8/88 – 6/90 K90 ✓

FINAL REPORT FOR TRAVEL GRANT FOR CRC PROJECT UQ9L

Project title: Control of the pink-spotted bollworm (*Pectinophora scutigera*) by mating disruption with synthetic female pheromone.

Officer travelling: P. W. Walker

Project supervisor: M. P. Zalucki and P. H. Twine

Reasons for travel: To discuss current research on the control of *Pectinophora gossypiella* by mating disruption with synthetic female pheromone in the U.S.A., England and Egypt, and to participate in field trials.

Detailed itinerary:

Day 1. Arrived Los Angeles, met at airport by Professor G. Gordh, University of California, Riverside.

2. Visited Department of Entomology, University of California, Riverside, discussed current research on *Pectinophora gossypiella* with Professor Gordh, B. Beasley, M. Moratorio and T. Miller.

3. Continued discussions on *P. gossypiella* and related research with entomologists at Riverside; T. Baker, N. Toscano, G. Platner, T. Paine.

4. Departed Riverside to visit cotton crops in the Imperial and Coachella Valleys, southern California, where *P. gossypiella* pheromone trials were being conducted, with M. Moratorio.

5. At the Imperial Valley, met E. Natwick (Farm Advisor, El Centro), R. Staten and F. Wilson (U.S.D.A., Phoenix) for discussions on control of *P. gossypiella* using pheromones and host plant resistance. Returned to Riverside.

6. Departed Riverside, arrived Phoenix, Arizona. Met at airport by Dr H. Flint, Western Cotton Research Laboratory, U.S.D.A.

7. Discussed current research on the control of *P. gossypiella* with synthetic pheromones with U.S.D.A. entomologists' H. Flint, E. Miller and R. Staten.

8. Further discussions on all aspects of *P. gossypiella* control at U.S.D.A. laboratories with T. Henneberry, L. Bariola and J. Bartlett. Visited the U.S.D.A. *P. gossypiella* rearing facility in Phoenix and given a conducted tour by F. Stewart.

9. Field trip to Maricopa, Arizona, with E. Miller and H. Flint to examine cotton fields at the University of Arizona research farm where *P. gossypiella* mating disruption trials were being conducted. Inspected new hand-applied pheromone dispensers being evaluated in field trials.

10. Presented seminar to U.S.D.A. entomologists on current *P. scutigera* mating disruption trials in Australia. Further discussions on the use of pheromones in pest control with H. Flint, C. Doane (Sandoz, California) and E. Groskorth (Mitsubishi Corporation).

11. Visited the Overseas Development Natural Resources Institute (O.D.N.R.I.), Chatham, England, to meet entomologists involved in the control of insects by mating disruption in Africa, Asia and South America. Discussed present and future control of *P. gossypiella* with synthetic pheromones with D. Campion, D. Chamberlain and P. Beevor. Due to the absence of other entomologists my visit to O.D.N.R.I. was limited to one day instead of the planned two day visit.

12. Departed England, arrived Cairo and met O.D.N.R.I. entomologists B. Critchley and L. Mc Veigh who were in charge of the *P. gossypiella* mating disruption programme in Egypt.

13. Visited the Ministry of Agriculture in Cairo with B. Critchley and L. Mc Veigh to meet Egyptian entomologists involved in *P. gossypiella* control. Field trip to Zagazig with O.D.N.R.I. staff, J. Mumford (Imperial College London) and A. Youssef (Plant Protection Research Institute, Cairo) to watch the spraying of I.C.I. microcapsule pheromone formulation on cotton fields for the control of *P. gossypiella*. Returned to Cairo. Met Dr Yassein Osman (Under Secretary of State for Plant Protection) at Ministry of Agriculture, Cairo.

14. Second field trip to Zagazig cotton fields with O.D.N.R.I. staff to examine pest control methods and to watch a field trial to evaluate the efficacy of a crude virus extract to control larvae of

Spodoptera. Returned to Cairo. Met M. Hosny (formerly Ain Shams University, Cairo) to discuss control of *P. gossypiella* with pheromones in Egypt.

15. Field trip to Mansoura to meet Dr Ali Khidr, Head of Bollworm Research, Department of Plant Protection, and Dr El Adl, Mansoura University, for further discussions on the control of *P. gossypiella* with pheromone in Egypt. Returned to Cairo.

16. Further discussions with O.D.N.R.I. staff, K. Jones and D. Russell on cotton entomology and modelling *P. gossypiella* populations. Field trip to Fayoum cotton fields at night to inspect O.D.N.R.I. field trials investigating the nocturnal behaviour of*Spodoptera* in response to pheromone lures.

17. Field trip to Mansoura to watch the application of Sandoz hollow fibre pheromone formulation used for the control of *P. gossypiella*. Returned to Cairo.

18. Final discussions on O.D.N.R.I. *P. gossypiella* pheromone research with B. Critchley and L. Mc Veigh. Departure from Cairo.

Summary of discussions held

This trip was an invaluable insight into the current status of research on the control of *P. gossypiella* by mating disruption with synthetic pheromone and the problems associated in adopting the use of pheromones on a commercial basis.

In the U.S.A. pheromones are seen to be a viable alternative to insecticides for the control of *P. gossypiella*. However, at present their use is mainly limited to experimental research with relatively few farmers adopting them as a replacement for insecticides.

The largest user of synthetic pheromones in the U.S.A. for *P. gossypiella* control is the Californian state goverment in their programme to prevent the establishment of this pest in the Central Valley. At present, *P. gossypiella* is a pest of cotton only in southern California, in the Imperial and Coachella Valleys. However, moths are capable of long distance migration into the Central Valley. In order to prevent the establishment of migrants into the Central Valley the state goverment conducts large-scale releases of sterile *P. gossypiella*, in conjunction with the broad-scale application of synthetic pheromone, whenever wild moths are detected in the area. The pheromone is applied with a

synthetic pyrethroid to act as an attracticide to kill male moths rather than purely as a mechanism to prevent mating.

The poor commercial adoption of pheromones by farmers in southern California and Arizona, where *P. gossypiella* is a very serious pest of cotton, is surprising considering their proven success in past trials. For example, in 1982 farmers in the Imperial Valley voted to use pheromones (laminate flake formulation) in the entire valley, on about 14,700 ha of cotton, to try to reduce the amount of pesticide they were using. A board was established in which farmers who did not use pheromones to control *P. gossypiella* could be fined. The programme was considered a success with fewer applications of conventional insecticides being made, higher yields and only 5% of the crop damaged, compared to 30% in conventionally treated neighbouring fields. The mandatory programme was discontinued in 1984 with over 80% of the farmers expected to continue using pheromones. Unfortunately this did not happen and many farmers reverted to using regular applications of insecticides.

The failure of phermones as a commercial product was interpretated as being due to:

1) Problems associated with the application of pheromone formulations traditionally marketed in the U.S.A.; Mitsubishi ropes, laminate flakes or hollow fibres. The rope formulation must be applied by hand which, despite the availability of cheap labour and the need for only one application per season, was seen as too labour intensive. The laminate flake and hollow fibre formulations require specialised equipment for aerial application and both need to be re-applied 3-4 times per cotton season.

2) Most cotton farmers preferred to use insecticides as they potentially control other insect pests simultaneously whereas pheromone products specifically control *P. gossypiella.*

Many advocates of pheromones see this problem in commercial adoption as short lived due to 3 major factors threatening the future of cotton growing in southern California and Arizona:

1) Ever increasing problems with insecticide resistance in *P. gossypiella,* including resistance to synthetic pyrethroids.

2) Increasing secondary pest problems (mainly Sweet Potato Whitefly and to a lesser extent *Heliothis* spp.) directly associated with the application of insecticides to control *P. gossypiella*.

3) Increasing pressure from environmental bodies to reduce insecticide applications in cotton crops, particularly those made aerially.

In addition, with the development of new pheromone formulations and dispensers it is hoped that their use will increase in the future. One new formulation presently being trialled by the U.S.D.A. in Arizona is a sprayable solution, similar to that produced by I.C.I. and used in Egypt, which can be applied with conventional spraying equipment. An insecticide, methyl parathion, is encapsulated with the synthetic pheromone during the first application. Repeated applications are needed due to the short field life of the formulation (10-13 days) but preliminary trials showed that use of the pheromone reduced the need to spray *P. gossypiella* with insecticides by 30%. Other dispensers, based on the hand-applied ropes, are also being tested which have the potential to be applied mechanically. Such dispensers would have greater advantages over sprayable formulations due to their much longer field life.

In discussion with some researchers in California (B. Beasley, E. Natwick) and Arizona (T. Henneberry, L. Bariola) doubts were expressed over the ability of pheromones to effectively control *P. gossypiella* by mating disruption when moth populations are very high. Such doubts were also evident in Egypt (see below). Opinions were also expressed over the need to continue further research on pheromones when the major cause of the *P. gossypiella* problem is due to inadequate cultural control methods adopted by the farmers. It is believed that *P. gossypiella* would not be a major pest of cotton in southern California or Arizona if farmers adopted a short growing season. At present most farmers attempt to grow a second crop of bolls after the first crop is harvested. Such practices lead to the build-up of *P. gossypiella* populations at the end of the season and ensure the carry-over of large populations into the next growing season.

The situation in Egypt was markedly different from that in the U.S.A. due to complete goverment control over the use of pesticides on cotton crops. This control enabled the Egyptian Ministry of Agriculture to conduct large-scale field trials with *P. gossypiella* synthetic pheromones over many years, in collaboration with the O.D.N.R.I. in England. The success of

preliminary small plot trials lead to large-scale pheromone trials between 1981 and 1985. All formulations of pheromone used in these trials controlled *P. gossypiella* as well as insecticides and often resulted in increased yields. The success of these trials encouraged the Egyptian goverment to increase the area treated in 1986 to 20,000 ha. Unfortunately, infestations of *P. gossypiella* larvae in bolls were significantly greater in 1986 than in previous years. This was true in both pheromone and conventionally insecticide treated areas. Although yields in the insecticide treated areas were lower than average in 1986 than in 1985, yield reductions in the pheromone treated areas were seen as disappointing and the Egytian Ministry of Agriculture took a very cautious approach to further pheromone use in 1987.

Subsequent field trials again demonstrated the ability of pheromones to control *P. gossypiella*, partly restoring confidence in the Egyptian goverment over their use in pest control. However, during my visit in 1989 pheromones were still being tested on a trial basis. The goverment was in the process of treating 27,500 feddans of cotton (approximately 11,000 ha) with 4 different pheromone formulations.

Again, as in the U.S.A, it is expected that the use of pheromones to control *P. gossypiella* will increase in Egypt due to increasing insecticide resistance in this species and secondary pest problems.

Conclusions

1) Synthetic pheromones are a viable alternative to insecticides for controlling *P. gossypiella* in cotton. However, their large-scale commercial use will probably only occur when problems with conventional control (insecticides) breakdown through resistance and/or secondary pest problems.

2) Under high *P. gossypiella* population pressure it appears that pheromones fail to keep boll infestations under the economic threshold and insecticide applications may be necessary at the end of the cotton season. However, in most years moth populations stay at levels which can be contained by pheromone treatments alone.

3) It is expected that improvements in pheromone formulation and application will further increase their adoption in commercial cotton crops.