What is insect forecasting, and why do it

Knowing the risk of an insect becoming a problem weeks or months before the damaging stage(s) of the insect appears allows farmers and agronomists to prepare appropriately, and prioritize their field scouting as needed. Data from forecasts can be quite valuable if it is appropriately presented and correctly interpreted. But forecast data can also lead to incorrect decision making if it is not interpreted correctly. Knowing the objectives of forecasting programs and how to properly interpret the data is a necessary part of field scouting.

The definition of forecasting will vary somewhat with discipline. Meteorologists and plant pathologists also produced forecasts, but the nature of these forecasts are different than the insect forecasts discussed in this presentation. Insect Forecasting programs collect data on the population of a particular stage of insect and forecast the risk of later stages or populations of the insect being a problem. These forecasting programs differ from crop scouting or field monitoring. The intention of insect forecasts is not to determine if control is necessary in a particular field, but to provide an early warning of the risk of subsequent stages or populations being economical threats within the general region.

Forecasts for grasshoppers, diamondback moths, and bertha armyworms are produced annually in Manitoba. These 3 forecasting programs will be discussed with the aim of describing the objective of the forecast and how to properly interpret the data. Protocols for these forecasting programs, and the most recent data, is available on the Manitoba Agriculture, Food and Rural Initiatives website at: http://www.gov.mb.ca/agriculture/crops/insects/index.html.

Bertha armyworm forecasting:

Why a forecast for bertha armyworm?
Larvae of bertha armyworm feed on a variety of plants, although canola is a preferred host plant. The larvae are the only stage of this insect capable of causing damage to plants. Bertha armyworms overwinter as pupae, and will begin emerging as adult moths usually around mid-June. Since the adults are present earlier in the season than the damaging larval stage, there is an opportunity to monitor populations of the adult moths, to forecast what the risk of damage by the larvae will later be.

How forecasting is done

Figure 1. Trap for catching adults of bertha armyworm
Adult populations are monitored using a pheromone that lures male moths into a trap (shown above) containing an insecticide. Cumulative counts over a 6-week period are used to assess risk.

**Interpreting the data**
The following table shows how risk level relates to the number of bertha armyworm moths caught in the traps.

<table>
<thead>
<tr>
<th>Cumulative number of Moths / trap</th>
<th>Larval Infestation Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0 to To 300</td>
<td><strong>Low</strong> - Infestations are unlikely to be widespread, but fields should be inspected for signs of insects or damage.</td>
</tr>
<tr>
<td>300 to 900</td>
<td><strong>Uncertain</strong> - Infestations may not be widespread, but fields that were particularly attractive to egg-laying females could be infested. Check your fields.</td>
</tr>
<tr>
<td>900 to 1200</td>
<td><strong>Moderate</strong> - Canola fields should be sampled regularly for larvae and for evidence of damage.</td>
</tr>
<tr>
<td>1200 to 1500+</td>
<td><strong>High</strong> - Canola fields should be sampled frequently for larvae and for evidence of damage.</td>
</tr>
</tbody>
</table>

Data needs to be interpreted regionally, and is not meant to predict risk levels in individual fields, as there will be some variation between traps within a region. Regardless of the risk of bertha armyworm being a problem, farmers and agronomists are advised to be monitoring fields regularly, if possible, to assess the health of the crop. However, if trap counts show that there is a high risk of bertha armyworm larvae being at damaging levels, scouting for larvae of bertha armyworm becomes a high priority in late-July and August and the intensity of examining the lower surface of leaves for egg clusters and newly hatched larvae, the ground for larvae, and the plants for damage may need to be increased when fields are scouted. During the heat of the day, larvae will often be under debris on the soil surface.

**Diamondback moth**

**Why a forecast for diamondback moth?**
Larvae of diamondback moths feed on cruciferous plants such as canola and mustard. The larvae are the only stage of this insect capable of causing damage to crops. Adult moths are blown into Manitoba on wind from the south. These adult moths that are blown in are the first stage that will be present in Manitoba. Determining when these populations blow in, in what numbers, and what the conditions were like when they arrived can help predict the risk of larvae later being at levels capable of causing economic damage. This alerts farmers and agronomists of the need for a heightened level of scouting for larvae (the damaging stage) of diamondback moth and allows those involved in marketing or applying insect controls to prepare appropriately.

**How diamondback moth forecasting is done**
Adult moths are captured using a pheromone that lures male moths into a trap with a sticky bottom. A critical component in this forecasting program is getting the traps out early, sometimes before canola is even seeded, to determine how early populations arrive in Manitoba. Overall numbers are not as
important as knowing when the moths arrived, and what the conditions were like when and after they arrived.

Data is collected by farm production advisors and agronomists on a weekly basis, usually starting in early-May. Information is entered into a website which has been established to compile the data. Data from the trap counts, along with weather data and the conditions moths that arrived would be experiencing, are used to determine whether any areas of Manitoba would be at a higher risk of diamondback moth later becoming a problem.

Interpreting the data
Interpreting the data from traps for diamondback moth adults is quite different than interpreting the data from traps for bertha armyworm adults. No table of values has been established relating cumulative trap counts to risk level for diamondback moth; such a table would not be appropriate. How early in the season the moths arrive, and the weather conditions and availability of food when they arrive are important in determining the overall risk. These factors can at times be more important than the overall numbers. Whereas the emergence of bertha armyworm adults is controlled by the temperature the overwintering pupae experience, which is relatively consistent from year to year, diamondback moth adults are primarily being blown in and the time when they arrive can be quite variable from year to year. This time of arrival is quite important in the interpretation of trap counts for diamondback moth adults. A high level of diamondback moths in the traps early in the season has more of a potential for a damaging infestation than if high counts occur later in the season. Factors such as parasites and weather conditions could also determine to what degree the infestation develops. Cool, cloudy weather reduces moth flight activity, and the longer inclement weather persists, the more females die before egg laying is completed.

Once larvae of the diamondback moth are present, traps can still be used to detect new flushes of moths that have blown in, although once the second generation of adults begin emerging it will be difficult to distinguish moths that have recently been blown in from moths developing from pupae in local fields. Once larvae are present, monitoring the levels of larvae in the field becomes the first priority (since the larvae are the damaging stage); counts of adults in the traps is additional data at this point (in case new flushes of adults blow in). Once pupae of diamondback moth are starting to be seen on the plants, the value of trapping adult in minimal, and it is probably best to remove the traps and focus future monitoring on the larval stages. At this point it would be hard to determine where adults in traps are coming from (local emergence vs. being blown in) and extra time is better spent monitoring the damaging stages than doing adult counts.

Once canola has emerged, and the health of the crop is being checked through regular field scouting, the presence and relative abundance of adults and larvae of diamondback moth, and many other insects, may be observed while taking sweep net samples. Or numbers of larvae can be determined by shaking plants over the ground or a light-coloured surface. If high numbers of larvae are found while doing this more general field scouting, then more specific counts can be done to determine if economic thresholds for diamondback moth have been or are close to being surpassed.
It is important for agronomists and farmers to realize that traps counts of diamondback moth adults are not a substitute for looking for larvae, regardless of whether trap counts are high or low. The value of the traps is detecting high populations of diamondback moth adults that arrive, in advance of the damaging larval stages being present.

**Grasshoppers**

**Why a grasshopper forecast?**
Although all stages of grasshoppers, except the egg stage, feed on plants, it is the older grasshoppers later in the season that do the most damage to crops. The young stages are usually highly concentrated around field edges early in the season. These younger, concentrated populations of grasshoppers are much easier to control than older and more dispersed populations later in the season. Knowing the risk of grasshoppers being a problem the following season alerts farmers and agronomists to the important of monitoring field edges and vegetation surrounding the fields in late-May and June for young grasshoppers. It also enables companies that produce insecticides to prepare appropriately for the coming season.

**How grasshopper forecasting is done**
Knowing how many grasshopper eggs have been laid in the soil in late-summer can help predict what the population will be like the following year. Although grasshopper eggs can be counted by digging soil and shaking it through sieves, this is a very labour-intensive and time consuming process. Doing counts of the adults that are laying the eggs in late-summer can be done relatively quickly. This gives an estimate of the eggs that will be laid, and the risk level of grasshoppers the following year. This, combined with other factors, helps predict the risk of grasshoppers being problematic in a region the following year.

Grasshopper numbers are estimated by walking approximately 50m in an area that is suitable for grasshopper eggs to be laid and estimate the number of grasshoppers in 5 1m² areas along the 50m strip. Adding the 5 counts and dividing by 5 gives an average number per m².

To estimate grasshopper density, as you walk the 50m strip, focus on an area ahead of you that is about 1m². As you walk toward the m² area, estimate the number of grasshoppers that jump or fly from the area. If grasshopper numbers are high it will not be possible to get an exact count of the number of grasshoppers that jump or fly from the area of your count as you approach it. Estimating the approximate number, or a range (ex – 20-30) is sometimes all that can be done. Once at the m², count the remaining grasshoppers in the m². A quick and easy way to detect grasshoppers while at the m² is to disturb the plants in the area with your feet to encourage any grasshoppers still present to jump.
**Interpreting the data**

Grasshopper numbers are mapped according to the following categories and colour designations:

- 0-4 / m² = very light populations  green
- 4-8 / m² = light populations  light yellow
- 8-12 / m² = moderate populations deep yellow
- 12-24 / m² = severe populations  orange
- > 24 / m² = very severe populations red

White areas on the map will be areas where data was not collected.

The accuracy of preparing a forecast by this method depends on receiving sufficient data to represent the average egg-laying population of grasshoppers in a region. The accuracy of the forecast can also be altered by factors that influence the amount of eggs that will be laid and factors affecting the mortality of eggs or young grasshoppers. Some of these factors to consider are:

**Late-Summer and Fall weather**: Warm and dry summer and fall conditions will mean that there has been more opportunity for grasshoppers to lay their maximum amount of eggs. As well, there is some embryonic development that will occur in the egg before the colder weather sets in. Warmer conditions will mean that the embryonic development is further along before development ceases for the winter. The further along the development is going into winter, the earlier the eggs will hatch the next year. Earlier hatch means grasshoppers that are feeding on younger, less tolerant crops.

**Winter temperatures**: Very cold winter temperatures, with little snow cover, can result in higher mortality of grasshopper eggs as many will freeze. However, grasshoppers tend to lay their eggs in areas where snowfall will accumulate. So this will likely only be a factor in years with exceptionally low snow cover. Temperatures of -15°C or less at about 5 cm below the soil surface are needed to cause substantial mortality of grasshopper eggs.

**Spring and early-summer weather**: Warm and dry spring and summer days favour early and rapid grasshopper development. As well as affecting their ability to cause more harm to crops, this also means they will become adults and start laying eggs for the previous year sooner. So it is easy to see how several years of hot, dry conditions can build a grasshopper population up to outbreak levels.

There is often much confusion on how rainfall in the spring affects grasshoppers. Any rainfall that comes prior to late-May will have negligible impact on grasshopper egg hatch and survival. Our pest species of grasshoppers do not usually begin to hatch until late-May, and any grasshoppers present before that time are non-pest species. Grasshopper eggs have a nearly waterproof shell (called the chorion), so any precipitation before the eggs hatch will be of no harm to the grasshoppers. Experiments have demonstrated that complete immersion in water for a week will not kill the eggs of our pest species. In fact, grasshopper eggs need a little moisture for normal development and hatching. Precipitation as rain in March to May can benefit the embryonic growth of grasshoppers.

The negative effect of moisture on grasshoppers comes when the grasshoppers are hatching, which is usually around the end of May or early June (depending on spring temperatures). It is right after the grasshoppers hatch that they are most vulnerable to precipitation, particularly heavy rains. Rain in June can directly kill grasshoppers, promote disease in grasshoppers, and slow their growth and development. The key point to remember is that if rain comes before hatching, it has no harmful effect on our pest species of grasshoppers. Rain after hatching can cause grasshopper number to be lower than adult counts or egg counts may initially predict.
Natural enemies: All stages of grasshoppers can be affected by predators and parasites. When those that prey on grasshopper eggs and young grasshoppers are quite abundant, they can result in lower grasshopper numbers than adult counts or egg counts may initially predict.