New Developments in Wheat Midge

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The wheat midge continues to be a serious problem for Manitoba wheat producers. This pest is a tiny orange fly that lays its eggs on wheat heads as they emerge from the boot or flag leaf. The eggs hatch just as the wheat is pollinated and larvae feed on wheat seeds as they develop. The consequences of damage are reductions in yield due to shriveling of affected seeds, and reductions in grade due to the occurrence of wheat midge affected seeds in harvested grain. In this paper, three ongoing projects aimed at minimizing wheat midge damage are described: a farmer-friendly monitoring method to guide insecticidal control; progress towards developing resistant wheat; methods we might use to assure that resistance to the wheat midge is preserved. In addition a new development in relation to managing a relative of the wheat midge, Hessian fly, is also described.

Although our ultimate goal is to develop wheat resistant to wheat midge, in the interim producers need to use insecticidal control to protect their crops. Because the wheat midge is expensive to control, and does not always require control, producers need an effective monitoring method so that they can make cost-effective control decisions. We devised a sticky-trap monitoring system that meets this need (Lamb et al. 2002). The method uses 10 sticky traps, 3 x 5 inch yellow sticky cards, which are inexpensive and commercially available. They are placed on stakes at wheat head height when the heads are emerging from the boot. The traps should be spaced at 20 m intervals, at least 20 m into the field, and left in place for three consecutive nights. After three nights, the wheat midge adults caught on all 10 traps are counted. If 10 traps have caught a total of four or more wheat midges, then an insecticide application is warranted. The methodology was tested in commercial wheat fields in 1998 (67 fields), 1999 (66 fields), and 2001 (38 fields). In the first year of testing when the system was newly developed, 67% of decisions were correct, and in the subsequent two years the frequency of correct decisions rose to 82 and 76%, respectively. This method costs only a few dollars to use each year, and requires only 1-2 h of a producer’s time. If used widely, the majority of producers will be able to make cost effective control decisions, reducing wheat midge damage in infested fields, and reducing unnecessary insecticide applications in fields where the pest is sparse.

Progress is being made towards our main goal of developing wheat cultivars that are resistant to wheat midge damage. We have discovered a powerful resistance gene, called Sm1, in winter wheat from eastern North America, and have incorporated this gene in the main classes of spring wheat grown in western Canada (McKenzie et al. 2002). The gene was transferred to spring wheat using conventional plant breeding methods. The resistance prevents larvae from feeding on young developing seeds so that they eventually die, probably from starvation. The chemical basis for the defense is understood, and we know that the gene does not affect the quality of the ripe wheat seeds (Ding et al. 2001). The resistance all but eliminates wheat midge damage and wheat midge from wheat tested across Manitoba and Saskatchewan (Lamb et al. 2000). We now have many advanced breeding lines with resistance in our CWRS, CPS, and CWES breeding programs at the Cereal Research Center, as well as in CWAD lines. The most advanced breeding material is a CWRS line that was tested in the second year of the three-year COOP Trials in 2002. If this line continues to meet quality requirements it could be registered in 2004. It is only a matter of time until resistant wheat is available to wheat producers in Manitoba.

Once we have wheat that is resistant to wheat midge, it will be important to protect that resistance gene from breaking down. Resistance breaks down when a virulent wheat midge that can overcome the resistance gene evolves. The gene we have identified is the first one discovered to be highly effective against wheat midge. As it has not been widely deployed we do not know how likely it is to break down, or how quickly virulent wheat midge might evolve. Virulent strains of other pests of wheat in the USA,
such as Hessian fly and greenbug, have evolved rapidly, often within as little as 8 years from the time a resistant cultivar is deployed. If only one resistance gene is available, the most effective way to forestall the breakdown of resistance is to provide a refuge for avirulent wheat midge. A refuge is either a strip or block of susceptible wheat adjacent to the resistant field, or a mix of susceptible and resistant plants in the same field. The refuge allows sufficient avirulent wheat midges to develop and mate with the rare virulent wheat midge that the virulence genes in the wheat midges are prevented from increasing in frequency. Over the past three field seasons we have tested a refugia strategy for protecting the wheat midge resistance gene, and also a valuable parasite of the wheat midge. Our results consistently show that a 5% mix of susceptible seeds in 95% resistant wheat will protect the wheat from downgrading or measurable yield loss. This refuge assures that the virulence genes are kept in check in the wheat midge population and also that the parasite of the wheat midge is preserved. We are currently developing computer simulation models to explore the consequences of this methodology once wheat with resistance to wheat midge is deployed over a wide area. By the time the first resistant wheat reaches the market, we expect to have determined the optimal agronomic practices for preserving the resistance gene.

A pest that is related to the wheat midge but is less well known in western Canada is the Hessian fly. Most farmers have never noticed Hessian fly. It feeds on young wheat plants usually at a lower node, in the leaf sheath between the stem and leaf. The only stage that is ever seen is the pupa, which looks like a flax seed, visible only in mid to late-summer if the leaf is pulled back from the stem. The most obvious symptom of damage is stem breakage that usually occurs late in the season just before harvest. This damage can easily be mistaken for lodging, but the presence of the insect confirms the cause; the stem breaks where larvae fed. Feeding by the larvae reduces yield in the affected tiller by shriveling the seeds, even if the tiller isn’t lost because it falls over. Yield losses in individual Manitoba fields occasionally reach 20%, and in one province-wide survey of wheat, we detected Hessian fly larvae in about 12%, on average, of all tillers. The damage is usually most severe in wheat seeded late in May or at the beginning of June. Hessian fly has been the main pest of winter wheat throughout much of the USA for decades, and many cultivars of winter wheat with resistance to this pest have been released. A new development in the control the Hessian fly in western Canada is the release by the Cereal Research Center of the cultivar ‘Superb’. ‘Superb’ is a high-yielding CWRS wheat that also happens to shows a high level of resistance to Hessian fly. It should provide adequate protection for this pest without giving up any of the attributes we expect from our wheat cultivars.

References:


