



WHAT IS WRONG WITH MY CROP?: DIFFERENTIATING PLANT DISEASE ISSUES FROM ABIOTIC FACTORS AND SEED QUALITY CONCERNS

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Introduction

Each year farmers, crop scouts, industry agronomists, seed retailers, chemical company representatives, diagnostic labs, and research and extension staff can be faced with the challenge of correctly diagnosing crop production problems. Producers typically want to know what is causing the observed poor crop performance and what can be done to alleviate it. In addition, producers may be concerned regarding potential problems related to inputs like fertilizers, herbicides, fungicides, seed treatments, and seed. As a consequence of one or more of these concerns, product performance inquiries are often initiated. Depending on the problem, individuals or groups such as crop scouts, industry agronomists, seed retailers, chemical company representatives, diagnostic labs, and research and extension staff may be involved. To reach an effective resolution concerning a crop production problem it will be important to correctly identify the cause of these concerns. Unfortunately, misdiagnosis of the problem can lead to the unnecessary use of inputs, and lack of compensation or unnecessary compensation relating to product performance inquiries. Moreover, for the producer the true underlying cause of the crop production issue may not be resolved and it can continue to affect subsequent crops.

Crop production problems fall into two broad categories: biotic or abiotic factors. Biotic factors generally relate to stresses imposed on the crop by insects, weeds, diseases, or seed quality factors such as poor germination or vigour. In contrast, abiotic factors relate to stresses imposed by poor growing conditions, fertility issues, seedbed preparation and seeding concerns, and crop input injury issues. However, these categories are not mutually exclusive with abiotic stresses often increasing the susceptibility of plants to the effects of biotic factors like plant disease. The goal of this presentation is to provide an overview of the general characteristics of plant disease issues that may affect the crop from seeding to harvest. Recommendations to correctly identify these issues and differentiate them from other biotic and abiotic factors that may affect the crop will also be discussed.

Early season issues

Crop production concerns that occur early in the growing season can often be among the most difficult to diagnose. In general, at this stage of crop development the focus is typically on issues affecting seed germination, crop emergence, stand establishment, and general crop appearance. Information related to the accurate diagnosis of early season issues can be used to correct the problem, which mainly applies to non-disease issues, such as fertility concerns. The diagnosis can also be used to identify or rule out product performance or non-disease issues that may be related to seed treatments, fertility problems, herbicide residues, poor seedbed preparation, seeding practices, and seed quality issues. Producers can also use accurate diagnosis of early season issues to plan for the next growing season, especially where in-crop options are limited during the current growing season. For example, crop emergence and stand establishment issues may be related to poor seed-to-soil contact, deep seeding, or too much fertilizer in the seed-row.



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Plant diseases such as seed rots, damping off, and seedling blights may also be the cause of early season issues. It is important to recognize that these common names may be used interchangeably and often describe any symptom from seed decay to seedling death. It may be useful to think of early season disease issues in terms of the seedling disease complex, which consists of seed rot (various agents) damping off (*Pythium* spp.), seedling blight (*Rhizoctonia solani* and *Fusarium* spp.), and wirestem (*Rhizoctonia solani*). Symptoms caused by these diseases can be similar and it is very difficult to identify causal agents in the field, without collecting plant samples and running them through a diagnostic laboratory.

Risk factors for seed and seedling diseases include poor rotations where only a short interval (<2 years) used between host crops or where a particular crop type is grown continuously. Poor rotations lead to a build up of pathogen-infested crop residues or specialized pathogen resting structures at the soil surface or in the soil itself. Unfortunately, the host range of some of these seedling disease complex pathogens tends to be wide, which may limit the benefit of crop rotation. High quality seed, free from mechanical damage with good germination and vigour, while having a lower level of seed infection will help to limit the seedling disease complex. Mechanical seed damage can predispose seed to seed rots that can kill the seed before it has a chance to germinate. Poor quality seed and deep seeding can also slow down germination and seedling emergence prolonging the exposure of the seedling to potential problems. Furthermore, with deep seeding the seedling will be expending more energy to reach the soil surface and as a consequence may be weakened and less able to fend off attack from various soil-borne pathogens. Problems associated with poor quality seed, deep seeding, and poor fertility may lead to a less healthy crop that is more readily attacked and damaged by seedling and leaf diseases during the growing season.

In general, seedlings are most vulnerable to the seedling disease complex before the 2-4 leaf stage, while older plants become less vulnerable. Symptoms of the seedling disease complex may be scattered in patches throughout the field, but can also be associated with knolls or depressions. Above-ground symptoms produced on seedlings can be similar to other issues including fertility problems, water-logged soils, deep seeding, poor seed-to-soil contact, herbicide residues, soil compaction, and insect attack.

It is important to recognize that although the seedling disease complex may be the primary cause of field problems, other factors may be the primary reason for poor seedling growth or damage and thus provide an avenue for attack for these pathogens. As a consequence, these pathogens may not be the primary issue causing the problem. Some pathogens associated with the seedling disease complex can be opportunistic and take advantage of a poor seedling growth or damage, while not typically attacking a healthy, vigorously growing seedling.

Mid and late season issues

Crop production issues that appear during the middle of the season can often be relatively easy to diagnose. Typically these issues will affect the plant's ability to photosynthesize or its ability to absorb water and nutrients. For diseases that mainly affect the crop canopy, timely scouting will be critical as a correct diagnosis can be used to limit their impact by scheduling an in-crop fungicide application. For some issues there may be little that can be done in-crop, but the information obtained from accurate diagnosis of the issue can be used to plan for the next growing season. For example, extensive cereal leaf disease development on the upper leaves of a cereal canopy will greatly diminish the potential benefit of fungicide application; however, this information can be used to plan strategies for the next growing season, such as crop rotation and choosing a cereal variety with disease resistance. Accurate diagnosis can also be used to identify or rule out product performance or non-disease issues that may be related to fertility problems, herbicide residues, and poor growing conditions.

Late season issues often result from a producer's concern regarding poor crop performance, where crop yield and/or plant development are not as expected. Crop production issues that are identified late in the season will often, but not always be an extension of early or mid season problems. Because issues such as crop productivity and the quality of harvest grain are often problems that are identified later in the growing season, there is typically little that can be done during the current growing season. However, accurate diagnosis of late season issues can be used to develop disease or crop management strategies for the next growing season. Options to deal with some late season disease issues include crop segregation and modifying the use of harvested grain. To improve grade and quality, producers may choose to segregate grain harvested from fields or areas where disease levels are high versus where disease development has been limited. Cereal grain with significant levels of fusarium damaged kernels and potential for mycotoxin contamination could be used for feedlot cattle versus hogs or for human consumption. Once again accurate diagnosis of late season production issues is important to identify or rule out product performance or non-disease issues

**General tips for diagnosing plant disease issues versus abiotic and other biotic factors****Take the crime scene investigation (CSI) approach!**

Often disease will be incorrectly blamed for poor crop emergence or stand establishment, and poor crop growth and appearance. This may be due to a lack of information regarding the potential disease issues of concern. Unfortunately, it is often automatically assumed that it is a disease problem, because the symptoms “look like the picture”. It is important for all individuals involved in the diagnosis of a crop production problem to avoid jumping to conclusions. Don't assume anything when approaching a field problem and gather as much background information as possible on the field and prevailing weather conditions. Although it is important to approach a field problem with an open mind it is also important to have a general idea of what issues (biotic or abiotic) might be expected in a field depending on the growth stage of the crop. Make sure to access as much resource information as possible including checking information networks for any emerging pest issues that others have identified in the area. When dealing with a crop production issue be investigative and systematic in your questions and diagnostic approach. Often it is easiest to rule out simple things that may seem obvious, but have a tendency to be overlooked if your initial focus is on more complex solutions. Information that will be useful to gather includes the following:

- a. Field history (similar problems in previous growing seasons, locations in a field associated with old home sites or gas/oil exploration activity),
- b. Topography and soil characteristics (low spots in the field, knolls, areas with poor soil fertility, soil structure or pH problems),
- c. Rotation (interval between host crops, other potential crops that may serve as hosts, have volunteer issues),
- d. Fertility (soil test results will be crucial, look for any fertilizer application problems, heavy manure applications),
- e. Seed test results (seed germination, vigour, mechanical damage, herbicide damage as well as assessments of the presence and level of seed-borne diseases),
- f. Herbicides (residue problems from previous growing seasons, in-crop affects due to tank contamination, rates or drift, poor application conditions),
- g. Diagnostics (test representative samples from affected and unaffected areas, send samples to suitable diagnostic laboratories, consider soil and tissue testing for nutrients or herbicide residues), and
- h. Weather conditions (excessive moisture, heat or cold may result in crop damage, while lack of moisture may prematurely ripen or discolour the crop itself).

Consider getting a second opinion regarding the problem as well as ensuring that individuals from several disciplines look at the issue as long as they avoid jumping to conclusions. For example, a plant pathologist may assume that it is a disease issue, while a fertility specialist may conclude that it is a nutrient problem. Often by approaching an issue from several points of view you are more likely to arrive at an accurate diagnosis.

Scouting and assessment of symptoms

Timely scouting and sampling of plant tissues exhibiting symptoms are also very important. For example, issues related to seedling emergence are often left until there are visible signs of poor stand establishment. Unfortunately, plant samples collected at 2-4 weeks after crop emergence may harbour organisms that are not the primary cause of poor emergence. These organisms may represent “secondary invaders” that typically attack seedlings and plants that are already in a weakened state due to poor seed quality, deep seeding, fertility issues, or herbicide residue problems. For early season issues it is important for the producer or crop scout to monitor the crop at the time of emergence or expected time of emergence. For other issues that may affect the crop later in the growing season it is also important to sample the crop as soon as symptoms appear. If samples are not collected in a timely fashion other issues may mask the primary problem. For example, sooty molds have garnered the attention of producers over the last couple of growing seasons. Although symptoms of sooty mold are unsightly they only represent a “secondary concern” as the organisms that cause sooty molds will typically affect plant tissues that are prematurely ripened due to other production issues such as drought stress, root rots/take-all, and nutrient deficiencies. Timely scouting will ensure that the primary cause of the problem is identified.

Make sure that when you are scouting a field to note the symptoms that are present and the nature of their occurrence in the field. Make sure to inspect all parts of the plant, don't just focus on the above-ground parts, but be prepared to dig up and wash the root system to rule out root rots and crown diseases that may affect the seedling or adult plant. Note the age of the plant and growth stage as well as the extent and pattern of symptom development. Random patterns in field tend to suggest a biotic issue due to plant diseases, insects or weeds. In contrast, uniform patterns in field tend to suggest abiotic factors, such as planting, fertilizer or herbicide application problems. However, be careful about the patterns that occur as some diseases may not necessarily occur randomly through the field, but may be associated with field topography such as low or high spots.



When looking at the symptoms make sure to note whether they are chronic or acute as well as the nature of affected areas. If the affected areas appear to be gradually spreading, this may indicate a biotic agent, such as a plant disease or insect. If the affected area remains constant and does not appear to be spreading then it may suggest abiotic factors such as an area of poor soil quality/fertility or a previous herbicide spillage site. Noting changes in the affected areas may be more important for above-ground diseases that spread due to wind or rain-splash. In contrast, root rots such as take-all may remain confined to low areas in the field or areas where fertility problems are a concern. It is also important to note whether there is damage to the crop only or to all plants in the affected area. Damage that occurs on the crop as well as volunteers and weeds may indicate that an abiotic factor is responsible for the symptoms that are present.

Careful observation of symptoms and the use of resource information can help to identify the cause of a field problem. However, be cautious as the appearance of symptoms can vary dramatically, while different cropping issues may produce similar symptoms. It will be important to look for any diagnostic symptoms or structures that are produced by any suspected plant pathogens. Effective assessment of symptoms or pathogen structures will often require the use of a magnifying glass or microscope, which may not be practical to do in a field situation. At this point you may want to send the samples to a diagnostic lab for a more thorough assessment. While you are assessing symptoms in the field make sure to determine whether there are any correlations with field or weather characteristics as well as recent or past field activities, low spots, field edges, areas of compacted soil, well sites, etc. Be very cautious when trying to attribute symptoms to a plant disease when there have been periods of high temperatures and drought stress. These conditions will often lead to general yellowing or bronzing of the crop canopy as well as premature ripening. Unfortunately, we have seen too many cases of these types of symptoms being attributed to leaf disease problems. The common leaf diseases encountered in Alberta will typically produce distinct leaf lesions that may range from tan to dark brown in colour and may be immediately surrounded by areas of yellowing. Plant diseases routinely found in Alberta do not typically result in complete yellowing of leaves, without extensive lesion development.

Further Information

It is beyond the scope of the present paper to cover all potential issues that may affect your crop during the growing season. We have tried to highlight some general concepts and recommendations regarding the diagnosis of plant diseases and differentiating these from other issues that may affect the crop during the growing season. In addition, to this paper there is a wide selection of information available from various sources including extension staff, industry representatives, diagnostic laboratory personnel, and even your friendly neighbourhood plant pathologist. Some of the following websites may also be useful in terms of field scouting and the diagnosis of plant disease problems:

Canadian Phytopathological Society - <http://www.cps-scp.ca/index.html>

American Phytopathological Society - <http://www.apsnet.org>

<http://www.apsnet.org/education/IntroPlantPath/Topics/plantdisease/top.htm>

<http://scarab.msu.montana.edu/Diagnostics/DiseaseDiag.htm>

http://www.agf.gov.bc.ca/cropprot/sample_tips.htm

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/prm2365?opendocument](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm2365?opendocument)

<http://www.gov.mb.ca/agriculture/crops/cropproduction/gaa01d02.html>

<http://www.omafra.gov.on.ca/english/crops/pub811/1fscout.htm>

http://www.cahe.nmsu.edu/pubs/_h/h-158.html