Suppression of Codling Moth *Cydia pomonella* L. (Lepidoptera: Tortricidea) Populations in South African Apple and Pear Orchards Using Sterile Insect Release

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Abstract

Codling moth, *Cydia pomonella* L. (Lepidoptera: Tortricidea), is the key pest of apples and pears in South Africa. To date the control of codling moth in apple and pear orchards has depended on the application of insecticides and in some cases pheromone mediated mating disruption. Due to the development of resistance to insecticides and restrictions placed on the use of certain insecticides, control of codling moth has become problematic. Sterile insect release (SIR) of codling moth has been investigated as a potential addition to the current control strategy. The cost-benefit of codling moth SIR under local conditions, mass culture methods and initial field trials have been completed. It is envisioned that codling moth SIR will be used in conjunction with insecticide sprays and/or pheromone disruption. A large-scale pilot project is planned for the South Western Cape.

INTRODUCTION

Apple and pear production forms a significant part of the South African deciduous fruit industry, and consists of 22 901 ha of apples and 13 495 of pears. Codling moth, *Cydia pomonella* L. (Lepidoptera: Tortricidea) is a widely distributed primary pest of apples and pears in South Africa. The fruit production areas in the South Western Cape are confined to valleys isolated from each other by mountains. The geographic structure of the South Western Cape combined with the relatively low mobility of codling moth, would allow for the control of codling moth on an area-by-area basis.

Currently the control of codling moth in apple and pear orchards depends on the application of insecticides and in some cases pheromone disruption. Despite well-managed and costly control programs, codling moth remains a significant economic pest. Insecticide resistance, the restrictions placed on the use of insecticides and favourable weather conditions have resulted in increased levels of codling moth induced fruit damage. The direct cost of codling moth control (insecticides and pheromone disruption) is significant. Despite the relatively high cost of control, codling moth damage is a significant loss and populations remain high enough in orchards to cause extensive damage if control measures are not applied or applied incorrectly. In addition, the current control methods employed are limited and highly selective. If true integration of codling moth control is to be achieved, additional non-chemical control methods will have to be developed and applied.

STERILE INSECT RELEASE (SIR)

Sterile insect release (SIR) has been used in an attempt to eradicate codling moth in areas of western Canada (Bloem et al., 2000) and the United States (Calkins et al., 2000). The method involves the release of large numbers of sterilized codling moths into orchards over a wide area. Released sterile moths mate with fertile wild moths resulting in sterile progeny, thus controlling the population. A method of treating moths with a relatively low radiation dose, which results in full sterility of female moths and partial sterility of male moths, has also been used (Bloem et al., 1999). The partially sterile male mate with fertile wild moths and the progeny are sterile. The lower radiation dose results in more competitive and effective moths released into the field. The costs associated with SIR are relatively high when compared to conventional chemical control, and the method requires intensive management.

The Canadian SIR program involved the release of sterile codling moths for twenty weeks at a rate of 900 moths per acre per week. In 1997 the release rate was increased to 1500 moths per acre per week. Results of surveys carried out in 1997 showed that codling moth damage was absent from 91% of treated orchards and insecticide applications to control codling moth were reduced to an average of one per annum (Bloem et al., 2000). Calkins et al. (2000) released sterile codling moths in 180 hectares of pheromone treated orchards in Washington State. The initial phases of the program sterile moths were released during the second half of the season. In 1997 sterile moths were released at a rate of 1120 per hectare for the duration of the season. Moths were released from specially adapted vehicles at 30 intervals in the treated orchards. Results indicate that codling moth populations were effectively suppressed in the treated orchards, fruit damage was significantly reduced as were the number of insecticide applications.

PROPOSED SIR PILOT PROJECT

Based on the above results, a local pilot codling moth SIR program was proposed in 2002. The purpose of the pilot program is to demonstrate the method and to establish the economic feasibility of the method in commercial apple and pear orchards in South Africa. Due to financial constraints, the initial pilot will be limited to a total area of 500 ha. The selected orchards are planted in close proximity to each other and the area is semi-isolated from other orchards. No alternate host trees occur outside of the orchards. The orchards have been under integrated pest management of a number of years. Codling moth populations in the selected orchards are currently controlled with the use of pheromone disruption and the application of insecticides. The orchards are situated on two separate farms, and both farms have extensive pest and disease monitoring programs, thus historic data is available for all orchards.

It is proposed that the selected orchards will be treated with 2000 sterile moths per hectare per week from September to March (26 weeks) during the first year of the program. The laboratory reared moths will be marked with dye which is incorporated into the larval diet, thus allowing to easy identification in the field. All moths will be treated at 150 Gy of gamma radiation from a cobalt ^{60} source at the rate of 5 Gy per minute. Moths will be released from modified vehicles twice weekly at 30 meter transects. All orchards will be treated with pheromone disruption at full rate and would receive three applications of an insect growth regulator (flufenoxuron) during the first moth flight (October to November). Orchards will be monitored at weekly intervals using pheromone baited (10 mg) adhesive traps (1 trap per 2 hectares). Regular fruit damage assessment will be carried to determine the degree of control in orchards and to ensure that if supplementary insecticide treatments are applied correctly.

COST BENEFIT ANALYSIS

The development of insecticide resistance in codling moth populations has resulted in an increasing number of insecticide applications being applied. Pheromone disruption has been widely adopted to supplement insecticide applications. Current codling moth control programs consist of pheromone disruption combined with intensive insecticide applications. For example, the two farms involved in the current SIR program have applied pheromone disruption to all orchards, a total of 650 hectares. In addition, insect growth regulator insecticides have been applied followed by multiple organophosphate sprays. During the 2002/03 season, fruit damage, as determined by systematic fruit damage assessments was on average less that 0.5%.

The costs associated with the production of large numbers of insects for use in SIR are relatively high. In addition, the method requires intensive management and maintenance of sophisticated infrastructure. This cumulative cost has to be justified in terms of benefits accrued by the use of the method. Initial estimates of production costs indicate that the treatment of an orchard for 26 weeks with 2000 moths per hectare per week are comparable to the costs of codling moth pheromone disruption. Thus the use of

SIR in the initial season, that is in combination with pheromone disruption, will be relatively high. However, if successful, there will be a net saving in following years as codling moth populations are suppressed and the number of pesticide applications are reduced.

RESEARCH AND DEVELOPMENT

Current research and development needs include the development of suitable culture methods and the assessment of the overall fitness of laboratory cultured moths in the field. A locally adapted maize meal based diet has been developed and tested. A laboratory colony of codling moth imported from Canada and a colony of locally collected codling moths have been established. Radiated and non-irradiated have been assessed under field condition using mark and recapture methods (Bloem et al. 1998). The distribution of laboratory reared moths, in conventional and pheromone treated orchards has been assessed. Results indicate that locally produced moths are competitive and within the parameters set by the Canadian SIR program

CONCLUSIONS

The suppression of codling moth populations in South African apple and pear orchards using sterile insect release appears to be economically feasible under current conditions. The proposed pilot program in 500 hectares of commercial orchards will allow for a more comprehensive assessment of the method.

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Literature Cited

Bloem, K.A. and Bloem, S. 2000. Sterile insect technique for codling moth eradication in British Columbia. Pp 207-214. In: Ken-Hong Tan (ed.), Area-Wide Control of Fruit Flies and Other Insect Pests. Proc. FAO/IAEA Symp. Penang, Malaysia, 1998. Penerbit University Sains Malaysia, Pulau Pinang.

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

Bloem, S.K., Bloem, A., Carpenter, J.E. and Calkins, C.O. 1999. Inherited sterility in codling moth (Lepidoptera: Tortricidae): effects of substerilizing doses of radiation on insect fecundity, fertility and control. Ann. Entomol. Soc. Am. 92: 1-8.

Calkins, C.O., Knight, A.L., Richardson, G. and Bloem K.A. 2000. Area-wide population suppression of codling moth pp. 215-219. In: Ken-Hong Tan (ed.), Area-Wide Control of Fruit Flies and Other Insect Pests. Proc. FAO/IAEA Symp. Penang, Malaysia, 1998. Penerbit University Sains Malaysia, Pulau Pinang.