THE PUSH-PULL STRATEGY

— Behavioural Control of Heliothis

Bruce Pyke[1], Martin Rice[2], Bruce Sabine[3], Myron Zalucki[2]

1: The Cotton Marketing Board. 2: Department of Entomology, University of Queensland.
3: Entomology Department, Queensland D.P.I.

INTRODUCTION

Currently the management of *Heliothis* in cotton is almost totally reliant on insecticides. Associated with this reliance are increasing costs and the ongoing threat of resistance to our most valued chemicals. Therefore, there is an urgent need to develop viable alternative methods of pest control which can be easily integrated with our current practices.

The University of Queensland is currently supervising a new approach to insect control which is aimed at increasing the options available for the management of key pests such as *Heliothis* and sheep blowfly. This approach has been termed the **Push-Pull Strategy (PPS)** as it refers to the behavioural or sensory manipulation of pests away from the host to be protected (pushed) towards an attractant source (pulled) which removes the pest from the crop or livestock system. The PPS is achieved through the application of chemicals (allomones) which make the pest's food unattractive or unpalatable and **simultaneously** attracting "frustrated" insects to killing lures laced with attractive chemicals (kairomones). The PPS has already shown such promise for the control of the sheep blowfly that commercial development of the strategy is underway.

This article presents some of the results obtained from PPS experiments conducted on cotton in the Lockyer Valley. These experiments were designed to observe the effectiveness of the PPS on *Heliothis* egg laying activity. The results presented below refer to the 1986-87 season; results for the previous season (1985-86) were presented in the 1986 Australian Cotton Conference.

THE PUSH

An extract from the seeds of the Neem tree *(Azadirachta indica)* was used in all experiments as the "push" chemical. The active ingredient in this extract is a chemical called Azadirachtin which has both insect repellancy and growth disruption properties. With some of the insects tested so far the level of repellancy is very strong.

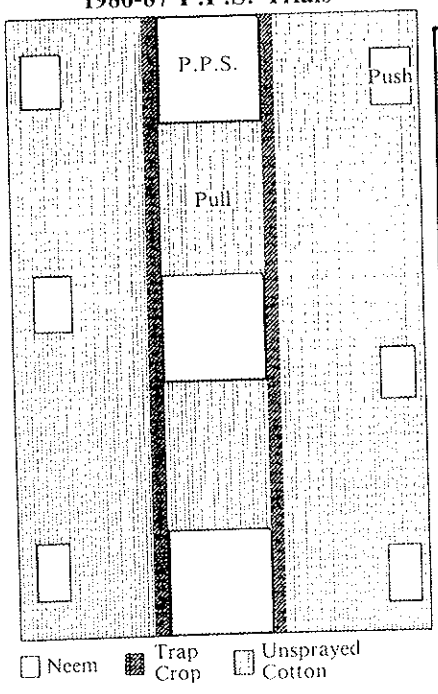
THE PULL

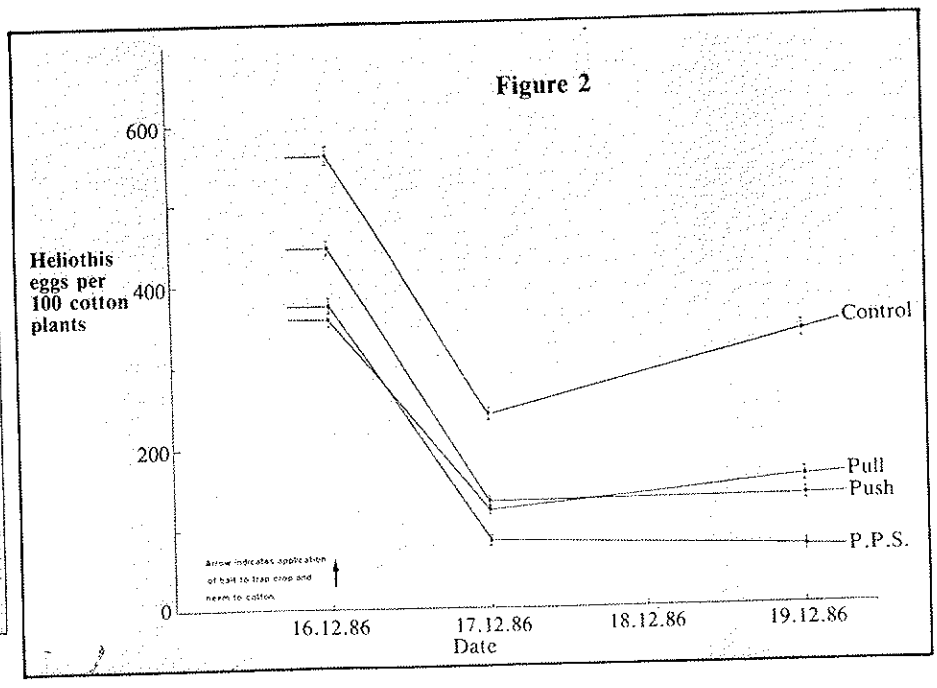
As no pure "pull" chemicals for *Heliothis* are currently available, it was necessary to use "trap" crops of either pigeoen pea (Forest Hill site) or maize (Gatton site). As shown in Figure 1, plots were set up with untreated controls, neem extract spray alone (i.e. push only), trap crop alone (i.e. pull only), and neem spray plus trap crop (i.e. PPS). The trap crop was sprayed with a lethal insecticide/sugar bait to enhance the effectiveness of the pull component by removing moths from the trial site.

FOREST HILL TRIALS

Trial 1 (Figure 2) occurred at the end of an egg peak in mid-December. It can be seen that the initial (pre-treatment) egg numbers in the push, pull and PPS plots were lower than in the control plots indicating that the pigeon pea trap crop was exerting some influence even prior to the application of the bait. (On December 17 (first day post spray) egg numbers had declined in all plots which was due to both the naturally declining egg laying and the treatments applied. The initial large

Figure 1 Basic Plot Layout for 1986-87 P.P.S. Trials





drop in the control plot egg numbers could have been due in part to the wide ranging effect (up to 40m) of the bait applied to the trap crop. Nevertheless, this trial showed that, compared to the control plots, push and pull plots had 50% fewer eggs while the PPS plots had 75% fewer eggs.

Trial 2 (Figure 3) involved a superior bait and neem formulation and also coincided with the upward side of an egg peak and the trap crop at near peak attractiveness. Compared to the control plots, pull resulted in approximately a 40% egg reduction, push in approximately a 78% reduction and PPS in a 92% reduction. These effects continued for at least three days at which time the field, in which the trial was located, was sprayed with an insecticide. This trial demonstrates that PPS has considerable potential for the reduction of egg numbers to below economic threshold levels.

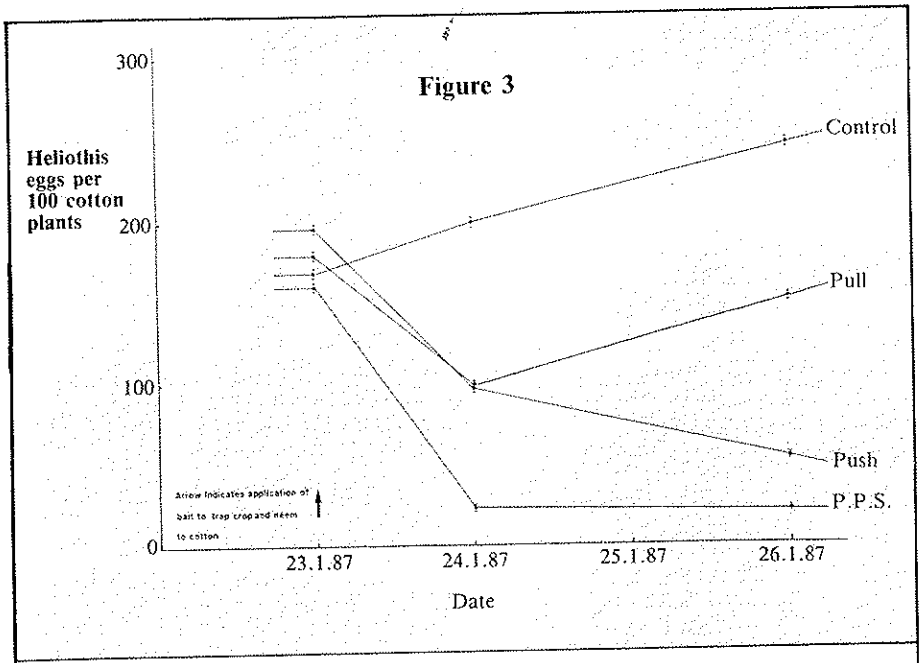
Trial 3 (Figure 4) was conducted at the start of an egg peak, but previous bait spray to the trap crop of the neem formulation was used. Note also that the initial egg numbers in the pull and PPS plots were still showing some effects from the previous bait spray to the trap crop even though the trap crop was now much less attractive than in Trial 2. Despite these mitigating factors, the push and pull treatments reduced egg numbers by aproximately 40% and the PPS by between 65% and 70%.

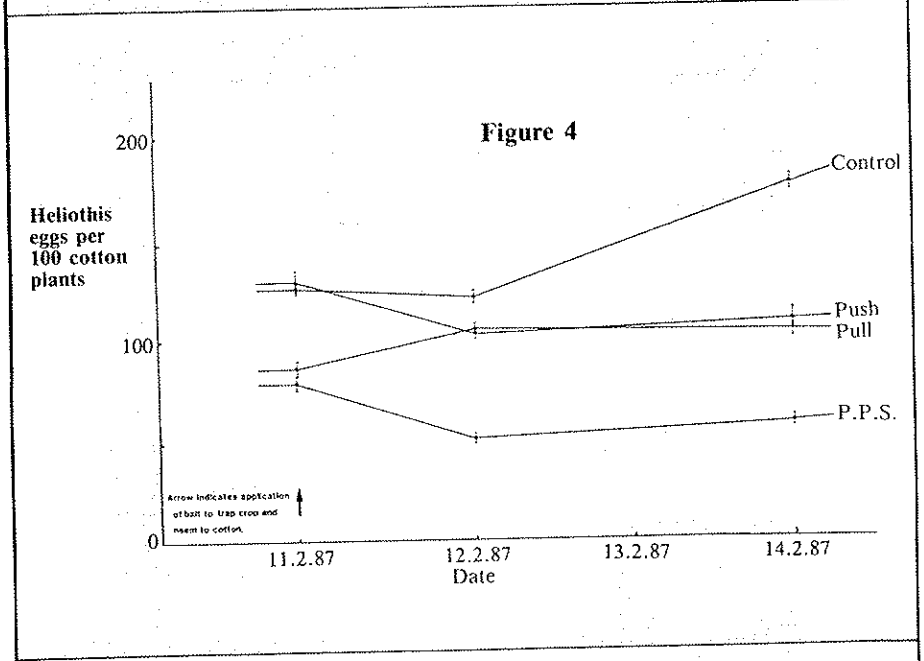
GATTON TRIAL

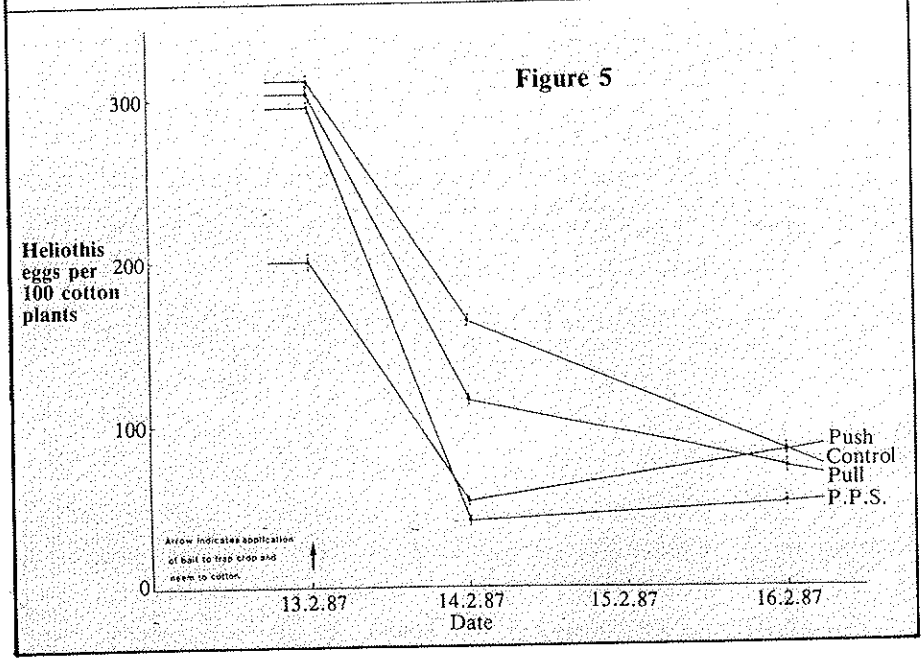
Only one trial was conducted at the Gatton site (Figure 5) and even this was applied under sub-optimal conditions. For instance, it was the end of an egg peak, the trap crop was no longer very attractive and the rates of the neem and bait sprays were lower than those used in Trials 1 and 2. The pull plots also showed some residual effects from a previous neem spray. Whilst these results are not as marked as in the Forest Hill trials, it can be seen that the same basic trends were evident. Namely, push, pull and PPS treatments all reduced egg numbers with PPS being the most effective.

FUTURE DEVELOPMENTS

Commercial Demonstration: The experiments discussed here provide sufficient evidence of the viability of the PPS to extend the programme into a commercial-sized plot. This project will be a top priority for the 1987-88 season.







Trap Crops: The concept of trap crops has met with a certain amount of criticism. This is understandable, but it should be recognised that trap crops are being used in these studies as a temporary measure while attractive chemicals and trapping systems are being developed. Nevertheless, the success of the trap crops used in these trials suggests that their possible use in commercial cropping as a component of the PPS should not be dismissed out of hand until more is known about the minimum area of trap crop required to provide an effective pull.

Neem Extract: Apart from *Heliothis,* neem extract has been observed to repell cotton aphids. Studies are being conducted to determine if it has any effect on two-spotted mite. The proposed 1987-88 studies will include observations on other cotton pests such as mirids and tipworm and beneficial species.

If the commercial application of the PPS is successful in 1987-88, it will serve to pave the way for further expansion of commercial scale trials in other cotton-growing areas. However, in the short-term (5 years) there will be difficulties in obtaining large quantities of neem seed because very few neem trees are currently growing in Australia. The neem tree grows in many parts of Asia, Africa and the sub-continent where tropical to sub-tropical climatic conditions prevail, therefore, Australia should provide many suitable regions for its cultivation. The prospect of growing what may become a major contributor to pest management in Australia is certainly very appealing.