FINAL PROGRESS REPORT

PROJECT NO.: ARS

TITLE: Improving the Effectiveness of Codling Moth Area-Wide Management Projects (CAMP) by Improving the Production, Delivery, Performance and Use of Sterile Codling Moths

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ACCOMPLISHMENTS:

Research conducted during 1998 with funds from the WSTFRC continued to broaden our knowledge of CM biology, as well as CM mass-rearing and delivery of high quality sterile insects to the field. As was proposed in 1997, an implementation plan to incorporate diapause into the mass-rearing operations at the SIR facility in Osoyoos, BC was prepared and submitted to the Commission at the Apple Research Review meeting in January, 1998. The document outlines the steps required and the estimated costs of incorporating diapause mass-rearing into fall and winter operations of the SIR Canadian facility taking into account the available storage space and providing several options for alternative storage and their associated costs.

During 1998, we also conducted season long releases of partially sterile codling moth males (and fully sterile females), both alone and in combination with different "levels" of mating disruption for codling moth control. Finally, we conducted further evaluations of the use of laboratory-reared codling moths in diapause as a tool to help predict biofix in the field. Results of these last objectives are listed below.

Season long releases of partially sterile CM in combination with MD. The objective was to evaluate whether MD, CM-IS or a combination of both, either at full or ½ rate, was more effective at controlling or reducing moderate CM populations. The treatments were:

1. MD at full rate (400 ropes/ac)
2. IS at full rate (1,000 10 krad CM/ac/wk for 21 wk)
3. MD + IS at full rates
4. MD + IS at ½ rates (200 ropes/ac + 500 10 krad CM/acre/week for 21 wk).

Three replicates were run concurrently and treatment effects were evaluated by conducting mid- and end of the season exhaustive fruit sampling and by banding a sub-sample of tree trunks in the fall to ascertain the level of overwintering CM and whether F1 sterile larvae were being generated in the field. Results were compared to damage recorded in outside check blocks managed conventionally. In addition, the effect of season long releases of partially sterile CM and "fully" sterile CM were compared in the Kernan orchard in Oroville, WA. Releases were made twice per week for 21 weeks. Six >1 ha plots were used, with 3 receiving partially sterile (10 krad) CM and 3 "fully" sterile (25 krad) CM. Evaluation of results included fruit sampling as indicated above and banding of trees to determine overwintering population levels and infusion of F1 sterility into the wild population.

Results obtained in both experiments have yet to be statistically analyzed, however it is clear that no significant differences in % damage were found among the treatments used in both experiments. The mean % damage over the entire season for plots receiving MD at full rate was 0.04%, 0.05% for plots receiving IS at full rate, 0.05% for combination plots receiving MD + IS at full rate, and 0.05% for plots treated with MD + IS at ½ rate. The internal control showed damage of 0.02% over the entire season. Dispersal of the released CM throughout the experimental areas was monitored with pheromone-baited traps. Data from the traps suggest that the released moths dispersed actively throughout the experimental orchards. As such, we cannot say that our results are independent from one another even though every effort was made to sample in the center our (1 ha or >1 ha) plots. In contrast, control plots outside of the treatment areas showed 0.68% damage at harvest even though 4 applications of organo-phosphates for CM were used during the growing season.

During mid-and end of the season fruit sampling no difference was found in the amount of CM damage in plots that had received 10 krad or 25 krad treated CM. The damage levels were extremely low in both treatments -- 0.04% at mid-season and 0.03% at harvest (or 3 and 2 out of 7,500 apples sampled, respectively). Our internal check plots showed 0.05% damage at mid-season and 0.04% at harvest. As in the previous experiment, control plots outside of the treatment area showed 0.68% damage at harvest (or 34 out of 5000 apples sampled). No clear conclusions can be drawn from our data as to whether the use of a single tactic (MD or IS) is more beneficial than the combination of tactics for control of CM or whether 10 krad treated CM were better than 25 krad treated moths at controlling the wild population. However, it is clear from our experiments that moderate CM pressure can be effectively controlled by the use of environmentally acceptable tactics such as MD and CM-IS.

In late 1997, CM larvae induced into diapause in the laboratory and collected into corrugated bands were placed inside mesh cages and distributed to several researchers in OR and WA. The bags with larvae were placed in orchards at the various locations where they then spent the winter. In 1998, eclosion of the laboratory material was compared to pheromone trap captures in these areas. In a second experiment, wild CM in diapause collected at 3 different locations in BC during late 1997, were split into 3 groups and a portion of each sample was allowed to spend the winter at each of the collecting locations. In 1998 adult eclosion from all samples, as well as from lab material, was compared to trap captures in the areas where they spent the winter.

Results for the first experiment showed that as expected, wild CM trap captures occurred earlier at more southerly locations. The first trap captures were reported on 22 April in Medford, OR, and on 21 May in Creston, BC (the most northerly location used). Location did not have nearly the influence on when the lab. strain began to emerge at each of the different locations. Emergence of the lab-reared CM occurred between 27 April and 6 May at all sites, with no north/south trend. Emergence of the lab material was most synchronous with wild trap captures near the mass-rearing facility in Osoyoos, BC, and became more and more asynchronous further away from the home site. At sites north of Osoyoos lab-reared material emerged before wild codling moth trap captures occurred, whereas at sites south of Osoyoos lab-reared material emerged increasingly later than wild field populations.

The emergence pattern for diapausing CM collected and held in different locations in southern BC was as follows: In general, regardless of where the material was held, Osoyoos material emerged first, followed by material collected in Kelowna and then Creston. Likewise, regardless of where the material originated, it emerged earlier when it was held in Osoyoos, later when held in Kelowna, and latest when held in Creston. Wild CM trap captures also occurred first in Osoyoos, followed by Kelowna, and then Creston. In this experiment and at all locations lab-reared diapausing CM began emerging before the first wild CM was captured in a trap. The number of days between wild captures and lab-reared material emerging was 2, 3, and 17 days in Osoyoos, Kelowna, and Creston, respectively. Unlike lab-reared material, diapausing larvae which were collected and held at a given site always emerged after the first trap capture occurred at that site.

It appears that SIR colony CM can only be useful in the prediction of biofix in areas that are relatively close to the mass-rearing facility in southern BC. However, the idea of collecting overwintering wild CM in bands at locations throughout the Pacific Northwest and using them in the manner in which we conducted our experiment would undoubtedly aid growers to predict biofix in their particular regions.

Two publications are currently in preparation, one that reports the results of our season long releases of partially sterile moths and the other that deals with the results of our biofix experiment. Copies will be provided to the Commission once the articles are published.

PUBLICATIONS:

S. Bloem, K. A. Bloem and L.S. Fielding. 1997. Mass-rearing and storing codling moth larvae in diapause: a novel approach to increase production for sterile insect release. Journal of the Entomological Society of British Columbia. 94: 75-81.

S. Bloem, K.A. Bloem and A.L. Knight. 1998. Assessing the quality of mass-reared codling moths (Lepidoptera: Tortricidae) using field release-recapture tests. Journal of Economic Entomology. 91: 1122-1130.

S. Bloem, K.A. Bloem and C.O. Calkins. 1998. Incorporation of Diapause into Codling Moth Mass Rearing: Production Advantages and Insect Quality Issues. IN: Area-Wide Control of Insect Pests Integrating the Sterile Insect and Related Nuclear and Other Techniques. Proc. FAO/IAEA Symp. Penang, Malaysia. In Press.

K.A. Bloem and S. Bloem. 1998. Sterile Insect Technique for Codling Moth Eradication in British Columbia, Canada. IN: Area-Wide Control of Insect Pests Integrating the Sterile Insect and Related Nuclear and Other Techniques. Proc. FAO/IAEA Symp. Penang, Malaysia. In Press.

S. Bloem, K.A. Bloem, J.E. Carpenter and C.O. Calkins. 1998. Inherited Sterility in Codling Moth (Lepidoptera: Tortricidae): Effect of Substerilizing Doses of Radiation on Insect Fecundity, Fertility, and Control. Annals of the Entomological Society of America. In Press.

S. Bloem, K.A. Bloem, J.E. Carpenter and C.O. Calkins. 1998. Inherited Sterility in Codling Moth (Lepidoptera: Tortricidae): Effect of Substerilizing Doses of Radiation on Field Competitiveness. Environmental Entomology. Submitted.