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These e-Updates are a regular weekly item from K-State Extension Agronomy and Kathy Gehl, Agronomy e-Update Editor. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Kathy Gehl, 785-532-3354 kgehl@ksu.edu, or Curtis Thompson, Extension Agronomy State Leader and Weed Management Specialist 785-532-3444 cthompso@ksu.edu.

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1. Factors to consider in winter survival of wheat

The following are some of the factors to consider when evaluating the outlook for winter survival of wheat:

Cold acclimation of the crop and maintenance of cold hardiness

During the fall, winter wheat seedlings spend the first month or so of their lives developing their first leaves, the crown, and a secondary root system. All the while the seedlings are building and storing the energy they will need to go through the cold acclimation process and survive the winter. Normally seedlings will need a minimum of 4-5 leaves and one or two tillers to build up enough stored energy reserves to survive the winter. Ideally, the wheat plant would have 3 to 5 tillers prior to the onset of the winter. Seedlings will have a better chance of winter survival if their crowns are well developed in firm soil, about one inch below the soil surface.

Winter hardiness or cold tolerance is a physiological process triggered by gradually cooling temperatures in the fall. During the process of cold acclimation, certain genes within winter wheat begin to initiate the production of "anti-freeze" type substances to protect the cell membranes. The process of cold acclimation within a sufficiently developed wheat seedling begins when soil temperatures at crown depth fall below about 50 degrees F (Figure 1).

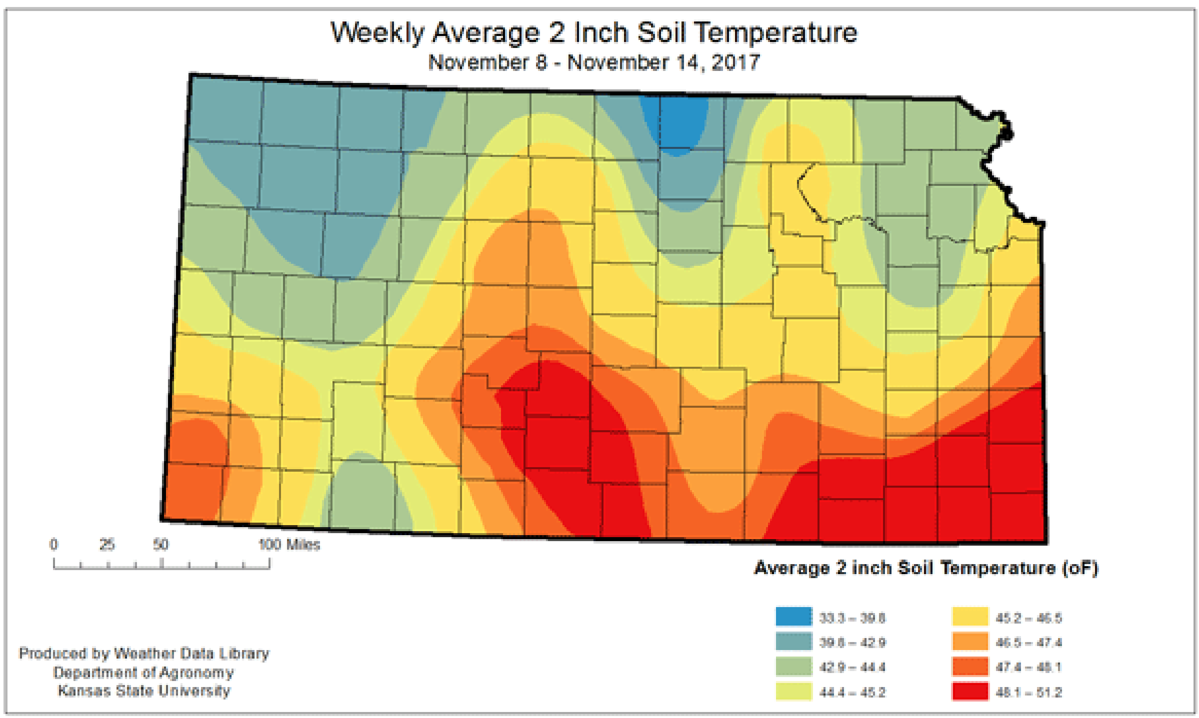

Figure 1. Average 2-inch soil temperature during the November 8 – 14 period, 2017. Temperatures for the majority of the state were below the 50°F threshold needed to initiate the process of cold acclimation in winter wheat. Data and map by Kansas Mesonet.

Below 50 degrees F, there is an inverse relationship between crown temperatures and cold acclimation, meaning that plants will acclimate twice as fast when crown temperatures are 32 degrees F as compared to 40 degrees F. Photoperiod also plays a role in the process of cold hardening, with shorter days and longer nights helping initiate the process. Winter survival depends on the crown remaining alive and the substances that produce cold acclimation are most needed within the crown.

It takes about 4 to 6 weeks of soil temperatures below 50 degrees at the depth of the crown for winter wheat to fully cold harden. The colder the soil at the depth of the crown, the more quickly the plants will develop winter hardiness. However, cold hardiness is not a static state. After the cold hardening process begins in the fall, wheat plants can rapidly unharden when soil temperatures at the depth of the crown get above 50 degrees F. But the plants will re-harden as crown temperatures cool below 50 degrees again. By the time winter begins, winter wheat will normally have reached its maximum level of cold hardiness. Wheat in Kansas normally has its maximum level of winter hardiness from mid-December to mid-January, unless there are high temperatures during that period.

Even during the depths of winter, winter wheat is still respiring and roots may be growing – as long as the ground is not frozen. It is not unusual to find a much more developed crown root system in early February than existed in early December. It is also not unusual to see some green leaves intermingled with straw-colored or pale leaves in the winter (Figure 2). The fact that some of the leaves have some green color does not mean the wheat is not cold tolerant.

Figure 2. Wheat plants starting to show straw-colored or pale leaf tips as consequence of cold temperatures near Healy. Brown, dried leaves do not necessarily indicate winter injury. The only way to assess the plant's condition following winter is to examine the crown for winterkill.

Photo by Romulo Lollato, K-State Research and Extension.

Once winter wheat has reached the level of full cold hardiness, it will remain cold hardy as long as crown temperatures remain below about 32 degrees F– assuming the plants had a good supply of energy going into the winter.

If soil temperatures at the crown depth rise to 50 degrees F or more for a prolonged period, there will be a gradual loss of cold hardiness, even in the middle of winter. The warmer the crown temperature during the winter, the more quickly the plants will start losing their maximum level of cold hardiness. Winter wheat can re-harden during the winter if it loses its full level of winter hardiness, but will not regain its maximum level of winter hardiness.

Even at its maximum level of winter hardiness, winter wheat can still be injured or even killed by cold temperatures if temperatures at the crown level reach single digits or if plants are subjected to long periods when soil temperatures approach the minimum survival temperatures. Thus, winter survival is affected not only by how cold it gets, but the duration of cold temperatures. As soil temperatures at the crown level rise to 50 degrees or more, usually in late winter or spring, winter wheat will gradually lose its winter hardiness entirely. Photoperiod also plays a role in this process, and there are varietal differences in winter hardiness. When the leaves switch from being prostrate to upright, the plants will have completely de-hardened.

Fall root system development

Good top growth of wheat doesn't necessarily indicate good root development. Poor root development is a concern where conditions have been dry. Where wheat plants have a good crown root system and two or more tillers, they will tolerate the cold better. If plants are poorly developed going into winter, with very few secondary roots and no tillers, they will be more susceptible to winterkill or desiccation, especially when soils remain dry. Poor development of secondary roots may not be readily apparent unless the plants are pulled up and examined (Figure 3). If secondary roots are poorly developed, it may be due to dry soils, poor seed-to-soil contact, very low pH, insect damage, or other causes.

Figure 3. Differences in wheat development prior to winter dormancy. Both examples should be able to make it through the winter, although the more developed root system in the photo to the right will be able to provide water and nutrients with less limitations to the plant during the winter. Photos by Romulo Lollato, K-State Research and Extension.

Soil temperatures at the crown level

Soil temperatures at crown level depend on snow cover, moisture levels in the soil, and seedbed conditions. Winterkill is possible if soil temperatures at the crown level (about one inch deep if the wheat was planted at the correct depth) fall into the single digits. If there is at least an inch of snow on the ground, the wheat will be insulated and protected, and soil temperatures will usually remain above the critical level. Also, if the soil has good moisture, it's possible that soil temperatures at the crown level may not reach the critical level even in the absence of snow cover. However, if the soil is dry and there is no snow cover, there may be the potential for winterkill, especially on exposed slopes or terrace tops, depending on the condition of the plants. During the 2017-18 growing season, despite excellent moisture conditions at sowing (early to mid-October), most of the wheat growing region in the state has not received substantial precipitation for over 30 days (Figure 4), and the topsoil is possibly dry through central and western Kansas. Dry soils and loose seedbeds warm up and cool down much faster than moist or firm soils, contributing to winter injury.

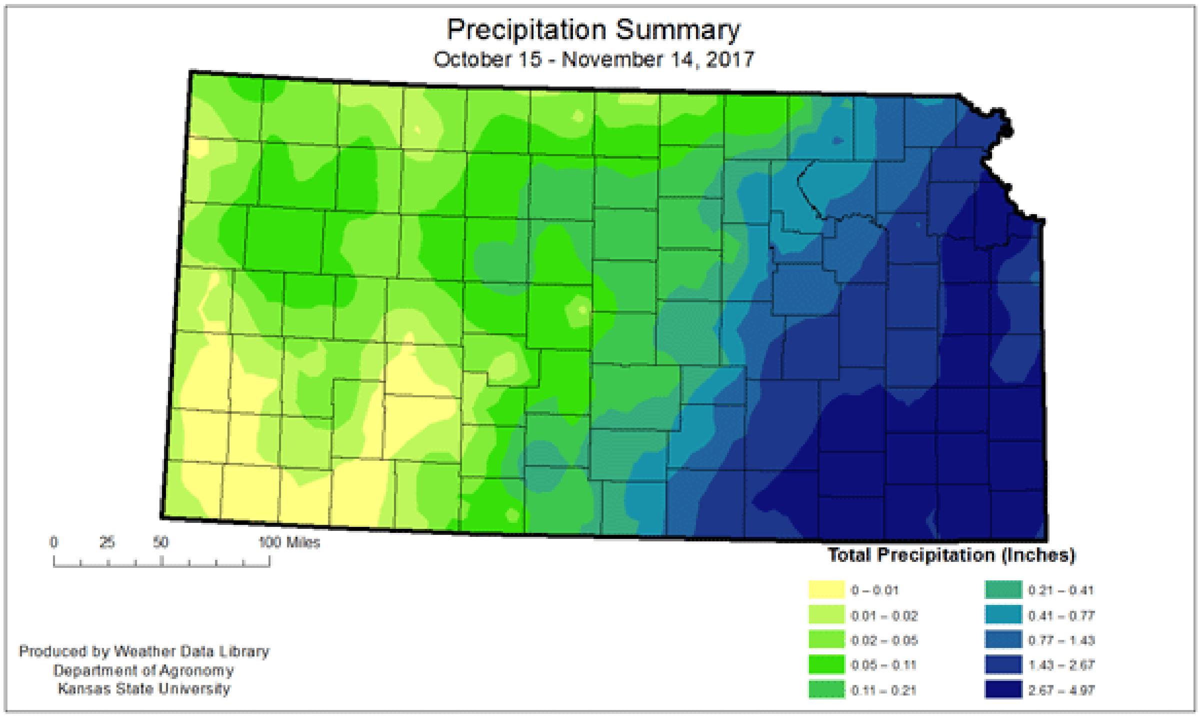

Figure 4. Cumulative precipitation from October 15 – November 14, 2017. While eastern Kansas received as much as 4.97 inches, the majority of the central and western portions of the state, where wheat is mostly grown, received less than 0.21 inches. Dry topsoil might result in greater exposure to winterkill, especially if the canopy is not well developed (see accompanying eUpdate article for a discussion on current crop conditions). Map and data from Kansas Mesonet.

Is the crown well protected by soil?

If wheat is planted at the correct depth, about 1.5 to 2 inches deep, and in good contact with the soil, the crown should be about one inch below the soil surface and well protected by the soil from the effects of cold temperatures. If the wheat seed was planted too shallow, then the crown will have developed too close to the soil surface and will be more susceptible to winterkill. Also, if the seed was planted into loose soil or into heavy surface residue, the crown could be more exposed and susceptible to cold temperatures and desiccation.

Is there any insect or disease damage to the plants?

Plants may die during the winter, not from winterkill, but from the direct effects of a fall infestation of Hessian fly. Many people are familiar with the lodging that Hessian fly can cause to wheat in the spring, but fewer recognize the damage that can be caused by fall infestations of Hessian fly. Wheat infested in the fall often remains green until the winter when the infested tillers gradually die. Depending on the stage of wheat when the larvae begin their feeding, individual tillers or whole plants can die. If the infestation occurs before multiple tillers are well established then whole plants can die. If the plants have multiple tillers before the plants are infested then often only individual tillers that are infested by the fly larvae will die.

The key to being able to confirm that the Hessian fly is the cause of the dead tillers is to carefully inspect the dead plants or tillers for Hessian fly larvae or pupae. This can be done by carefully removing the plant from the soil and pulling back the leaf material to expose the base of the plant. By late winter all of the larvae should have pupated and thus the pupae should be easily detected as elongated brown structures pressed against the base of the plant. The pupae are fairly resilient and will remain at the base of the plant well into the spring.

Damage from winter grain mites, brown wheat mites, aphids, and crown and root rot diseases can also weaken wheat plants and make them somewhat more susceptible to injury from cold weather stress or desiccation.

Fall armyworms and army cutworms may have fed on emerging wheat in the previous month, leaving bare patches. If the worms were fall armyworms, they have died by now. If the worms were army cutworms, they will overwinter where they are in the soil and continue to feed on wheat plants anytime the temperature is 45 degrees F or higher from now through around April.

So if you have bare patches now, it is a good idea to keep an eye on them and if they slowly expand over the winter, get out and check in the soil around the base of the plants to see if there are small worms curled up about an inch or two below the surface, especially in loose soils. A spot application of a registered insecticide on a warm (above 55 degrees F) winter afternoon will do a pretty good job of controlling the worms and allow the plants to come back in the spring as these worms only feed on the above-ground leaf tissue, and not on the roots or crown.

Symptoms of winter survival problems

Symptoms of winterkill will be more apparent when the weather warms up and plants start to green up early spring. If plants are killed outright by cold temperatures, they won't green up next spring. But if they are only damaged, it might take them a while to die. In some cases, damaged plants will green up and then slowly go "backwards" and eventually die. This happens because although there may be enough nutrients in the crown to allow the plants to green up, the winter injury causes vascular damage so that remaining nutrients cannot move, or root rot diseases move in and kill the plants. This slow death is probably the most common result of winter injury on wheat.

Direct cold injury is not the only source of winter injury. Under dry soil conditions, wheat plants may suffer from desiccation. This can kill or weaken plants, and is actually a more common problem than direct cold injury.

Summary

Ideally wheat plants should have at least 1-2 tillers and 3-5 leaves, as well as a good crown root system development, when going into the winter. However, the majority of the Kansas wheat crop was sown relatively late during the 2017-18 growing season, and has faced below-average temperatures, which slowed down crop development (please see accompanying eUpdate article on the current crop development and considerations with the delayed emergence). A fall with open field conditions, gradually falling soil temperatures, and little snow cover until freeze-up, will contribute to winter hardiness development by the wheat crop. During the winter, moist and firm soil, as well as at least an inch snow cover, will help buffer and insulate crown temperatures and increase the chances of winter survival.

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2. Kansas wheat crop progress as of mid-November 2017

The 2017 winter wheat crop in Kansas started out with the unusual challenge of excessive moisture conditions during the optimum sowing window. As a consequence, wheat sowing was delayed for a large portion of the state until mid-October. Afterwards, temperatures have been below-average, thus slowing down crop development. What are the consequences of the delayed sowing progress and below-average temperatures?

Winter wheat sowing delay for 2017-18

Not much of the wheat area was planted before the late-September/early-October rains started as the majority of Kansas was relatively dry. The USDA estimates of crop progress indicated 14% of the Kansas wheat crop was planted by Sept 24 and 21% was planted by October 1st, roughly when the majority of the rain started. Thus, about 21% of the crop was planted before the rain. These early-sown fields had issues with excessive precipitation, which led many producers to replant, especially in low-lying areas that were water-logged and had large drowned out spots. By October 15, wheat in the state of Kansas was only 42% planted as compared to >70% for the same period historically, which provides some perspective on the degree of sowing delay. (Figure 1). As of early November, the majority of the crop has been sown and Kansas is close to the historical normal.

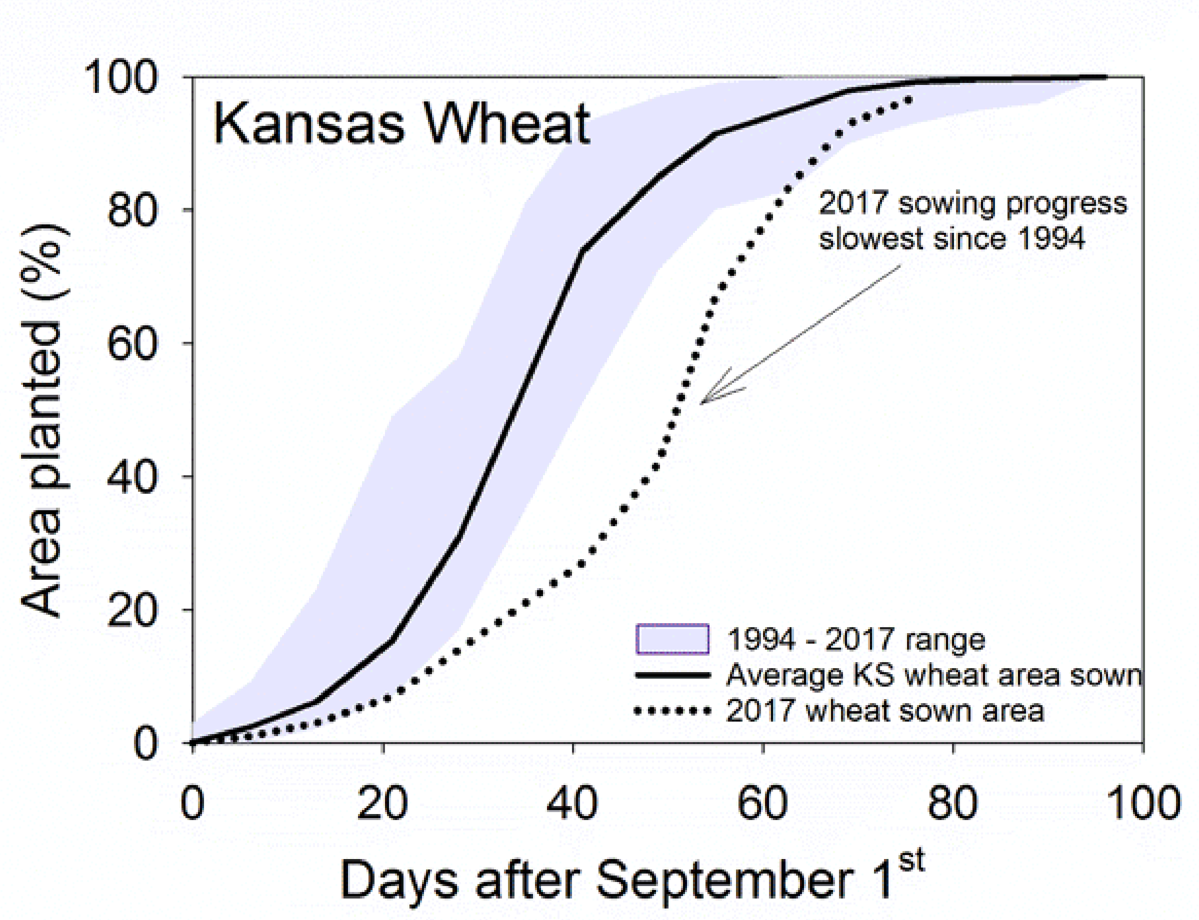

Figure 1. Wheat sowing progress in Kansas during 2017 (dashed line) as compared to the 1994 – 2016 average (solid line) and range (purple area). Wheat sowing progress in 2017 was the slowest since 1994, considerably below the range observed in the period. Graph based on USDA-NASS crop report of progress as of November 16, 2017.

Crop development for the Kansas winter wheat crop

Early-sown wheat fields were subjected to water logging and in many cases required re-planting portions of the field. Wheat fields planted after mid-October have been facing cooler-than-normal temperatures since the time they were sown, as well 30+ days without significant precipitation in many parts of the state, which has slowed crop development. Therefore, the majority of the Kansas wheat crop does not have much fall growth or tillering at this point (Figure 2). The forecast for the later part of November is warmer-than-normal temperatures, which might help the crop produce some extra tillers before the onset of winter, and in many situations be favorable to help with winter survival. Soil moisture increases tillering and winter survival, while a dry topsoil would reduce tillering and increase susceptibility to freeze damage.

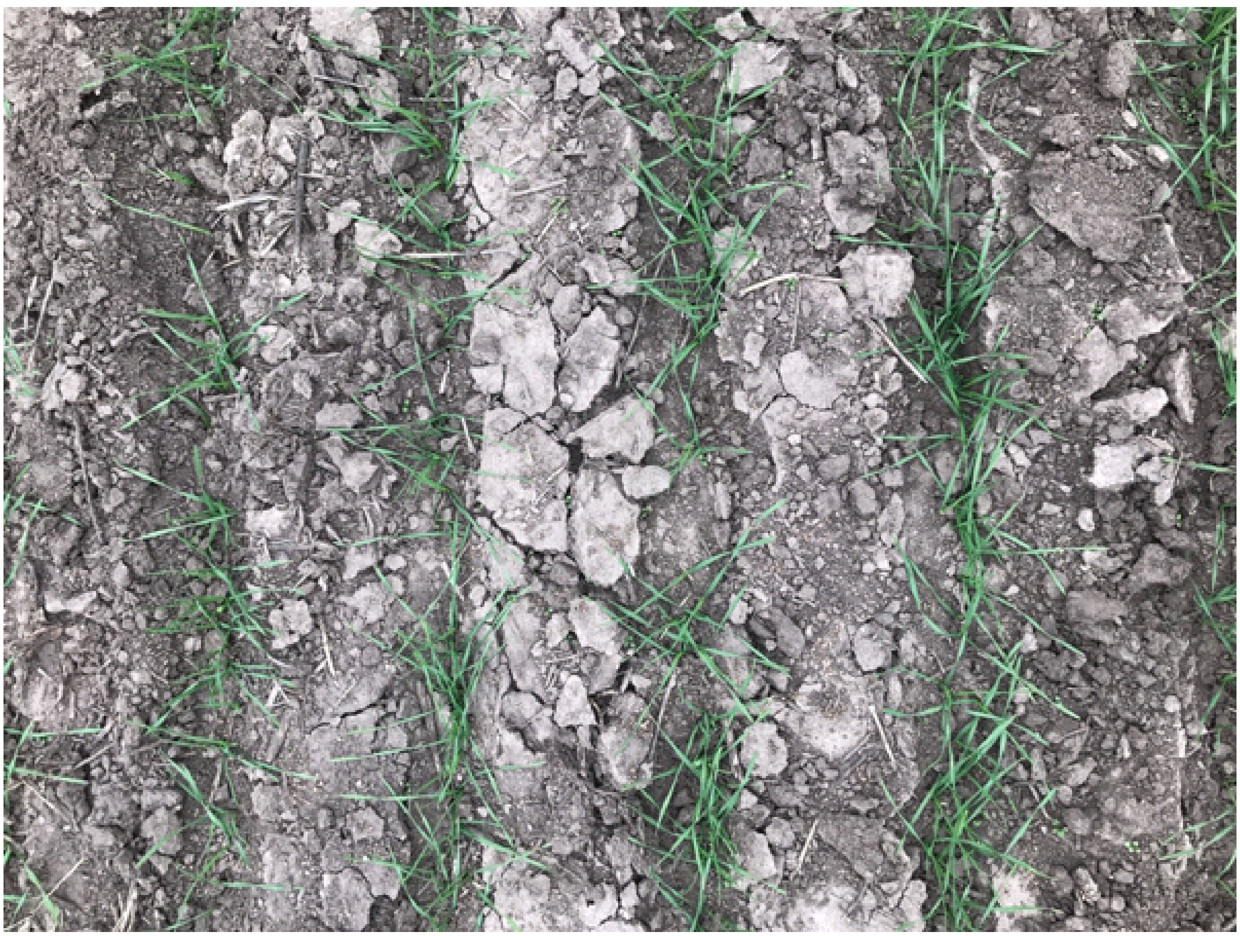

Figure 2. Wheat plants sown in mid-October at the three-leaf developmental stage as of Nov. 13, 2017. At this stage, the first tiller has already started to develop but might not yet be visible. If temperatures had been warmer in late October /early November, these plants could potentially be producing their second or third tiller. However, below-average cool temperatures delayed wheat development. Ideally, these plants need to produce an additional

3-4 tillers before the onset of winter dormancy to maximize cold hardiness. Photo taken near Hutchinson by Guilherme Bavia, visiting scholar at K-State Wheat and Forages Production Team.

Delayed sowing and wheat yield potential

Generally, delaying wheat sowing date past the optimum window causes the wheat yield potential to decrease (Figure 3). However, if weather conditions are optimal (mild winter, and cool and moist spring), the crop might still result in decent yields. Reasons for the generally observed decreased yield potential with a delay in sowing date include:

i. Less fall tillering potential: fall-formed tillers are generally more productive than spring-formed tillers. When wheat is sown late, it will have less time to tiller in the fall, which decreases the production of higher yielding tillers as well as total tiller production.
ii. Delayed cycle: late sowing often delays the entire crop cycle as compared to a crop sown earlier. As a consequence, the grain filling period might occur a few days later and under hotter air temperature conditions, which decreases yield and test weight.
iii. Greater exposure to winterkill: a wheat crop with 3 – 5 fall-formed tillers has greater cold tolerance than a crop that has only one or two tillers. As a consequence, late-sown fields might be more exposed to winterkill, especially in dry conditions. Winterkill is discussed in more detail in the accompanying article in this current eUpdate issue.

Research conducted by Merle Witt with late-sown wheat in Garden City during 1985 through 1991 is summarized in Figure 3. Averaged across all these years, delaying wheat sowing from October 1 to November 1 delayed heading date by 6 days and decreased wheat yields in 23%. Grain filling period was progressively shortened in about 1.7 days and occurred under hotter temperatures (about 1.5 degrees F) for every month of delay in sowing date.

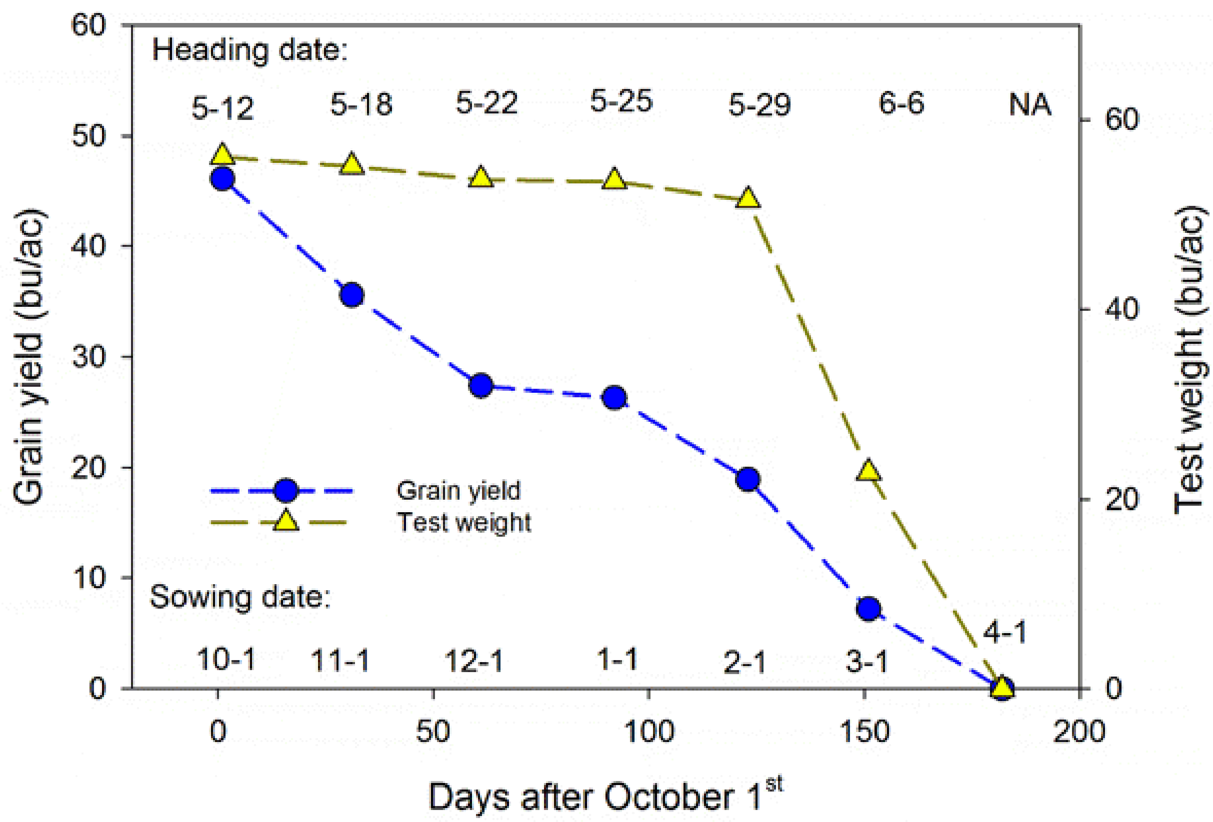

Figure 3. Wheat grain yield, test weight, and heading date responses to sowing date between 1985 and 1991. Data adapted from Kansas Agric. Exp. St. SRL 107.

Therefore, the potential consequences of the delayed progress of the Kansas wheat crop during October include greater exposure to winterkill (especially in dry soil conditions with little snow cover – see accompanying eUpdate article for more details), delayed crop cycle for grain filling under warmer conditions, and a lower yield potential due to decreased fall tillering.

Yet more importantly is the favorable fall precipitation which has allowed the wheat crop to become established. Even if planting and emergence are delayed a few weeks later than optimal, the precipitation that was received in October is setting the 2018 wheat crop up better than had conditions been dry and wheat emergence delayed or prevented due to dry soil conditions. Particularly in the western half of Kansas, research evaluating effects of weather conditions on long-term variety performance tests indicated that wheat yields were influenced the most by favorable precipitation conditions during the fall that promoted stand establishment and moist soil conditions (Holman et al. 2011).

Holman, J.D., A.J. Schlegel, C.R. Thompson, and J.E. Lingenfelser. 2011. Influence of Precipitation, Temperature, and 56 Years on Winter Wheat Yields in Western Kansas. Crop Management 10(1), available at: https://dl.sciencesocieties.org/publications/cm/abstracts/10/1/2011-1229-01-RS

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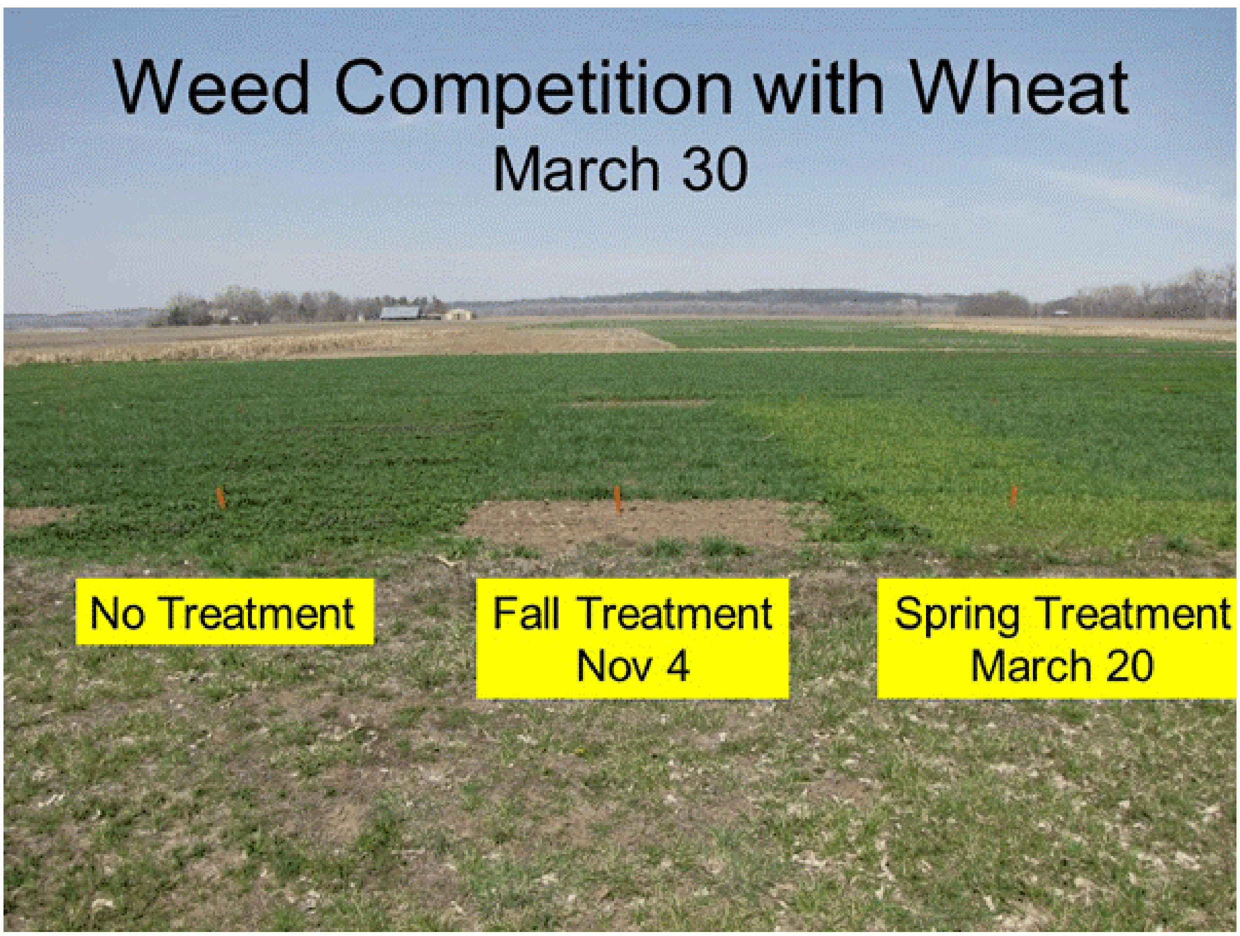
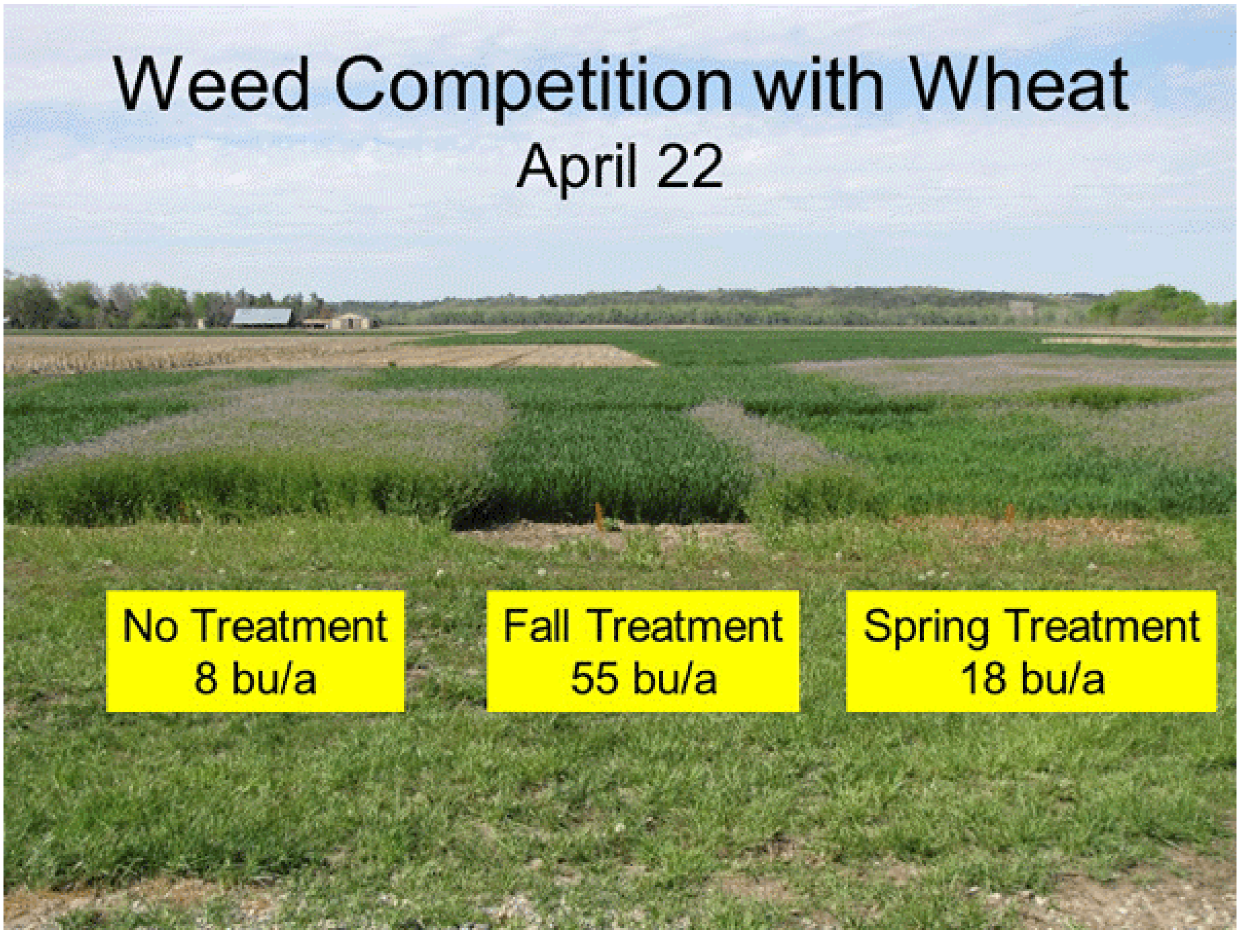
3. Control of mustards in wheat

Too often producers do not notice mustard weeds in their wheat fields until the mustards start to bloom in the spring. As a result, producers often don't think about control until that time. Although it is still possible to get some control at that time with herbicides, mustards are much more difficult to control at that stage and often have already reduced wheat yields by then.

To keep yield losses to a minimum, mustards should be controlled by late winter or very early spring, before the plants begin to bolt, or stems elongate. If winter annual broadleaf weeds are present in the fall, they can be controlled with any number of ALS-inhibiting herbicides, including Ally, Amber, Finesse, Affinity, Rave, Olympus, or PowerFlex. Huskie, Quelex, 2,4-D, and MCPA can also provide good control of most mustards if the weeds are at the right stage of growth and actively growing, and if the wheat is at the correct growth stage. Dicamba and Starane are not very effective for mustard control.

In the late winter or early spring, blue mustard is perhaps the most difficult of the winter annual broadleaf weeds to control because it bolts very early. To be effective on blue mustard, herbicides typically need to be applied in late February or early March. Blue mustard is more difficult to control than tansy mustard with 2,4-D because blue mustard has often already bolted by the time 2,4-D can be safely applied to wheat. Thus, 2,4-D often is applied too late to be effective on blue mustard.





Figures 1a and 1b. Effect of timing of blue mustard control in wheat: K-State research, 2014. Photos by Dallas Peterson, K-State Research and Extension.

Flixweed and tansy mustard should be treated when they are no larger than two to three inches across and two to three inches tall. As these plants become larger, the control decreases dramatically. Ester formulations of 2,4-D and MCPA are more effective on tansy mustard and flixweed than amine formulations. Field pennycress is easier to control than tansy mustard or flixweed. Herbicide applications made before the pennycress bolts are usually effective. Wheat should be fully tillered before applying 2,4-D or tillering will be inhibited and wheat yields may be decreased.

Most ALS-inhibiting herbicides control winter annual mustards very well, although there are populations of treacle mustard and flixweed in Kansas that are ALS-resistant and cannot be controlled by these products.

Alternative measures will be needed to control these populations. The best approach is to use other herbicides such as 2,4-D, MCPA, or Huskie or in a tank-mix with the ALS herbicides. MCPA can be applied after the wheat is in the 3-leaf stage; but as mentioned above, 2,4-D should not be applied until after wheat is fully tillered -- which often doesn't occur until spring. Huskie can be applied between the 1-leaf and flag leaf stage of growth. None of these herbicides has much residual control, so the majority of weeds need to be emerged and actively growing at the time of treatment.

Quelex is a new product from Dow AgroSciences that is a premix of a short-lived ALS herbicide and a new auxin-type herbicide called halauxifen. It generally can provide good control of most mustard species. Quelex can be applied from the 2-leaf up to flag leaf emergence growth stages of wheat and should be applied in combination with nonionic surfactant or oil concentrate for control of small, actively growing weeds. If ALS-resistant weeds are present, Quelex alone may not be effective.

Some producers commonly apply ALS herbicides with fertilizer in January or February. Unfortunately, MCPA, 2,4-D, and Huskie are most effective when applied to actively growing weeds, so application when weeds are dormant may not provide good control. As a result, if an ALS-inhibitor tank-mix with one of these herbicides is applied to dormant ALS-resistant mustards in the winter, poor control could occur.

ALS-resistant bushy wallflower seems to be present in a number of fields in central Kansas. ALS-resistant flixweed has only been confirmed in the Saline county area, but may start to show up elsewhere. Producers should watch for cases of poor control, and consider alternative herbicides or herbicide tank-mixes to help prevent or manage ALS-resistant weeds.

Crop rotation with corn, grain sorghum, soybeans, cotton, or sunflowers is a good way of managing mustards as long as they are controlled in the spring prior to producing seed. Crop rotation will usually result in a gradual reduction of mustard populations in the future as the seedbank in the soil gradually decreases.

For detailed information concerning the different mustard species in Kansas, see the companion article in this eUpdate issue, "Identification and characteristics of the different mustard species in Kansas".

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4. Identification and characteristics of the different mustard species in Kansas

Tansy mustard and flixweed

Tansy mustard and flixweed are two similar mustard species common in central and western Kansas. These weeds emerge in the fall and grow as a rosette with finely lobed compound leaves. Tansy mustard and flixweed bolt in the spring. Small, orange seeds are produced in long, narrow seed pods. Seed pods of tansy mustard are usually about 1/2 inch long and thicker than flixweed seed pods, which are generally 1 to 1 1/2 inches long.

Tansy mustard (*Descurania pinnata*) is a native winter annual. The plant is covered with fine hairs. The stem is erect, branched and 4 - 30" high. The flowers are small, pale yellow, and occur in small clusters. Tansy mustard spreads by seed from early to late summer.

Figure 1. Tansy mustard. All photos by Dallas Peterson, K-State Research and Extension.

Flixweed (*Descurainlia sophia*) is very similar to tansy mustard, and often confused with it. It is an introduced annual or winter annual species from Eurasia which reproduces by seed. Stems are erect, branched, and 4 - 40" high. Flixweed often grows taller than wheat, while tansy mustard generally does not. Leaves have a lacy appearance. The stem and leaves are covered with fine hairs. Flowers are small, pale yellow, and grow in small clusters. Although tansy mustard is native to the area and flixweed is introduced, flixweed is probably the more common weed problem in wheat fields.

Figure 2. Mature flixweed (top photo); rosette stage (bottom photo).

Bushy wallflower (treacle mustard)

Bushy wallflower, or treacle mustard, (*Erysimum repandum*) is a common weed in central and eastern Kansas. It is native to Eurasia. It usually emerges in the fall and forms rosettes with long narrow leaves and irregular leaf margins. Most vegetative growth occurs during the spring. Bushy wallflower rosettes bolt in the spring and bear bright yellow flowers at the top of the plant, which only grows to about 12 – 18" tall. Seeds are produced in long, narrow seed pods.

Figure 3. Bushy wallflower or treacle mustard (top photo); rosette stage (bottom photo).

<u>Field pennycress</u>

Field pennycress (*Thlaspi arvense*) is native to Eurasia. The seedling develops as a compact, vegetative rosette. If it emerges in the fall, it overwinters either as seedlings or vegetative rosettes. It can also emerge from seed in the spring. It bolts in the spring and bears white flowers at the top of the plant, which may grow from 1 to 2 feet tall. Field pennycress has a flat, broadly winged seed capsule that looks something like a penny. Field pennycress reproduces solely by seed. It is often found in grain fields, roadsides, and other disturbed areas. Once this weed is established in a field, the soil will soon become contaminated with its seeds. It is an aggressive competitor with crops and can cause significant yield reductions. Field pennycress may produce from 1,600 to 15,000 seeds per plant. The seed shatters readily. Seed dispersal is primarily by wind. Seeds can remain viable for as long as 6 to 10+ years in the soil. This persistent viability of field pennycress seeds in the soil, their capacity to germinate when brought to the surface by cultivation, and the very large reservoir of dormant seeds present in the soil of a heavily infested area are all factors that contribute significantly to the persistence of this troublesome weed. Field pennycress has a strong, foul odor, even causing cows to produce bitter flavored milk after eating it. It is sometimes called stinkweed.

Figure 4. Field pennycress (top photo); rosette stage (lower photo).

Blue mustard

Blue mustard (*Chorispora tenella*) is a winter annual that germinates in the late summer and fall, and produces a rosette similar in appearance to a dandelion. The plant overwinters as the rosette. Blue mustard bolts in the spring. With mild February weather, the flower stalk may elongate in early March. Cold weather in February results in late March elongation. It bears purple or blue flowers at the top of the plant, which may grow from 12 to 18" tall. Seeds are produced in long, narrow seed pods 1 to 2 inches long. Viable seed can be produced approximately 10 days after bloom. Blue mustard is a problem in winter annual crops, such as winter wheat, throughout Kansas. Blue mustard was introduced into the U.S. from Siberia. Uncontrolled blue mustard can be extremely competitive with wheat, causing as much as 85% yield loss from season-long competition. Research at K-State in 2014 found more than 65% yield loss where blue mustard was not controlled until spring.

Figure 5. Blue mustard (top photo); rosette stage (bottom photo).

For detailed information on controlling the different mustard weeds in Kansas wheat fields, see the companion article in this eUpdate issue, "Control of mustards in wheat".

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5. Does canola need additional sulfur?

Sulfur (S) deficiency was once limited to high-yielding crops grown on irrigated, sandy soils that were low in organic matter and subject to leaching. However, S deficiency has become a widespread problem, domestically and internationally, due to several factors including more concentrated fertilizers containing little to no S, a reduction of sulfur dioxide emissions, higher S uptake and removal by high-yielding crops, and decreased levels of soil organic matter (SOM).

Studies in spring canola have found that S application can increase both yield and oil content. But winter canola response to sulfur application has not been studied in western Kansas thus a study was established in Hugoton, KS consisting of 2 acre plots with four replications and four S treatments to examine canola response to S.

Results from this study found winter canola yields increased 10 to 13% in response to an application of 30 lb S per acre [10 lb S as 10-18-0-10S (ammonium polyphosphate (APP) and 20 lb S as thio-sulfate (TS)] and [10 lb S as APP and 20 lb S as potassium thio-sulfate (KTS)]. The fertilizer was side-dressed in early spring.

These results led to the questions:

1. How reliable is soil test S?
2. Should canola growers be applying S?

How reliable is soil test S?

Soil tests for inorganic S (sulfate–S) often have the reputation of being unreliable compared to other soil nutrients. While this may be true, it is important to note that interpretation of a sulfate-S test must take into consideration SOM levels, soil texture, crop to be grown, amount of S in irrigation water, crop residue input and manure applications, and the expected yield level. This is because a yield response to S application is most likely for crops with a high demand for S (i.e. corn, canola and alfalfa), sandy and/or eroded soils, soils low in organic matter, cropping systems with high residue removal, and soils with low sulfate-S within the profile. Accurate estimates of sulfate-S cannot be made from a surface sample alone because sulfate-S is mobile. Therefore, sampling to a 24-inch depth is required.

The study in Hugoton was conducted on a sandy soil with SOM less than 1%. Soil samples were collected to a depth of 36" and analyzed for inorganic N and S (Table 1). Based on the Great Plains Canola Production Handbook, https://www.bookstore.ksre.ksu.edu/pubs/MF2734.pdf, recommendations for canola, only soils having < 20 lb/acre sulfate-S should receive supplemental S. This would suggest there is adequate S available and no additional S is required.

In some areas, nitrogen-to-sulfur (N:S) ratio has been used with some level of success as an indicator of the plant sulfur status. The drawback to this approach is that deficiencies identified late in the season may not have time to be corrected until the following year. Table 2 shows plant analysis of canola (whole plant) taken at flowering for the different S treatments.

Table 1. Sulfur and inorganic N soil test results from Hugoton site.

Sample Depth (in)	NO^-_3 (lb/acre)	NH^+_4 (lb/acre)	SO^{2-}_4 (lb/acre)
0-12	4.0	5.0	52.0
12-24	4.0	4.0	48.0
24-36	4.0	4.0	80.0

Table 2. Plant analysis of canola taken at flowering with S treatments

Treatment	Total N	Total S	Total K	N:S
lb per acre	%			
0 (control)	4.5	0.6	4.0	7.0
10 lb S (APP)	4.3	0.6	3.8	7.3
20 lb S (APP +TS)	4.2	0.6	3.7	7.2
30 lb S (APP + TS)	4.3	0.6	3.9	7.1
30 lb S + 29 lb K (APP + KTS)	4.6	0.6	4.1	7.7

Should canola growers be applying S?

According to both soil and plant analyses, there is no need for additional S fertilization. However, the study found that application of 30 lb S per acre significantly increased yield by approximately 2.5 bu per acre (13%) over the control (Table 3). It should be noted that canola yields in southwest Kansas were significantly impacted by a snow storm on April 30, 2017 (Figure 1). Regardless, the yield response seen in this study was similar to results obtained in Saskatchewan that showed increased spring canola yield with fertilizer applications of approximately 30 lb S per acre. In another study in Saskatchewan, S fertilization was critical to achieving any response to N fertilizer and at higher rates of N fertilizer, more S was required to increase yield. Yield was maximized with approximately 30 lb per acre S and 90 lb per acre N. According to the Great Plains Canola Production Handbook, a good rule to follow is to keep the N:S ratio about 7:1.

Table 3. Effect of S rate on canola yield in southwest Kansas.

Treatment (lb per acre)	Yield (bu per acre)
0 (control)	23.5
10 lb S	23.4
20 lb S	23.4
30 lb S	26.1*
30 lb S + 29 lb K	25.4*

*Indicates a significant difference compared to the control at LSD=1.5

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Figure 1. Canola in Hugoton study before the snowstorm on April 30 (top photo); Canola in Hugoton study nine days after the snowstorm (bottom photo). Photos by AJ Foster, K-State Research and Extension.

More studies are needed in the Great Plains to better understand canola response to S fertilization. Until then, it is a good idea to apply S to soils with test levels less than 20 lb S per acre. Nitrogen-to-sulfur ratios should be kept to 7:1 or one may simply apply 10-30 lb S per acre, depending on the yield level. Canola is a heavy user of S and deficiencies may result in reductions in pod set and seed quality.

For more information about canola fertilization, please consult the Great Plains Canola Production Handbook: https://www.bookstore.ksre.ksu.edu/pubs/MF2734.pdf

Support for this project was provided by Joel McClure Farm in Hugoton KS, Tessenderlo Kerley, Inc. and Exactrix Global System.

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6. 2018 Kansas Corn Management Schools

We are excited to announce the three regional 2018 Corn Management Schools.

Central Kansas: Monday, January 8, Hesston
AGCO building, 420 W. Lincoln Blvd

Western Kansas: Tuesday, January 9, Garden City
Clarion Inn, 1911 E. Kansas Ave.

Eastern Kansas: Friday, January 12, Leavenworth
The Barn, 17624 Santa Fe Trail

Topics are focused on agronomic practices and research updates. Each school's sessions are designed to fit the farmers in the region. Topics include:

- Weed control
- Production Management
- Nutrient Management
- Insect update
- Disease update
- Planter technology update
- Corn marketing and price update
- Usable Corn Condition Progress Tools

Schools are free to attend thanks to the generous support of DuPont Pioneer and Kansas Corn. Lunch is included, so please pre-register online at: **KScorn.com/Cornschool**

You can also register with KSRE local extension offices.

Hesston School:

Ryan Flaming, Harvey County, flaming@ksu.edu 316-284-6930
Zach Simon, Sedgwick County, zsimon@ksu.edu 316-660-0153
Darren Busick, Reno County, darrenbusick@ksu.edu 620-662-2371

Jake Renner, Kingman County, jwrenner@ksu.edu 620-532-5131
David Kehler, Butler County, dkehler@ksu.edu 316-321-9660
Rickey Roberts, Marion County, rroberts@ksu.edu 620-382-2325
Shad Marston, McPherson County, smarston@ksu.edu 620-241-1523

Garden City School:

AJ Foster, Southwest Area Crops and Soils Specialist; anserdj@ksu.edu
Andrea Burns, Ford County, aburns@ksu.edu, 620-227-4542
Kurt Werth, Grey County, kwerth@ksu.edu, 620-855-3821
Lacey Noterman, Haskell County, lnote@ksu.edu, 620-675-2261
Bill Haney, Kearny County, haney@ksu.edu, 620-355-6551
John Beckman, Scott County, jbeckman@ksu.edu, 620-872-2930

Leavenworth School:

Karol Lohman, Leavenworth County, klohman@ksu.edu, 913-364-5700
Jessica Barnett, Johnson County, Jessica.barnett@jocogov.org 913-715-7000
David Hallauer, Meadowlark District, dhallaue@ksu.edu, 785-863-2212
Ray Ladd, Atchinson County, clad@ksu.edu 913-833-5450
Roberta Wyckoff, Douglas County, rwyckoff@ksu.edu, 785-843-7058
Leroy Russell, Shawnee County, lrussell@ksu.edu, 785-232-0062
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7. Coming this December - The 2017 Census of Agriculture

Kansas farmers and ranchers have the opportunity to make a positive impact on their communities by participating in the 2017 Census of Agriculture. Conducted every five years by the USDA's National Agricultural Statistics Service (NASS), the Census of Agriculture is a complete count of all U.S. farms and ranches as well as those who operate them.

The Census is the only source of uniform, comprehensive agricultural data for every county in the nation. It is a critical tool that gives producers a voice to influence decisions shaping the future of their community, industry and operation. The Census looks at land use and ownership, operator characteristics, production practices, income, expenditures, and other topics. This information is used by all who serve farmers and rural communities from federal, state and local governments to agribusinesses and trade associations. Answers to the Census impact farm programs and rural services that support Kansas communities. So whether you're rural or urban, working thousands of acres or just a few plots, your information matters.

Census forms will be mailed to producers in December. Completed forms are due by **February 5, 2018**. Producers may complete the Census online via a secure website, or return their forms by mail.

"The updated online questionnaire is very user-friendly – it can now be used on any electronic device, and can be saved and revisited as the producer's schedule allows," said NASS Census and Survey Division Director Barbara Rater. "Responding online saves time and protects data quality. That's our mission at NASS – to provide timely, accurate, and useful statistics in service to U.S. agriculture. Better data mean informed decisions, and that's why it is so important that every producer respond and be represented."

Federal law requires all agricultural producers to participate in the Census and requires NASS to keep all individual information confidential. Remember, the Census of Agriculture is your voice, your future, your opportunity. Respond when you receive your census in December.

For more information about the process, including a list of frequently asked questions, please visit www.agcensus.usda.gov.


2017
CENSUS OF AGRICULTURE
YOUR VOICE. YOUR FUTURE. YOUR OPPORTUNITY.
USDA
AGRICULTURE COUNTS
COMING THIS DECEMBER
www.agcensus.usda.gov

8. Cover crop field day: November 29 in Holton, Kansas

A cover crop field day will take place on November 29 from 9:30 am to 12:00 pm. Topics to be covered include:

- Benefits of planting cover crops
- Selecting a cover crop – Midwest Cover Crop Council
- Grazing management on cover crops
- Life in the soil – Build organic matter
- Infiltration
- Funding programs available for implantation of cover crops
- Cover crops in brome – Benefits to wildlife

Featured speakers include:

- Dr. DeAnn Presley, K-State Research and Extension
- David Hallauer, Meadowlark Extension District
- Jamie Johnson, NRCS
- Tyler Warner, KDW&P
- Henry Hill and Kurt Kathrens, producers

There is no cost to attend the field day and registration is not required. The event will take place on producers Henry Hill and Kurt Kathrens' cropland fields – 254th and S Road, Holton, KS. Go 3 miles north of Holton to 254th road, then east to S Road. A noon lunch will be held at El Milagro in Holton.

For detailed information on sponsors, please see the field day flier below.

Questions should be directed to Roberta Spencer, Jackson County Conservation District, at 785-364-3329, ext. 136

Cover Crop Field Day

November 29, 2017 -

9:30 a.m. - Noon

Henry Hill and Kurt Kathrens' Cropland Fields—254th & S Rd,

Holton, KS

3 Miles North of Holton to 254th Road, East to S Road

Noon Lunch at El Milagro, Holton

Featured Speakers:

Dr. Deann Presley, KSU

David Hallauer, Meadowlark Extension District

Jamie Johnson, NRCS DC

Tyler Warner, KDW&P

Producers - Henry Hill and Kurt Kathrens

Topics Covered:

Benefits of planting cover crops

Selecting a Cover Crop - Midwest Cover Crop Council

Grazing Management on cover crops

Life in the Soil—Build Organic Matter

Infiltration

Programs Available to fund cover crops

Cover Crops in Brome - Wildlife Benefits

Questions? Call (785)364-3329, ext. 136 - Roberta Spencer, Jackson County Conservation District

Sponsored by:

Jackson County Conservation District

K-State Research & Extension

Meadowlark Extension District

Natural Resource Conservation Service

KDA-DOC "Funding provided by the KDA-DOC through appropriation from the Kansas Water Plan."

"The U.S. Department of Agriculture is an equal opportunity employer and provider."

Grazing After Frost

9. Comparative Vegetation Condition Report: November 7, 2017 - November 13, 2017

The weekly Vegetation Condition Report maps below can be a valuable tool for making crop selection and marketing decisions.

The objective of these reports is to provide users with a means of assessing the relative condition of crops and grassland. The maps can be used to assess current plant growth rates, as well as comparisons to the previous year and relative to the 28-year average. The report is used by individual farmers and ranchers, the commodities market, and political leaders for assessing factors such as production potential and drought impact across their state.

The Vegetation Condition Report (VCR) maps were originally developed by Dr. Kevin Price, K-State professor emeritus of agronomy and geography, and his pioneering work in this area is gratefully acknowledged.

The maps have recently been revised, using newer technology and enhanced sources of data. Dr. Nan An, Imaging Scientist, collaborated with Dr. Antonio Ray Asebedo, assistant professor and lab director of the Precision Agriculture Lab in the Department of Agronomy at Kansas State University, on the new VCR development. Multiple improvements have been made, such as new image processing algorithms with new remotely sensed data from EROS Data Center.

These improvements increase sensitivity for capturing more variability in plant biomass and photosynthetic capacity. However, the same format as the previous versions of the VCR maps was retained, thus allowing the transition to be as seamless as possible for the end user. For this spring, it was decided not to incorporate the snow cover data, which had been used in past years. However, this feature will be added back at a later date. In addition, production of the Corn Belt maps has been stopped, as the continental U.S. maps will provide the same data for these areas. Dr. Asebedo and Dr. An will continue development and improvement of the VCRs and other advanced maps.

The maps in this issue of the newsletter show the current state of photosynthetic activity in Kansas, and the continental U.S., with comments from Mary Knapp, assistant state climatologist:

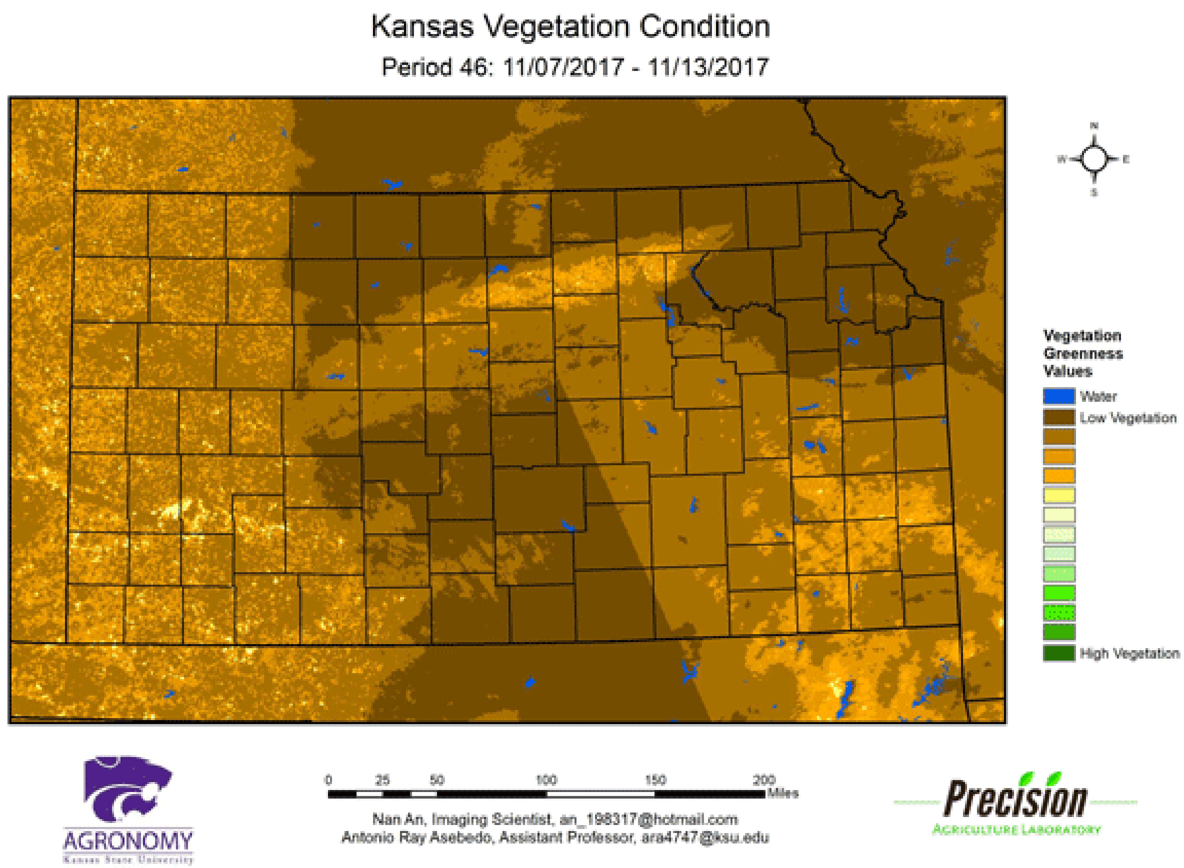

Figure 1. The Vegetation Condition Report for Kansas during November 7 – November 13, 2017 from K-State's Precision Agriculture Laboratory again shows little vegetative activity this week as the growing season is ending. Temperatures averaged 6 degrees F below-normal for the week.

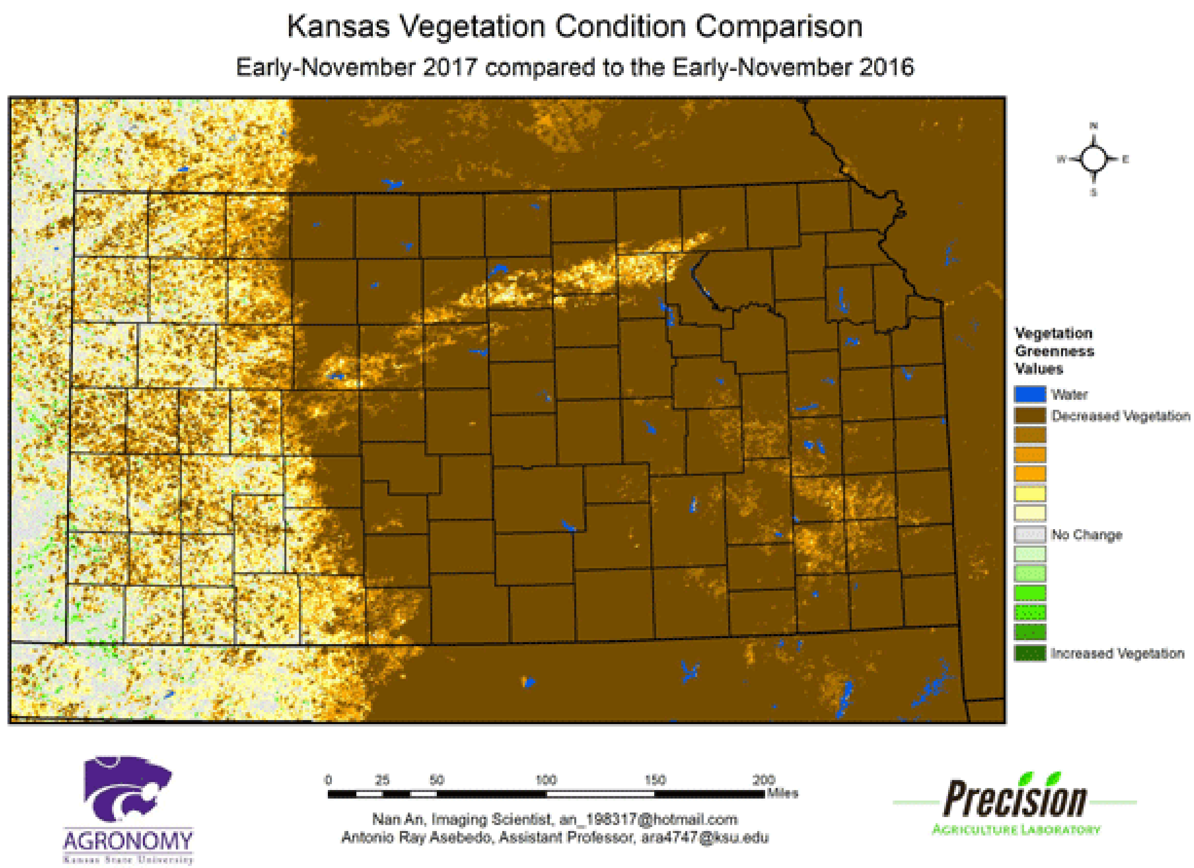

Figure 2. Compared to the previous year at this time for Kansas, the current Vegetation Condition Report for November 7 – November 13, 2017 from K-State's Precision Agriculture Laboratory shows a decrease in vegetative activity. This is particularly true in the eastern two-thirds of the state where there was persistent cloud cover, although not much rain.

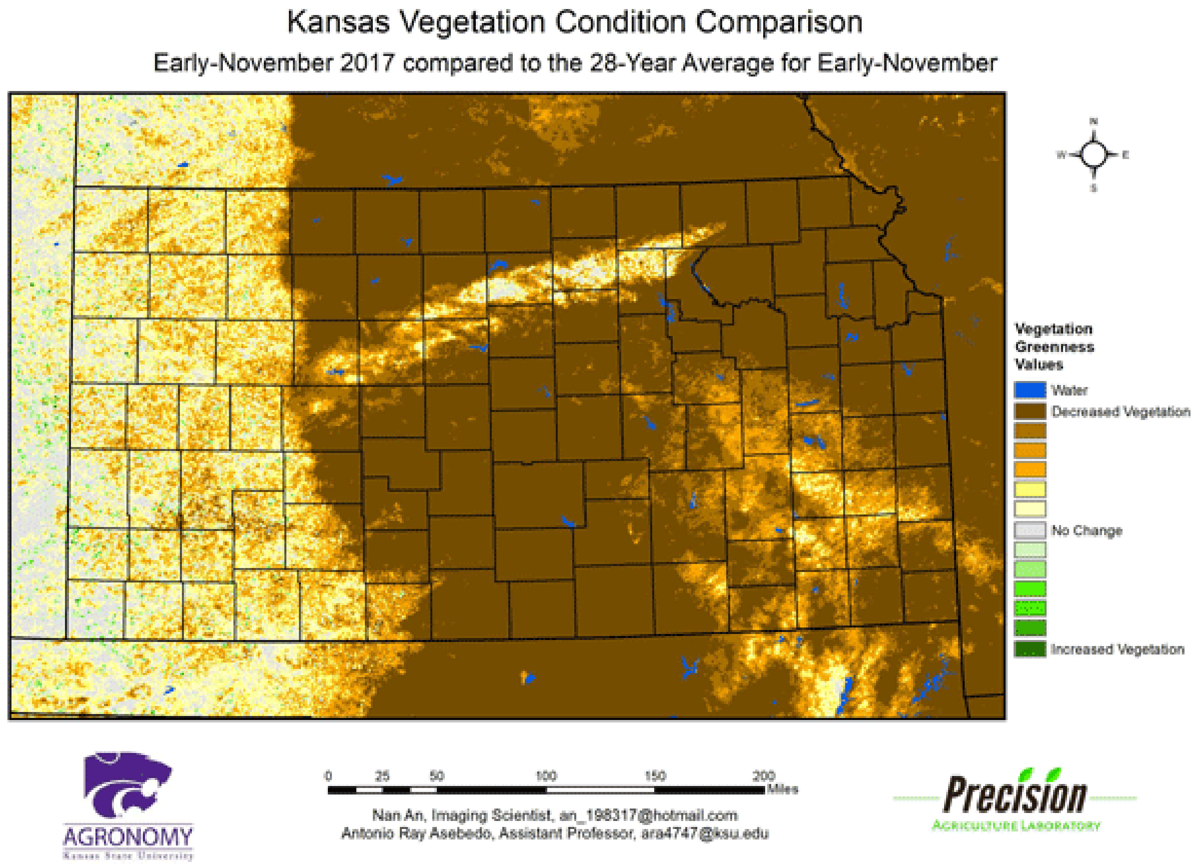

Figure 3. Compared to the 28-year average at this time for Kansas, this year's Vegetation Condition Report for November 7 – November 13, 2017 from K-State's Precision Agriculture Laboratory show much below-average conditions across the eastern two-thirds of the state. Persistent cloud cover was the major contributing factor.

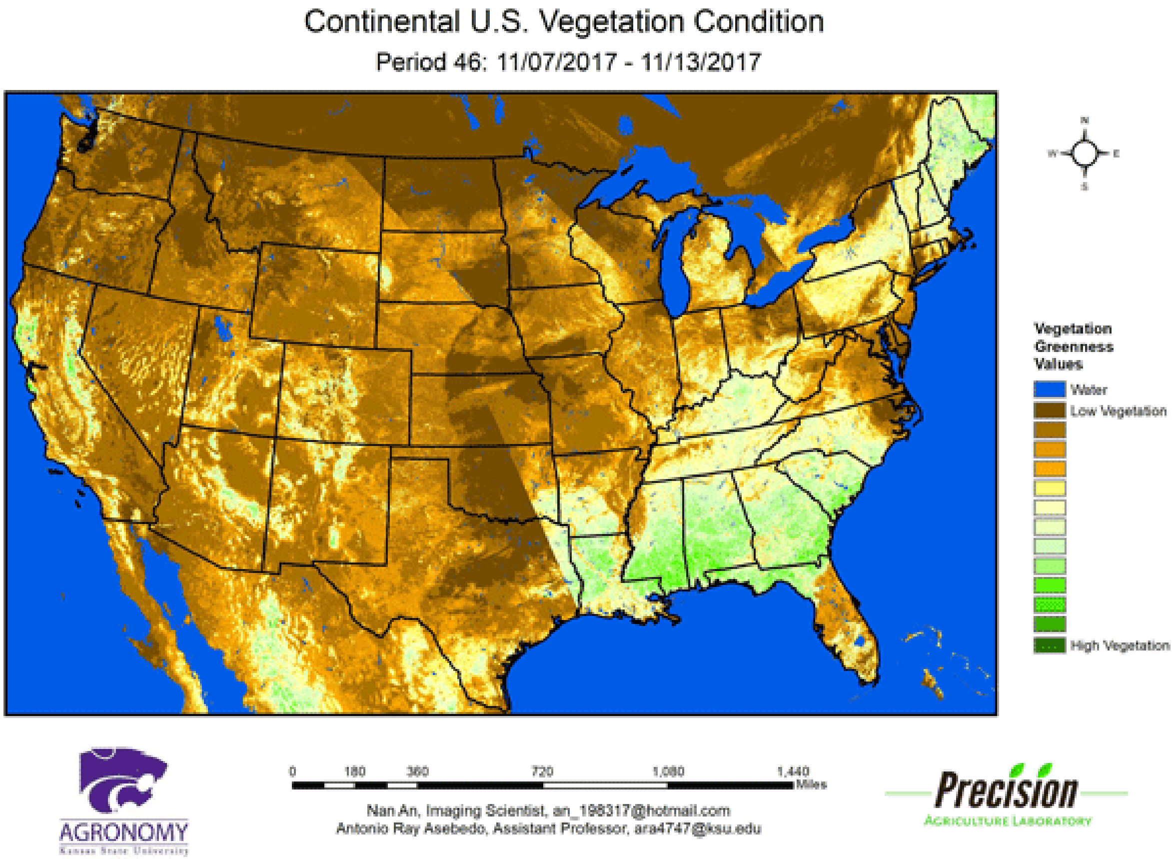

Figure 4. The Vegetation Condition Report for the U.S for November 7 – November 13, 2017 from K-State's Precision Agriculture Laboratory shows the highest NDVI values across the Gulf Coast. Milder temperatures have remained in these areas. Clouds and cool weather have limited vegetative activity in the Central and Northern Plains.

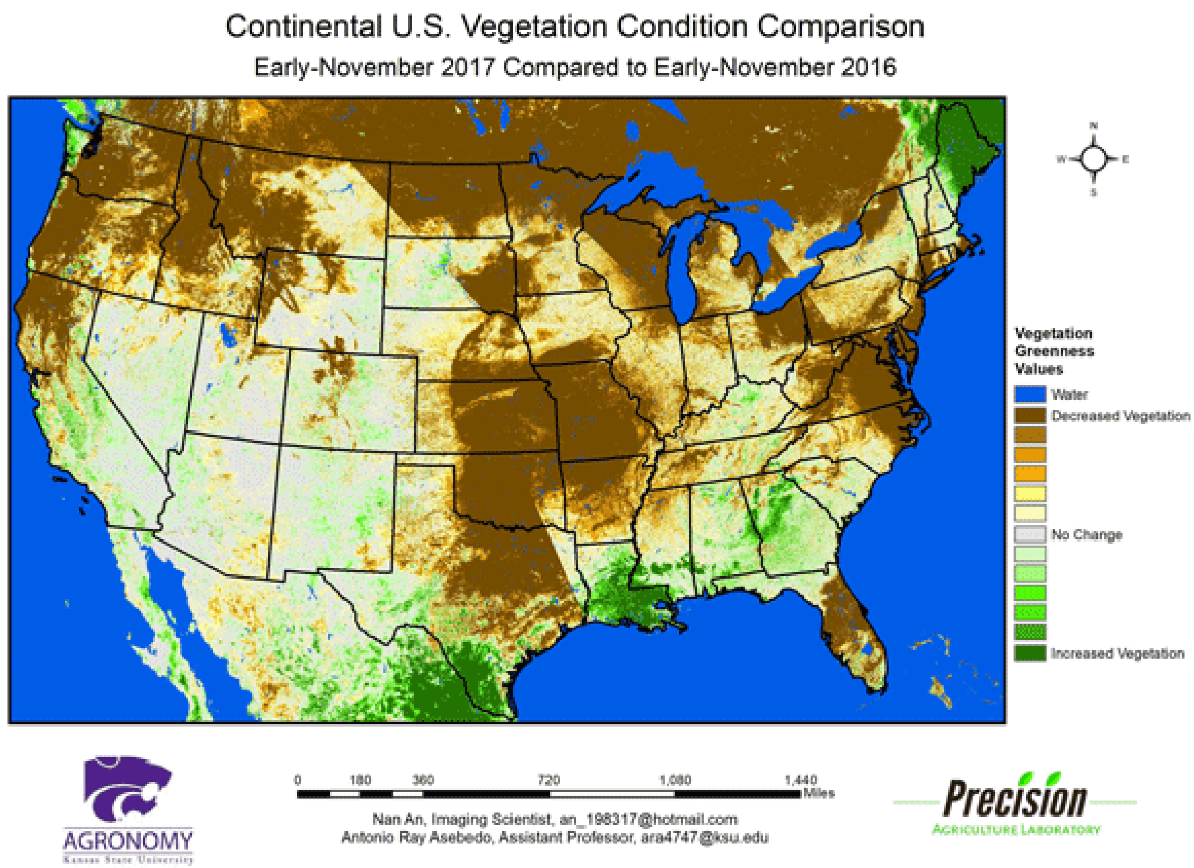

Figure 5. The U.S. comparison to last year at this time November 7 – November 13, 2017 from K-State's Precision Agriculture Laboratory shows higher NDVI values across the Pacific Northwest and eastern Texas. Last year, Montana and the Dakotas were moving into a dry pattern that was the start of the intense drought that dominated this year. This year, vegetative activity is masked by snow, clouds, and rain. This also extends across central and eastern Kansas and into Texas.

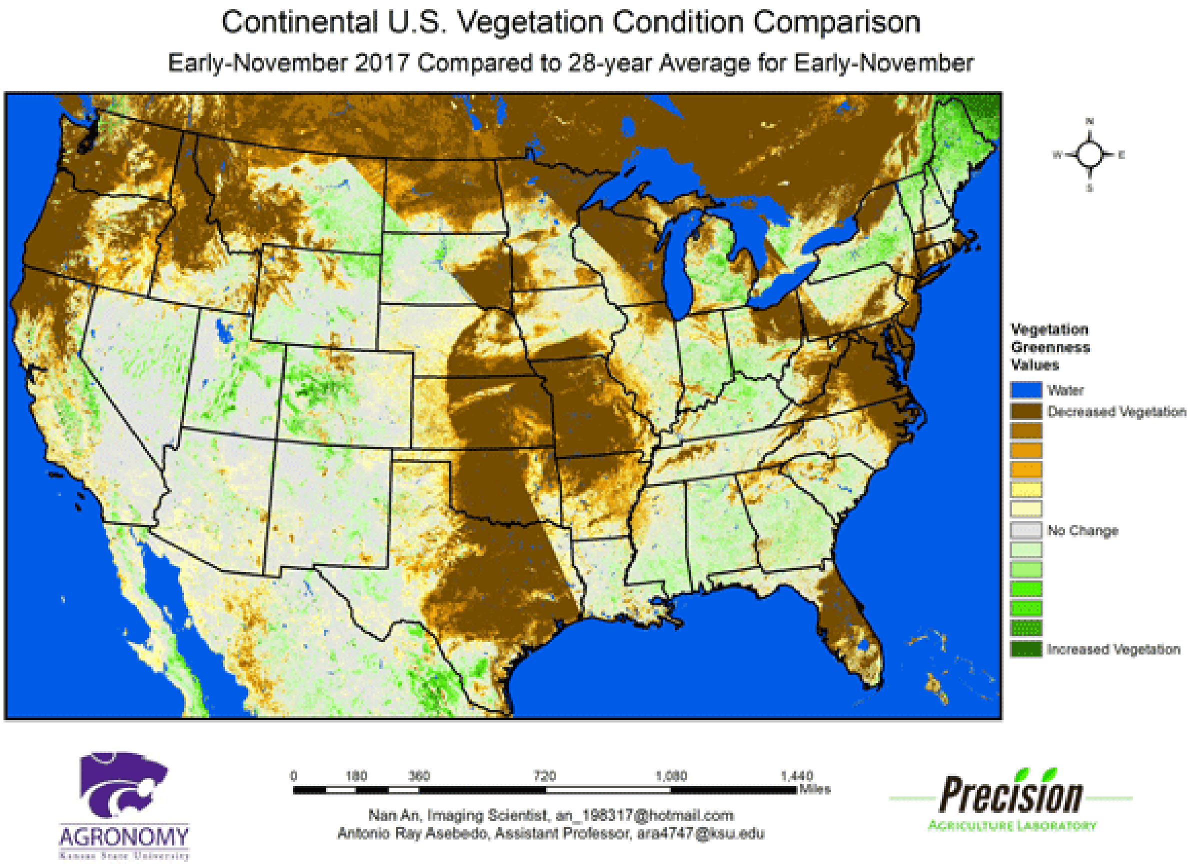

Figure 6. The U.S. comparison to the 28-year average for the period of November 7 – November 13, 2017 from K-State's Precision Agriculture Laboratory shows a large area of below-average NDVI values across the northern United States and from eastern Kansas to eastern Texas. These lower-than-average NDVI values are the result of persistent cloud cover, coupled with snow and/or rain in the regions.

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