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Major Fusarium Diseases on Corn, Wheat, and Soybeans in Nebraska

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Fusarium species have been associated with many important diseases of corn, wheat and soybean, causing significant yield loss in Nebraska; some produce mycotoxins that are harmful to both human and animal consumers. These pathogens are very common in agricultural field soil across the Midwest and cause numerous types of diseases.

***Fusarium graminearum* (*Gibberella zeae*)**

F. graminearum is an important pathogen of both corn and wheat at seed, seedling and mature stages. *F. graminearum* causes several diseases, such as Gibberella stalk rot, ear rot and kernel rot in corn, head blight (scab) of wheat, and seed rot and seedling diseases in both corn and wheat. Wheat-corn rotation is a popular dryland (non-irrigated) cropping system, and increases both wheat and corn diseases caused by *F. graminearum*.

***Fusarium verticillioides* (formerly *Fusarium moniliforme*)**

F. verticillioides is an important economic pathogen causing stalk rot, ear rot and kernel rot of corn. It is a different species from *F. graminearum*. Fusarium stalk rot in corn can be easily confused with Gibberella stalk rot, which can produce reddish discoloration of the internal stalk tissues.

Fusarium virguliforme

Fusarium virguliforme (formerly *Fusarium solani* f. sp. *glycines*) is a unique Fusarium species causing sudden death syndrome (SDS) of soybean. It was first discovered in Arkansas in 1971.

Multiple Fusarium species along or in combination cause seed, seedling and root diseases

Multiple Fusarium species existed in soil, some of them are common plant pathogens, which can damage seeds and seedlings and cause root rot. For instance, the following Fusarium species can cause seed and root rot on corn, wheat and soybeans, such as *F. oxysporum*, *F. solani*, *F. verticillioides*, *F. graminearum*, *F. culmorum*, *F. sublutinans*, *F. acuminatum*, *F. equiseti*, *F. merismoides*, *F. proliferaum*, *F. pseudograminearum*, and *F. semitectum*. Also in most of the time, Fusarium infects plant in combination with *Rhizoctonia*, *Phytophthora*, and *Pythium species*, which kill seeds before germination and cause seedling death under suitable condition for pathogens.

Most of the pathogenic Fusarium species are either soil borne or seed borne. The rest of the Fusarium species include saprophytic and endophytic (found within the plant without causing symptoms, for instance, *F. verticillioides* on corn). The majority of the growers in Nebraska use a wheat-corn, corn-soybean or corn-soybean-wheat rotation in combination with reduced-tillage or no tillage systems, which help prevent erosion, increase organic and soil water content. On the other side, crop residue left on the surface of the field will increase the diseases caused by Fusarium species to some extent. Also the wheat-corn rotation is used in pivot corners, so every three years the continuous irrigated corn is surrounded by wheat.

Fusarium diseases on corn

Gibberella stalk rot

Pathogens: *Fusarium graminearum.*

Symptoms: The inside stalk is pink to red discoloration, disease may produce small, round, black reproductive structures called perithecia on the surface of the stalk.

Conditions: Disease normally occurs at warm and wet weather in late summer, under stress such as drought, freezing and insect damage or herbicide injury.

Overwinter and Dispersal: the pathogens can over winter in crop residue, seed and soil. The pathogens can spread by soil and residue borne hypha and spores through root or stalk infection.

Management: Disease management includes seed treatment, planting less susceptible hybrids, avoiding crop stress and wounding, and crop rotation.

Gibberella ear or kernel rot

Pathogens: *Fusarium graminearum.*

Symptoms: Ear and kernel were characterized with reddish mycelium, starting usually on the tip.

Conditions: Disease normally occurs at cool and wet weather within 3 weeks after silking.

Overwinter and Dispersal: The pathogens can over winter in crop residue, seed and soil. The pathogens can spread by soil, air, and residue borne spores.

Management: Disease management includes seed treatment, planting less susceptible hybrids, avoiding crop stress and wounding, crop rotation, and harvesting early to prevent mold growth.

Fusarium stalk rot

Pathogens: *Fusarium verticillioides*.

Symptoms: The pith disintegrates; white fungal growth may develop on outside of the stalk, a pink discoloration inside rotted stalks, and lacks visible reproductive structures.

Conditions: Disease normally occurs at warm and wet weather after silking, under water stress and foliar diseases, insect or hail injury, and imbalanced fertility, such as high N to K ratio.

Overwinter and Dispersal: The pathogens can over winter in crop residue, seed and soil. The pathogens can spread by soil borne hypha and spores.

Management: Disease management includes seed treatment, planting less susceptible hybrids, avoiding crop stress and wounding, and balancing soil nutrient (avoid too much N), and crop rotation.

Fusarium kernel or ear rot

Pathogens: *Fusarium verticillioides*.

Symptoms: White, pink, to lavender mycelium on kernels scattered around ear. Some kernels may develop a "starburst" pattern.

Conditions: Disease normally occurs at hot and dry weather.

Overwinter and Dispersal: The pathogens can over winter in crop residue and soil. The pathogens can spread by soil borne hypha and airborne spores.

Management: Disease management includes seed treatment, planting less susceptible hybrids, avoiding crop stress and wounding, balancing soil nutrient, and crop rotation.

Fusarium root rot

Pathogens: *Fusarium oxysporum, F. verticillioides, F. graminearum et al.*

Symptoms: Complexes symptoms, roots are dark brown to black, discolored decaying or completely rotted.

Conditions: Diseases normally occur at cool wet weather, and stress.

Overwinter and Dispersal: The pathogens can over winter in crop residue and soil. The pathogens can spread by soil borne mycelium and spores through root infection.

Management: Disease management includes seed treatment with fungicides, minimizing stresses such as herbicide injury, foliar diseases, hail damage or drought, and crop rotation.

Fusarium diseases on wheat

Head blight (scab)

Pathogens: *Fusarium graminearum.*

Symptoms: Tan or brown discoloration at the base of a florets. Diseased spikelets become light tan or bleached. Orange clusters of spores on the glumes. Kernels are shriveled, white and chalky, and develop to pink discoloration.

Conditions: Disease normally occurs at intermediate to warm temperatures.

Overwinter and Dispersal: the pathogens can over winter in crop residue, seed and soil. The pathogens can spread by spores carried by air current.

Management: Disease management includes certified seeds with seed treatment, planting less susceptible varieties, balancing soil nutrient, and crop rotation with non-host, planting varieties with different flowering dates, and fungicide application at early flowering.

Fusarium seed and foot rot

Pathogens: *Fusarium graminearum*; *F. culmorum et al.*

Symptoms: Dark brown lesion around node of plants, whole stem base may become girdled by dark brown lesion. A cottony pink mycelium appears on stem base, plant produces white head when mature.

Conditions: Diseases normally occur at cool wet weather, under reduced tillage and stress.

Overwinter and Dispersal: the pathogens can over winter in crop residue and soil. The pathogens can spread by soil borne mycelium and spores through root infection.

Management: Disease management includes seed treatment with fungicides, planting adapted cultivars, controlling weeds in summer, and rotation with non-host crops.

Fusarium diseases on soybean

Sudden death syndrome (SDS)

Pathogens: *Fusarium virguliforme*.

Symptoms: Early symptoms are chlorotic mottling and crinkling of leaves, later lead tissue between the major veins turns yellow to brown. Interveinal cholorosis and necrosis are typical symptoms.

Conditions: Diseases normally occur at cool wet weather, under reduced tillage, stress such as infection by soybean cyst nematodes (SCN).

Overwinter and Dispersal: the pathogens can over winter in crop residue and soil, and infect through roots. The pathogens can spread by soil borne hypha and spores.

Management: Disease management includes planting tolerant varieties, delaying planting date, minimizing soil compaction and preventing soil movement.

Fusarium seed, root rot and wilt

Pathogens: More than 10 *Fusarium* spp.

Symptoms: Major symptom is characterized with seed decay, and brown to black cortical decay or vascular discoloration in roots. If root rot become severe, soybean plants develop foliar symptoms including stunting yellowing, wilting and defoliation.

Conditions: Disease normally occurs at cool wet weather, reduced tillage, and stress.

Overwinter and Dispersal: the pathogens can over winter in crop residue and soil. The pathogens can spread by soil borne mycelium and spores through root infection.

Management: Disease management includes seed treatment with fungicides, minimizing soil compaction, minimizing stress and injury by herbicides, iron deficiency, and hail injury, and planting soybean when soils are warmer.

Fusarium diseases and drought

2012 was a drought year with hot and dry weather, which influence Fusarium diseases in Nebraska. Drought can impact Fusarium diseases on corn, wheat and soybean at a certain level. Fusarium stalk rot, ear rot and kernel rot of corn caused by *Fusarium verticillioides*, are ones of the most common corn diseases, which cause significant yield losses and toxin contamination under drought and high temperature. Wheat root diseases, such as Fusarium crown rot caused by *Fusarium* spp., are also more severe under dry soil conditions. The early root infection can cause severe yield reduction under high temperatures in dry soils. However, sudden death syndrome (SDS) of soybean is not favored by drought conditions.

Overall management of *Fusarium* diseases

The pathogenic Fusarium species are soil borne microbes, which can survive in soil and crop residue for a long time. Fusarium pathogens constantly exist in soil and wait for the right condition to infect plants. Many factors can lead to disease development. Plant stress can increase the incidence and severity of the diseases. When plants are under stress, such as injury by herbicides, foliar diseases, hail damage and drought, or plants in soil with unbalanced fertility in macronutrients, nitrogen and potassium; Fusarium pathogens can easily penetrate and infect the stressed plants. Compacted soil also increase Fusarium diseases, therefore, minimizing soil compaction will help drainage, improve plant root growth, and reduce Fusarium diseases. If Fusarium infected grain is used as seed, fungicide seed treatments can be used to reduce seed rot and seedling diseases caused by *Fusarium* spp. Fungicide seed treatments can also reduce buildup of the Fusarium pathogens in soil. However, seed treatment is not suitable for the control of SDS of soybean. Cultural practice such as plowing can reduce Fusarium diseases, but plowing can increase soil erosion and loss of soil moisture. Another cultural practice is crop rotation with non-host crops such as wheat/corn with soybean/alfalfa rotation. Continuous cropping should be avoided, if the Fusarium diseases are severe in field, especially in reduced or no-till cropping systems. Again, SDS of soybean cannot by controlled by crop rotation. Using tolerant cultivars with different planting dates can help to reduce losses caused by Fusarium diseases.

In summary, since there is a lack of highly resistant or tolerant cultivars to Fusarium pathogens, integrated disease management should be adopted to manage Fusarium diseases. Therefore the following management strategies could be used to reduce losses caused by *Fusarium* spp.

- Minimize stress and injury by herbicides, foliar diseases, hail damage or drought
- Optimize soil fertility level
- Minimize soil compaction
- Seed treatment
- Crop rotation
- Planting tolerant cultivars