PROSPECTS FOR THE GENETIC ENGINEERING OF HELIOTHIS RESISTANT COTTON VARIETIES.

Danny J. Llewellyn, Yvonne L. Cousins, Bruce R. Lyon, Elizabeth S. Dennis and W. James Peacock. C.S.I.R.O. Division of Plant Industry, Canberra A.C.T.

INTRODUCTION

The last year has seen a growing public concern over the use of chemical pesticides for the control of insect pests in cotton at a time when the Cotton Industry itself is still facing the real risk that these chemical pesticides will become ineffective due to the development of resistance by the insects. Improvements in the natural tolerance of cotton varieties to insect attack, by whatever means, should satisfy both parties by, one the one hand, reducing the need for pesticide application and its consequent deleterious impacts on the environment, and, on the other, by providing another weapon in the arsenal for the control of insects by an Integrated Pest Management strategy.

One strategy that has been suggested, and currently under assessment by the breeders at Narrabri, is to increase cotton's Host Plant Resistance to *Heliothis* by breeding for the production of allelochemicals that the insects will find unpalatable. While this approach may be successful, the yield and quality penalties of producing these chemicals remains uncertain. We have adopted an alternative approach that will use genetic engineering to introduce into cotton genes for the production of insecticidal proteins that will be toxic to *Heliothis* larvae, but hopefully with little yield or quality penalty since the expression of these genes can be very tightly regulated to the cotton tissues at most risk to insect attack.

NEW GENES INTO COTTON

Since the last Australian Cotton Conference we have made some significant advances in our ability to genetically engineer new genes into cotton. The first relates to our ability introduce foreign genes into the genetic material of the cotton plant - the process of genetic transformation. Central to this process is the ability to regenerate whole cotton plants from small pieces of tissue via embryo production. Yvonne Cousins has perfected this process and can confidently regenerate plants at a relatively high frequency from Siokra 1-3, but we are now applying her improved techniques to other cultivars and hope to have a similar success with Siokra 1-4 and perhaps some of the newer varieties to be released this comming season. The transformation process has been slow in comming for Siokra but only recently we obtained our first embryos from transgenic Siokra tissues and hope to shortly have some transgenic plants expressing the 2,4-D resistance gene discussed in Lyon et al.,in these proceedings. Having achieved transformation we are now in the process of optimising the procedure so that we can routinely produce transgenic Siokra plants with new genes. Concurrently with our Siokra program, Ms Cousins and Dr. Bruce Lyon have been duplicating other researchers' work in transforming an American variety, Coker, that has proven to be simpler and quicker to regenerate than Siokra. While, as discussed below, it is possible to cross new genes into Siokra from Coker, the two differ considerably in agronomic characteristics and an extensive back-cross program would be needed to produce a new Australian variety from a transgenic Coker plant, but it provides us with another option if direct transformation of Siokra proves too long-winded. We can now confidently say that the technology for genetic engineering of Australian cottons has arrived and we are now limited only by our imagination as to what new genes can be harnessed to improve the characteristics of Australian varieties. As indicated in the introduction we have targeted improving the insect tolerance of cotton, although we also have a program to increase the tolerance of cotton to 2,4-D (see Lyon et al, this proceedings).

INSECT RESISTANT COTTON VARIETIES ON THE HORIZON

Our second success of the last two years was the signing this May of a research agreement with the American biotechnology company, Monsanto, to introduce one of their BT-toxin genes into Australian cotton varieties, both directly by transformation and indirectly by crossing with a transformed Coker plant expressing this insecticidal gene. BT-toxins are proteins produced by the bacterium *Bacillus thuringiensis* that when eaten by certain insects cause the disruption of the gut lining and rapid larval death. The toxins are highly specific and are not toxic to humans, animals or, in fact, many of the non-pest insects that may be beneficial in a field of cotton. While not holding a monopoly on the technology that allows the gene for this toxin to be expressed in plants and protect them from insect larvae, Monsanto has invested considerable research effort into BT-toxins and currently has the best gene construct available. On a recent vist to the U.S. Dr Lyon saw in glasshouse trials the Monsanto gene in action, providing almost total protection for transgenic Coker cotton plants against the larvae of *Heliothis zea*, a common pest in American cotton fields. While this is impressive, insects can develop resistance to BT-toxins and this new resource will have to be managed with similar zeal to the remaining chemical pesticides.

SOME HOME-GROWN INSECT RESISTANCE GENES

Our strategy is not to rely on a single gene to protect the cotton crop but to develop a number of genes that can be introduced together to minimize the risks of resistance development. BT-toxins with different sites of action in the insect gut are kown and we are screening through a collection of new isolates produced by Drs. Richard Milner and George Lutton (C.S.I.R.O. Entomology) in an effort to find isolates that might be complimentary to the Monsanto gene. In so doing, we have brought ourselves up to date with the BT-toxin gene technology and are isolating and manipulating our own toxin genes independantly of the resitrictions on the Monsanto gene. We also have initiated programs of research to find new classes of insecticidal genes and have a number of promising proteins under investigation.

These recent advances in the introduction of genes into cotton and the isolation and manipulation of insecticidal genes will make possible improvments to Australian cotton varieties not possible by traditional breeding methods and hopefully foreshadows a promising future for genetically engineered cotton varieties in Australia.