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Differentiating Chemical and Disease Symptoms in the Field

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Introduction

In years with conditions favorable for seedling disease and other disease there are typically concerns and inquiries about the cause(s) of symptoms in agronomic plants. Many of the questions focus on differentiating between plant injuries potentially caused by recent herbicide applications versus symptoms caused by plant pathogens. Chemical injury in row crops is caused by chemicals such as herbicides, fertilizers, fungicides, insecticides, growth regulators, and crop oils when they are applied individually, as a mixture, or together with adjuvants. If chemicals are applied incorrectly, plants may be damaged at any point during the growing season. Chemical injury can result from carryover in the soil, contamination of the spray tank, spray drift, or misapplication. Damage may even be realized with chemical applications when recommended application guidelines are followed if other environmental conditions are adverse, including low soil temperatures, high soil moisture levels, or if young plants are exposed to high levels of various fertilizers. Factors such as the mode of action of the chemical, application rate, growing conditions, and growth stage of the crop determine the extent of injury and symptom expression. Symptoms of chemical damage are diverse and include leaf lesions with burned, necrotic patches, wilting, damping off and sometimes death of mature plants. These symptoms could easily be confused with those caused by various plant pathogens found throughout the state.

In most instances management actions cannot be taken during the year of the injury once you are past the replant timing. Therefore, you will want to correctly identify what is causing any stand problems to aid with future management actions.

Scouting – Determine Symptom Distribution

Field Distribution:

Symptom distribution in the field and on the plants can be the most valuable clues to the cause of the problem. Diseased plants can be identified by their overall wilting and discoloration of leaves. They will have rotted, decaying roots and/or lower stems. Because some organisms that cause disease survive in the soil, their diseases usually occur in patches in the field — randomly scattered or often associated with low, wet areas (Figure 1). Typically, when chemical injury is the cause, a high percentage of the plants will exhibit symptoms and the distribution will be more uniform across a field or in patterns that may be associated with applications (Figure 2.). Injury is not likely to be concentrated in pockets. Diseased plants also may be randomly scattered among otherwise healthy plants in the field. Field topography will be key in distribution factors. In very flat fields it is possible to have plants with seedling disease scattered across the field but this is rare. In the event that a high percentage of the plants are affected across the entire field, typically another stress or injury is triggering the plant response. Depending on the chemical history, it may be the result of an underlying chemical injury.

Plant Distribution:

After the distribution of symptoms has been identified in the field, the next level to evaluate is the symptom distribution on individual plants (Figure 3). The actual plant part affected can give critical clues to differentiating the cause of the problem. Most seedling diseases caused by a pathogen will result in root symptoms.
Conversely, the roots of a plant displaying herbicide injury on the aboveground parts may be completely healthy.

Plant Part Distribution:

Distribution patterns on the individual plant part (root, stem, leaf) can offer clues as to the pathogen involved. For example, soybean damage at the lower portion of the root system can often be associated with *Fusarium*, while lesions near the soil line are often due to *Rhizoctonia* (Figure 4).

Early Crop Development Symptoms and Injury

Seedling diseases are common in both soybean and corn. The most common seedling diseases have been those caused by *Pythium* species. These organisms require wet conditions so that their swimming spores can move toward and infect plant roots. Frequent and/or heavy rainfall events and cool temperatures are very conducive for infection by *Pythium* species.
Seedling diseases are often difficult to diagnose because their symptoms are very similar among several seedling diseases and may also be easily confused with other problems. Seedling diseases can be confused with insect injury, herbicide damage, planting problems, or environmental stresses that often have similar symptoms. Some of the possible symptoms of seedling diseases are:

- Rotted seed prior to germination
- Rotted or discolored seedlings after germination prior to emergence
- Post-emergence seedling damping off
- Root decay

Carefully dig up symptomatic plants/roots, as any rotted roots may be broken off more easily and lost in the soil. Distribution patterns on the individual plant root systems can offer clues as to the pathogen involved. We encourage you to correctly identify what's causing any stand problems to aid with future management actions.

More specific examples of early season injury are below.

Soybeans and Preemergence PPO Herbicide Injury

Three PPO herbicides are predominantly used for pre-emergence weed control in soybeans. These are:

- flumioxazin (in Valor®, Valor XLT®, Gangster®, Enlite®, and Envive®),
- saflufenacil (in Sharpen®, Optill®, Optill® PRO, and Verdict®), and
- sulfentrazone (in Authority First®, Authority Assist®, Authority® MTZ, Authority® XL, Authority® Elite®, Spartan®, and Sonic®).

These active ingredients provide residual control of many important annual broadleaf weeds in soybeans. They also can be effective in preplant burndown situations — depending upon the rate and weed species — because of their postemergence activity. They can be applied early preplant to shortly after soybean planting; however, severe injury can occur if they're applied as the soybean is cracking through the soil surface. (All labels of these products warn against applications at this point.)

From a weed management perspective, using these products in a diversified herbicide weed control program is beneficial and can help curb the progression of glyphosate-resistant weed development in Nebraska. However, if these products are not used properly, as with most herbicides, crop injury can occur. In very general terms, injury potential increases

- as the use rate increases, and/or
- as soil organic matter decreases, and/or
- the closer the application is to planting.

Additionally, there is a variable injury response among soybean varieties, ranging from highly tolerant to fairly susceptible. In the future, informing your seed dealer of your planned herbicide program is an important step to avoid pairing a susceptible variety with a preemergence PPO-based soybean herbicide program. Prolonged cool and wet weather conditions are ideal for adverse crop response to these products. Frequent or heavy rains as the hypocotyl arch is cracking through the soil surface or shortly after the cotyledons emerge can cause excessive herbicide uptake and subsequent injury. Cool temperatures reduce the rate at which the plant can metabolize (break down) the herbicide.

Injury will commonly display as reddish to purplish to brownish spots leading to necrotic tissue on the cotyledons and possible whittling of the stem at or near the soil surface. The potential to see injury often remains through the first few vegetative stages. Rain can splash soil with herbicide onto the unifoliates and first trifoliates, causing necrotic spotting and a crinkled appearance to some of the early developing trifoliates. In some instances it is difficult to assign specific levels of stand reduction to suspected causes such as herbicide injury, a soil-borne seedling disease, or cultural problems such as improper planting depth and soil crusting/compaction. Tissue injury from an excessive concentration or uptake of a PPO herbicide could cause points of infection for seedling diseases, while lack of vigor from seedling diseases could reduce a plant's ability to metabolize the PPO herbicide fast enough to prevent injury. Therefore, in many cases it can be difficult to identify the main cause of the injury.

Reduced Stands Can Still Perform Relatively Well

The fortunate reality is that soybean yield potential can remain relatively high, even at reduced populations resulting from herbicide injury or seedling disease. Based on the calendar date, decisions must be made regarding destroying and replanting thin soybean stands and should be considered in only the most extreme circumstances. Populations of 70,000-90,000 plants/acre and above should be accepted and retained at this point in the growing season.

While often difficult, it is important to correctly identify the cause of the stand reduction before determining future management actions for the field.

Wheat Disease or Herbicide Injury?

Diagnosing chemical injury in wheat can be difficult because the symptoms often resemble those caused by other abiotic agents and even some plant pathogens. To diagnose chemical injury requires thorough knowledge of individual plant symptoms, distribution of the injury in the field, chemicals that were recently applied to the field and its surroundings, environmental conditions, cultural practices, and field history. Clues to chemical injury include uniformly distributed symptoms that appear suddenly in the entire field or within areas in the field and absence of plant pathogen signs (e.g. fungal mycelium, fruiting structures, or spores; or bacterial ooze).

There is a wide variety of symptoms caused by chemical injury. Some symptoms are general whereas others result from specific chemicals or groups of chemicals. Phytotoxic seed treatments or excessive fertilizers can cause poor root development and seedling emergence. Excessive amounts of some herbicides (e.g. trifluralin) can cause swollen or ruptured coleoptiles.

Photosynthetic inhibitor herbicides such as atrazine can cause chlorosis followed by necrosis of leaves, starting from the leaf tip and progressing toward the base. Bleaching of foliage can result from exposure to pigment inhibitor herbicides such as clomazone.

A common symptom of chemical injury in wheat is localized foliar burn or leaf desiccation. This symptom, which can easily be confused with lesions caused by plant pathogens, insects, or physical damage, results when chemicals such as foliar fertilizers and certain herbicides are applied in concentrated droplets or drift from adjacent fields. Plants usually recover from this injury because it does not affect new growth and physiological development of the wheat crop.

Several different symptoms are caused by plant growth regulator herbicides such as 2, 4-D and dicamba. These symptoms include prostrate growth of tillers, stunting, and head abnormalities such as trapped or twisted awns, spikelet abortion, or sterility.

Exposure of wheat to glyphosate can cause severe injury at all stages of growth. Exposure during the vegetative growth stages can result in chlorosis, discoloration, and gradual plant death. In the heading growth stage, exposure to glyphosate at low levels can cause whitening and death of heads, leaving the rest of the plant green. This symptom can easily be confused with Fusarium head blight or scab (Figure 5).

Dry Bean Disease or Herbicide Injury?

Salt Damage

Beans are particularly susceptible to high levels of salinity whether in soil or irrigation water. This can be seen early in the season on newly emerging seedlings, or can also occur anytime during the season when salt from irrigation water may accumulate around plant stems at the soil level. This can then be confused with root disease caused by *Pythium* or *Rhizoctonia* as post-emergence damping-off. Plants affected by either problem will wilt quickly and die.

This is largely due to herbicide carryover due to lack of moisture that would normally flush any remaining chemicals out of the profile. The same relationship can be observed with salt. It accumulates in soils and doesn't get flushed out of the profile when we receive less than normal amounts of moisture from rain or snow.

Management

The best strategy for avoiding chemical injury is to follow label instructions and restrictions when applying a fertilizer, herbicide, fungicide, or insecticide. Application equipment should be correctly calibrated to avoid misapplication and applications should be avoided during extreme environmental conditions such as gusty winds and high or low temperatures.

Even with all of these clues, diagnosis of plant injury might require submission to a diagnostic laboratory for further confirmation. The Plant and Pest Diagnostic Clinic at the University of Nebraska – Lincoln offers disease diagnosis and can identify chemical injury based on field history and symptom identification.

Figure 1. Patchy distribution of symptoms in the field often associated with plant disease.

Figure 2. Uniform distribution of symptoms in the field associated with chemical injury.

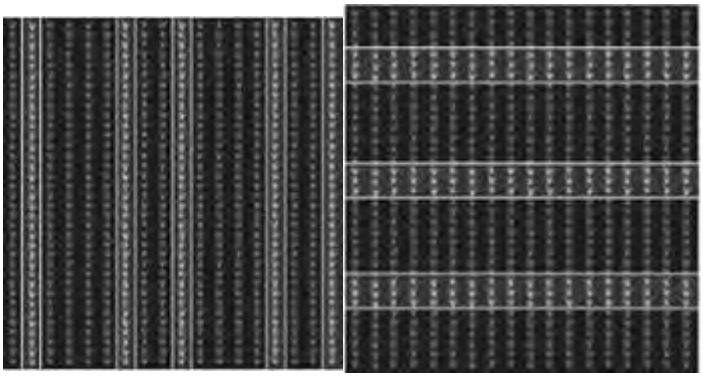

Figure 3. Symptom distribution on the plant level showing various plant parts affected.

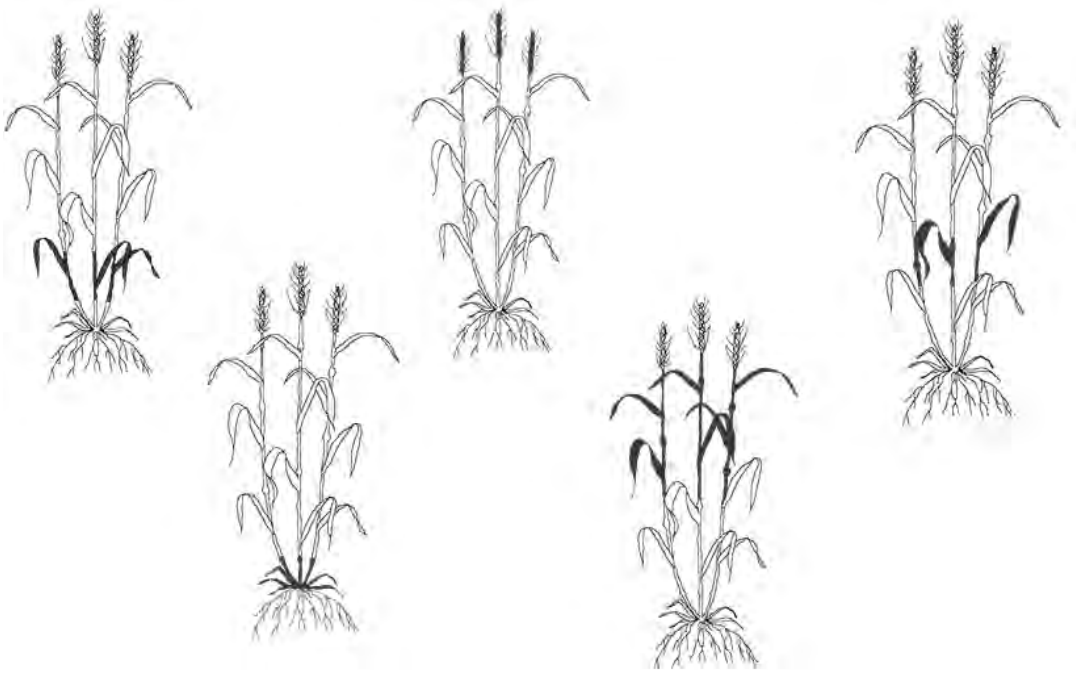

Figure 4. The difference in symptom expression between a) *Fusarium* and b) *Rhizoctonia* seedling diseases of soybean. *Fusarium* causes lesions on the lower root portions while *Rhizoctonia* causes lesions near the soil line. (Photo: Jim Stack, Kansas State University)

Figure 5. a) Glyphosate damage in a wheat field. Symptoms follow the pattern of the spray application. b) Fusarium head blight of wheat. Symptoms are randomly distributed throughout the field. Some heads are blighted while others are not.