, this moratorium was partially lifted when two products, alphacypermethrin and deltamethrin, were given provisional approval for one year for summer use.

Much work has described the impact of pyrethroids upon the natural enemy complex of pests in UK cereals in the summer (Inglesfield, 1985; Shires, 1985; Cole *et al.*, 1986; Vickerman *et al.*, 1987). However, little work has been carried out to assess the impact of pyrethroids on the guild of insects of importance in the diet of farmland vertebrates. The chicks of the grey partridge (*Perdix perdix* L.) feed on a range of mostly phytophagous species in cereal fields in June-July (Southwood & Cross, 1969; Potts, 1986). As obligate insectivores for the early weeks of life they are susceptible to pressures (starvation, increased susceptibility to disease, predation, etc.) caused by reduced levels of insect feeding following the use of pesticides, leading to low levels of chick survival (Potts, 1986).

This paper describes a small, manipulative semi-field experiment in which six currently approved insecticides including the two provisionally approved pyrethroids were examined to discover the extent of their insecticidal activity against one of the most important chick food groups: the larvae of sawflies (Hymenoptera:Symphyta:Tenthredinidae).

MATERIALS AND METHODS

Insecticide application

The trial was conducted in a field of spring-sown wheat (cv Tonic) undersown with rye-grass on a farm on the Hampshire - Dorset border in southern England. Applications were made at GS 61 (Zadoks *et al.*, 1974) on 26 June 1990, between 11.10 am and 13.30 pm. The six insecticides were used at recommended field rates. Details are given in Table 1. The compounds were applied with a Oxford Precision Sprayer using a 2 m boom (medium nozzles) held about 70 cm above crop height. The sprayer was calibrated to deliver spray solutions at 2 bar, at a volume rate equivalent to 208 l/ha and at an average walking speed of 1.03 m/s. Applications of tap water were made to control plots prior to the six insecticides which were applied in the order given in Table 1. Conditions during spraying were dry and still with $^{5}/_{8}$ cloud cover, 20°C and 78% r.h.

TABLE 1. Details of the six insecticides and their rate of application (g AI/ha) used against sawfly larvae, in plots of spring wheat, Hampshire, June 1990.

AI	Product name	Rate (g AI/ha)
pirimicarb	Aphox	140.0
alphacypermethrin	Fastac	15.0
deltamethrin	Decis	6.25
phosalone	Zolone	490.0
demeton-S-methyl	Metasystox 55	121.8
dimethoate	BASF Dimethoate 40	340.0

Experimental design and analysis

Sawfly larvae (third-fourth instar *Dolerus* spp.) were collected by sweeping from a nearby field of rye-grass. An unbalanced randomised block design was used in which each treatment plot measured 2 x 10 m. Seven replicated treatments were incorporated into six blocks. Three of the blocks contained all seven treatments (six insecticides and water controls). A shortage of sawfly larvae meant that the remaining three blocks only contained three treatments, namely the water control, the toxic standard (dimethoate) and the selective standard (pirimicarb). The success of the experiment required that the caging technique worked well to confine larvae within the treated areas and that pesticides were being delivered to the plots accurately, hence the use of the control or check plots only in the remaining three blocks.

Caging

Two hours after the plots were sprayed, cages were set up in the middle of each plot and 18 larvae introduced into them. Cages consisted of cylinders of transparent plastic (1 m high x 30 cm diameter) placed over an area of the crop. The tops were sealed with muslin and soil was banked up around the cylinder bases. After three days the cages were dismantled and larvae (alive and dead) were recovered. Live and moribund larvae were returned to the laboratory and fed uncontaminated wheat leaves for a further three days. Percentage survival was expressed as the number of actively feeding larvae present six days after spraying. In these experiments larvae were exposed to the insecticides via both surface residues and the ingestion of contaminated material. The larvae were never directly sprayed.

Analysis was conducted by two-way ANOVA in an unbalanced randomised block design using arc sine-transformed data, and pair-wise comparisons of the treatments carried out using the Tukey-Kramer procedure (Sokal & Rohlf, 1981).

RESULTS

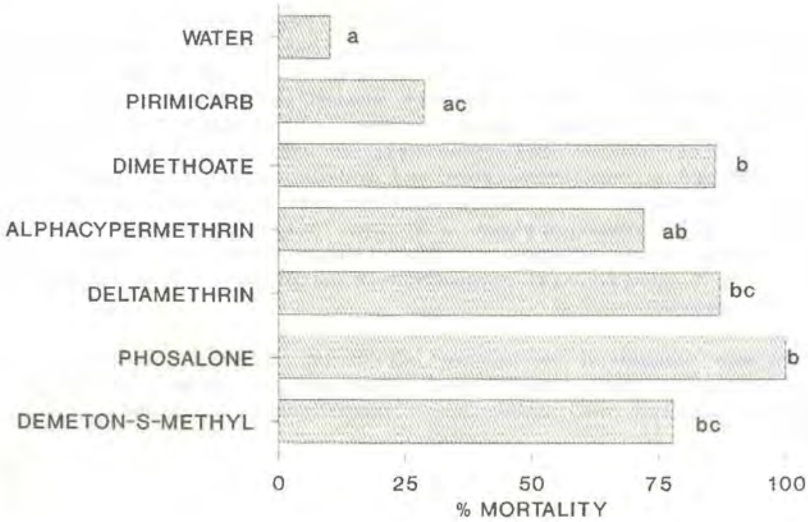
Mortality rates among batches of sawfly larvae treated with either water or solutions of six insecticides are presented at two dates post-treatment (Figures 1a & 1b).

Control larvae were well confined within the cages and very few live larvae (11 individuals of the original 108) could not be recovered. Subsequently missing larvae from treated plots were assumed to be dead even though not every dead body could be recovered after three days' field exposure. After three days, larvae exposed in field cages sprayed with the three organophosphate compounds (dimethoate, phosalone and demeton-S-methyl) and the two pyrethroids (alphacypermethrin and deltamethrin) suffered losses ranging from 72-100%. In contrast, larvae sprayed with pirimicarb suffered only a 29% loss (Figure 1a). It should be noted that, at three days although mortality under deltamethrin was slightly higher than under dimethoate, the difference between pirimicarb and deltamethrin was not significant whereas that between pirimicarb and dimethoate was. This was a direct consequence of the replication for dimethoate being twice as high as for deltamethrin (see experimental design).

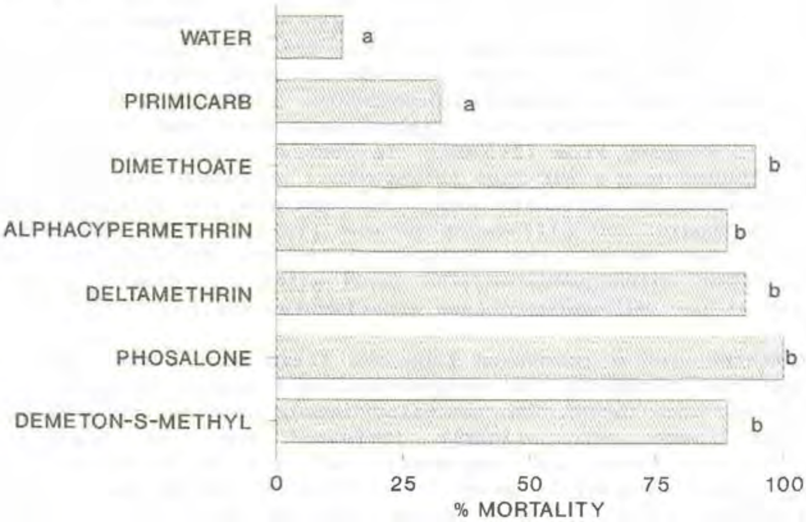
Many treated larvae recovered from the field were either moribund, exhibited abnormal movements, or stopped feeding. Losses estimated after a further three days showed that mortality among control and pirimicarb treated larvae were only slightly increased and that statistical differences between these two treatments could not be detected (Figure 1b). In contrast mortality among other treated larvae had risen to between 89% and 100%. All larvae treated with pyrethroid or

FIGURE 1. Mean mortality rates of batches of sawfly larvae exposed in caged areas of a spring wheat crop sprayed with either water or solutions of six insecticides at recommended field rates, Hampshire, June 1990. Columns with the same letter do not differ at the 5% level of significance.

a) After three days



b) After six days



organophosphate suffered significantly higher rates of mortality than those treated with water or pirimicarb (Figure 1b). Despite the differences in replication mentioned for the data collected after three days, after six days' assessment, all treatments gave significantly higher mortalities compared to pirimicarb.

DISCUSSION

This trial confirmed the broad-spectrum activity of organophosphate insecticides against chick-food insects (Vickerman & Sunderland, 1977; Sotherton, 1989; Aebischer, 1990). These data also confirmed the relative selectivity of pirimicarb against these beneficial species and now completes our knowledge of the impact of cereal aphicides on all the major groups of chick-food insects (Sotherton, 1989; in press). The need to continue assessment of larval mortality beyond the times of field exposure was clearly demonstrated. This was necessary to overcome any confusion arising from the characteristic knockdown and recovery phenomena of some species exposed to type II pyrethroids such as alphacypermethrin and deltamethrin. In the sawfly larvae, all individuals exhibiting lack of coordination or partial paralysis later died.

For all insecticides, including pirimicarb, the levels of sawfly mortality recorded in this trial were likely to have been underestimated. Larvae were not directly treated as would have been the case under more rigorous field conditions. Confirmation of these effects will require modification to the cage design and are urgently required.

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