# INSECT PEST MANAGEMENT - WHERE ARE WE NOW?

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When someone asks where you are, you reply by referencing landmarks, or recognizable signposts, which give perspective to your location. I'll begin this talk by describing some signpost that you all can recognize in insect pest management on potato.

## Insecticide resistance of Colorado potato beetle

There are over 3 million kinds of insects worldwide. Less than 600 are pests, but over half of those have shown some resistance to insecticides. Only 3 species of insects are resistant to all classes of insecticides, and one of those three is the Colorado potato beetle (CPB). In most insect populations, there are a few individuals who possess a rare gene which helps them avoid or detoxify a chemical poison. Insecticide resistance develops when these few individuals survive an insecticide application, and then reproduce by mating with one another.

### Resistance in Eastern & Midwestern US

Most of the eastern US CPB stay close to home. That is, they reproduce in the same potato field where they were born, and are subjected to the same insecticides generation after generation. Because of the high levels of insecticide resistance potato growers in the eastern US have resorted to vacuum cleaners, flame throwers, and plastic-lined trenches to control CPB. That's not IPM; its survival! The resistance phenomenon seems to be moving westward.

### Two generations of CPB in the Columbia Basin

Development of resistance can be delayed if the surviving individuals mate with others who have not been challenged with the same class of insecticide. Seasonal trends in adult activity show two peaks. The first represents those adult beetles which survived the winter underground, emerging in spring to lay eggs which develop into larvae on commercial and volunteer potato. The second peak occurs as the larvae mature and develop into new, summer generation, adult beetles. Here in the Columbia Basin many of these new adults lay eggs before the onset of winter, giving rise to a partial second summer generation.

A significant part of the summer generation of beetles move off potato and lay their eggs on nightshade weeds. This removes them from the agrichemical environment, and provides a refuge from which individuals susceptible to insecticides can be reintroduced to populations of individuals which may have survived an insecticide application. Because our producers practice crop rotation, and their potato fields tend to be large, the refuge provided by nightshade helps slow the development of resistance to insecticides.

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**Accurate timing for insecticide applications**

In eastern Europe, Russia, and the newly-independent states only one summer generation is possible due to the cool temperatures. Until recently crop rotation was widely practiced on collective, state-owned farms, slowing development of resistance to insecticides by CPB. The most common management practice currently is to provide a single application of a pyrethroid insecticide when most of the CPB larvae have reached the third stage of development. This practice effectively wipes out the population, with the survivors forced to wait until the following year to reproduce. And a lot of bad things can happen to a beetle during the harsh winters.

When beetle pressures are not too intense, growers in the Columbia Basin may succeed in getting good beetle control with a single, well-timed application. However, the potential for population growth during the summer generations can continue to cause problems.

**Aphid vectors of potato viruses**

The green peach aphid is the only significant vector of potato leafroll virus. Other aphids may play roles as transmitters of mosaic viruses, but if you plant only high quality seed there won't be enough of these viruses to cause yield problems. In some other areas of the US a border planting may be used to clean the migrating aphids of virus particles. In our areas wind and large circles conspire to spread aphids to any part of the field.

**No acceptable action thresholds**

Since only a small percentage of internal disorders, such as net necrosis, can be tolerated, and aphid flights can be heavy, the majority of decision makers won't tolerate any green peach aphids. Thus there is no basis acceptable to growers and processors on which to make control recommendations. Aphids must be prevented from entering or surviving on commercial potato.

**Leafhoppers and other transmitters of pathogens**

During the last 2 years we've seen an increase in diseases from pathogens transmitted by leafhoppers. While these are acknowledged as potato pests nation-wide, no action thresholds have been developed on the basis of disease spread.

**Tuber Feeders (wireworms, craneflies, tuber moths)**

Tuber moths are rarely introduced from more southern potato growing areas. They apparently can't survive our winters. Craneflies (leatherjackets) cause occasional damage, but seem to be confined to certain locations. Wireworms sporadically increase in importance, but can be managed by not planting potatoes following high residue crops, such as barley.

**Other foliage feeders (loopers, blister beetles, army worms, mites, flea beetles)**

These insects do not survive, or do so only poorly on potato. When they cause problems, it is because a large number of them arrive in your potato field at one time.

They are hungry and will try to eat the potato foliage even though it's poison to them. Only when a large populations attacks very small potato plants should any control measures be indicated.

**Prophylactic, or preventative, control of insects remains our norm**

Compared to control of pathogens, and potential losses to net necrosis, chemical control of aphids remains a good buy, especially when control of other insects, such as defoliators are automatically included.

**Tools Available**

**Crop rotation**

Is practiced by almost all potato producers in the Columbia Basin. The first step in slowing or preventing the introduction of a pest or disease into a field is to force the organism to seek out and move to the field.

**Plant resistance (including transgenics)**

To an entomologist resistance does not necessarily mean immunity. Most plants have some characteristics that make it resistance to insect feeding. The plant may just taste bad. Or it may have compounds or physical structures which decrease its suitability as insect food. I mentioned earlier that few insects can feed on potato leaves because they contain poisonous chemicals such as citrinoids. However even the Colorado potato beetle, responds differently to different potato cultivars. We showed you a couple of years ago that when several cultivars were planted side by side and infested with beetle, there were differences in which cultivars were preferred for feeding and which were preferred for laying eggs.

Molecular genetics techniques allow breeders to selectively, and sometimes quickly, insert specific traits into a breeding line. The recent availability of a potato cultivar which is immune to attack by beetles because it contains a gene which produces the Btt toxin may have a regional effect on our potato pest complex.

**Effective insecticides**

Our insecticides are effective. Some last longer than others, but properly applied all of the available synthetic compounds kill insects. I mentioned above how insects develop resistance to insecticides, and that resistance can be delayed if mating occurs with insects from outside the agricultural ecosystem. In the Basin, a significant portion of the summer Colorado potato beetles leave potato and feed on nightshade. Furthermore, potato vines are killed before green peach aphid fly back to peach orchards for mating. In each of these cases a refuge exists which produces new insects that have not been treated with the insecticides used on commercial potato.

**Selective insecticides**

Soon to be available through registration or reregistration are selective insecticides that kill specific groups of insects. Often this results in leaving populations of beneficial insects, such as predators and parasites, virtually unharmed. An example is pirimicarb which we have shown kills relatively few parasites within aphids but does a much better job on non-parasitized aphids. Another example goes by the trade name Spinosad and is very effective on larvae of Colorado potato beetle, but doesn't do much damage to the predatory bugs and beetles.

**Reliable prediction of aphid flights**

Is available throughout the potato growing areas of the Basin. These predictions are accurate to within half a week for sites where daily maximum and minimum air temperatures are available. We have shown that not all aphids carry virus, and have research results that will be used to predict when the potential for viruses to enter the field becomes great enough to warrant treatment.

**Action thresholds and timing for CPB**

Is available for potatoes grown on short season programs and for cultivars which don't develop net necrosis. Like aphids, beetles develop at rates that are determined by the insects temperature. Because we know that the early, small larvae of Colorado potato beetle don't eat much, we can predict on a daily basis when beetle larvae in a field will develop to the numbers and size to economically warrant treatment.

**What IPM Tools Are Used by Potato Growers in Washington?**

**A survey of Washington potato growers conducted by WSU and the Washington State Potato Commission about 2 years ago showed that**

- The vast majority of growers use crop rotations, field histories, cull management, monitoring for other pest categories.
- The vast majority also use systemic insecticides applied at planting, and additional aphid controls when "Its time" to do so.
- Preventative treatments, or improperly timed treatments are unfortunate because early use of a chemical such as Monitor may result in its having no residual effect left when the pest insects finally arrive.

**What IPM Tools Need to be Developed to Advance IPM on Potato?**

**Reliable, acceptable region-wide monitoring and prediction capacity for vector and pathogen dispersal, including contributions by "typhoid Marys", or cultivars that carry disease but do not show symptoms of it.**

The PAWS system gives us real-time weather information from about 57 weather stations in the lower, or south part, of the Basin.

If you look at the maps of station locations, you'll note some important gaps in the coverage. As I said earlier, information from these stations enables precise prediction of insect population development and movement near the stations. The closure of local National Weather Service bureaus makes it more difficult to interpolate in the gaps.

The fieldmen and others who make their livings by providing information to growers should work with us to develop sampling plans that are acceptably accurate, yet efficient enough that they will be widely used. Then the insect data they collect should go into a pool of timely information that extension agents and specialists can use to make timely and appropriate recommendations on insect control.

We need more research on the contributions of neighboring potato fields and weed patches to the virus loads carried by aphids. Some potato cultivars harbor virus but either don't exhibit net necrosis, or are harvested and marketed before net develops.

**More and cheaper selective insecticides which do not harm, and may even enhance, activities of natural enemies**

We also need more, and cheaper, selective insecticides which do not harm, and may even enhance, activities of natural enemies of aphids and other insect pests. Compounds such as Pirimor and Spinosad are examples which are soon to be available to potato growers.

Finally we need to integrate insect management with management of weeds, nematodes and pathogens, and with management of the crop production system. All of our bulletins and manuals currently discuss how to solve one problem at a time, not how to prevent a variety of pest problems from occurring in the first place.

**Where are we now? That was the question.**

**I see us at a fork in the road, or at least at a place where the road becomes a multilane highway.**

Transgenic cultivars can provide immunity to viruses and defoliators. Selective insecticides will allow short-season growers alternatives to deal with the potato insect complex.

The return of aldicarb, and the recent registration of imidacloprid give the convention, long-season grower effective, long-lived insect protection.

**We have many more options than ever before. However, unless we develop and use the needed tools I discussed earlier we will, as in the past, find our options disappearing.**