Forecasting for Insect Pests on the Canadian Prairies - a Saskatchewan Perspective

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Abstract

There are a number of insect pests that represent potentially serious economic threats to agricultural producers on the Canadian prairies. Integrated Pest Management (IPM) is a long term approach to maintain pest densities below an economic level and help to reduce pesticide use. However, part of the overall strategy is being prepared to intervene with reactive measures if infestations reach significant proportions. Pest population densities, their distribution within the Province and timing of their emergence within a crop are estimated through surveys, monitoring programs and forecasts that are conducted annually by Saskatchewan Agriculture and Food, Saskatchewan Crop Insurance and other agencies. In addition, the Tri-provincial Monitoring Group, coordinated out of A.A.F.C., Saskatoon, uses Saskatchewan, Alberta and Manitoba insect data and Environment Canada data to provide a prairie-wide view of insect pests and environmental effects The main programs focus on Orange Wheat Blossom Midge, grasshoppers, Bertha Armyworm, and Diamondback Moth.

Introduction

Historically, strategies for dealing with insect pests have been largely reactive with the use of insecticides. Chemical control measures may still be warranted if insect infestations reach significant levels. However, by implementing an Integrated Pest Management (IPM) approach to farming systems, pesticide use can be optimized or can often be avoided entirely. For example the cultural practice of crop rotation from canola to wheat, would counter the threat of Bertha armyworm by eliminating a suitable host. In this case, other cereal pests such as the potential threat of wheat midge, would have to be taken into account. A variety of agronomic factors will influence agricultural decisions. In Saskatchewan, forecasting insect populations and their potential risk, provides information to assist producers in making cropping decisions. One component of the decision process may be to implement timely, effective control measures should they be required. Surveys and associated forecast or risk maps are based on existing populations and provide a broad estimation of potential risk. Monitoring programs are designed to provide a more current evaluation of densities of pest species during the growing season.

Saskatchewan Agriculture and Food, Saskatchewan Crop Insurance and Agriculture and Agri-Food Canada, Saskatoon are the main partners involved in forecasting and monitoring insect pests in Saskatchewan. The Tri-provincial Monitoring Group, coordinated out of A.A.F.C., Saskatoon, involves the cooperation and funding from provincial and federal governments, and Dow AgroSciences. Prairie-wide forecasts using Saskatchewan, Alberta and Manitoba insect data help to provide a regional perspective of insect pest populations and their geographical distribution. The group also uses weather data from Environment Canada, in conjunction with mathematical models for insect development, to produce maps that estimate the timing of key insect life stages. Saskatchewan benefits by having access to this shared information because insect pests do not recognize political borders. As a result our producers receive a more representative overview of insect populations. The main programs focus on Orange Wheat Blossom Midge, grasshoppers, Bertha Armyworm, and Diamondback Moth. But other potential pests are also being monitored.

Methods

The methods used to monitor and forecast for insect pests will depend on specifics relating to the insect biology and migration or movement. Because of the diversity in insects and their behavior, a number of strategies are implemented throughout the prairie region. Each method is, in some degree related to cost, relative importance of the pest, timing and labour intensity required to monitor the pest. For some insects, such as flea beetles, individual producers can probably get their own best estimate of densities while harvesting their canola. Beetle population levels observed in the fall will reflect potential risk as they are the over-wintering adults that will cause the damage to canola seedlings in the following spring. Large-scale projects such as the grasshopper and wheat midge surveys would be impractical and far too costly for an individual producer. Therefore, with funding through government and industry, regional surveys are conducted by appropriate government departments or contracted by independent agencies. The Tri-Provincial Monitoring Group generates precipitation, degree-day and estimated insect development maps relating to current conditions during the growing season. These assist agrologists and producers in timing their monitoring programs and in preparation for potential insect pest infestation.

As a gauge for modeling insect development, degree-days are utilized. Temperature is a major factor influencing insect growth and development. Each species will experience optimum growth between certain minimum and maximum temperatures because enzymes that regulate metabolism will only function efficiently within these temperatures. Below the minimum temperature development is reduced or suspended. Temperatures above the maximum for a species will also result in reduced or arrested development. Extremes above or below this range can also result in the death of insects. Research to determine the temperature limits of the various species is important in pest management. In temperate regions like Saskatchewan the minimum or base temperature is the most critical factor affecting development. A specific number of heat units accumulated within the acceptable temperature range are necessary to complete each stage in the life cycle of an insect. Once ascertained, this knowledge can be used in models to simulate development in an attempt to predict the growth stages of an insect. This in turn has very practical applications for determining the timing of strategies for insect and crop management. The heat units required by an insect to complete each phase in a temperature based physiological time scale are measured in degree-days.

Although there are different variations of this formula is use, the simplest method of calculating degree-days from daytime temperatures is:

$$\text{Degree days} = \frac{\text{Maximum temperature} + \text{minimum temperature}}{2} - \text{Base Temperature}$$

Base temperature is specific to a particular organism. Degree-days are calculated using recorded temperatures for a single day, and then accumulated during the growing season as a running total. Two economically important examples with known minimum developmental temperatures are grasshoppers (base 10 degrees Celsius) and the Orange Wheat Blossom Midge (base 5 degrees). Emergence of adult wheat midge from the soil is estimated to commence at 700 accumulated degree days and peak emergence is predicted at about 800 degree days under normal soil moisture conditions. Computer generated maps indicating regions of accumulated degree days, using corresponding base temperatures for specific insects, were circulated weekly during the growing seasons of 1998 and 1999 by the Prairie Monitoring Group and distributed to Rural Service Centres (SAF).

The degree-day data has become of interest to others in the agricultural industry. Since the physiological requirements of insects are linked to host plant development, host plants and pests can often exhibit optimum development within similar temperature ranges. For example, the degree-day data is being used to provide some possible explanations for some regional differences in development of pulse crops.

Insect Pests

The most current outbreaks of **Bertha armyworm** in western Canada caused estimated losses in canola yields of 28 to 30 million dollars in (1994) and 50 to 60 million dollars in (1995). Financial losses of this magnitude warrant considerable effort to forecast potential risk. Predictions are based on over-wintering populations present as pupae in the soil. Beginning early in April, a model incorporating degree-days and other data to estimate the extent of pupal development, is run through a computer to generate weekly maps depicting areas with the necessary requirements to complete development of the adult moths. Overlapping this period, a network of traps is set up across the prairies, to lure male moths. The traps contain a synthetic chemical, mimicking the pheromone released by the females to attract males of the species. During June and July, over 200 Saskatchewan cooperators record the number of Bertha armyworm moths collected in the traps. This information is submitted weekly to Saskatchewan Agriculture and Food. The data are compiled and subsequently mapped and posted on the SAF website. The cumulative number of male moths suggests potential risk for associated areas in Saskatchewan. The correlation between male moths and economic infestations is then monitored, at the field level, for verification with actual larval densities. The added advantage of historical records from Bertha armyworm trap counts and associated maps will assist researchers in improving long range predictions of cyclical changes in populations.

Diamondback moths present a different challenge for forecasting in that populations do not over-winter in Saskatchewan. Annual infestations are more difficult to predict as the adult moths are carried on wind currents from the southern United States. Extent of infestations in an area will depend on timing of suitable winds, the number of moths arriving and environmental conditions during the growing season. As with Bertha armyworm, it is the larvae that cause the economic losses. Generally the influx of moths will not be sufficient enough to cause crop damage immediately, however, because Diamondback moths can reproduce relatively quickly on the prairies during the growing season, the second or third generation larvae can become increasingly abundant. The number of generations in a year will depend on how early the first moths arrive. Tracking potential wind currents that may be carrying moths has recently been added to pest monitoring programs as a result of a joint project with Environment Canada. Daily reports of wind trajectories, altitude variations and end points indicate potential drop sites and therefore, possible sources of infestations. On the ground these sites can then be monitored to verify presence of the moths and ultimately, larvae. Although not as extensive as the monitoring system for Bertha armyworm, pheromone traps are set up in a "sentinel" system. These are used largely to determine presence rather than population densities. Follow-up field monitoring, in the vicinity of the trap, gives the best actual numbers of the pest.

In Saskatchewan **grasshoppers** have been officially declared a pest through legislation. Because of the economic losses due to these insects, they have been the focus of attention for decades. An annual forecast map is produced, based on adult numbers observed in a fall survey that is conducted by extension agrologists with Saskatchewan Agriculture and Food. This is the most extensive pest survey in the province with over 1900 and 1600 sites observed, in 1998 and 1999 respectively. As adult grasshoppers are sexually mature, the fall observations will indicate the reproductive potential of the grasshopper population and the associated risk levels for the following spring. An egg survey is also conducted before the fall freeze-up, by A.A.F.C. By examining embryos within the eggs, developmental progress can be used to estimate the time required to complete development and through modeling, hatching periods are identified on a regional basis. The survey map can be found on the SAF website and developmental maps are distributed to Rural Service Centres.

The **Orange Wheat Blossom Midge** has become a perennial pest of wheat in Saskatchewan. Since the first outbreaks in the northeast and east central regions in the early 1980's, midge populations have now spread to most of the arable land in the province. Earlier surveys to estimate densities and distribution focussed on larvae within the wheat heads. The present soil survey was developed at A.A.F.C., Saskatoon as a more effective method to estimate population levels over a large area. An annual fall survey is conducted to collect midge cocoons present in the soil. All midge cocoons are extracted and dissected to determine levels of parasitism. Any parasitized larvae are discounted from the total to give the number of viable midge. The data from about 500 sites provides a spatial pattern of midge distribution that is subsequently mapped to show existing population levels and attempts to forecast new and high infestations for the following year. Recent information on degree-day associations with midge emergence have been incorporated into monitoring. The wheat midge has always been a more difficult pest to monitor in the field so information on optimum monitoring periods should prove beneficial to the producer.

Other pests considered as serious potential threats to crops in Saskatchewan such as the Russian wheat aphid, the cabbage seed pod weevil and Lygus bugs are also being monitored. The Russian wheat aphid has been an occasional pest in the southwest but has not been of major consequence to date. A more extensive monitoring program has now been reduced to a suction trap near Robsart accompanied by field scouting. The suction trap is also part of an early warning system to detect the spread of the cabbage seed pod weevil from southern Alberta into Saskatchewan. As Alberta has benefited from the annual wheat midge surveys, in a similar manner Saskatchewan can anticipate receiving advanced warning of the spread eastward of cabbage seedpod weevil through surveys conducted along the western border. Frequent field monitoring, using sweep nets, along the shared border are also part of the program to identify the presence of this pest.

Lygus bugs are a relatively new problem for canola producers. Although Saskatchewan has not experienced the population levels seen in Alberta in 1998, a concerted effort is being made to determine information about Lygus species in the province. The Meadow Lake region has had Lygus in excess of economic thresholds and insecticides have been applied annually, to significant acreage since at least 1997. In 1999 a limited survey was conducted and showed high numbers in the Choiceland region as well as Meadow Lake. Other areas in the province indicated low densities in canola. In 2000 a more extensive survey will be conducted and will include insect collection to determine species composition along with distribution and density.

Conclusion

As new pests continue to affect Saskatchewan crops, appropriate monitoring programs will be implemented. Field scouting and monitoring will always be the best gauge of specific situations. Forecasts are continuing to be improved through refinements in current computer models and data collection. More comprehensive knowledge of the biology of the pests will further enhance the ability of entomologists to predict insect infestations and to develop pest management tools.