Cotton insect management in the Northern Territory – challenges ahead and research to overcome the challenges

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Introduction

Northern Australia has long presented a series of problems in terms of sustainable cotton insect management. This is exemplified by the failure of the Ord cotton industry in the early 1970's under extreme insect pressure. Numerous studies and reports have suggested that for cotton growing to be successful in Northern Australia considerable changes to the production system were required (Yeates 2001). The advent of transgenic cotton has provided the impetus for renewed research interest in cotton in northern Australian. The production system proposed involves growing transgenic varieties in the winter or dry season. The move to the dry season is largely in response to research findings showing that insect pressure from *Helicoverpa armigera*, *Spodoptera litura*, and *Pectinophora gossypiella* are lower in this period. Although preliminary research has shown this to be true, a number of additional problems have become apparent. This paper discusses some of the entomological issues associated with cotton production in northern Australia and the research being undertaken to address these problems.

Pest insects being encountered

In the reborn northern Australian cotton industry a number of pest insects have become apparent (Figure 1). Although the move to winter production has meant that the problems previously encountered with *Spodoptera litura*, and *Pectinophora gossypiella* have been largely avoided, *H. armigera* has remained a problem.

In addition to the problems being encountered with Helicoverpa, sucking insects appear to present a significant problem in the early part of the season with Mirids (both brown and green) being a problem from first square onwards and shield bugs such as Green Vegetable Bugs (GVB) and Redbanded Shield Bugs (RBSB) becoming a problem from about first flower. In contrast to southern Australia where Ingard production is capped at 30%, it is proposed to base any commercial industry in Northern Australia entirely on transgenic varieties and inparticular Bollgard II. This will further exasperate the problems caused by sucking insects as Helicoverpa control will not be required until late in the season, if at all.

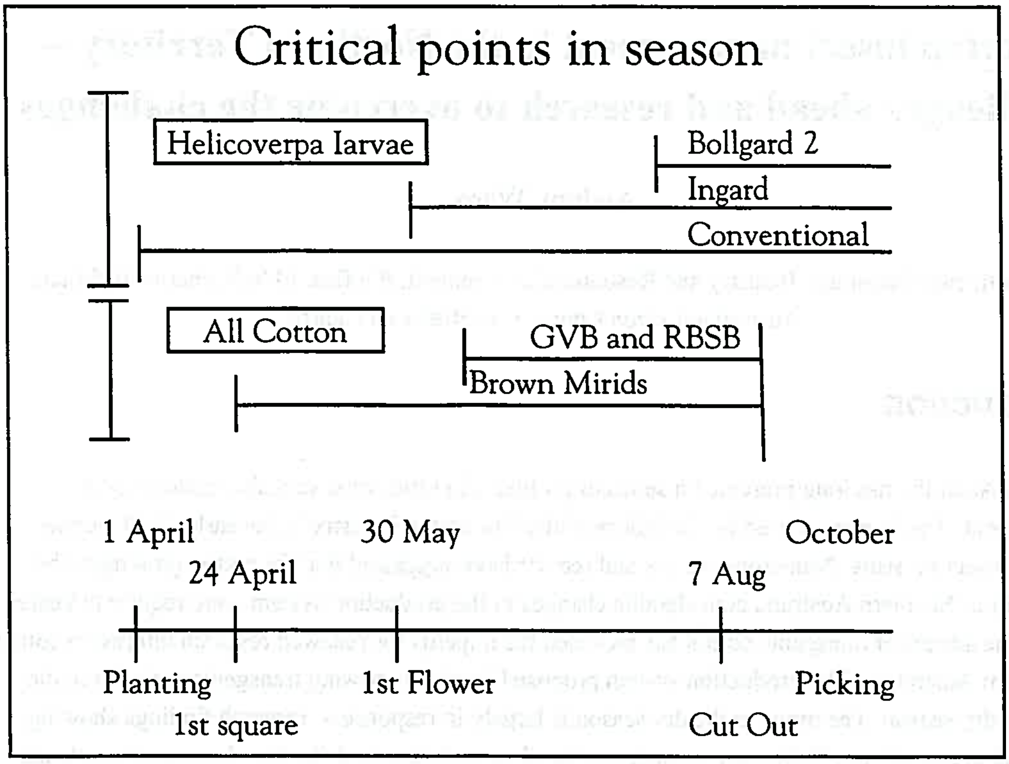

Figure 1: Crop stage and the pest problems encountered in cotton grown in the Northern Territory.

Developing an IPM system for the Northern Territory

Preliminary trials growing Bollgard II have indicated that it will provide protection from Helicoverpa for considerably longer than Ingard. Ingard expression appears to last approximately 9 weeks whilst Bollgard II lasts about 16 weeks. The improved protection afforded by Bollgard II will place greater emphasis on sucking insects in our quest to develop cotton insect management systems which have minimal reliance on insecticides. In developing an IPM system appropriate for use in the Northern Territory we are examining a range of tools including methods to preserve beneficial insects and the role of trap crops.

Beneficial insect preservation

One of the advantages of growing transgenic cotton varieties is that the requirement for Helicoverpa control in the early part of the season is negated. This allows beneficial insect populations to build up in cotton crops to sufficient levels that they can control Helicoverpa populations after the expression of the Bt gene falls mid season. Although this concept works well in the southern production areas, in Katherine we have observed a different pattern. Following the onset of the dry season (when planting takes place) beneficial insects move into the cotton. This is thought to be the result of the rapid dry down of the bush around the cotton fields which essentially turns the cotton into an oasis where both pest and beneficial insects can seek respite from the dry surrounds. Sampling in bush areas has confirmed that insect populations in the bush fall rapidly following the onset of the dry meaning that the seasons compliment of beneficial insects enter the field soon after planting. The requirement to spray sucking insects early in the season puts considerable pressure on beneficial populations meaning that the scope for using beneficial insects to control Helicoverpa populations after the failure of Ingard is limited if sucking insect control is required. In 2001 this was exemplified when levels of egg parasitism were observed to fall rapidly following planting (Figure 2). An explanation for this rapid decline may have been that the requirement to spray sucking insects twice in the period between first square and first flower killed the trichogramma resulting in very low levels of parasitism when Bt expression fell below lethal levels in early June.

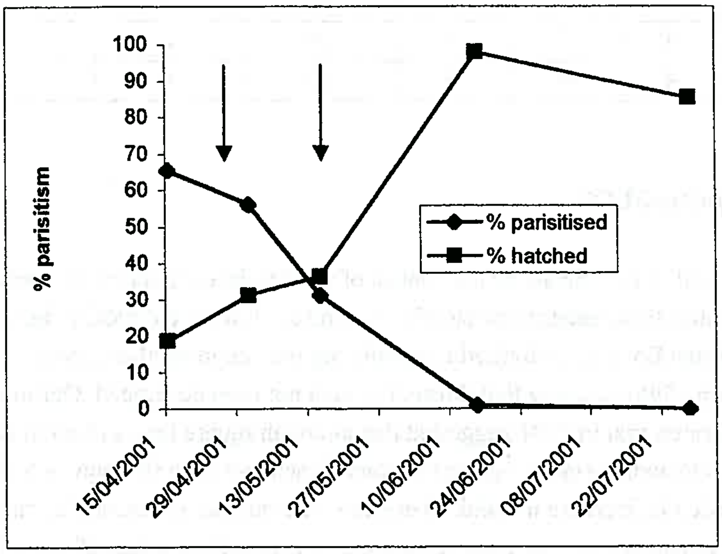

Figure 2: Helicoverpa egg parasitism in cotton in 2001. The two arrows represent applications of Regent to control Brown Mirids.

Trap crops

Trap crops are seen as an integral part of the IPM system being developed in the Northern Territory. Due to the complex of insect pests experienced in the Northern Territory the perfect trap crop would be one that is attractive to both sucking insects (GVB, RBSB and brown mirids) and *Helicoverpa*. To this ends a number of crops were investigated in 2001. The crops assessed were niger, chickpea, sesame, lab lab, kenaf and pigeon pea. Sesame established poorly and chickpea was damaged by wallaby feeding. Of the remaining crops the results obtained indicate that lab lab was highly attractive to sucking insects and pigeon pea and chickpea were highly attractive to Heliothis (Table 1). Although these results are no great revelations we do have a requirement to fit them into our program to get maximum benefit from them. In an Ingard cotton production system we have several requirements from our trap crops. These are that they are attractive to Heliothis, RBSB and GVB in mid June when Ingard expression seems to fall rapidly and when the bugs migrate into cotton (Fig 1). With a shift to Bollagrd 2 the emphasis will shift to attractiveness to early season sucking insects and the ease with which the crops can be established and managed. To achieve this, work will continue to optimise planting times to ensure the crops are at their peak in attractiveness when they will be of most benefit in our production system.

Table 1: Ranking of trap crops tested at Katherine for their attractiveness to a range of pest and beneficial insects. Crops labelled 1 are the most attractive and 5 are the least attractive.

Crop	*H. armigera* larvae	GVB	RBSB	Brown Mirid	Total Pests	Beneficials	Total all Insects
Lab Lab	1	1	1	1	4	3	7
Pigeon Pea	4	2	2	2	10	5	15
Niger	2	5	3	1	11	2	13
Kenaf	5	3	5	3	16	1	17
Cotton	3	4	4	5	16	4	20

Thresholds and compensation

Considering the disruption caused to beneficials by the control of sucking insect populations early in the season, the necessity to control them needs to be closely scrutinised. Two of the sucking insects identified in Katherine (RBSB and BM) are of limited economic importance in southern cotton growing areas (Pyke and Brown 1996) meaning that thresholds have not been developed. Our initial observations in a small unreplicated trial in 2001 suggested that although square losses of up to 30% at first flower were attributable to Brown mirids our efforts to control them between first square and first flower resulted in only a 0.2 bale / ha increase in yield. There may be a number of reasons for this including the ability of cotton to compensate for early season square loss without a loss of yield. This suggests that any threshold developed needs to consider compensation particularly in the early part of the season before flowering commences. A different approach may be required post flowering, as sucking insect damage to bolls does not appear to result in compensation but instead direct losses of locks within bolls (Tom Lei Pers. Comm).

In response to the need for thresholds for RBSB and BM, thresholds are being examined in the 2002 season. Two approaches are being taken in these studies. The first is using direct field studies in which insecticide applications are applied at predetermined pest densities. The second avenue for threshold research is examining the impact of simulated damage to bolls in the flowering phase of cotton production. In this work small volumes of pectinase (1uL) are being injected into bolls to simulate the effect of mirid feeding. An inherent problem with using simulated damage is its lack of comparableness to real insect damage. To overcome this, the results of this study will be overlaid on the results of the direct field observation study.

Resistance Management

If resistance to Bt is selected for the sustainability of cotton production in northern Australia would be seriously jepidised. This emphasises the requirement for refuges. Studies are being undertaken examining the areas required for refuge crops for Helicoverpa. A number of options are being examined including the use of unsprayed conventional cotton, peanuts and sorghum. Peanuts and seed sorghum are seen as potential rotation crops for cotton. Another area that is being examined is the genetic make up of our Helicoverpa populations. This work is being undertaken with CID at University of Queensland. In 2001 the pattern of Helicoverpa egg lays suggested that there were only three immigration events. The dry nature of our surrounds would suggest that there are very limited residual populations of Helicoverpa in the environment and that any surviving populations at the end of the season would constitute a significant proportion of the residual Helicoverpa in the environment going into the wet. Research is being undertaken to see what proportion of the moths coming into cotton in the following season are derived from the previous seasons insects. Understanding these seasonal population dynamics will provide a solid foundation on which to develop our resistance management strategies in the future.

Problems with current research

The small area in which our research is being undertaken puts a series of caveats on our research. It remains to be seen whether as the areas produced increase, the insects problems we have experienced will decrease. It would be reasonable to hypothesis that moderate increases in area would not increase the "pulling power" of the cotton area by the same degree. To a certain extent this may have been observed this year. Our area has increased from 18 Ha to 42 Ha with much of the area having avoided the need for sucking insects sprays (at least up to the time of writing this paper). By the same time last season two applications had been made to most areas.

Conclusions

Although significant advances have been made in terms of cotton insect management in Northern Territory since the original northern Australian cotton industry collapsed there are still a number of significant entomological problems to be overcome. Many of these problems centre around reducing insecticide input to preserve beneficial insects and how to manage sucking insects without insecticides.

Acknowledgments

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