Undestanding Insects and Their Control in Different Cropping Systems

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Introduction

Insect infestations can vary considerably in different cropping systems and in different agricultural regions throughout the province. This variability in insect infestation levels poses challenges to producers. Perhaps the greatest shift that has occurred in cropping systems over the last 20 years has been the adoption of minimum or zero tillage systems over conventional tillage systems. Minimum tillage systems offer considerable potential for maintaining or improving soil productivity, particularly in regions where moisture is limiting. The implementation of reduced tillage systems can also offer important benefits to producers in terms of managing some economically important insect pest species. For example, flea beetle and cutworm infestations are more damaging in conventional tillage systems than with reduced tillage. However, reduced tillage also presents new challenges for growers because some species, like root maggots and wheat stem sawfly, thrive under these conditions and can cause greater yield losses to growers.

In addition to tillage regime, insect pest species respond to several other factors that characterize different agroecological regions of Alberta. The insect responses, however, can vary among insect species based on the suite of conditions to which they are adapted. For example, root maggots prefer cool, moist conditions and so are more damaging to crops in central and northern Alberta than to crops in southern regions of the province. Moreover, natural enemies of insect pests are also influenced by agroclimatic factors, and under conditions that favor their development, can have a major impact on pest populations. For example, the diamondback moth outbreak of 1995 was terminated over vast regions of western Canada when an insect pathogen decimated their populations.

The objective of this presentation is to provide growers with updated research information on how different insect pest species respond to different cropping systems, and to identify strategies for reducing insect pest crop damage and minimizing insecticide use.

Insect Responses To Cropping Systems

Insect pest infestation levels are affected by several factors that characterize different agroecosystems in Alberta. Agroecological regions are characterized by their soil type, precipitation levels, and climatic features. Some insect species respond to each of these variables. In addition, insects are affected by agronomic practices like tillage regime, crop rotational pattern, seeding rate, and row spacing. The presence and abundance of predators and parasites of crop pests can also play a critical role in determining insect pest densities, and the need to employ pest control strategies.

Insects can be affected by soil type, either directly or indirectly. Soil texture can influence insects directly through egg-laying by species like root maggots and cutworms, and the quantity of clay in soil can affect the ability of some species to penetrate and move through soil. Indirectly, soil type may influence the survival of parasitoids, which can then influence pest populations. In general, insect species affected by soil type are those which complete a portion of their life history in the soil (e.g., root maggots, cutworms, grasshoppers).

Insect infestation levels are influenced to a large degree by precipitation, either directly or indirectly. For example, a heavy rainfall when diamondback moth larvae are small, in their second or third instars, can directly affect mortality by washing them off their host plants and drowning them. Rainfall in spring, when cutworm larvae are most damaging, can draw larvae to the soil surface where they can be attacked by predators. Lack of rainfall can cause larvae of orange wheat blossom midge to remain in dormancy for an additional year until the return of more favorable conditions. However, perhaps the greatest impact of precipitation on insects occurs indirectly through its effects on host plants. Plants not under moisture stress can withstand considerably more herbivory by insects than plants affected by drought. When moisture is plentiful, host plants are better able to compensate for feeding damage than when moisture is limiting.

Climate can also affect insect infestation levels. Insect development is primarily temperature dependent, so warmer conditions facilitate more rapid development, or the development of additional generations than would occur otherwise. Across western Canada, southern Manitoba receives more degree days than central Saskatchewan, and central Saskatchewan has more degree days than central Alberta. When these conditions are maintained, emergence and flight of bertha armyworm adults begins first in Manitoba, then in Saskatchewan, and finally in Alberta. Grasshoppers also respond to temperature. Historically, grasshopper outbreaks coincide with periods of warm and dry summers which enhance their development, feeding, and reproduction.

Insect pests also respond to various agronomic practices. Virtually any agronomic practice will affect one or more insect species in some way. For example, insect pest species respond to tillage regime: populations of some species increase under reduced tillage, some increase under conventional tillage, and other species are not affected by tillage regime. Grasshoppers, wheat stem sawfly, and root maggots tend to be more damaging to crops grown under reduced tillage systems, but others like flea beetles and cutworms cause greatest crop losses with conventional tillage. The type of response is dependent on the insect species, and how its life history is impacted by soil disturbance. A key factor affecting the economic damage inflicted by crop pest species in different tillage regimes is whether one or more of its life stages occur in the soil or in the crop residue.

Minimizing Insect Pest Impact in Cropping Systems

A number of key strategies are important for controlling insect pests in different cropping systems. Implementation of these practices can be important for minimizing crop damage and enhancing economic returns.

1) Assess Insect Pest Populations on a Field-by-Field Basis

Insect infestations can vary due to their attractiveness to certain crops relative to others. For example, grasshoppers favor lentil and barley crops over field pea and oats. Even though a field of oats may be in close proximity to a field of barley (in the same region), the relative infestation levels of these insects can vary considerably among fields.

Some insect pests also favor host plants at certain developmental stages over others. For example, canola in early flowering is more attractive to ovipositing female bertha armyworm moths than canola in late flowering. Similarly, wheat heads in pre-flowering are highly attractive to egg-laying females of orange wheat blossom midge, but post-flowering heads are nonsusceptible to oviposition.

2) Consider Agroecoregion When Making Insect Pest Risk Assessments

The different agroclimatic regions of Alberta differ considerably in their soil type, annual rainfall levels, and number of degree days. Insects are more adapted to some ecoregions than others, and the insect pest complex is likely to vary in any given year among ecoregions. For example, southern Alberta consistently has drier conditions with more degree days than central and northern Alberta. The southern region of the province is therefore often at greater risk of infestation from pests that thrive in warm, dry conditions like grasshoppers, flea beetles, and diamondback moth. Producers in central and northern Alberta will likely need to contend with infestations of root maggot on an annual basis, but this pest poses little risk to growers in southern regions of the province.

3) Consider Meteorological Events in Making Insect Risk Assessments

Meteorological events can have great impact on insect pest infestations. Most Alberta populations of diamondback moth originate with migrations on air trajectories from the southern U.S.A. In spring, sustained air flow from the south can usually be associated with an influx of diamondback moth adults and the timing and extent of their migrations are critical to growers. An early-season migration, such as that experienced throughout western Canada in 2001, can result in a requirement to apply foliar insecticide to crops in the seedling stage. Sustained air flow from the south is also usually associated with immigration by other insect pests, like alfalfa looper, thistle butterfly, leafhoppers, and aphids, which need to be considered in making pest management decisions.

4) Use Optimal Crop Management Practices for Vigorous Plant Stands

Healthy crop stands, comprised of well nourished plants of optimal genetic background can tolerate and compensate for considerable herbivore pressure by insect pests. It is critical, therefore, that growers identify crop fertility requirements, through comprehensive soil testing, and meet these requirements. Growers should select crop varieties suited for their particular agricultural region and soil type. Attention should be directed toward ensuring that optimal seeding depths, seeding rates, seeding dates, and row spacings are followed for the crop species being planted. Weed control is vital for minimizing loss of water, and maximizing nutrients and growing space available to crop plants.

Population densities of several insect pest species can be reduced by avoiding continuous cropping of single crop species. For example, root maggot and flea beetle infestations are greatest in continuous canola cropping systems. Rotating crop types can disrupt insect pest life cycles, making it more difficult for them to increase to economically damaging levels. Crop rotation is a key strategy for minimizing damage by orange blossom wheat midge, sweetclover weevil, wheat stem maggot, and several other insect pests of field crops. Crop rotation is also important for minimizing economic losses from diseases and weed infestations.

5) Consider Insect Pest Infestations in the Context of Integrated Crop Management

Some agronomic practices may favor management of a particular insect pest species, but their implementation can have a negative impact on other important aspects of agricultural sustainability. For example, fall and spring tillage reduces the survival of overwintering life stages of grasshoppers, root maggots, bertha armyworm, and wheat stem sawfly, but adoption of this practice can result in excessive soil erosion and loss of residual soil moisture. In general, growers gain greater advantage from reduced tillage systems than the disadvantage they experience from increased insect feeding damage in such systems. Similarly, recent research has shown that increasing fertility in canola results in greater damage to plants from root maggot attack; however, the yield advantage derived from maintaining higher fertility levels exceeds losses from root maggots. Producers are therefore still encouraged to fertilize crops to recommended levels in spite of greater root maggot damage with this practice.

Summary

The soil type, quantity of precipitation, and climate of a given agroecoregion can affect the species composition and abundance of insect pests infesting crops in that area. Growers therefore need to assess insect pest populations on a field-by-field basis, and relate them to climatic events, historical trends, and the particular species of insect pest involved. Insect natural enemy populations, including predators, parasites, and pathogens should also be considered and enhanced where possible. By following the cornerstone principles of integrated pest management, including improved crop monitoring, maintaining vigorous plant stands, adopting appropriate crop rotations, and basing insecticide applications on economic thresholds, growers can minimize crop losses from insect pests and maximize their economic returns. Finally, insect infestations should not be considered in isolation, but rather in the context of other pests (e.g., weeds and plant diseases), and the best management practices for a particular crop. The overriding management strategy will then result not only in control of individual insect pest species, but rather in integrated crop management where insect species complexes, their interactions with weeds, plant diseases, and agronomic practices are considered in an holistic view of crop production.