The surprising bunts and smuts: “Still a threat after all these years”.
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The bunt and smut pathogens of barley, oats and wheat belong to a group of fungi sometimes referred to as the smut fungi. There are only two genera of smut fungi that growers in western Canada normally deal with; *Tilletia* spp. which cause common bunt of wheat, and *Ustilago* spp. which cause loose smut of wheat, loose smut, false loose smut and covered smut of barley, and loose smut and covered smut of oat. Other genera and species are important because of their status as quarantine pathogens (Wilcoxson and Saari 1996), but they will not be discussed in this article.

The smut fungi are essentially, obligate pathogens, or in other words, they survive only on living host tissue in nature. They likely originated with their hosts in their centres of origin, and the diseases they cause have been known since the earliest times of agriculture. These pathogens are seed-borne, and efficient dispersal of these pathogens, either locally or on a worldwide basis, is through the movement of infected or infested host seed. Except for a few instances where quarantines have been effective in excluding these pathogens, they generally occur wherever their hosts are grown (Wilcoxson and Saari 1996).

Bunt and smut diseases are often considered as the most important diseases of cereal crops in the Mediterranean region and the near east, next to the rusts. On average, they cause 1 to 7% yield loss per year. Historically, these diseases were a problem in western Canada. In the late 1800’s, the smut diseases were seen as the most serious diseases of small grain cereals on the prairies. Copper sulphate and hot water seed treatments were recommended for control of bunt as early as 1892 (Johnson 1961). In 1896, the smut diseases of oat and barley were reported to have destroyed 10 to 25% of the crop in Manitoba and Saskatchewan, with some fields having 75% of the plants smutted. These diseases virtually disappeared by the middle of the 20th century because of the development of resistance host varieties and effective fungicide seed treatments. These techniques of disease control are still effective today, leading some to consider these diseases as “diseases of the past”. However, if proper disease management techniques are not practiced, or growers become complacent about these diseases, significant yield, quality and economic losses can still occur.

The life or disease cycles of these pathogens are described in Diseases of Field Crops in Canada (Bailey et al 2003). The important part of the different life cycles to remember is that loose smut pathogens of wheat and barley are embryo infecting fungi. In other words, they are carried from season to season inside the host seed. Common bunt of wheat, false loose smut and covered smut of barley and loose smut and covered smut of oats are seedling infecting fungi. The most important source of inoculum for the seedling infecting smut fungi are teliospores that adhere to the surface of host seed. For all these pathogens, there is only one infection cycle per year, and sexual reproduction occurs before every infection.

The occurrence of these fungi on the small grain cereals in western Canada varies with the species. Surveys of commercial fields in Manitoba and eastern Saskatchewan over the last 10 years found that on average, approximately 25% of fields of hexaploid wheat, 55% of durum wheat and barley fields and 7% of oat fields were infested with smutted
plants. The mean percentages of infected plants in the infested fields range from trace (<0.01%) to 0.1% levels, but fields with 10% infected plants for wheat and oat, and 25% loose smut infected plants for barley have been observed. Such high levels of disease indicate the threat of disease losses remains, particularly as society demands reduced dependency on fungicides, as is the case in organic production.

The common occurrence of these diseases in commercial fields is often underestimated because of the nature of the disease symptoms. At low levels of infection, the presence of bunt and smut can be easily overlooked. The most obvious symptoms of smut are the smutted spikes that appear at heading. Other symptoms of loose smut of wheat and barely include narrow lines of dark sori on the flag leaf (more common on barley than wheat), reduced tillers and the cessation of growing of smutted plants after heading. Although some of these symptoms may be quite striking at heading, they may not be readily apparent at harvest. On the other hand, symptoms of common bunt may not be apparent until harvest. Wheat plants infected by the common bunt pathogens may have spikes that are darker green, and the spikes may remain green longer than others. Mature spikes are slightly lighter in colour, with a slight bluish grey colour, compared to healthy spikes. Formation of bunt balls in the wheat kernels can cause the florets to be slightly flared, but they will have a near normal appearance. Often, common bunt goes unnoticed until harvest, when a cloud of bunt spores appears during the harvest operation. Producers and seed retailers report instances of higher levels of smut or bunt in fields sown to susceptible varieties, especially in circumstances where the producer sows their own seed from the previous year’s crop for a number of years in succession, without monitoring each successive crop for these diseases. It is likely that the seed producers used to plant their field became infected or infested with the pathogen the year before, and likely from pathogen propagules that were produced in the same field as the seed they are planting. The pathogens do not generally spread long distances in nature. Loose smut teliospores from a smutted head of barley or wheat generally infect healthy florets within one metre of the smutted head. Common bunt spores or spores of the seedling infecting smuts generally infest seed during harvest, in the combine. A heavily smutted or bunted crop most likely arose from last year’s crop, which was also contaminated with smut or bunt.

The disease management practices used to control these diseases are similar. The growing of resistant varieties, when available, can be very effective. The scarcity of false loose smut and covered smut in barley, and the smuts diseases of oats can be attributed to the good to very good levels of resistance of most commercial varieties. On the other hand, most commercial varieties of barley have poor to very poor levels of resistance to loose smut, which is reflected in the common occurrence of loose smut in barley fields. Loose smut was the sole cause of smutted plants in 88 barley fields identified with smutted plants during surveys of Manitoba and eastern Saskatchewan during 2005 to 2009.

Resistence to common bunt varies among the different wheat classes. Hard red spring and durum wheat varieties are generally resistant, but soft white spring, Canada Prairie Spring, and winter wheat varieties are generally susceptible. An outbreak of bunt in winter wheat occurred in Manitoba in 2009, and this was attributed to the high susceptibility of winter wheat varieties coupled with the lack of proper fungicide seed treatment. Current triticale and rye varieties are immune to common bunt.
Most wheat varieties within the CWRS class of wheat have fair to very good resistance to loose smut. However, the majority of CPS wheat varieties have a poor resistance to loose smut, and all the durum varieties have either a poor or very poor level of resistance to this disease.

The majority of wheat varieties recommended for Manitoba have fair to very good resistance to common bunt. The winter wheat class is dominated by varieties with poor to very poor resistance to this disease.

The use of seed treatment fungicides can also be effective in controlling these pathogens. There are a number of different fungicides registered for this purpose. It is important to remember that for loose smut of wheat and barley, systemic fungicides must be used because the pathogen is present in the embryo of the seed, rendering contact fungicides ineffective. For the other smut diseases, and common bunt, the teliospores are located on the seed surface, and prophylactic or contact fungicides can be used for disease control. The infection court of these pathogens is the coleoptile of the germinating seedling. The application of seed treatment fungicides is therefore in the infection court of the pathogen, which results in the fungicides being highly effective in controlling infection. With common bunt, however, there can be problems with some older seed treatment fungicide, whereby their effectiveness can be reduced at lower temperatures or high inoculum loads. The presence of strains tolerant to the fungicide carboxin has also been reported for the loose smut of barley and wheat pathogens. These strains are not common in western Canada, and carboxin based fungicides are still highly effective against most pathogen strains, but it does illustrate how reliance on one seed treatment fungicide can lead to the pathogen evolving to overcome the fungicide treatment. It is recommended that fungicides be used in rotations, with different fungicide active ingredients being used each year, so that fungicide tolerance or resistance does not evolve. In recent years, seed treatment products that contain triazole compounds have become available to producers, and the advantages of these over older products include efficacy for smut and bunt control at lower doses, and improved safety for the applicator.

The use of certified seed will also aid in management of these diseases. Tolerance levels for smut in fields producing certified seed are low enough to ensure that smut is not a problem in the next crop. The inspection of certified seed crops will also ensure low levels of common bunt in the seed as well.

Estimations on the levels of loose smut of wheat and barley can be obtained from commercial laboratories that conduct the embryo test. This test involves the boiling of wheat or barley seed in an alkaline solution to make the seed transparent, and then treating the seed with a stain specific for the smut pathogens. One can determine the percentage of seed that are infected with the pathogen, which is good information when trying to determine if a fungicide seed treatment is necessary for the seed lot. This test does not work with the seedling infecting smuts and common bunt.

Some crop management practices can be effective in reducing the effects of the common bunt pathogens. Optimum infection of wheat seedlings by these pathogens occurs at 5 to 10°C, and decreases as the temperature rises. Seeding earlier in the fall or later in the spring into warmer soils can reduce the levels of bunt infection. Seeding at a depth of 7 cm can increase bunt, compared to a 4 cm seeding depth for the same reason. A deeper depth of seeding places the seed in soil at cooler temperatures. Crop
rotations can also help to reduce bunt incidence and severity. Although most infections of germinating seedlings arise from common bunt spores carried on the seed, some infections occur involving soil borne common bunt spores. Teliospores of common bunt can last 1 year in Canadian soils, so a rotation to a non-susceptible crop will eliminate infection by soil borne teliospores.

Hot water treatment of seed infected or infested with the smut and bunt pathogens can also be effective in managing these diseases. One treatment involves submerging the host seed in water at 54°C for ½ hour, and then immediately transferring the seed to cool water before drying. Another technique involves submersion in 20°C water for 5 hours, 49°C for 1 minute, 52°C for 11 minutes, and then cool water before drying. Hot water treatments could be very attractive to producers that wish to avoid using fungicide seed treatments, such as organic producers. However, these techniques require the proper equipment and expertise for proper application. If the seed gets too warm, the seed will be killed by the treatment, and if the water is too cool, effective killing of the fungal mycelium or spores will not occur. In any event, some death of seed will occur with these treatments, so a higher seedling rate needs to be used.

In conclusion, it is important to remember that the smut and bunt diseases of small grain cereals were once diseases of major impact to agriculture. These diseases are not major problems today because of effective control techniques such as resistant varieties and effective fungicide seed treatments. Despite this, some of these diseases are common in western Canada, albeit at low levels. They can cause losses to producers who use susceptible varieties, improperly apply other control techniques, or are too complacent about these diseases.

References

