Integrated Management of Crop Pests - Abundance of Wheat Midge and Its Parasite in Different Management Systems

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Abstract

Populations of wheat midge larvae and parasite larvae were assessed in six management systems at Kernen Farm near Saskatoon in 1997-1999. Ten soil cores were collected from each plot in mid May and late June. Emergence cages were placed in wheat plots in 1997 and canola plots in 1998-2000 to monitor emergence of adult wheat midge and parasite. Wheat plots were inspected in the evening to estimate numbers of wheat midge during heading and anthesis. In 1997, wheat midge populations exceeded one midge per 4-5 wheat heads during heading and were controlled with chlorpyrifos. Adult populations were below the economic threshold in 1998, 1999 and 2000.

Results showed that emergence of adult wheat midge and parasites differed in management systems. Emergence of each species was 1.4-2.0 times higher in early-seeded systems than in late-seeded systems and 1.5-2.0 times higher in zero-till systems than in tilled systems. Late-seeded management systems with high tillage had the lowest emergence of adult wheat midge and parasite. Wheat production on the same land for two consecutive years should be discouraged in zero-till systems to deter buildup of wheat midge populations.

Emergence of adult wheat midge and female wheat midge varied greatly from year to year. Emergence was 4-10 days earlier in 1997 and 1998 than in 1999 or 2000. In 1997-2000, dates for 10%, 50% and 90% emergence were July 10, July 19 and July 25, respectively. Degree-day requirements for 10%, 50% and 90% emergence of adult wheat midge were similar with air temperatures (706, 811, and 894 degree-days, respectively) and soil temperatures at 2.5cm depth (706, 817 and 906 degree-days, respectively). Accumulated degree days, based on AES air temperatures or hourly soil temperatures at 2.5cm and 5.0cm depths, provided a reliable method of evaluating emergence of adult wheat midge.

Introduction

Wheat midge, *Sitodiplosis mosellana* (Géhin), has become a serious pest of hard red spring wheat, *Triticum aestivum* L., in the Northern Great Plains (Anonymous 1996). The insect overwinters in the soil as a mature larva (Doane *et al*. 1987). After diapause is terminated, larvae enter a moisture-sensitive period which lasts about 6-8 weeks. If conditions are moist, larvae pupate near the soil surface and emerge as adults over a six-week period beginning in late June or early July (Elliott 1988). Flight of female wheat midge appears related to calendar dates rather than growing degree-days (Lamb *et al*. 1999). Females deposit eggs on glumes of emerging wheat heads. The larvae hatch within 4-7 days and feed on the surface of developing kernels. Damage reduces yield, grade and grain quality. Individual wheat heads are most susceptible to damage from the time the spikes emerge from the boot until anthesis begins (Elliott and Mann 1996).

Hard red spring wheat is grown under diverse management systems in western Canada. Systems differ in several respects including level of herbicide use, frequency or intensity of cultivation and planting date. However, little is known about the impact of these management practices on survival and development of wheat midge, wheat midge damage, parasitism and grade of harvested grain. This project was initiated to address these deficiencies and gain a better understanding of wheat midge/parasite/host plant interactions in different management systems.

Objectives

Six crop management systems were evaluated in the study: Low Herbicide - Zero Till (LH/ZT); Medium Herbicide - Zero Till (MH/ZT); High Herbicide - Zero Till (HH/ZT); No Herbicide - High Till (NH/HT); Low Herbicide - Low Till (LH/LT); Medium Herbicide - Medium Till (MH/MT). The LH/ZT, MH/ZT and LH/LT systems were seeded in early to mid-May whereas the HH/ZT. MH/MT and NH/HT systems were seeded in late May.

The objectives that specifically related to wheat midge included:

1. Evaluate the abundance of wheat midge larvae and parasite larvae in different management systems.
2. Evaluate emergence and abundance of adult wheat midge and parasites in different management systems.
3. Evaluate wheat midge damage to kernels and harvested grain.
4. Determine the degree-day requirements for emergence of wheat midge.

Methods and Results

Goal 1. Abundance of wheat midge larvae and parasite larvae.

Methods. Soil cores (n=10) were collected from each plot in mid May and late June in 1997-2000. Cores were collected from wheat plots in 1997 and from canola plots grown in wheat stubble in subsequent years. Samples were washed, sieved and examined microscopically to determine numbers of wheat midge larvae and parasite larvae present (after Doane *et al*. 1987).

Results. Numbers of wheat midge larvae and parasite larvae varied significantly depending on the year, sampling date and management system. Populations of wheat midge in May were 1.4 times higher in early-seeded systems than in late-seeded systems and 1.4 times higher in zero-till systems than in tilled systems. By late June, populations ranged from 265 larvae/m^2 in the

NH/HT system to 1090 larvae/m^2 in the HH/ZT system. Populations were 2.2 times higher in zero-till systems than in tilled systems. Populations of parasite larvae in May were 1.8 times higher in zero-till systems than in tilled systems and 2.2 times higher in the HH/ZT system than in the NH/HT system. Counts in late June ranged from 150 larvae/m^2 in the NH/HT system to 495 larvae/m^2 in the HH/ZT system. Numbers of parasite larvae were 1.9 times higher in zero-tilled systems than in tilled systems.

Goal 2. Emergence and abundance of adult wheat midge and parasite

Methods. Emergence cages (n=3 cages/plot) were placed in wheat plots and canola plots to monitor emergence of adult wheat midge and parasite (after Elliott 1988). Specimens caught were examined under a microscope to determine numbers of wheat midge and parasite present. Adult sex was also recorded. Cumulative daily emergence was plotted graphically to determine calendar dates for 10%, 50% and 90% emergence of adult wheat midge and female wheat midge.

Results. Numbers of wheat midge and parasites in emergence traps at Kernen Farm varied significantly depending on the year and management system. Midge emergence ranged from 280 adults/m^2 in the NH/HT system to 865 adults/m^2 in the MH/ZT system. More males and females emerged from early-seeded systems than from late-seeded systems. Emergence was 1.5-1.7 times higher in zero-till systems than in tilled systems and 1.8-3.6 times higher in the HH/ZT system than in the NH/HT system. Calendar dates for 10%, 50% and 90% emergence of female wheat midge varied greatly from year to year. In 1997-2000, calendar dates for 10%, 50% and 90% emergence averaged July 11, July 20 and July 26, respectively. Emergence of parasites ranged from 45 adults/m^2 in the NH/HT system to 245 adults/m^2 in the MH/ZT system. Adult emergence was 1.7 times higher in the early-seeded systems than in late-seeded systems and 2.0 times higher in zero-till systems than in tilled systems.

Goal 3. Wheat midge damage to kernels and harvested grain

Methods. Fifteen wheat plants were collected from each plot in early August. Primary and tillering heads, distinguished on the basis of stem length, were dissected to determine numbers of midge larvae/head, damaged kernels/head and undamaged kernels/head (after Elliott 1988, Elliott and Mann 1996). Plant height, heads/plant and kernels/head were also recorded. Eight 100-seed subsamples of harvested grain from each plot were evaluated to determine the percentage of midge-damaged kernels present. Samples were graded on the basis of midge damage. New tolerance standards established by the Canada Grains Commission in August 1999, limit wheat midge damage in hard red spring wheat to 2% in No. 1 CWRS, 5% in No. 2 CWRS and 10% in No. 3 CWRS.

Results. Numbers of wheat midge larvae and midge damage were very low in all management systems in 1997 after treatment with chlorpyrifos. Numbers of wheat midge larvae and kernel damage differed in management systems in 1998-2000. Larval counts and midge damage were marginally higher in early-seeded systems than in late-seeded systems. Damage ranged from 14% in the HH/ZT system to 20% in the MH/ZT system. Midge damage to harvested grain from early-seeded systems ranged from 2.7% to 4.7%, reducing grade to No. 2 CWRS. Damage to harvested grain in late-seeded systems ranged from 4.0% to 5.0%, reducing grade to No. 2 CWRS. Therefore, chemical control of wheat mdige may be required to prevent grade losses when midge populations are less than one adult per 4-5 wheat heads.

Goal 4. Degree-day requirements for emergence of wheat midge

Methods. Accumulated degree-days were calculated from AES air temperatures and from daily min/max, hourly and 20-minute average air and soil temperatures in the HH/ZT system. Soil temperatures were monitored at 2.5cm and 5.0cm depths. AES air temperatures were recorded throughout the year whereas the remaining temperatures were recorded beginning in early May. Allen sine curves derived from min/max daily temperatures were used to estimate degree-day accumulation above 5°C during May through August. With the exception of AES air temperatures, degree-day accumulations started at planting time.

Results. Accumulated degree-days at varied depending on the year and temperature source. Air temperatures and soil temperatures were highest in 1998. Daily min/max air temperatures under-estimated heat unit accumulation whereas daily min/max soil temperatures over-estimated heat unit accumulation. Therefore, AES air temperatures and hourly air and soil temperatures at 2.5cm and 5.0cm depths were used to estimate degree-day requirements for wheat midge emergence and heading/anthesis.

Degree-day requirements for 10%, 50% and 90% emergence of adult wheat midge averaged 706, 811 and 894 degree-days, respectively, using AES air temperatures; 706, 817, and 906 degree-days using hourly soil temperatures at 2.5cm depth; and 689, 800 and 893 degree-days using hourly soil temperatures at 5.0cm depth. Degree-day requirements for 10%, 50% and 90% emergence of female wheat midge were, on average, 10-15 degree-days higher than those for adult wheat midge.

Conclusions

Populations of wheat midge larvae and parasite larvae differed in management systems. Depending on the year and sampling time, larval populations were 1.4-3.0 times higher in early-seeded systems than in late-seeded systems and 1.4-2.0 times higher in zero-till systems than in tilled systems. Late-seeded management systems with medium or high tillage had the fewest midge larvae and parasite larvae. Tillage reduced the abundance of midge larvae and parasite larvae but had no effect on percentage of parasitism.

Emergence of adult wheat midge and parasites differed in management systems. Emergence of each species was 1.4-2.0 times higher in early-seeded systems than in late-seeded systems and 1.5-2.0 times higher in zero-till systems than in tilled systems. Late-seeded management systems with medium or high tillage had the lowest emergence of adult wheat midge and parasite. Wheat production on the same land for two consecutive years should be discouraged in zero-till systems to deter buildup of wheat midge populations.

Emergence of adult wheat midge varied greatly from year to year. Emergence was 4-10 days earlier in 1997 and 1998 than in 1999 or 2000. In 1997-2000, dates for 10%, 50% and 90% emergence were July 10, July 19 and July 25, respectively.

Control of wheat midge with recommended and reduced rates of chlorpyrifos in 1997 reduced midge damage in harvested grain to less than 2%. Grain samples graded No. 1 CWRS.

Early seeded systems had higher midge damage than late-seeded systems.

Accumulated degree days, based on AES air temperatures or hourly soil temperatures at 2.5cm and 5.0cm depths, provided a reliable method of evaluating emergence of adult wheat midge.

Degree-day requirements for 10%, 50% and 90% emergence of adult wheat midge were similar with AES air temperatures (706, 811, and 894 degree-days, respectively), soil temperatures at 2.5cm depth (706, 817 and 906 degree-days, respectively) and soil temperatures at 5.0cm depth (689, 800 and 893 degree-days, respectively).

Chemical control of wheat midge may be required to prevent grade loss when midge populations are less than one adult per 4-5 heads.

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