Pyrethroid resistance in Heliothis armigera from unsprayed crops in New South Wales 1983–1988

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Introduction

Heliothis armigera, the cotton bollworm, is a serious pest of cotton and other summer crops. Pyrethroid insecticides were used successfully for its control until 1983, when resistance was diagnosed. In 1983 pyrethroid resistant H.armigera were only confirmed to crops sprayed with pyrethroids and non-sprayed pest populations had negligible resistance. In response to this resistance problem, agricultural authorities, insecticide manufacturers and insecticide users initiated a voluntary insecticide resistance management strategy in New South Wales and Queensland restricting pyrethroid use to 6 weeks each summer. The strategy has been followed for the past five seasons. The long term management of pyrethroid resistance in H.armigera is based on the assumption that after pyrethroid spraying ceases, resistance levels will drop partly due to dilution by pyrethroid susceptible H.armigera in non-sprayed populations outside major cotton growing areas.

At the time of the initiation of the H.armigera resistance management strategy, there was a need to demonstrate that any increase in resistance was limited to crops sprayed with pyrethroids. An increase in resistance in these populations could lead to a consistently high level of resistance in cotton areas. This paper reports the results of a resistance survey on H.armigera collected from 1983–1988 in New South Wales.

Procedure

Unsprayed H.armigera eggs and small larvae were collected from cattle fodder maize in dairying areas of New South Wales. Maize used for this purpose is not sprayed with insecticides and provides a source of unsprayed H.armigera. Sampling locations, shown in Fig 1, were mainly in northcoast and Hunter Valley dairying regions some 300-400km from the Namoi/Gwyder irrigation district. Each site was sampled in Stages 1,2 and 3 of each season from 1983 -1988. Heliothis this collected, were tested for pyrethroid resistance using a single discriminating dose of Fenvaleate. Results for collections made in each stage were pooled to produce the mean percent resistance for stages 1,2 and 3 of each season.

Results

Results of this survey are shown in Fig 2. During 1983/84 and 1984/85, resistance levels were low, but in 1985/86 resistance frequency increased considerably (to 50%) throughout the season. These levels have remained reasonably constant since, to 1987/88. In the first two seasons of the survey some H.armigera populations were fully susceptible, but was followed by a loss of susceptibility. From 1985 there was a flattening off of the upper resistance levels, suggesting some self regulation of the resistance levels.

Discussion

The implications for the long term management of pyrethroid resistant H.armigera may be serious, given the present rate of contamination of the H.armigera susceptible refugia, 30-50% of individuals in unsprayed H.armigera populations are resistant.

The success of the Heliothis insecticide resistance management strategy requires that pyrethroid resistants be mainly confined to sprayed populations.

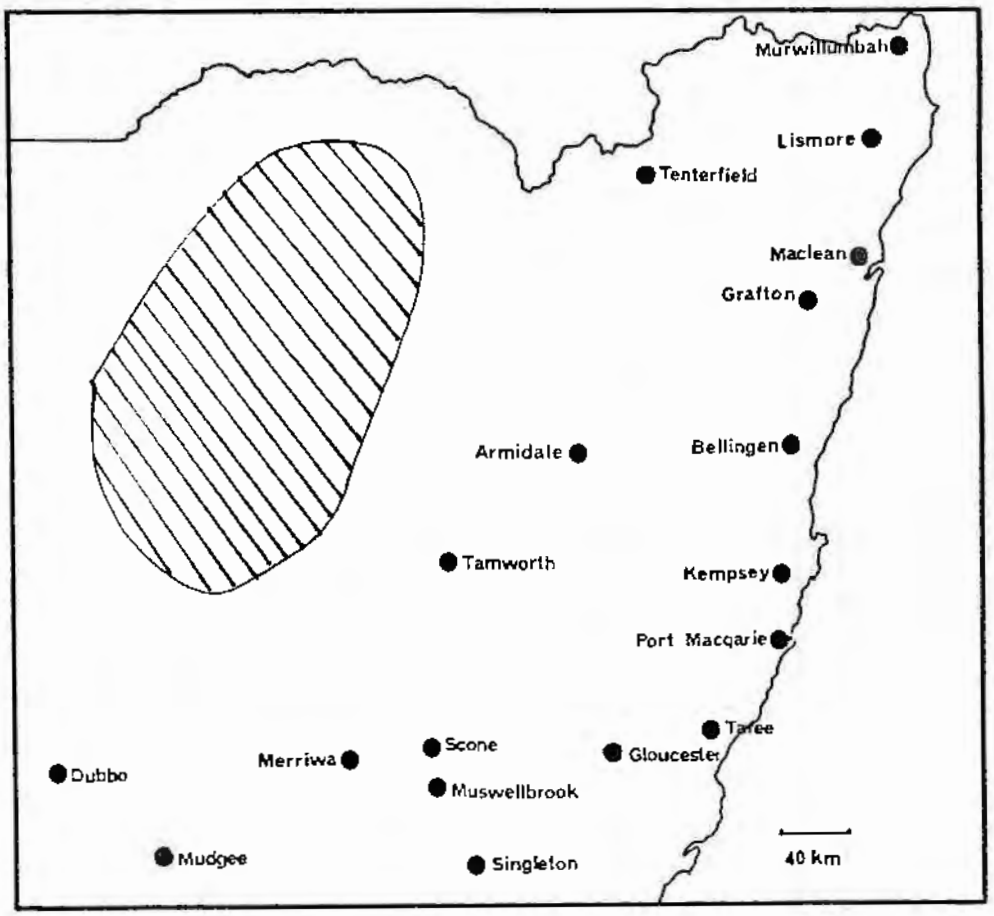
Immigration from (unsprayed) susceptible populations is needed to dilute the resistance frequency of sprayed populations. Pyrethroid resistance in the unsprayed H.armigera populations of this study were initially low and immigration of the populations into the sprayed cotton growing areas may have contributed to the greatly lowered resistance levels of the Namoi/Gwydir populations in Stage 3 1983/84, 1984/85. Pyrethroid resistance levels in the unsprayed populations were very much increased in 1985–88 as were the resistance levels of the sprayed Namoi/Gwydir populations.

The high levels of pyrethroid resistance and increase in variation found in H.armigera in districts and crops not sprayed with pyrethroids may be explained by the migration of resistant H.armigera from the sprayed cotton areas. H.armigera is known to be a long distance migrant and this data shows that resistant H.armigera appear to have dispersed widely, including into the non–sprayed populations.

If the present management practices of pyrethroid resistant H.armigera are maintained it is interesting to speculate about the ultimate resistance frequencies from unsprayed crops. Increasing resistance requires two conditions, continued pyrethroid use and Heliothis migration. A factor that will assist increasing the frequency of resistance may be a change in fitness or selective advantage of the resistants with time. Initially, it is assumed that resistant individuals are at a selective disadvantage in the population without insecticides. However this study suggests that resistant H.armigera are no longer disadvantaged relative to susceptibles, as they are increasing in areas where no pyrethroids are used. Fixation of insecticide resistance in pest populations in not unknown. An agronomic factor which may limit increasing pyrethroid resistance in H.armigera is that the resistance management strategy should self regulate the amount of pyrethroid selection of H. armigera in stage 2. Growers will not continue to use pyrethroids, in

stage 2, unless effective control is guaranteed; thus limiting pyrethroid selection pressure. The flattening off of the upper limit of resistance levels 1985-87 suggest that self regulation of resistance has occurred.

Figure 1. Sampling sites of non-sprayed H. armigera



● Unsprayed sampling sites

▨ Namoi /Gwydir sprayed summer cropping area.

Fig 2 Pyrethroid resistance in unsprayed H.armigera populations 1983 - 1988