

## Physical Barriers Against Insect Potato Pests: Locking the Door to Insects

Dr. Gilles Boiteau

I work at a potato research centre in Fredericton. Most of my research work deals with traditional potato farming, but integrated pest management aspects of it, and therefore a lot of what we've learned through our research is quite applicable to organic potato production, and I will try to take that angle in my presentation today.

Why do I say that we need to lock the door to insects? It's essentially because the potato field is very, very attractive to many insect pests. It's a big, open house, it's fully accessible, with lots of interesting things for beetles to feed on, for aphids to probe on, and as a result of that, we have developed integrated pest management programs to try to prevent the entry of those insects into the fields. The traditional integrated pest management programs are made up of essentially two main components, one which deals with the current year production practices, monitoring the sampling of the insect pests in those fields to try to determine if they are a pest, if they cross the economic threshold, and therefore if we need to have remedies (curative action) taken. That's a lot to do with the traditional approach to potato production. In organic potato production we have to be more attentive to the multi-year approach. There we look at the field history. We look at the ecology of those insect pests to try to forecast the populations—anticipate when and where different insect pests might be a problem so that we can try to prevent the problem. Prevention is the key in this, and that's why my presentation deals more with this aspect of integrated pest management (IPM). How do we prevent the entry of insects into fields?

Most of the people present here have definitely seen Colorado potato beetles; many of you have had to manage those pests but, in a nutshell, I'll go over the life cycle of it. It starts this time of the year. They are still in the ground, overwintering. They'll emerge in the early spring as the plants crack the ground. They'll lay eggs almost immediately. The larvae will hatch, and we get 4 different instars. In July they already begin to go in the soil to pupate and transform into the adults—the only generation we get in this part of the country. Where they feed they do not reproduce, as a rule. They will go down in the soil to diapause, either in the field itself or surrounding woodlands and wood edges. Those insects can disperse quite significantly either by walking or even by flight, and they seem to be using more and more flight to disperse from the overwintering sites to the fields, within the fields, between fields, and from those fields to the overwintering sites again to start a cycle. So dispersal plays a tremendous role in how they access those attractive fields.

The potato beetle has been studied for many, many decades, but it's relatively recently—since 1985 or so—that we've paid more attention to the dispersal part of their lifecycle. Because of that, we're now in a position to deal a little bit more with preventing access, because we know a little bit more about dispersal. In the limited time I have, I'll give you an idea of the type of research that's taking place to try to gain more information. A 3-year study we did a few years ago looks at how the beetles invade the fields and how they go from borders of fields toward the centre of those fields—how they distribute there. Basically, the study established grids of 20 meters by 20 meters over 10-hectare sections of commercial fields in New Brunswick and monitored every corner of the grid for the amount of different instars week after week. The type of information we obtained out of that is summarized here in this graph. The weeks are on this axis, from week 1 (the beginning of the season) to week 11 (the end of the season). Here is the distance from the border in meters. The first column shows that approximately 40% of the total counts of the adult CPB that week were essentially in the first 0-20 meters of the field. This went

down to about 15-20% in 20-40 meters and also went down somewhat in the 40-60 and 60-80 meters. After 80 meters there were essentially very, very small levels of beetles. There is a strong gradient from the border toward the middle of the field in the distribution of the adult beetles, and that was observed in 2001 and 1999. It is applicable both to the spring colonization and to the summer adults. So there is a border effect.

I would like to call your attention to the difference with many other insect pests on other crops. Normally in the first week most of the adults would be in the 0-20 meter area right at the border of the field, and then a little later you would find more and more of the beetles moving in the field and even more in the third week, and so on. The potato beetle moves right away, right from the beginning. Some of the population disperses far into the field. So if we want to stop the beetles from invading the field, it means we have to act very early in the season. What I have summarized here are the two key things to remember. Border control must be timed early on. We have to act early. The border is a very wide one; it's 40 to 80 meters wide. Therefore, if we are farming on a small surface, a small area of field, in the eyes of the beetle essentially all of the field is a border because it will colonize essentially from week 1.

Other important pests in potatoes are aphids, and there, too, dispersal is the key. We have the Buckthorn aphids flying in from the buckthorn bushes, green peach from nursery plants and from Canada plum, and potato aphids from rosebushes. So those aphids move in (migratory flight), they find the potato crop, and in there they will use local flights between host and non-food plants to disperse, lay the nymphs, disperse their progeny, and, unfortunately, disperse virus problems too.

How do we replace those "open house" signs with "no trespassing" signs? We want to clearly indicate to those insects that they are not welcome in those areas, and we do have some means of doing that. The trap crop is essentially the method that you will find in most trade journals, in the scientific literature, and academic literature. In most crops, including potatoes, it is recommended that the beetles can be removed from the first 4 to 6 rows of potatoes along the edges of the field in some states. The problem with the potatoes in our region is that a trap crop, as I have shown, needs to be much wider than this 4 to 6 rows—40 to 80 meters is needed. The removal/destruction of the beetles is required essentially on a daily basis because, as I have shown, the beetles just move in from the very beginning. So it makes it very, very difficult to apply that method here. On crops where a trap works, it is essentially where it is possible to plant the trap and have it up before the main crop so that there is no such movement possible to the main crop and of course, with the short season we have in eastern Canada and the varieties we have to work with, it's impossible to achieve that.

We can, however, find an alternative solution to that, and that is the plastic-lined trench. The trench is lined with plastic. The beetles walking from the overwintering site towards the new potato crop will fall in it, and you have essentially 100% retention of those who walk into the trench. There is actually an extruded plastic trap which is available from British Columbia. It works as well. It's problem may be that it is more costly and requires a level field, which in our provinces is not easy to find or produce. This trench is relatively easy to install. The equipment—the applicator—exists. Plans are available. It is low-cost equipment that can be built in a welding shop. It's also commercially available. The trench does not need to grow up like the trap crop; it can be installed easily either before or slightly after planting the potato crop. It has been tested on commercial fields with good efficacy; we had reductions of 47% and 49% of the adult counts in the crop adjacent to those trenches. This is a good catch. What is more

significant is that there is a reduction in the egg masses of close to 75%, and that will result in the longer-term protection of the foliage from the larvae and the summer adults.

Obviously, from the results I just showed, there are some beetles that fly above the trenches and move into the field, and we do not have any mechanical, physical barrier against that. The only barrier we have is distance—rotation of the fields away from previous crops or from overwintering sites. Data from the United States shows that if we do not rotate the fields, we can expect 100% of the beetles that are in the overwintering areas surrounding the previous crop to find the crop and colonize it and give you problems. By moving 300 meters or so, we cut by 50% that pressure of the beetle. Where that is not possible, a trench then becomes the alternate solution. Moving 1.5 km almost assures you that there would be no colonization or very, very little colonization of the fields. Of course, that's not always a practical option.

In the past we've looked at the effect of crop rotation. It has been demonstrated elsewhere. In New Brunswick very significant reduction in the abundance of the adults can be obtained, an average of 2.4 versus 0.2, 4.5, and 2.1, and those were rotations well within the 300-meter distance. Even by not going very far, crop rotation is the best method.

The only available barriers to CPB invasion of the fields by air and by ground are floating row covers. The limitation is the surface area that can be covered, therefore it would be limited to varieties that have special meaning or production of seed. It is very important to install those shortly after planting to minimize the risk of trapping adults or larvae under the row cover. Those have been studied to good extent in the province of Quebec by a number of colleagues.

Landscape barriers are things that we tend to forget. The large trees and the forest edges and so on will divert the dispersal of the beetles, especially by flight. Even though we're not sure exactly how they work at this moment, landscape barriers could create interceptions which would mean that closer rotations might be possible between fields that are separated by woodlands. We are working on that now, trying to monitor the movement of the beetles with electronic tags and also using forecasting models. The aphids are also subject to those landscape barriers. We know that seed potatoes, for example, are grown preferentially on elevations where they are windswept, so those are important barriers.

Time barriers (delayed planting) is really not a physical method, but it is a very high efficacy method. We've shown in earlier tests that a one month's difference in planting date can result in a tremendous difference in the overall abundance of aphids on the plants. That is because with the early planting, the plants are fully exposed to the migratory flights of aphids. The aphids will lay their nymphs on those plants, whereas the late planting missed most of the migrant aphids.

To end, I would just like to make a comment. It is very often said that all those alternative methods and barriers and others are most applicable to small-scale farming or home gardens only, because they tend to be expensive. This is one of the things we had observed in an older study of 3 years of looking at conventional pest management using chemical pesticides essentially, to IPM using bacterial sprays, *Beauveria bassiana*, plastic-lined trenches, etc. in different combinations. We found that for every dollar spent in a 1-hectare field, with conventional pest management, we had to spend between \$2.50 and \$7.00 in IPM. However, when we went to a 50-hectare field, the same dollar became only approximately \$2.00 to \$4.00 in IPM because of the difference in size. Many of the alternative methods are border-based, and as we know, the surface of the field increases much faster than its border land. As a result of

that, borderland methods tend to decrease in cost with increasing size. So all I wanted to show with this is that increasing the size of production is not an obstacle to the use of alternative methods. On the contrary, it makes them more economical. So I think that physical barriers and others are an area where we can really expand in the future, and I think organic farming is well-poised to take advantage of that. Hopefully together we can team up and improve those methods.

Q: You were talking about crop rotations. Does it matter what you use for the crop?

A: I was referring mostly to the use of distance—the fact that by rotating the crop you move away from the overwintering sites of adult beetles who would otherwise be ready to just step right into the new planting the following year. This is essentially creating distance, and the further away it is, the better.

Q: Have you made experiments in how high the potato beetle flies?

A: We've tried to do that, and it has been difficult. Most of the flights occur at very low levels above the crop canopy. But we do know that beetles will occasionally be caught in the movement of large air masses and can be distributed over long distances. But that is only occasionally.

Q: (inaudible)

A: That was the idea. But we actually ended up trying to build traps to monitor beetles in flight, and the difficulty there is that beetles are very, very effective at visualizing the traps. They actually see the traps and avoid the traps, which is why we think that the forest edges are actually avoided by beetles in flight.

Q: Is there any relationship between when beetles fly, and air temperature?

A: There is a big relationship between the two. Beetles need temperatures of 25° Celsius or more, and often 30°, and a quasi-absence of wind also. This combination can result in flight. It will not necessarily result in flight, but it can. Of course, you may go back this summer and find beetles that are flying at 20° C; it does happen, but overall, any major dispersal will take 30° or so and a lot of sun insulation and essentially no wind.

Q: Do adult beetles not need to eat in the spring?

A: They can go a long way without eating. They will survive longer if they can eat, but they do not necessarily need to eat. Probably a lot of the females emerging (about 50% of them) are already mated when they emerge in the spring; therefore, they don't need a male to start laying eggs, but they do need access to water.