Biointensive IPM and Disease Management in Apples

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Apple growers were among the first to adopt integrated pest management (IPM), and New England apple growers have a thirty-year history of leading in utilization of IPM. Yet in recent years, the enthusiasm for apple IPM, or at least for advancing apple IPM, has decreased. Faced with global competition, labor issues, dealing with pest resistance, and juggling decreasing pesticide options, apple growers have not pushed forward with new IPM methods. In fact, in some areas, notably disease management, the use of older, conventional pesticides has actually increased in recent years. For example, for many years the annual use of captan in a typical New England apple orchard averaged three to five applications, or about 12 lbs. of Captan 80W per acre. Over the last five years, captan use has shot up. This past season, some growers approached the annual label limit, 40 lbs. per acre, applying the fungicide eight to twelve times. Admittedly, last year (2009) was an extreme, but captan use has gone up steadily since resistance to the demethylation inhibitor fungicides (SI or DMI fungicides such as Rally, Rubigan and Procure) became widespread.

Risk and expense drive decreased innovation in apple IPM. Generally, as IPM systems develop they reach a point where the expense of using more advanced IPM tactics become greater than the money saved on reduced sprays. At the same time, growers perceive the risks of these new tactics as much greater. So, while consumers and society in general still want fewer pesticides, growers who have to pay the cost of IPM and deal with risks of pest damage and crop failure, are increasingly reluctant to try more advanced IPM methods.

Consumers increasingly want food that they feel is produced with few if any pesticides. However, apple pest management, even with IPM, is focused around pesticide applications. What can be done? To address this, it's useful to listen to one of the originators of apple IPM, Ron Prokopy. He wrote that "the essence of IPM may be summarized as a decision-based process involving **coordinated use of multiple tactics** for optimizing the control of all classes of pests (insects, pathogens, weeds, vertebrates) in an ecologically and economically sound manner". In other words, to get more advanced IPM systems, several tactics have to used, not just pesticides, and they have to be coordinated to work together.

It's difficult to coordinate different management tactics even when dealing with just one class of pests, such as pathogens. The diagram below shows the multiple tactics that may be used in plant disease management, including cultivar resistance, cultural controls, biological controls and chemicals. It also shows how forecast models based on weather or sampling may be used to determine the need for treatment. To date, apple IPM has focused on using forecast models to guide chemical control, for the most part ignoring other kinds of management tactics. Prokopy felt that for IPM to advance, it needed to balance use of all management tactics. In disease management in apples, this would mean employing more resistance to disease in apple cultivars, incorporating cultural practices into the program on a regular basis, and using biological controls or chemicals that have less environmental impact when such materials can be effective. This kind of system, which is less focused on conventional chemicals, has been referred to as biointensive IPM.

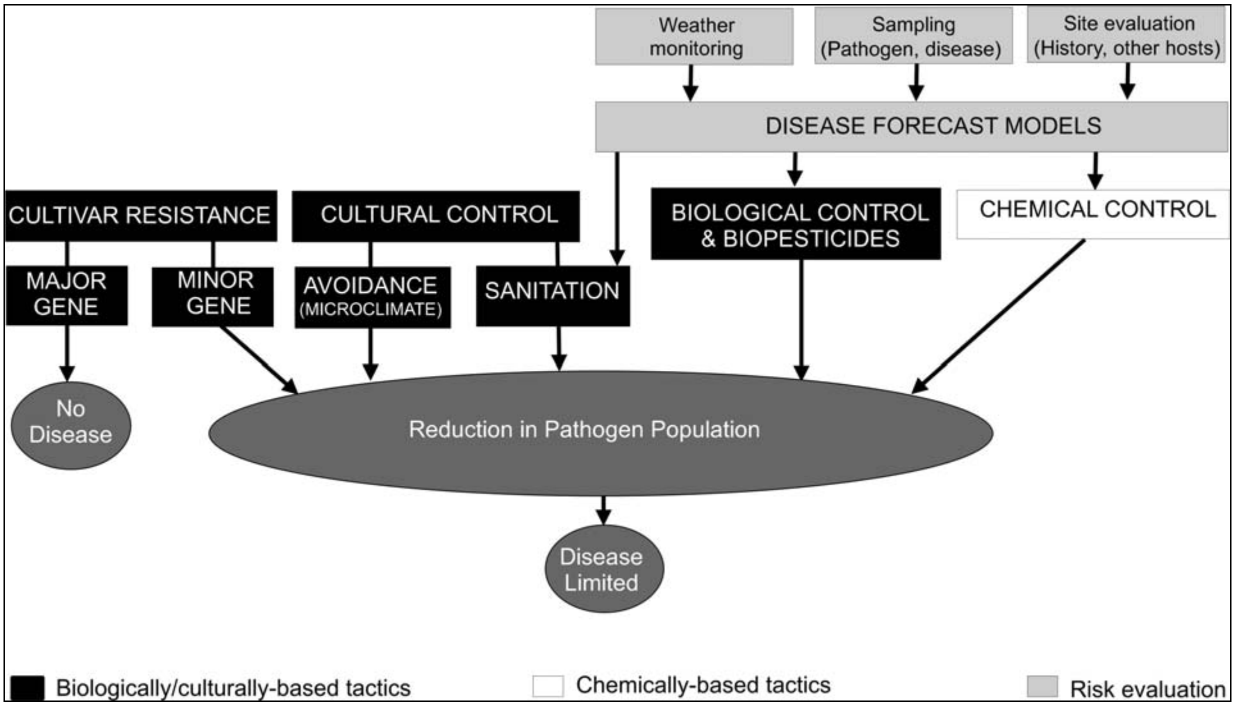

Figure 1. Schematic of disease management tactics that may be used in biointensive apple IPM (Cooley, 2009).

There are a surprising number of biointensive IPM options available to New England apple growers. They are not widely used, but it may be time to look at them and see which might be useful in getting the disease management elements of apple IPM back on track.

Cultivar resistance has been an idea that has yet to have an impact in the US. Almost always, disease resistance in apples means resistance to apple scab, so-called scab-resistant cultivars (SRCs). Prokopy felt that an orchard built around SRCs had great promise in reducing fungicides, and therefore planted his own experimental orchard with them. Since then, extensive testing has shown that scab-resistance alone will not eliminate the need for fungicides, and that the existing named SRCs can be both difficult to grow and have limited market appeal in the US. In Europe, where growers are increasingly planting disease resistant apples, such as 'Topaz', there has been greater market acceptance. However, other serious problems threaten extensive SRC use. Most SRCs depend on a single source of resistance, the V_f gene, which has started to fail in Europe, and a race of scab that can infect V_f apples has recently been identified in the US. There is a principle in plant disease management that suggests that extensive planting of one type of resistance will inevitably lead to that resistance failing, and this appears to be happening with apple scab.

In the long run, rather than depending on single-gene resistance as a magic bullet against disease, it may be better to use several minor genes. This is the sort of resistance that is seen in some cultivars such as 'Honeycrisp' and 'Golden Delicious', cultivars that can be infected by scab but are not nearly as susceptible as 'McIntosh'. In Europe, growers are planting mixed blocks of cultivars with varying degrees of resistance. Such blocks require fewer fungicide sprays, and have less chance of producing new, virulent scab races. In a coordinated advanced

IPM system, new blocks would incorporate mixed cultivars, using either partial or complete resistance in economically viable cultivars.

Cultural controls present a largely untapped source of disease management options. The canopy of a high-density apple block is radically different from that of the old M-7 blocks. Yet we spray both blocks in much the same way. Air circulation, and leaf drying, are known to discourage development of diseases, particularly the summer blemish diseases. Fungicide coverage is better in well-pruned, open trees. So, a slender spindle block may require less fungicide than a semi-dwarf block. In addition, new types of spraying technology may be adaptable to smaller trees. For example, over-the-row shielded sprayers could deliver fungicides precisely to trees, capture drift, and ultimately use less pesticide than a traditional airblast sprayer. Ultimately, it may be possible to build fixed, over-the-tree pipelines that would be able to rapidly deliver fungicides and other pesticides without the time-consuming process of driving a sprayer through the orchard.

Cultural controls can also reduce or eliminate inoculum that is the source of disease. Growers are familiar with, and generally use, the practice of removing old fire blight cankers. Yet reducing scab inoculum is not a widely used management tactic, even though there is no doubt that it is a good idea to use some form of scab inoculum reduction.

Similarly, virtually all of the inoculum for the summer blemish diseases (sooty blotch and flyspeck) comes from reservoir hosts, plants in the woods and hedgerows next to orchard blocks. To reduce infections from this inoculum, it is useful to keep as much separation as possible between apple trees and the reservoir hosts. Bu this can be an expensive undertaking, involving cutting or otherwise destroying plants along orchard borders, or leaving large amounts of open buffer land between apples and the woods.

Other cultural management tactics, including pruning dense trees and regularly mowing, changes the ‘microclimate’ in the orchard, making it drier and making it more difficult for sooty blotch and flyspeck to develop. Ultimately, sooty blotch and flyspeck can be cleaned from apples using post-harvest bleach solutions and rubbing. Whether or not this is a ‘cultural control’, it is a tactic that could be used to reduce fungicide use. However the machinery to do this has not been developed.

Biological controls, strictly speaking, involve the use of one organism to control a pathogenic organism. In plant diseases, this usually means using one microbe to manage another microbe. Today, the EPA and other organizations have developed a more general term, biopesticides. Biopesticides are used much like conventional pesticides, but, according to the definition, depend on modes of action that present fewer risks to the environment and human health. Biopesticides, also called biorationals, may be relatively benign chemicals like potassium bicarbonate (e.g. Armicarb), bacterial protien (e.g. Messenger) or a bacterial preparation (e.g. Serenade). It would be simple to substitute these relatively benign chemicals for the conventional fungicides like captan that raise public concern. The problem is that they are often not as effective, and that they are not consistent in their efficacy. Still, some new classes of these chemicals, such as the phosphites (e.g. Phostrol, Agri-Fos, ProPhyte), have shown promise in managing apple diseases, and need to be further evaluated to see how best to use them. Under the right conditions, biorational pesticides could play a role in a more biointensive apple IPM system.

Forecasting models have been used in apples primarily to manage apple scab and fire blight, and there is growing use of one or another model to manage sooty blotch and flyspeck. These models are generally used to determine when a fungicide or antibiotic spray is needed. Growers are very familiar with the Mills Table and its revisions, which relate how long apple leaves are wet to temperature, and determine whether an infection has occurred. Note the past tense. In order to use the Mills Table, growers need fungicides that are effective when applied after infections have started, or they need reliable weather forecasts, or both. Similarly, programs such as Maryblyt and Cougarblight relate the growth stage, most critically bloom, to rain or heavy dew and temperature, as well as the history of blight in a block, to determine whether streptomycin sprays are needed to control fire blight. For sooty blotch and flyspeck management, the accumulated hours of leaf wetness are recorded from petal fall or first cover, and as a threshold is reached, varying from 170 to 250 depending on which model one uses, a fungicide is applied. These models are highly dependent on the chemical control being used. They can provide useful guidelines for sprays, but are not a solution by themselves.

One interesting use of a forecasting model is the potential ascospore dose, or PAD, evaluation developed by Bill MacHardy. This model evaluates the amount of apple scab present in a block in the fall, and estimates the number of infection periods or the tree growth stage at which the first scab fungicide needs to be applied the next year. In blocks with very little or no scab, the first spray may be delayed until pink or after the first three Mills periods. The PAD evaluation may be combined with leaf treatments that reduce scab inoculum. Growers have not widely adopted this approach, perhaps because there is concern that early-season infections present more risk than other infections, and there are no fungicides to provide a safety net in case the delayed sprays fail.

This last example of a biointensive IPM tactic illustrates how risk influences adoption. While the PAD and delay method can eliminate up to three scab sprays, growers fear a catastrophic scab outbreak. From an economic perspective, the insurance of two or three fungicide applications outweighs the cost of those sprays.

Given this, it's important that researchers and growers work together to design a mix of the biointensive options, combine them with biointensive options for insect management, and test them as systems on a small scale. By testing and demonstrating what works, and what doesn't, both growers and researchers can gain confidence and knowledge about more advanced IPM tactics. Ultimately, this may allow the New England apple industry to once again lead in the adoption of cutting edge IPM for apples.

Cooley, D. R. 2009. "Biorational Approaches to Disease Management in Apples." pp. 214-252. In: T. Leskey, M. Aluja and C. Vincent, eds. In <u>Biorational Tree Fruit Pest Management.</u> CABI Publishing. 320 pp.