COMMERCIAL POTATO VARIETIES SHOW RESISTANCE TO COLORADO POTATO BEETLE

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Thanks to all of you for coming, and to Dr. Thorton and the supporters of this Conference for inviting us here. I'll be reporting on a part of an overall project to find and integrate alternative controls for insects, and to make better, more efficient use of the controls that we have. Some of this can be accomplished through better timing of insecticide applications, and I'm going to show you today that the variety of potatoes you're growing has implications for timing control of the insect pests. And of course we'll want to integrate insect controls with controls for other kinds of pests as well.

Some acknowledgments: obviously I wouldn't have much to talk about if we didn't have a team of hard working students who work during the season about 20 hours a day. These people are funded in part by the Washington State Potato Commission whose funding and support has helped us to do some work which then enabled proposals to be written that garnered additional funding from the National Potato Council. WSPC funding also supports the seed lot trials that Dr. Thorton conducts at the Othello Research Unit, where all of our varietal comparisons, so far, have been conducted.

Dr. Unruh of the ARS Lab in Yakima and I developed a system to mark adult Colorado beetles. We make small holes in the elytra of the Colorado potato beetle and by doing these in different locations and different stripes we can uniquely identify the beetles when we find them again. In the seed lot trials this enables us to mark beetles on various potato varieties and seed sources, and then to recover them later. One of our students, Mr. Xu would go out through those seed lots and collect beetles, look at their backs, and determine (from the marks on them) where they had originally been marked and released, where they came from, and where they went. So this enables us to look at the number of recaptured beetles and calculate a kind of "Index of Immigration". We found that beetles marked elsewhere tended to move into Russet Burbank, and that beetles marked and released on Norkotah left and went elsewhere.

Now when we began this early study we were looking at the potential for development of insecticide resistance by the beetle. We weren't especially looking at varietal resistance but this began to pique our interest.

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Let me say right at the outset though, that these were overwintered beetles, the first ones to come out in the spring. So there are implications of preference for variety that we're seeing here, but since they're done in the seed lot trials where varieties are adjacent to one another, and we have since learned that beetles do not move very far if food is available, what we see here would not be valid on a circle to circle comparison.

When overwintered beetles emerge in the Spring, they will walk considerable distances looking for food. It doesn't matter if the food is particularly good for them, or if it's one of the potato varieties they prefer. They will lay eggs on it, and eat some of it and then go about looking for better, preferred food. Soon those eggs will hatch into early instar larvae, very tiny little grubs a millimeter to a millimeter and a half long.

These small larvae are relatively easy to control. They can be controlled by botanical chemicals; they can be controlled by relatively low rates of commonly used chemicals; and they don't eat much. They grow, of course, if you don't control them, and become large larvae. Large larvae eat a lot. In fact about 75% of all the material that's consumed by a Colorado potato beetle during it's life span is consumed in this stage. There also quite a bit harder to control. They are bigger, they have more enzymes, and they can break down toxic products applied to them.

Eggs that were laid by adults who went through the winter in the ground produce a generation of new adults. But these adults do not repeat what their parents did and go back into the ground to spend the winter, at least not very many of them. These new, summer adults lay eggs which then go through this entire process again. And if the season is reasonably favorable, will result in a second generation of adult beetles which then spends the winter in the ground. The implication of that is that these two generations are almost different kinds of beetle. They have different kinds of preferences, different kinds of behavior and different susceptibilities for us to use to control them.

What information did we get from the mark-recapture trials? When we compared Nooksack, Russet Burbank and Norkotah, a lot of beetles preferred to be on Nooksack but laid fewer eggs there while on Norkotah fewer adult beetles preferred to be there but they laid more eggs. Then going further, those eggs may hatch into larvae. On the Nooksack variety the eggs tend to hatch into larvae without significant losses to mortality, but on the Norkotah a lot of eggs results in fewer larvae.

Of the different kinds of tactics that you might use to manage your insects, the concept of plant resistance isn't well understood by growers, but that's what this talk is really about. We hear about a new variety of plant resistant to herbicides, or to a disease. Resistance of a plant to a pathogen or to a chemical arises through somewhat different mechanisms than does resistance to insects. Insects can move around and they can, in effect, make choices, so we find there are certain recognizable properties of plant resistance to insects that we can explore as management tools.

One of the mechanisms of resistance is tolerance. A vigorously growing plant gets its job done early by producing a lot of foliage and, in the case of potato, tuberizes sooner. This plant can deal with a lot more defoliation by beetles than a plant which takes longer to get going.

There is also an antibiotic effect. Very few organisms are able to eat potato foliage because potato foliage has poisons in it. In antibiosis, the organisms which try to consume that foliage will die. The Colorado potato beetle is one of a few organisms which has adapted to detoxify that poison. All potato varieties have some sort of antibiosis to most insect herbivores.

Finally, there is a type of resistance that I will call nutritional because that's a more recognizable term. We've got a highly technical term for it in the business. What this amounts to is that all food is not the same. So an insect can chew on the leaf of a plant and get a certain mix of nutrients out of it. It might then chew on the leaf of another kind of plant and get a different mix of nutrients that may influence the development of the insect

Remember I said earlier a typical seasonal trend of adult beetles would show a peak of activity during the early spring when we start to get overwintering beetles coming out of the ground. Then as the summer begins to progress activity of those beetles begins to decrease. They have laid their eggs, their offspring are developing and those old beetles begin to die. Then during midsummer the eggs and larvae that were produced back in the spring become new adults and repeat the process again, so we see another peak of adult activity.

Now let us compare what happens on our potato varieties with this "typical" kind of activity, and see what it tells us about beetle development and plant resistance. We collected the date from the field. Each week we counted how many small larvae, large larvae, and adults of Colorado potato beetle were present on different varieties of potato.

The figure for Russet Burbank shows a fairly typical pattern of beetle population development. Each bar shows the total beetle population on a certain date, and each pattern or color within a bar shows how much of the population is eggs (bottom segment), small larvae (segment next to bottom), large larvae (third segment from bottom), and adults (top segment). What you would expect in a typical field is eggs at one date would develop into small larvae and move up the bar during the following bar or two, one to two weeks later. Try working through the figure yourself: there are some small larvae. Some of these small larvae develop over time into large larvae, then the large larvae begin to disappear from the foliage as they begin to pupate, and finally we start to get the summertime adults coming back on the potatoes, and laying eggs. Here we see again the two generation system that occurs on Russet Burbank.

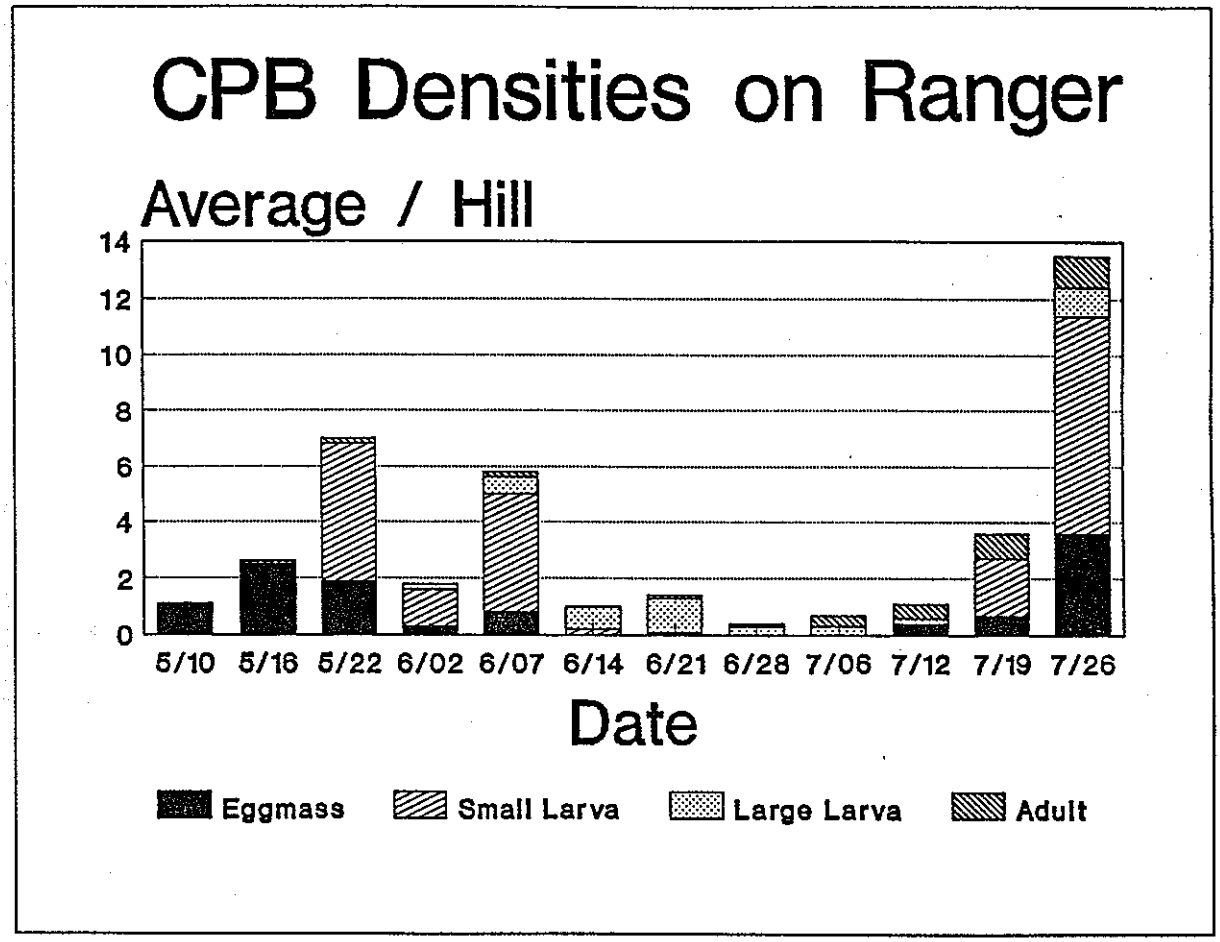
None of these plots were treated with insecticide. You probably haven't seen this sort of thing in your fields. We're going to look at some other varieties in the same way to see if we can find some differences. Both the changes in heights of bars (total beetles) and patterns tell us what is happening in terms of population development.

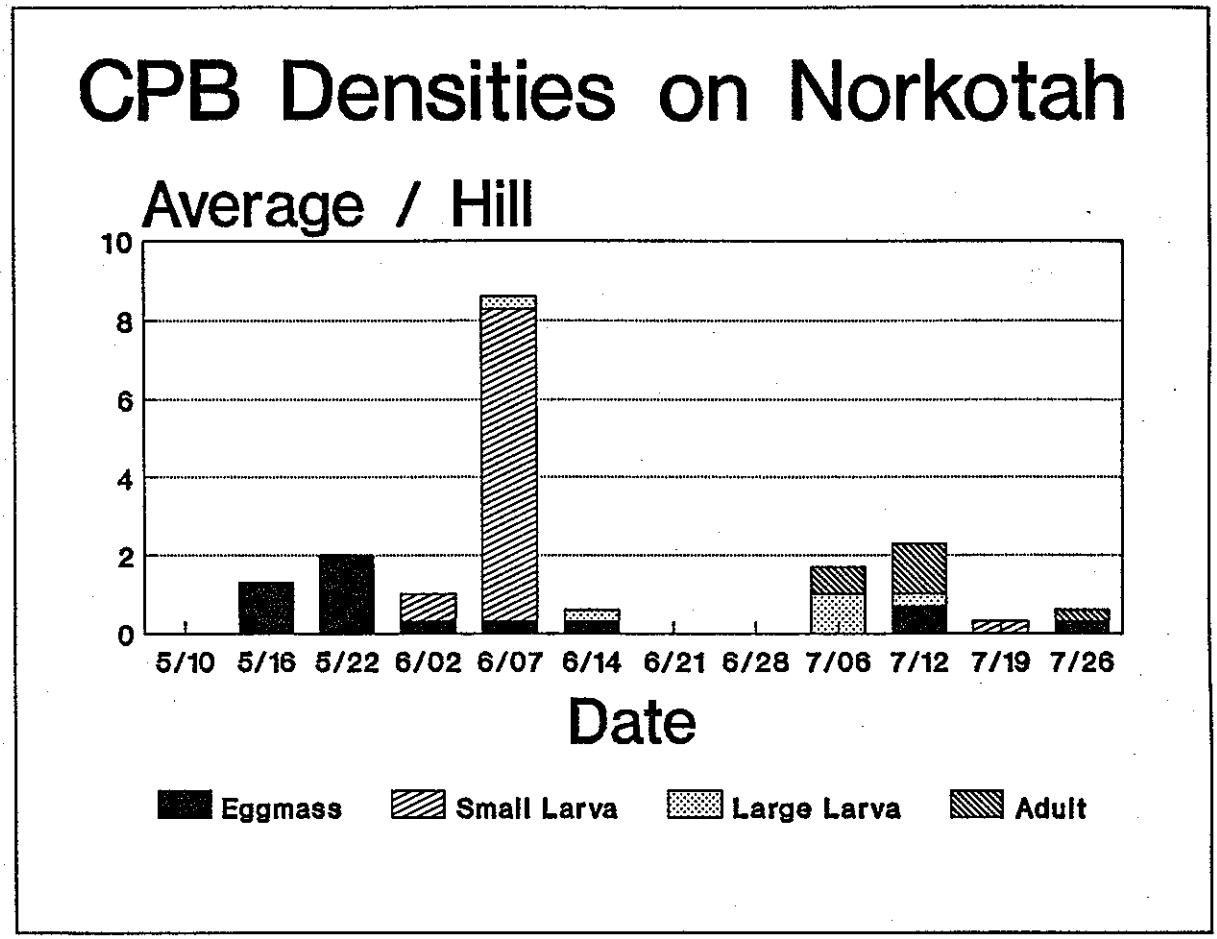
Shepody is one of the early varieties. We see eggs on Shepody, and the eggs developing into quite a number of small larvae. The small larvae then develop into a lot of large larvae, and then into adults. Over the same period of time with the Russet Burbank we saw two generations of beetle develop. What we see on Shepody is no eggs laid by the summer generation. This probably shows a nutritional type of plant resistance. The beetles that are available to lay eggs during the summer generation move to more palatable plants (other varieties) to lay their eggs. If we have an early season, such as we might be having this year, when temperatures are relatively warm, we might expect high beetle populations very early. That kind of knowledge would allow you to target that population with confidence that you're not going to have to go back and retreat a second generation later.

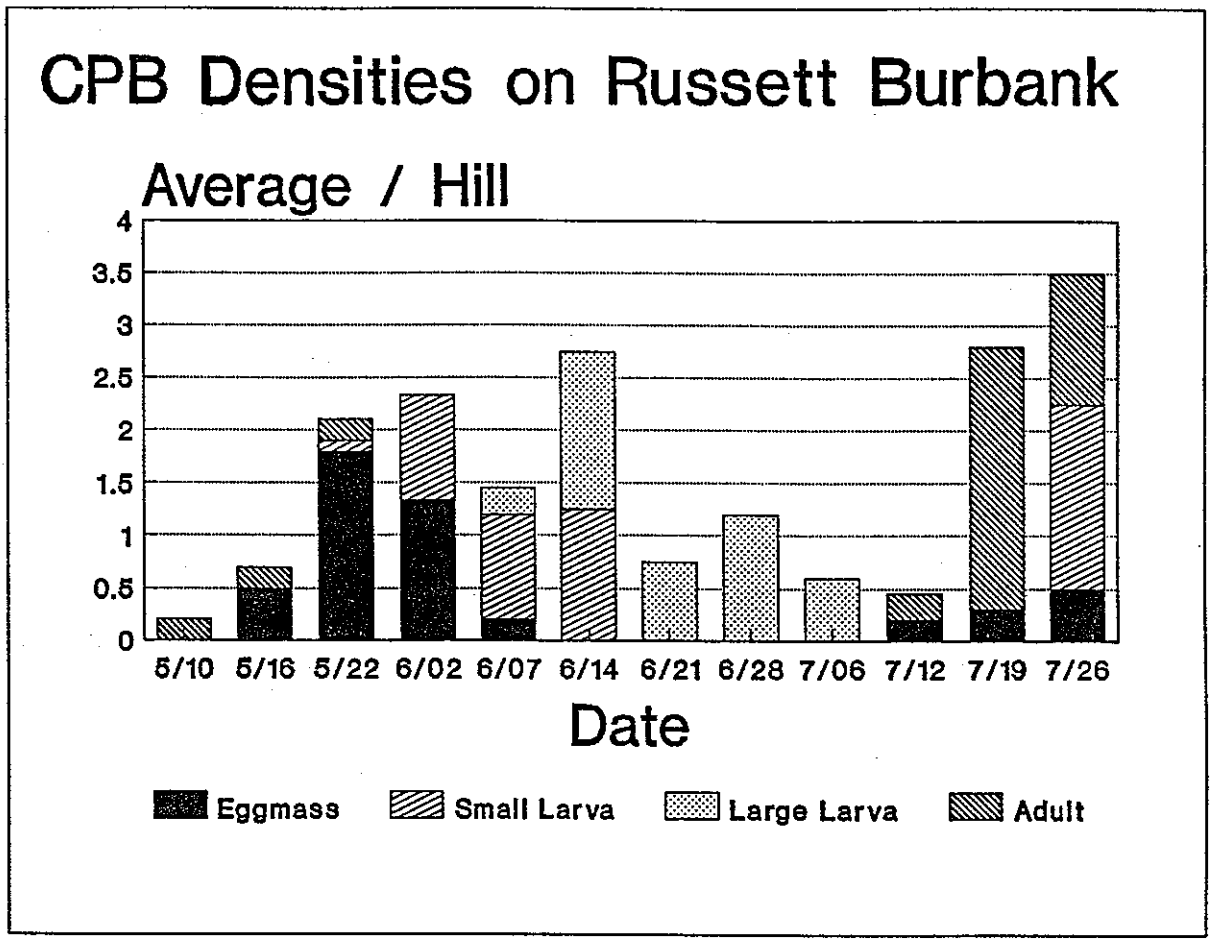
On Norkotah we probably see antibiosis although there also may be a nutritional component. During the first generation eggs develop into small larvae, small larvae develop into large larvae. Then we see new adults and their eggs, but we don't see small larvae hatching from those eggs. Although large larvae persist, these are hangers on from the earlier population. They developed a lot slower but they still reach the large damaging size. The reason the data does not show those eggs hatching into small larvae in the second generation (It turns out that they actually do hatch. Beetle eggs will hatch on newspaper if you put them on it.) is when those little guys start to feed, the nutrition from the foliage is so poor they can't survive. They die and don't develop further. Meanwhile the larvae that were around from that earlier generation can still manage because they are much larger (Remember they're harder to kill with almost anything you do including whatever Norkotah might have in its foliage) and they can still develop. Knowing this would allow us to target early populations again, with confidence that we're not going to have to deal with a late season problem.

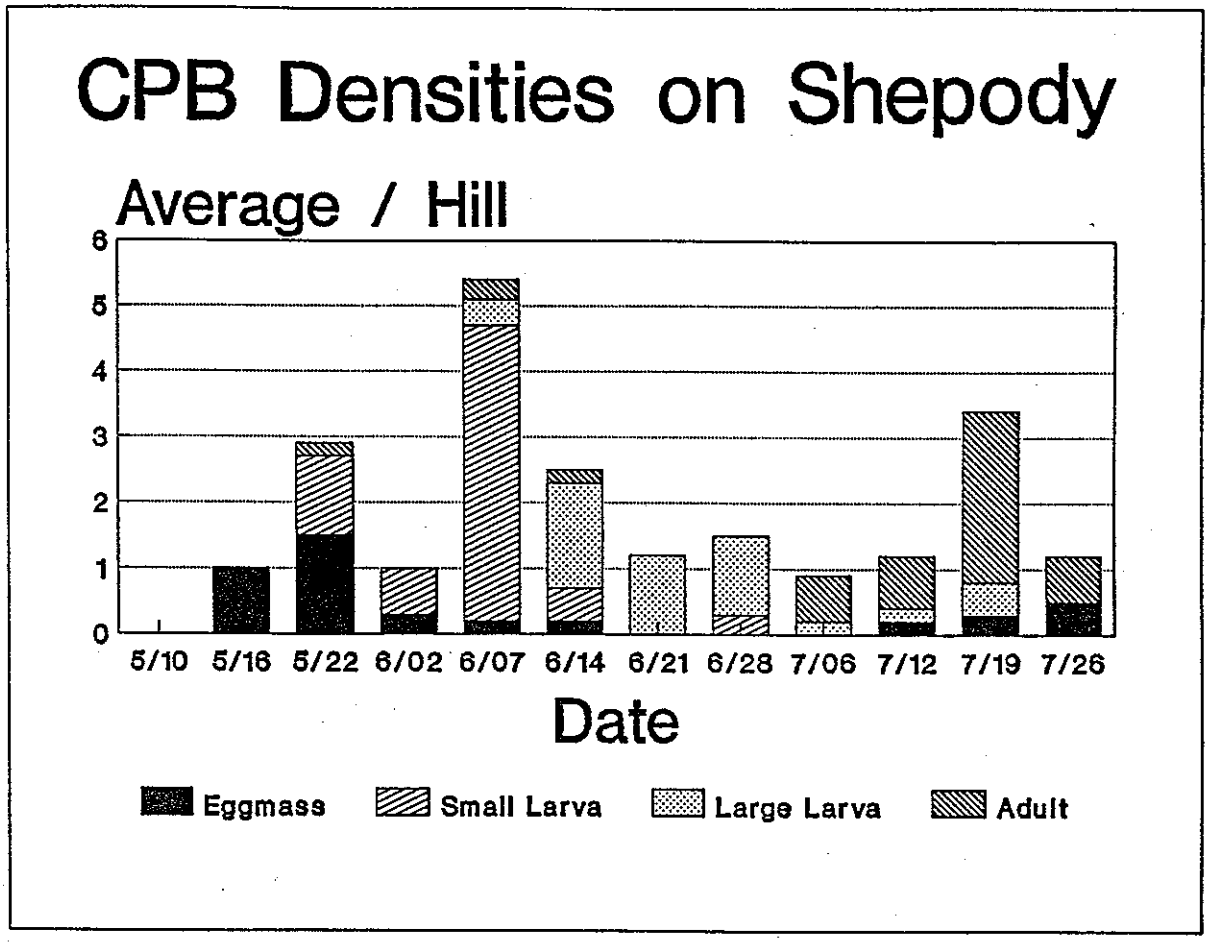
Now let's look at our Ranger, an increasingly popular variety. You see small larvae, some more eggs, some large larvae, large larvae developing. The second generation produces more eggs which develop into more small larvae, then large larvae and adults late. In other words there is a great deal of feeding and development by the Colorado potato beetle in the late summer on Ranger.

So the take home message is: choice of potato variety is going to influence choice in IPM programs. On Ranger, for example, you are going to have to watch out for development of late generations if you go to softer chemical programs to control the earlier beetles. Big populations of beetles can develop on Ranger. Summer generations of beetles don't develop well on Shepody and Norkotah. But Norkotah may influence management of aphids. That's another story. We'll try to keep you updated so you don't get surprised. Thank You very much for your attention.


CPB Densities on Ranger
Average / Hill
14
12
10
8
6
4
2
0
5/10
5/16
5/22
6/02
6/07
6/14
6/21
6/28
7/06
7/12
7/19
7/26
Date
Eggmass
Small Larva
Large Larva
Adult


CPB Densities on Norkotah
Average / Hill
10
8
6
4
2
0
5/10
5/16
5/22
6/02
6/07
6/14
6/21
6/28
7/06
7/12
7/19
7/26
Date
Eggmass
Small Larva
Large Larva
Adult


CPB Densities on Russett Burbank
Average / Hill
4
3.5
3
2.5
2
1.5
1
0.5
0
5/10
5/16
5/22
6/02
6/07
6/14
6/21
6/28
7/06
7/12
7/19
7/26
Date
Eggmass
Small Larva
Large Larva
Adult


CPB Densities on Shepody
Average / Hill
6
5
4
3
2
1
0
5/10
5/16
5/22
6/02
6/07
6/14
6/21
6/28
7/06
7/12
7/19
7/26
Date
Eggmass
Small Larva
Large Larva
Adult