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Disease Factors to Consider in No-till

The effects of no-till on the development and severity of crop diseases is variable, depending on the disease and the effectiveness of disease management practices used. No-till generally reduces soil temperatures, conserves soil moisture, and leaves crop residue on the soil surface. These factors, by themselves, may increase, decrease, or have no effect on the development and potential severity of a disease, depending on the disease.

Crop diseases that are favored by cool, wet soils may be more troublesome with no-till, while diseases favored by higher soil temperatures and drier soils may be less bothersome. The largest number of diseases affected by no-till are those whose pathogens readily survive in infected crop residue left on the soil surface. These diseases include foliar diseases, ear rots, and stalk or stem rots. With many of these diseases, the effects of no-till are most noticeable where continuous monoculture cropping is practiced.

Knowledge of the important crop diseases in an area, the conditions that favor their development, and the history of disease occurrence for each field are important for the selection of adequate disease management practices. Because diseases, weather conditions, cultural practices, and hybrids or varieties grown can differ widely by geographical area within the state, this publication deals primarily with disease management principles. Symptoms and more specific management information of the diseases discussed can be found in other Kansas State University Research and Extension publications.

Disease Development

Every agricultural crop is subject to various plant diseases. Each disease has a specific set of conditions favorable for infection, development, and progression. The type and severity of diseases vary from year to year, from area to area, from field to field, and often within a field in any given year. Some diseases, even when present, are not economically important, while others can result in significant economic losses in certain years. While some level of disease will occur in every field each year, the objective is to keep any disease from developing to economically damaging proportions. The development of any given disease depends on three factors:

- Susceptibility of the crop cultivar
- The presence of a virulent pathogen
- Environmental conditions favorable for infection and disease spread

Pathogens found in Kansas include many species of fungi, bacteria, viruses, and nematodes. The most critical environmental factors include air and soil temperatures, soil moisture, rainfall frequency or amounts, relative humidity, soil type, and, with certain diseases, soil pH and fertility. Some pathogens (most viruses and a few bacteria) require a vector, such as an insect, fungus, or nematode, in order to move from plant to plant or field to field. The population and activity of a vector depends on factors similar to those that affect disease development. When all three factors (host, pathogen, and environmental conditions) occur at the right time, a disease occurs. If these factors remain favorable for an extended period of time, the disease can become an epidemic. If one or more of the factors is absent, the disease will not develop. Disease management practices therefore are aimed at eliminating, reducing, or altering one or more of these factors.

General disease management practices include:

- Crop rotation
- Tillage
- Use of resistant or tolerant hybrids or varieties
- Planting date
- Insect management
- Weed control
- Maintaining adequate soil fertility
- Use of fungicides when needed

The major diseases affected by no-till in Kansas can be grouped into four categories:

- Seed rots and seedling blights
- Foliar diseases
- Root, stem and stalk rot diseases
- Ear and seed diseases

Virus diseases are usually not directly affected by no-till. Some aphid-vectored virus diseases may be reduced under no-till since research has shown that winged aphids are more often attracted to barren ground, such as in a conventional tillage system, compared to ground covered by residue. Where adequate weed control is not maintained in no-till, weeds such as Johnsongrass may serve as virus reservoirs.

Corn Diseases

Seed Rots and Seedling Blights

Seed rots are most damaging when soils are cold and wet, and the seed does not germinate in the soil for an extended period of time. No-till conditions, especially if combined with early planting, often favor the development of seed rot. Seedling blights, which generally occur within a few weeks after emergence, are most damaging when cold soil and air temperatures significantly reduce the rate of seedling development. Improperly stored carryover seed that has a reduced germination rate increases the chances for both seed rots and seedling blights. Several organisms can cause these diseases; some are seedborne, while others reside in the soil. The severity of disease depends on the pathogen, seed-to-soil contact, seed quality, soil moisture, and soil temperature. To reduce the incidence and severity of seed rots and seedling blights in no-till:

- Avoid the use of carryover seed.
- Plant at proper depth and spacing, and when soil temperatures are higher than 52 degrees Fahrenheit.
- Make sure press wheels are adjusted to insure proper closure of the seed furrow.
- All commercial corn seed is pretreated with a fungicide, but supplemental hopper box treatments have been shown to improve emergence and final stand count when weather and soil conditions are especially severe.

Foliar Diseases

Numerous foliar diseases affect corn. Only those that overwinter in Kansas are directly affected by no-till. Foliar diseases found in Kansas no-till fields include gray leaf spot, anthracnose, northern corn leaf blight and occasionally Physoderma brown spot.

The most important of these diseases is gray leaf spot. Yield losses as high as 40 percent have been reported in individual fields. Gray leaf spot often leads to increased stalk rot damage as well. The disease causes the greatest yield losses in the hilly areas of northeast, south central, and southwest Kansas where no-till is needed to prevent significant wind and water erosion. Under continuous, no-till corn, the severity of gray leaf spot depends on the susceptibility of the hybrid and the weather conditions before tasseling. Prolonged periods of wet, cloudy, humid weather are usually associated with the development of severe gray leaf spot problems. Yield losses usually occur when symptoms occur on or above the ear leaf before the dough stage. Thus, the earlier gray leaf spot occurs in the season, the greater the yield loss may be. Where continuous, no-till corn is being grown, especially in the previously indicated areas, an active scouting program is recommended. Fields should be scouted once or twice per week starting 2 to 3 weeks before tasseling is expected. A fungicide should be used when economic thresholds are reached.

In Kansas, northern corn leaf blight and Physoderma brown spot rarely develop to levels high enough to warrant spraying. Foliar symptoms of anthracnose are usually minimal. However, this disease can be important as a stalk rotting pathogen.

To reduce the incidence and severity of foliar corn diseases in no-till:

- Select hybrids based not only on yield potential, but also on disease resistance. These ratings are usually available in seed company catalogs.
- Use crop rotation. In some instances where residue breakdown is slow, 2 years out of corn may be necessary to reduce the amount of disease inoculum to a level below that which will not potentially require a fungicide application.
- Scout fields 2 to 3 weeks before tasseling and apply a fungicide if the economic threshold is reached.

Ear Diseases

Ear disease pathogens survive best in crop debris. Thus, there can be increased levels of ear rotting diseases when no-till is combined with continuous corn production. Numerous pathogens cause ear rots in Kansas including *Aspergillus*, *Fusarium, Diplodia, Gibberella, Trichoderma, Penicillium,* and *Nigrospora*.

The most important ear-rotting fungi are those that produce mycotoxins in infected kernels. Mycotoxins are chemicals produced by some fungi that are toxic to both animals and humans. These mycotoxins are perhaps more significant than any yield loss caused by fungi. *Aspergillus flavus,* a common ear rot pathogen, can produce aflatoxin, a potent carcinogen. It is most severe in years when there is drought stress during kernel development, followed by wet conditions late in the season. Research indicates that aflatoxin is often less severe where soil moisture is maintained by no-till conditions. Other ear rotting fungi can produce mycotoxins as well. Vomitoxin and zearalenone are produced by *Gibberella zeae,* and fumonisin is produced by *Fusarium moniliforme.*

To reduce yield and quality losses resulting from ear rots in no-till:

- Select adapted hybrids.
- Rotate crops, especially in fields that had significant ear rots or certain stalk rots the previous year

and when good resistant hybrids are not available.

- Control insects such as corn earworms, etc. by using Bt type hybrids where the event is expressed in the ear.
- Harvest promptly. When ear rots are present, dry the grain to 14 percent moisture as rapidly and as thoroughly as possible. Dry grain management and aeration are essential to prevent further disease development or mycotoxin production.

Stalk Rot Diseases

Stalk rot diseases occur throughout Kansas every year. The most common stalk rot diseases are Fusarium, Gibberella, anthracnose, charcoal rot, and Diplodia. All of the stalk rots except charcoal rot are potentially more severe where corn follows corn in a no-till system. Where crops are rotated, on the other hand, charcoal stalk rot may be less severe under no-till due to better moisture conservation. In almost all cases, stalk rot diseases are more severe when plants are stressed by any of several factors during the growing season, regardless of tillage system. Stalk rots prematurely kill plants and can cause lodging. Prematurely killed plants will yield less as a result of smaller ears and lightweight kernels.

To reduce the incidence and severity of stalk rots in no-till:

- Select hybrids that have good stalk strength and stay-green characteristics. Full-season hybrids are generally more resistant to stalk rots than short-season hybrids.
- Use hybrids with resistance to leaf blight diseases. Leaf blight stress, especially from gray leaf spot, can increase the incidence and severity of stalk rots.
- Rotate crops (to crops other than grain sorghum), especially in fields that had significant stalk rot the previous year and where good resistant hybrids are not available.
- Manage soil fertility to minimize nutrient deficiencies or excesses. Shortages of both potassium and chloride may result in increased lodging, especially where high rates of nitrogen are used.
- Do not exceed plant populations recommended for the particular hybrid used, or for the soil moisture available.
- Control insects such as root worms, corn borers, etc.
- Manage stress-producing factors such as soil compaction, nutrient deficiencies, herbicide stress, weeds, low soil pH, etc.
- Harvest promptly. When significant stalk rotting (15 percent of the plants in a field) is present, harvest as early as possible to reduce potential lodging losses. Drying costs seldom exceed yield losses due to lodging when stalk rot is prevalent.

Grain Sorghum Diseases

Seed Rot and Seedling Blights

The two major seedling blight diseases in grain sorghum are caused by *Pythium* and *Fusarium*. *Pythium* is favored by cool, wet soils, and therefore may be favored by no-till. *Fusarium* species survive well in crop debris and also are favored by no-till. Management of seed rots and seedling blights in grain sorghum is similar to corn.

To reduce sorghum seedling blights in no-till:

- Avoid the use of carryover seed.
- Use adapted hybrids that have good early season vigor.
- Plant at the proper depth and spacing. Make sure press wheels are adjusted to ensure proper closure of the seed furrow.
- Plant after soil temperatures reach 70 degrees Fahrenheit to ensure rapid germination and emergence.
- All commercial grain sorghum seed is pretreated with a fungicide, but supplemental hopper box treatments have been shown to improve emergence and final stand count when weather and soil conditions are especially severe.
- Make sure soil is limed to a pH of 6.0 or higher. Acid soils favor Fusarium infection.

Foliar Diseases

While a number of foliar diseases occur on grain sorghum, only sooty stripe has been shown to cause significant economic yield loss. Yield losses can approach 30 percent where susceptible hybrids are grown. Increases in zonate leaf spot and rough leaf spot also have occurred in recent years. The severity of these foliar diseases has increased over the years as tillage has been reduced. This is especially true where rotation is not practiced. This increase has occurred because these organisms readily survive through the winter on surface debris.

To reduce levels of foliar diseases in no-till:

- Plant hybrids tolerant to sooty stripe when available.
- Rotate crops. When disease levels are high, one year is probably not sufficient.

Stalk Rot Diseases

Fusarium and charcoal rot are the predominant stalk rots attacking grain sorghum in Kansas. Fusarium stalk rot will be favored by continuously cropping sorghum into high levels of sorghum or corn residue. Research has shown that in a no-till, wheat-sorghum-fallow system, also known as ecofallow, the increase in available soil moisture greatly limits the development of stalk rot. Likewise, increased soil moisture may actually reduce charcoal rot severity under no-till. Since

stalk rot in grain sorghum is caused by the same organisms that cause stalk rot in corn, management principles are the same. See management practices for stalk rots of corn.

Soybean Diseases

Seed Rots and Seedling Blights

Seed rots and seedling blights occur when soil temperature and moisture conditions are unfavorable for rapid seed germination and/or seedling growth. The most important seedborne diseases are Phomopsis, anthracnose and purple seed stain. Important soilborne diseases include Phytophthora, Rhizoctonia, Pythium, and Fusarium root rots. Phytophthora and Pythium root rots are more severe in poorly drained, fine-textured clay soils. Research shows that these diseases are most severe in no-till planting systems. *Pythium* is favored by cool, early-season soil temperatures. *Phytophthora* is favored by the warmer, wetter soils of mid- to late-summer. Phomopsis, anthracnose, purple seed stain, and Rhizoctonia root rot may or may not be more severe with no-till, depending on seed-to-soil contact, seed quality, and soil moisture and temperatures.

To reduce the incidence and severity of seed rots and seedling blights in no-till:

- Delay planting until soils are drier and warmer.
- Plant at the proper depth and spacing when environmental and soil conditions favor rapid germination and seedling growth.
- There are many races of Phytophthora in Kansas soils. Select cultivars with good field tolerance to Phytophthora root rot on fields with a potential for this disease. Use of race-specific resistance can provide excellent control in some fields. The broadest spectrum of resistance will be provided by varieties with either the Rps1c or Rps1k source of resistance.
- Seed treatment fungicides containing azoxystrobin, pyraclostrobin, trifloxystrobin, carboxin, thiabendazole, thiram, etc. are effective when Phomopsis or other seedborne diseases are present, especially when planting under unfavorable conditions. Seed treatment with a fungicide containing metalaxyl or mefanoxam can be beneficial in reducing the effects of *Phytophthora* and *Pythium* in soils with a history of either of these diseases.

Root and Stem Diseases

The major root- and stem-disease-causing organisms of soybeans can survive in the soil in the absence of soybeans for several years and are not greatly affected by no-till. Exceptions are Phytophthora root rot and sudden death syndrome (SDS), which are favored by the wetter soils associated with no-till; and stem canker, which survives primarily in infected crop residue and may be more severe where soybeans follow soybeans and infected crop residue is left on the soil surface. White mold also may be favored by the increased soil moisture associated with no-till. No-till may reduce losses due to charcoal rot by conserving soil moisture and reducing soil temperature.

To reduce the incidence and severity of root and stem diseases in no-till:

- Select cultivars with either race-specific resistance or field tolerance to Phytophthora root rot on fields with a potential for this disease. Resistant cultivars for stem canker are also available.
- Where SDS is a problem, select tolerant varieties. Varietal performance against SDS can be found for all varieties entered in the K-State soybean crop performance test.
- Rotate soybeans with non-legume crops.
- Delay planting until soils are drier and warmer.
- Narrow-row or solid-seeded soybeans planted no-till may reduce the severity of charcoal rot by conserving soil moisture. However, excessive plant populations may increase the severity of charcoal rot in hot, dry years.
- Avoid drilling or solid-seeding soybeans where white mold has become established.

Foliar Diseases

There are numerous foliar diseases that may affect soybeans, but typically yields are unaffected. Common foliar diseases that survive on crop residues include brown spot, frogeye leaf spot, bacterial blight, and Cercospora blight (purple seed stain). These diseases are only a problem in no-till where rotation is not practiced.

To reduce the incidence and severity of foliar diseases in no-till:

- Rotate crops. Generally one year out of soybeans is sufficient.
- Use a fungicide when crop prices make it economical to do so.

Seedborne Diseases

Phomopsis, also known as the pod and stem blight complex, purple seed stain, and anthracnose are the most common seedborne diseases in Kansas. All may be more severe where soybeans follow soybeans and infected crop residue is left on the soil surface. All are favored by extended wet weather during pod fill. The pod and stem blight complex can be especially damaging when warm, wet weather occurs during the later stages of pod fill or when harvest is delayed by wet conditions.

To reduce the incidence and severity of seed diseases in no-till:

- Rotate crops. Generally one year out of soybeans is sufficient.
- Harvest early to reduce pod and stem blight development, especially in fields being grown for seed.

- Use a fungicide applied at the R3 (pod set) to R5 (pod fill) stage of development.

Nematode Diseases

The soybean cyst nematode (SCN) is the second most serious disease of soybeans in Kansas after charcoal rot. No-till may slow the rate of spread of the nematode by minimizing soil movement in a field. The SCN also interacts with charcoal rot to create greater losses than either disease would cause individually. No-till can affect the charcoal rot disease complex by reducing losses through the conservation of soil moisture and the reduction of soil temperatures.

To reduce losses from the SCN in no-till:

- Select cultivars with good resistance to SCN. Varietal performance against SCN can be found for all varieties entered in the K-State soybean crop performance test.
- Rotate crops and sources of resistance. Where alternate sources of resistance are not available, rotate resistant varieties each time soybeans are planted.

Wheat Diseases

No-till production of wheat can be done efficiently in many parts of Kansas. The transition to no-till production, however, will increase the importance of other disease management practices including rotation, variety selection, and foliar fungicides. For example, tan spot and head scab are two diseases that are commonly associated with no-till production of wheat in Kansas because the fungi that cause these diseases survive on the crop residues. Tan spot is often most severe in fields planted to continuous wheat and the risk of head scab is elevated when wheat is planted into corn residue. The risk of tan spot, and head scab can be reduced through crop rotation. A single year of rotation with soybean or other legume crop is often enough to reduce the risk of disease.

No-till production also can increase the risk of several other diseases including Septoria tritici blotch, Stagonospora blotch, and take-all. If volunteer wheat is not completely killed before planting wheat, then no-till also can result in a higher risk of wheat streak mosaic and leaf rust in continuous wheat. The risk of these diseases varies throughout the state, and the importance of the diseases depends on the environmental conditions. It is important to learn about the relative importance of these diseases in your area and implement management strategies to reduce the potential impact on the productivity of your farm operations. Additional information regarding the regional importance and management of wheat diseases in Kansas can be found online at the extension plant pathology Web site for Kansas State University.

Summary

- The risk of many leaf spots, ear rots, and stalk rots is increased by continuous, no-till cropping.
- No-till is riskier in continuous cropping because disease organisms can survive in the old crop residue.
- Crop diseases favored by cool, wet soils may be more troublesome with no-till. These include seed rots and seedling diseases.
- Moisture conservation due to no-till cropping decreases the occurrence of charcoal rot in many rotations.

Effect of No-Till vs Conventional till on Disease Risk Following various crops

	Previous Crop / No-Till									
Crop / Disease	**Wheat**	**Corn**	**Grain Sorghum**	**Soybeans**	**Sunflower**	**Oats**	**Alfalfa**	**Native Grass**	**Barley**	**Brome grass**
Wheat										
Leaf Rust	L*	—	—	—	—	—	—	—	—	—
Septoria leaf blotch	M	—	—	—	—	—	—	—	—	—
Stagnospora leaf blotch	M	—	—	—	—	—	—	—	—	—
Tan spot	H	—	—	—	—	—	—	—	—	—
Take-all root rot	H	—	—	—	—	—	—	—	H	H
Wheat streak mosaic	H*	—	—	—	—	—	—	—	H*	—
Scab	L	H	L	—	—	—	—	—	L	—
Corn										
Seed rots and seedling blights	M	H	H	M	M	M	M	M	M	M
Gray leaf spot	—	H	—	—	—	—	—	—	—	—
Anthracnose	—	H	—	—	—	—	—	—	—	—
Northern corn leaf blight	—	H	—	—	—	—	—	—	—	—
Fusarium/Diplodia stalk rots	L	M	M	—	—	—	—	—	—	—
Charcoal stalk rot	B	L	L	L	B	B	B	B	B	B
Ear molds	M	M	H	—	—	—	—	—	—	—
Grain Sorghum										
Pythium seedling blight	M	M	H	M	M	M	M	M	M	M
Fusarium seedling blight	M	M	H	—	—	—	—	—	—	—
Sooty stripe	—	—	H	—	—	—	—	—	—	—
Zonate leaf spot	—	—	H	—	—	—	—	—	—	—
Maize dwarf mosaic	—	—	—	—	—	—	—	—	—	—
Fusarium stalk rot	L	M	M	—	—	—	—	—	—	—
Charcoal stalk rot	B	L	L	L	B	B	B	B	B	B
Soybeans										
Seedling diseases	M	M	M	H	M	M	M	M	M	M
Phytophthora root rot	L	L	L	H	L	L	L	L	L	L
Stem canker	—	—	—	H	—	—	—	—	—	—
White mold	L	L	L	M	M	L	L	L	L	L
Charcoal rot	B	L	L	M	B	B	B	B	B	B
Brown spot	—	—	—	H	—	—	—	—	—	—
Purple seed stain	—	—	—	H	—	—	—	—	—	—
Pod and stem blight	—	—	—	H	—	—	—	—	—	—
Sudden death syndrome	—	—	—	M	—	—	—	—	—	—
Sunflower										
Seedling diseases	M	M	M	M	H	M	M	M	M	M
Rust	—	—	—	—	L	—	—	—	—	—
Phoma black stem	—	—	—	—	H	—	—	—	—	—
White mold	L	L	L	M	M	L	L	L	L	L
Rhizopus head rot	—	—	—	—	L	—	—	—	—	—

H = High additional risk of disease due to no-till vs. conventional tillage
M = Medium additional risk
L = Low additional risk
— = No additional risk
B = Beneficial effect of no-till vs. conventional tillage on disease severity
*Additional risk depends on amount of volunteer present at planting

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