Regenerating orchard IPM: Managing key apple pests with ecologically-based IPM approaches

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Many apple growers can reduce their use of pesticides, while still harvesting quality fruit, through the set of common-sense practices known as Integrated Pest Management (IPM). IPM is an effective and environmentally friendly approach that relies on a combination of cultural, mechanical, biological, behavioral, and chemical controls to manage pests. IPM programs use current, comprehensive information on the life-cycles of pests and their interactions with the crop plants, with natural enemies, and with the environment to prevent pests from exceeding economic damage thresholds. IPM means controlling pests using the most economical means with the least possible hazard to people, non-target organisms, and the environment.

In the apple agro-ecosystem, current recommendations to control key insect pests such as plum curculio (PC), and apple maggot fly (AMF) rely on insecticide applications targeting adults. Due to various environmental and regulatory concerns, there is a need to develop alternative and more sustainable management strategies for the most damaging pests. This presentation focuses on ecologically based IPM approaches that were developed for PC and AMF control.

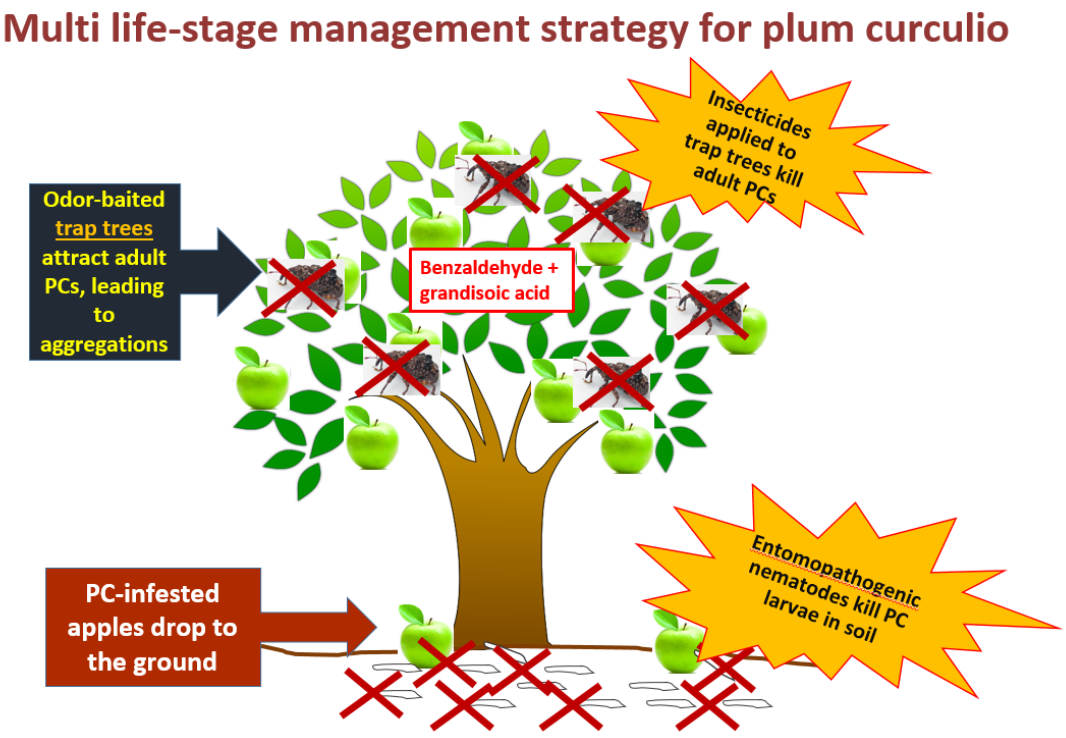
"Attract-and-kill" system for PC control. To successfully manage PC in a reduced-spray environment it is imperative that alternative management strategies consider the ecology and behavior of the target pest. Previously, extensive field research that aimed at screening compounds for attractiveness to PC led to the identification of a synergistic two-component lure. This dual lure, comprised of the plant volatile benzaldehyde (BEN) in association with grandisoic acid (GA), the synthetic PC pheromone, was used to develop an effective monitoring system for PC involving odor-baited trap trees. This novel approach calls for baiting perimeter-row trap trees with GA plus BEN as a practical approach to determining need and timing of insecticide applications against overwintered PCs.

More recently, odor-baited trap trees were evaluated for direct PC control. This new approach calls for baiting the branches of several perimeter-row trees, which results in aggregations of adult PCs on those trap trees, and then confining insecticide applications to those trees only. Results from a 2018 field study involving odor-baited trap trees to manage adult PCs after the full-block petal fall insecticide spray indicate that (1) About 10 times more injury by PC was found within trap trees (17.2% on average) in trap tree plots compared with unbaited 'control' trees (1.5% on average) in perimeter-row plots. Injury in the plot interior was similar in trap tree plots and in plots subject to perimeter-row sprays. This result confirms findings from previous studies indicating that the synergistic lure composed on GA+BEN results in significant aggregations of PC adults and fruit injury in trap trees. These specific insecticide-treated trap tree canopies function as an "attract-and-kill" trap crop for adult PCs. Application of insecticides only to trap trees resulted in the same level of PC control achieved with perimeter-row sprays, with a concomitant reduction in insecticide use.

Biological control of PC. The trap-tree approach makes use of attractive lures to pull adult PCs to selected perimeter-row trees. Because odor-baited trap trees congregate PCs, there is also aggregation of fruit injury by PC on those trees. Recent research has evaluated the use of entomopathogenic (= insect-killing) nematodes (EPNs) to kill PC larvae in the soil. EPNs are very small, soft bodied, non-segmented roundworms that are parasites of insects and occur naturally in soil environments.

A second 2018 field investigation aimed at demonstrating the level to which the EPN *Steinernema riobrave* applied to the soil underneath the canopies of perimeter-row apple trees is effective at killing PC larvae. Results indicate that the application of *S. riobrave* led to a 5.5-fold decrease in the number of adult PCs emerging relative to the untreated check. Therefore, EPNs applied to the soil of those trees effectively kill PC larvae.

The main goal of the studies in this project is to develop an integrated multi-stage management program for PC that minimizes the use of insecticides. The combined findings indicate that both PC adults and larvae can be killed successfully using an "attract-and-kill" system combined with biological control using entomopathogenic nematodes.



"Attract-and-kill" system for AMF control. Research conducted for several decades by the late R. J. Prokopy at the University of Massachusetts led to the development of effective IPM alternatives to whole-orchard sprays against AMF. One of those approaches involves deployment of odor-baited sticky traps on perimeter-row apple trees to intercept adults immigrating into orchards from nearby wild hosts before oviposition occurs. This approach has proven successful in providing effective orchard-wide control across several successive growing seasons. A summary of the IPM approach developed by Dr. Prokopy for assigning distances among odor-baited, disc-capped spheres that employs an index incorporating orchard factors such as size of trees, quality of pruning, cultivar composition and nature of bordering habitat will be discussed. This research showed that behavioral control of AMF could be as effective and affordable as whole-block insecticide sprays, especially for large blocks of apple trees that are on dwarfing rootstock and well pruned.

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