HELICOVERPA PUNCTIGERA IN INLAND AUSTRALIA: THEN AND NOW

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SUMMARY

The CRDC-funded project, "Ecology of *Helicoverpa punctigera* revisited: implications for Bt resistance", followed our inland trip in May 2009 to determine the extent of winter breeding of the native budworm, *Helicoverpa punctigera* in the Diamantina and Eyre Creek floodplains, and collect larvae for testing Bt resistance in these populations, in collaboration with Sharon Downes (CSIRO). We have now conducted four field trips to far western Queensland, and established a network of pheromone traps and permanent vegetation monitoring sites in a transect from Bourke to Birdsville and Bedourie. The inland floodplains, where the annual verbine, *Cullen cinereum* is common, can support continued activity of *H. punctigera* well into spring/summer in response to floods/winter rains.

In contrast to what was found by the *Heliothis* Inland Research Group (HIRG) in the 80s-90s, very few host plants and larvae are now found in the mulga areas, which serve as a "bridge" between the far western floodplains and deserts and the eastern cropping regions. Substantial moth numbers were caught only in the pheromone traps in the floodplains (Bedourie and Birdsville). Traps at Windorah, Eromanga, Thargomindah and Eulo (in the mulga areas) had very low numbers. In the cropping areas at Bourke and Narrabri, moth numbers were also low. These results suggest that there has been very little immigration from the inland into the cropping regions in recent years.

INTRODUCTION

Unlike the cotton bollworm, *Helicoverpa armigera, H. punctigera* never sustained resistance to pesticides for decades, and this was attributed to the differences in the ecology of the two species. Earlier studies on the ecology of *Helicoverpa* in inland Australia by the *Heliothis* Inland Research Group (HIRG) in 1987-1993 demonstrated that following autumn-winter rains in the inland, ephemeral host plants can sustain *H. punctigera* breeding (Zalucki et al. 1994). In early spring inland moths that have not been exposed to pesticides can migrate to the eastern cropping regions and thus, dilute any resistant populations in this area (Gregg et al 1995).

Recently however, *H. punctigera* resistance alleles for Cry2Ab in Bollgard II® have been reported (Downes et al 2010). It now appears that either our previous understanding of the ecology of this species based on the HIRG findings was inadequate, or something has changed. Hence, we need to update our understanding of *H. punctigera* ecology. It is time to re-visit questions like overwintering which was previously thought to be rare, and immigration from the remote inland regions which was previously thought to be extensive.

This project aims to re-examine these questions and hopes to provide relevant information to update current Resistance Management Programs (RMPs) for Bt cotton. In this paper, we present results of our inland vegetation and larval surveys in the last two years, and we compare some of our results with previous HIRG findings to better understand the reason for the current apparent lack of immigration from the inland into the cropping regions.

METHODS

We are using the methods developed by HIRG to study inland winter breeding and immigration from the inland. These methods include vegetation and larval surveys during winter-spring and establishing pheromone trapping network in the inland regions. Vegetation surveys and photographs are done every 20km along the route, scoring the total amount of green vegetation and noting the presence of any *Helicoverpa* hosts. These are recorded using a Fuji digital camera which is synchronised with a GPS tracker device (Phototracker DPL900). Larval surveys are done using sweep nets (20 sweep samples replicated 5 or 10 times on each host at each site). Larvae are kept on artificial diet in tissue culture wells during the trip and transferred to individual cups with diet on return to the laboratory for rearing into adults to verify species.

A PhD project (Kris Le Mottee) is looking at the overwintering aspect of the project under laboratory and field conditions, and will be using standardised GIS-based modelling to compare results of this project with the earlier findings of the HIRG.

RESULTS AND DISCUSSION

We have completed four inland trips in the last two years and established a pheromone trap network in the cropping and inland regions serviced by local collaborators (notably schools) (Figure 1).

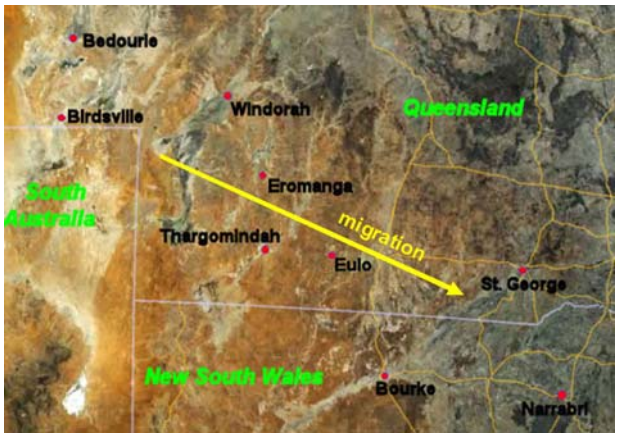

Figure 1. Location of pheromone traps.

Our field surveys have shown that substantial populations of *H. punctigera* breed in the floodplain areas. A second generation of *H. punctigera* and continued moth activity into spring were observed in 2010 and 2011. In 2010, it was likely due to the prolonged spring rain that kept the hosts in good condition, presumably in the sandy deserts as well as the floodplains, whereas in 2011, it was because the late floods led to delayed host growth, in the floodplains only.

Only the traps in the floodplains (Bedourie and Birdsville) caught substantial numbers of moths between 2010-2011. Traps in the mulga regions (Eromanga, Thargomindah and Eulo), and those in the cropping regions (Bourke and Narrabri) had very low moth numbers.

To see if there were differences in the HIRG findings in the 80s-90s compared to what is happening in the inland in recent times, we examined the previous data of HIRG in similar or nearest trapping sites as the current project, and compared these with our data in the last two years in relation to host plants, larval surveys, and pheromone trap catches (Figure 2). In the sandy deserts, significantly more hosts were recorded during the HIRG surveys, compared with what we found in the four inland trips in 2010-11. HIRG recorded vast areas of the poached egg daisy, *Polycalymma stuartii,* a very good host plant, on the sand dunes, especially the Simpson Desert, whereas only occasional plants of this species were found in our recent trips. There were significantly more hosts recorded during the HIRG surveys compared with those in the recent surveys but no significant differences in the % of larval surveys with and without larvae between the HIRG and recent surveys (Figure 2a).

The floodplains, particularly the Eyre Creek and Diamantina floodplains, are dominated by the annual verbine, *Cullen cinereum,* which can support large numbers of *H. punctigera* larvae in response to floods or winter/summer rains. Substantial numbers of larvae were also found on two other related species, *C. australasicum* and *C. pallidum*, in the sandy deserts. *C. pallidum* is likely to be a particularly important host for extending *H. punctigera* population growth into the spring, and perhaps even allowing populations to survive the summer Back then, when HIRG surveys were done mostly in the Cooper Creek floodplains, the most abundant hosts were daisies like *Senecio* and *Calotis* spp. The % of vegetation surveys with host plants and the % of larval surveys with larvae found were not significantly different between the HIRG and recent surveys (Figure 2b).

In contrast to what was found by HIRG, very few host plants and larvae were found in the mulga areas, which serve as a "bridge" between the far western floodplains and deserts and the more easterly cropping regions (Figure 2c). HIRG surveys recorded the abundance of a number of host plants, eg, various daisies (Asteraceae), *Vellia glabrata* (Goodeniaceae) and *Sida platycalyx* (Malvaceace), mostly in response to autumn-winter rain (April-June). On the other hand, our recent surveys in the mulga recorded no hosts, or if hosts were present, they were very scattered in small patches, and not suitable for net sweeping.

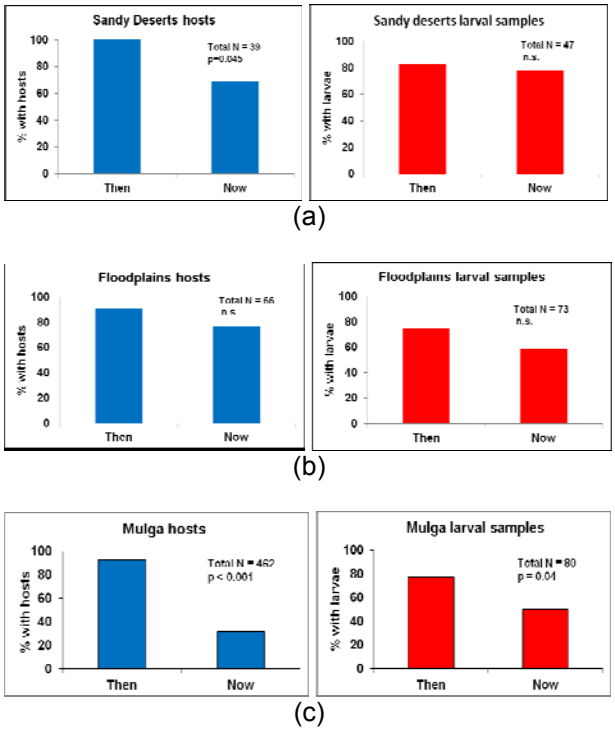

Figure 2. Comparison of inland vegetation (left) and larval surveys (right) by HIRG in 1987-93 (Then) and in 2010-11 (Now) for H. punctigera in the sandy deserts (a), floodplains (b) and mulga regions (c) in inland Australia.

Figure 3 compares the pheromone trap catches during the 1980s-90s (HIRG) and in 2010-11, in the floodplains (Birdsville and Glengyle/Bedourie, Figures 3a and 3b) and in the mulga regions (Eromanga and Eulo, Figures 3c and 3d). Trap data have been log transformed (natural log), and start of each year is July.

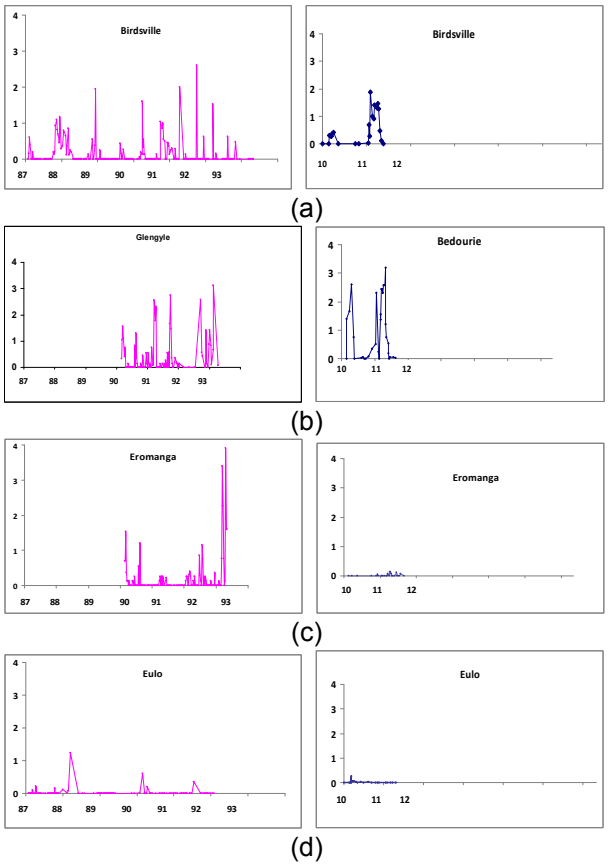

Figure 3. Comparison of pheromone trap catches in HIRG (left) and current traps (right) in the floodplains (a, b) and in the mulga regions (c, d).

In the floodplains, the patterns of peak trap catches in winter/spring and occasionally in summer/autumn were more or less similar in both periods. On the other hand, trap catches in the mulga regions in the 80s-90s and in the last two years were very different. HIRG traps had significantly higher catches compared with our current traps at Eromanga and Eulo, which caught very few larvae over the last two years. These results are consistent with our observations that in recent times, there were very few host plants to support any winter breeding in the mulga. It is likely that this reflects the impact of the prolonged drought (2002 to 2009) in this area. Although there has been extensive recent rain in these areas, it has predominantly occurred in summer, when it generates grasses rather than the daisies and legumes which host *H. punctigera* populations.

These results support the hypothesis that there has been little immigration from the inland for many years, despite the recent breaking of the drought, and the relatively few *H. punctigera* seen in cropping areas may have come predominantly from local overwintering, which would explain the apparently surprising increases in frequency of resistance to Cry2Ab (Downes et al. 2010).

CONCLUSIONS

In response to floods or local rainfalls, the floodplains can support continued activity of *H. punctigera* well into spring/summer. The mulga regions might not serve effectively anymore as the "bridge" for *Helicoverpa* populations into the cropping regions. In the 80s-90s, HIRG findings demonstrated that the mulga regions supported winter breeding of *Helicoverpa* on various host plants due to autumn-winter rains, but in recent times, we found very few hosts and larvae in this region. It is likely that the long drought might have affected the seed dynamics of the host plants. Overgrazing not only by cattle and sheep, but also goats, might have also been a contributing factor.

Resistance management plans therefore, now need to consider *punctigera* as well. We can not assume that migration from the inland will take care of its resistance problem to Bt toxins.

ACKNOWLEDGMENTS

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