Issue 1017

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eUpdate

08/22/2024

These e-Updates are a regular weekly item from K-State Extension Agronomy and Kathy Gehl, Agronomy eUpdate 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 Dalas Peterson, Extension Agronomy State Leader and Weed Management Specialist 785-532-0405 dpeterso@ksu.edu.

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1. Soybean yield potential estimation

With most Kansas soybean fields already in reproductive stages, it is time to assess the yield potential. The latest USDA-NASS Kansas Crop Progress and Condition report (Aug 18) estimates that 90% of soybeans in Kansas are blooming. Around 67% of the soybeans in the state are setting pods, which is behind compared to 73% from last year (5-year average = 73%).

Soybean plants can more easily compensate for stress (relative to corn), more so if the timing of the stress is before seed filling. One of the key factors in the crop's ability to compensate for stress situations is the significant overlapping of vegetative and reproductive stages that indeterminate soybeans express, allowing them to keep producing new leaves even toward the reproductive period. On the other hand, the production of flowers could normally last between 4-6 weeks, which potentially allows to replace flowers and small pods abortion.

Since the final number of pods is not determined until the beginning of seed filling, when estimating soybean yield potential, we must remember that the estimate could change based on the timing of this estimation and weather conditions. For example, wet periods toward the end of the reproductive period can extend the seed-set period, promoting greater pod production and retention with heavier seed weight.

Estimating the final yield before harvest can be a very tedious task, but a simplified method using yield components can be applied to start setting yield expectations.

From a physiological perspective, the main yield components to consider are:

- plants per acre,
- pods per area,
- seeds per pod, and
- seed size.

When can I start making soybean yield estimates?

There is no precise time, but we can start making soybean yield estimates as soon as the end of the R4 stage, full pod (pods are ¾-inch long on one of the top four nodes), or at the onset of the R5 stage, beginning seed (seeds are 1/8-inch long on one of the top four nodes). Keep in mind that yield prediction is less precise at these early reproductive stages since the seed number per area, as well as the seed weight, are not yet completely defined. At this early stage of seed development, it is important to only consider the pods that are at least ¾-inch long to avoid over-optimistic estimations since smaller pods can still abort under stress conditions.

As we move into the R6 stage (full seed), the seed number (main yield component) is majorly defined, yet the conditions during seed filling will determine the final seed number as well as the size and weight of the seed. The closer to maturity (R7 stage) we make the estimation, the more accurate the expectation and overall yield prediction.

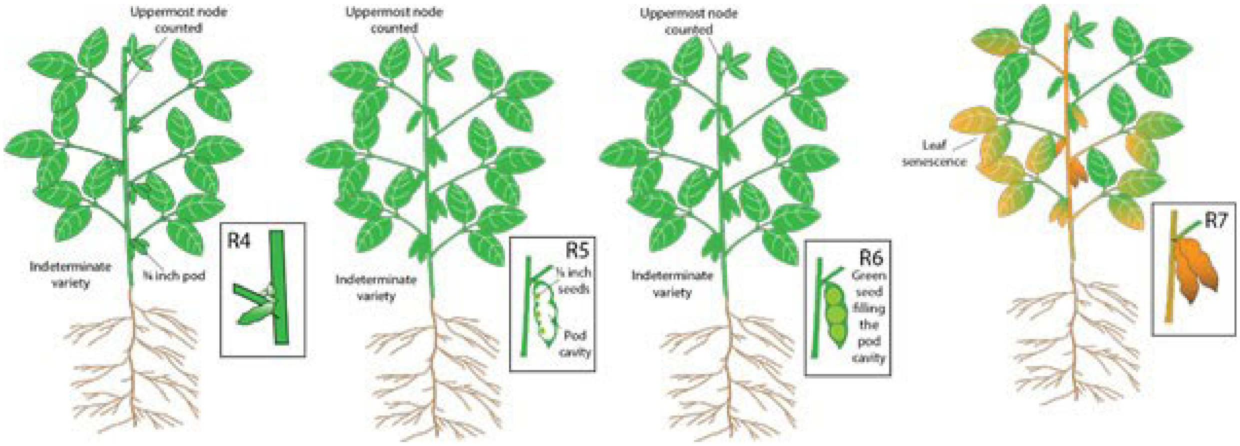

Figure 1. Soybean phenological stages to start yield prediction using the yield components method.

How many samples are needed to account for field variation?

We should make yield estimations in about 10 (at least 6, ideally 12) different areas of the field. Of course, properly recognizing and identifying the variation within the field is important, and then taking enough samples from the different areas to fairly represent the entire field. Within each sample section, take consecutive plants within the row to have a good representation. The variability between plants in terms of the number of pods and seed size needs to be considered when trying to get an estimation of soybean yield. Variability between areas within the same field also needs to be properly accounted for (e.g., low vs. high areas in the field). The more variability to represent, the more samples we would need for a proper estimation.

The yield components equation

Soybean yield estimates following the conventional approach are based on the following components (**Eq. 1**):

Eq. 1

$$\left[\left(\frac{plants}{ac.}\right) x \left(\frac{pods}{plant}\right) x \left(\frac{seeds}{pod}\right)\right] \div \left[\left(\frac{seeds}{lbs.}\right) x \left(\frac{lbs.}{bu}\right)\right]$$

where,

1. **Plants/ac.** A simplified approach can be applied by using samples covering 1/10,000th of an acre with sections of 30 inches width by 21 inches length (**Figure 2, step 1.**). Thus, the average number of plants in several sections multiplied by 10,000 will give us an estimation of the number of plants per acre. Following this simplified approach, if the soybean plants are arranged in 30-inch rows we just need to sample a single row; 2 rows if the row spacing is 15 inches; and 4 rows if the row spacing is 7.5 inches.

2. **Pods/plant.** Once the samples have been obtained, we count and later average the number of pods per plant (**Figure 2, step 2**).
3. **Seeds/pod.** Then, we proceed to count and later average the number of seeds per pod (**Figure 2, step 3.**). Soybean plants will have, on average, 2.5 seeds per pod (ranging from 1 to 4 seeds per pod), primarily regulated by the interaction between the environment and the genotypes. Under severe drought and heat stress, a pessimistic expectation would be an average of 1-1.5 seeds per pod.
4. **Seeds/acre.** Calculate the total number of plants/acre (1), pods/plant (2), and seeds/pod (3) to obtain the total number of seeds per unit area (Figure 2, step 4).
5. **lbs/bu.** For this estimation, the "test weight" for soybeans could be considered here as a constant number at 60 lbs./bu.
6. **Seeds/lbs.** The number of seeds per pound will vary depending on the seed-filling conditions, which will determine the seed size. Normally, this number could range somewhere between 2,500 (bigger seeds) to 3,500 (smaller seeds) seeds per pound for optimal to unfavorable seed filling conditions. Combined with a constant test weight of 60 lbs./bu, this will lead to a range of expectation of seeds per bushel between 150,000 seeds per bushel to 210,000 seeds per bushel, respectively (**Figure 2, step 5**).

The final step to estimating yield is dividing seeds/acre by seeds/bu to obtain the yield estimation in bushels per acre (**Eq. 2**).

Eq. 2

$$\left(\frac{seeds}{ac.}\right) \div \left(\frac{seeds}{bu}\right) = {}^{bu}/_{ac.}$$

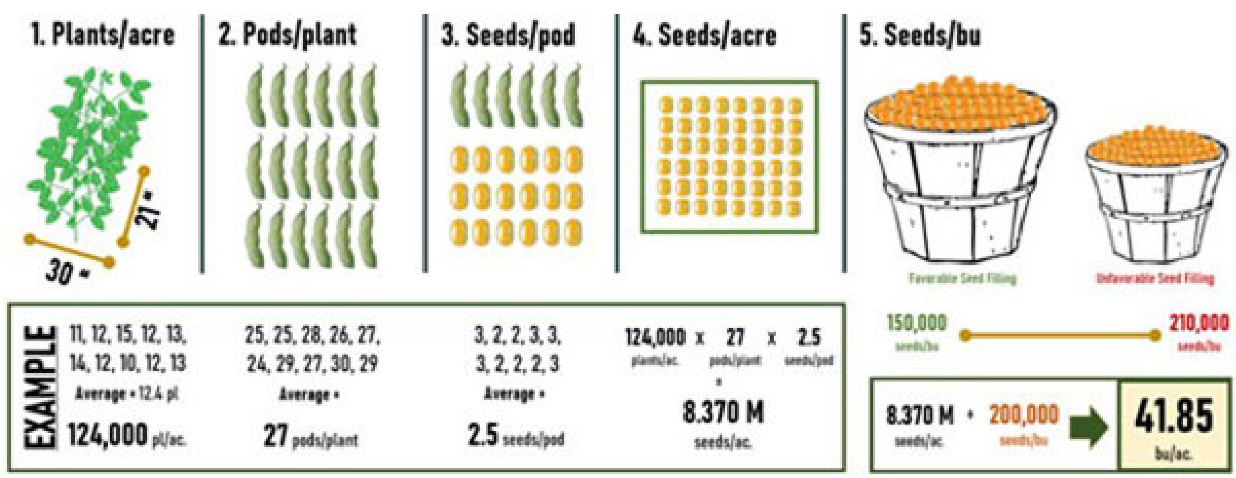

Figure 2. Example of yield estimation method using samples of 1/10,000th of an acre (21-inch x 30-inch sections) for a regular yield until seed filling, where the seed size is expected to be reduced compared to favorable seed filling conditions, increasing the #seeds/bu component.

Example representing average conditions

In Figure 2, we have taken 10 samples of 30x21 inches sections, leading to an average number of 12.4 plants. Since these sections are 1/10,000th of an acre, our first component, the plant density, is 124,000 plants/acre. Then, in those 12 plants, we measured, on average, 27 pods per plant. Assuming a "normal" growing season condition, we could expect to count around 2.5 seeds per pod. Combining these components, we obtained an expectation of 8.370 M seeds per acre. Finally, we had to assume (if the estimation is early) or represent (if close to maturity) the seed-filling conditions. In this case, we used regular-to-poor seed filling due to the lack of precipitation combined with heat. Thus, we divided the seeds per acre by an expectation of 200,000 seeds per bu (small seed size), giving us an estimate of roughly 42 bu/a.

Adjusting for 2024 expectations

Soybeans have started well this season, especially in May. However, drought has created more challenging conditions in some parts of the state. Thus, even if the pod number is the same as in a normal season, the final seed number and weight will be negatively impacted for a "droughty" (from R2 to R6 stages) growing season, such as the present one in some specific parts of the state.

Estimating seed yields in soybeans will allow farmers and agronomists to obtain a more reliable prediction of yields and scout fields for associated issues before harvest, such as insects, diseases, and other potential production problems. In the coming weeks, the effects of the current weather conditions can be assessed to obtain a more precise estimate of the final yield expected on this crop.

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2. Strategic tillage in long-term no-tillage systems

The adoption of no-tillage (NT) farming increased water use efficiency and allowed for cropping intensification, especially in semi-arid environments like western Kansas, because of greater soil water storage with more crop residue kept on the soil surface. With more residue retained in NT systems, wind and water erosion are reduced, and more organic matter accumulates in soil. However, despite these benefits, maintaining continuous NT has become increasingly challenging because of the lack of herbicide options for difficult-to-control and herbicide-resistant (HR) weeds, as well as issues with stratification of soil pH with increasing soil acidification near the surface.

The lack of effective herbicide options to control perennial grass weeds like tumble windmillgrass (*Chloris verticillata* Nutt.), tumblegrass (*Schedonnardus paniculatus*), and purple three-awn (*Aristida purpurea* Nutt.) as well as HR kochia (*Kochia scoparia* L.) and Palmer amaranth (*Amaranthus palmeri* S. Watson) pose some of the greatest challenges to long-term NT systems. With the increased costs of alternative herbicide options and increasing agricultural input costs, some farmers resort to tillage as a cost-effective strategy to manage weeds.

However, the decision to return to tillage after many years of NT management is difficult, as many farmers are concerned about losing the benefits accrued with long-term NT. Researchers at the Kansas State University Western Kansas Research-Extension Centers studied the use of strategic tillage in long-term NT fields to manage difficult-to-control and HR weeds and evaluated impacts on crop yields and soil properties over the past 8 years near Hays, KS.

What is strategic tillage?

Strategic tillage is defined as a one-time tillage operation in an otherwise NT cropping system to manage challenges of long-term NT (Figure 1), including difficult-to-control weeds and pH stratification. Following this strategic tillage operation, the system returns to NT. The most commonly used implement for strategic tillage is the sweep plow, which is a non-inversion conservation tillage implement. Inversion-type tillage with a disk may be preferable in correcting pH stratification if needed.

Figure 1. No-till (left) and strategic tillage (right) following tillage and fertilizer applications in fallow.

Impacts of strategic tillage

Following up on a previous study, researchers investigated the effect of one-time strategic tillage implemented in 2016 on soil properties and crop yields from 2017 to 2023 in otherwise long-term NT plots originally established in 1975 near Hays, KS. This experiment included three tillage treatments (NT, strategic tillage, and reduced tillage) and three crop rotations [continuous wheat (WW), wheat-fallow (WF), and wheat-sorghum-fallow (WSF)]. Tillage operations were implemented using a sweep plow equipped with pickers for effective weed control with minimal residue disturbance.

Soil properties

Results showed that soil organic carbon concentration under strategic tillage was not different from NT (Figure 2), whereas soils under reduced tillage had 8% less soil organic carbon. The wind-erodible soil fraction was not different among tillage treatments. However, the water-stable aggregate size under strategic tillage was similar to NT, and both were greater than under reduced tillage (Figure 3).

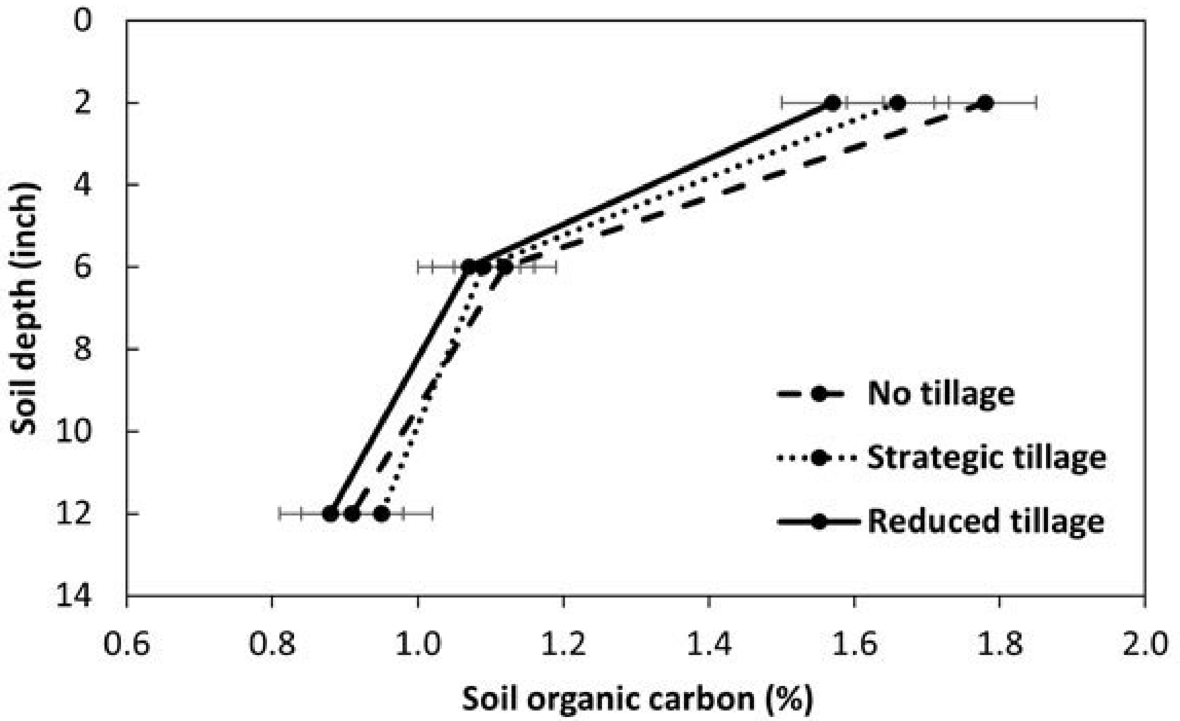

Figure 2. Tillage effects on soil organic carbon concentrations in long-term NT and RT (established in 1975) in comparison to strategic tillage (implemented in 2016) of long-term NT near Hays, KS. Error bars represent the standard error of the mean ($P \leq 0.05$**).**

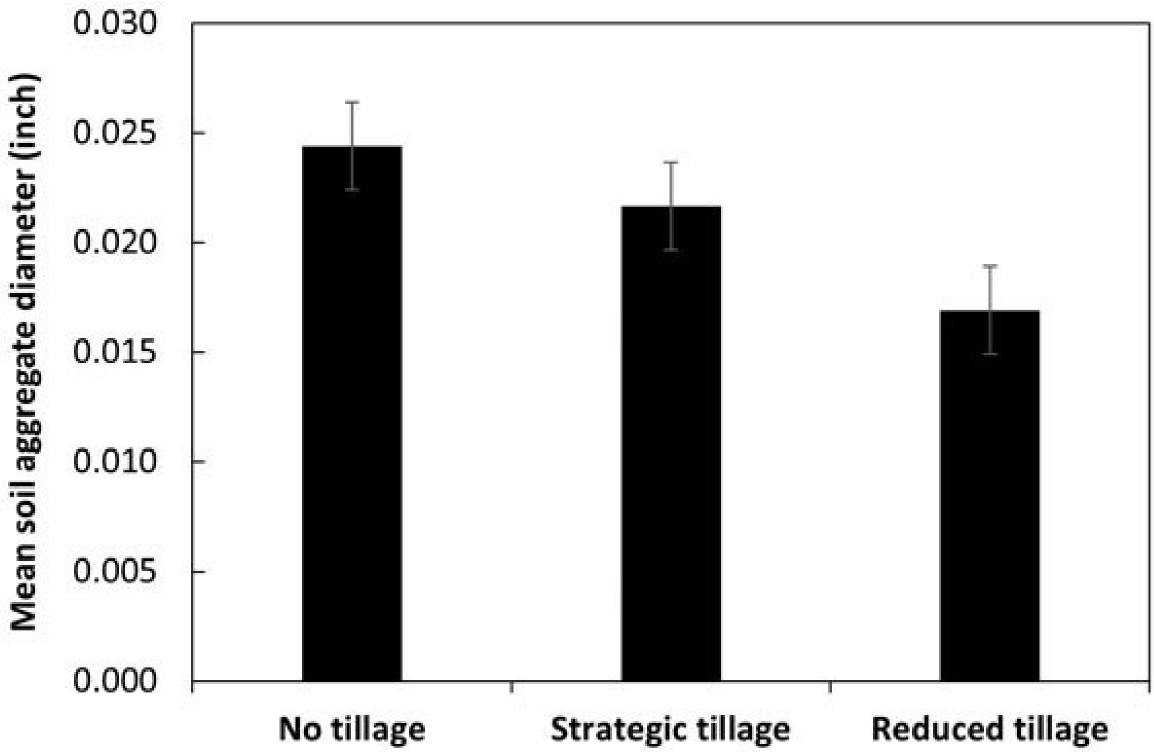

Figure 3. Tillage effects on the diameter of water stable aggregates in long-term NT and RT plots (established in 1975) compared to strategic tillage (implemented in 2016) of long-term NT near Hays, KS. Error bars represent the standard error of the mean ($P \leq 0.05$**).**

Wheat and sorghum yields

Strategic tillage increased wheat yields compared to NT in WW, mostly due to improved weed control, though wheat yields were similar across tillage treatments in the WF and WSF rotations (Figure 4). Grain sorghum yield in WSF was not different between strategic tillage and NT treatments, though both were 12% greater than under reduced tillage (Figure 5).

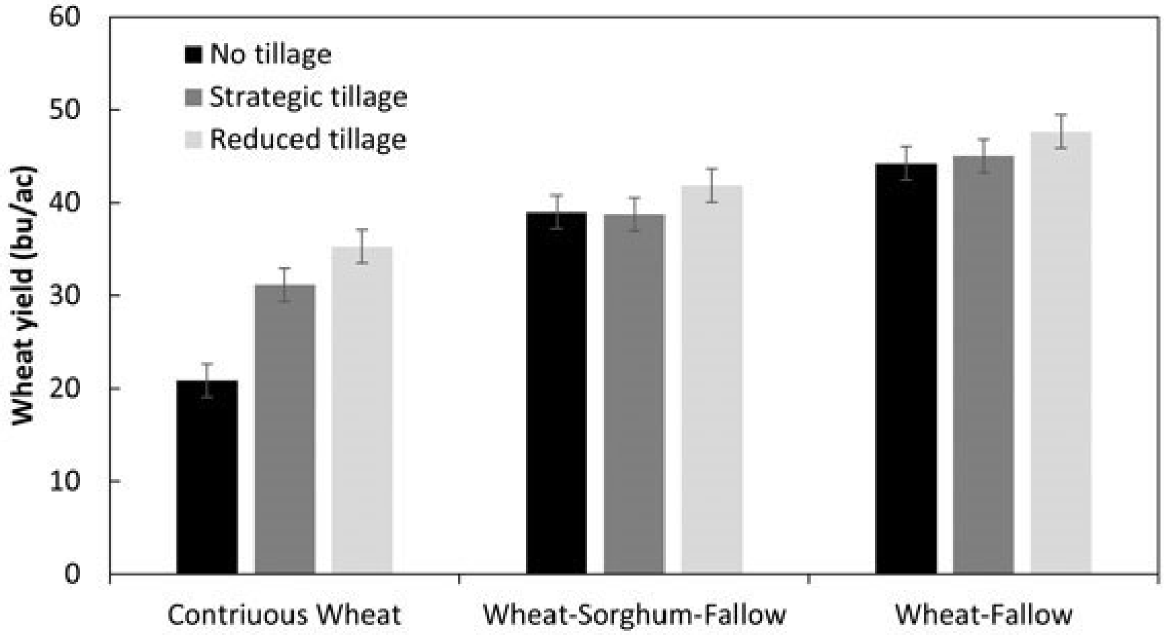

Figure 4. Averaged winter wheat yields (2017 to 2022) as affected by tillage and crop rotation near Hays, KS. Error bars represent the standard error of the mean ($P \leq 0.05$).

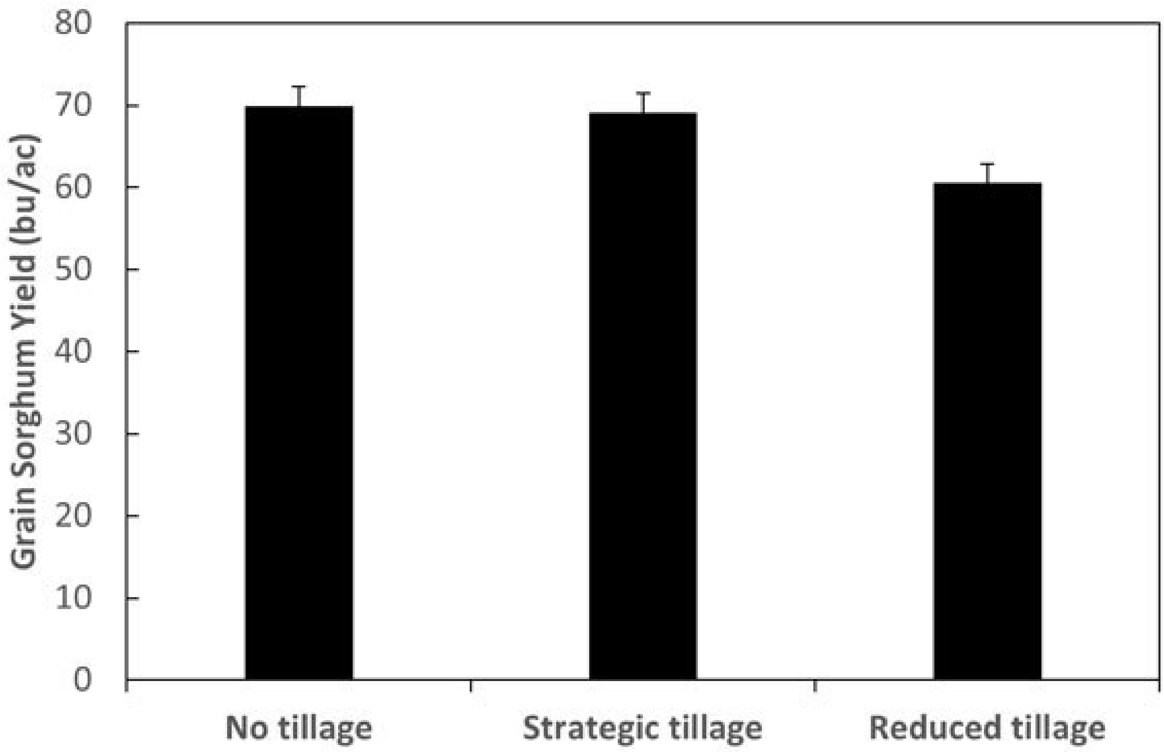

Figure 5. Averaged grain sorghum yield (2017-2022) as affected by tillage near Hays, KS. Error bars represent the standard error of the mean ($P \leq$ **0.05).**

Summary

Overall, strategic tillage of long-term NT had no negative effect on soil properties or crop yields. This could be an effective tool for farmers to manage difficult-to-control weeds. However, farmers should be mindful of best practices when implementing strategic tillage:

1. Strategic tillage with a sweep plow should be timed when soil erosion risk is lowest. In western Kansas, the best time is in summer fallow ahead of winter wheat.
2. Timing is critical to ensure successful control of perennial grass weeds. Tillage should be implemented with a sweep plow equipped with pickers, operated at shallow depth, on a hot, dry day with no chances for rain for several days following tillage.
3. The tillage depth should be kept shallow (1-2 inches) to control perennial grass weeds (most are shallow-rooted) and prevent the burying of crop residue. Deeper tillage may only spread and bury the weed rhizomes, increasing management challenges.
4. The frequency of strategic tillage will depend on the time it takes for issues to resurge after returning to NT management, though it may be six years or more between operations. More frequent tillage may result in negative impacts on soil properties and crop yields.

For more detailed information on this study, please refer to: "Assessing the Influence of Strategic Tillage on Crop Yields and Soil Properties in Dryland No-Tillage Systems" in the 2023 Kansas Agricultural Experiment Station Research Reports: Vol. 9: Iss.64.
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3. Occasional tillage strategies in dryland cropping systems

No-tillage (NT) farming has been widely adopted across Kansas and the High Plains to enhance soil water storage efficiency, increase grain yields, and reduce soil erosion. However, with an increasing abundance of difficult-to-control and herbicide-resistant (HR) weeds invading long-term NT crop fields and increasing observations of pH, phosphorus, and soil organic carbon stratification, some producers consider tillage a cost-effective way of controlling weeds. The lack of effective herbicide options to control HR kochia (*Kochia scoparia* L.) and Palmer amaranth (*Amaranthus palmeri* S. Watson) as well as perennial grass weeds like tumble windmillgrass (*Chloris verticillata* Nutt.), tumblegrass (*Schedonnardus paniculatus*), and purple three-awn (*Aristida purpurea* Nutt.) poses some of the greatest challenges in NT systems. Since 2013, researchers at the Kansas State University Western Kansas Research-Extension Centers have studied occasional tillage in NT fields to manage difficult-to-control and HR weeds and evaluated impacts on crop yields and soil properties near Hays, Garden City, and Tribune, KS.

What is occasional tillage?

Tillage systems can differ in frequency and equipment used, ranging from the most intensive conventional tillage using moldboard plows, chisels, or disks to less frequent occasional tillage or conservation tillage using sweep plows. Occasional tillage is defined as one or two tillage operations every three or more years to manage challenges of long-term NT, including difficult-to-control weeds as well as soil nutrient and pH stratification. This system of low-frequency tillage on a fixed schedule differs from strategic tillage, which is defined as a one-time tillage operation in an otherwise NT cropping system. By these definitions, occasional tillage may be considered a proactive approach while strategic tillage may be considered more reactive. The most commonly used implement for occasional tillage is the sweep plow, which is a non-inversion conservation tillage implement. Inversion-type tillage with a disk may be preferable in correcting soil nutrient and pH stratification if needed.

Impacts of occasional tillage

Kansas State University researchers investigated the effects of occasional tillage on soil properties and crop yields in a winter wheat-grain sorghum-fallow cropping system across three sites near Hays, Garden City, and Tribune, KS. The studies at Garden City and Tribune were originally initiated in 2013, followed by Hays in 2014, with treatments updated in 2016/2017.

The current experiment included five tillage treatments:

- continuous **NT**
- a single tillage pass during fallow before wheat planting (**STBW**)
- two tillage passes in fallow before wheat planting (**2TBW**)
- a single tillage pass after wheat harvest (**STAW)**
- a single tillage pass before wheat planting and a single tillage pass after wheat harvest (**TBTA**).

Tillage operations were implemented using a sweep plow equipped with pickers for effective weed control with minimal residue disturbance.

Results: Soil properties

Results showed that soil pH, organic carbon (SOC), and phosphorus content were unaffected by tillage treatments (Table 1). However, soil nitrate content was 1.4-fold greater with 2TBW compared to STBW or NT. Soil bulk density (BD), water-stable aggregates (MWD), and wind-erodible fraction (WEF) were also unaffected by tillage treatments (Table 1). However, soil penetration resistance (PR) was 11% less with STBW or 2TBW than NT.

Table 1. Occasional tillage effects on soil chemical and physical properties.

Treatments	pH	SOC (%)	NO_3 (ppm)	P (ppm)
No-tillage	6.4a[†]	1.27a	15.2b	77.9a
1 pass before wheat	6.5a	1.22a	16.6b	77.5a
2 pass before wheat	6.5a	1.25a	22.6a	71.2a

Treatments	BD (g/cm^3)	MWD (mm)	WEF (%)	PR (MPa)
No-tillage	1.32a	0.53a	27.6a	1.26a
1 pass before wheat	1.30a	0.46a	25.5a	1.13b
2 pass before wheat	1.30a	0.47a	25.5a	1.11b

[†]Means followed by the same lower-case letter within the same column are not significantly different ($\alpha = 0.05$) among treatments.

Results: Wheat and sorghum yields

Wheat yields were not different across tillage treatments in any year at Hays or Tribune (Figure 1). However, wheat yield varied across treatments at Garden City in some years. Generally, wheat yields were in the order of STBW > TBTA > 2TBW > NT > STAW. Grain sorghum yields at Hays were in the order of NT > STBW > 2TBW in 2019 and 2020 (Figure 2), but were unaffected by tillage in other years. At Garden City, grain sorghum yields were unaffected by tillage in 2019 or 2020. However, yields at Garden City were less with STAW than NT, STBW, and 2TBW. At Tribune, grain sorghum yields were unaffected by tillage in 2019 or 2022. In 2020, sorghum yields were greatest with STBW and least with TBTA. However, in 2021, sorghum yields were greatest with NT and 2TBW and least with STBW. Similarly, in 2023, sorghum yields at tribune were greatest with NT followed by STBW, STAW, and 2TBW and least with TBTA.

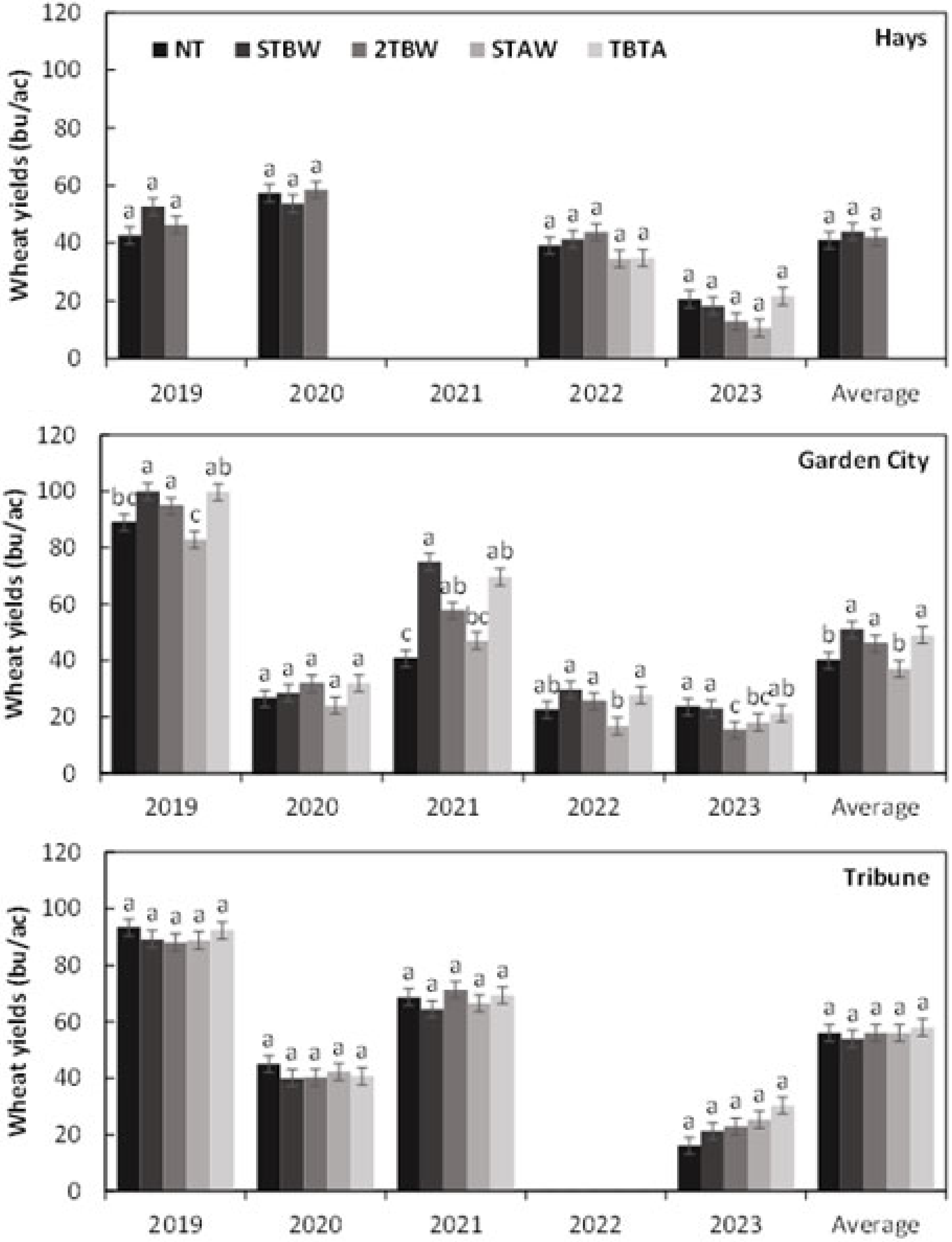

Figure 1. Occasional tillage† effects on subsequent winter wheat yields at Hays, Garden City, and Tribune, KS from 2019 to 2023.

†NT, no-tillage; STBW, one pass before wheat; 2TBW, two pass before wheat; STAW, one pass after wheat; TBTA, one pass before wheat followed by one pass after wheat.

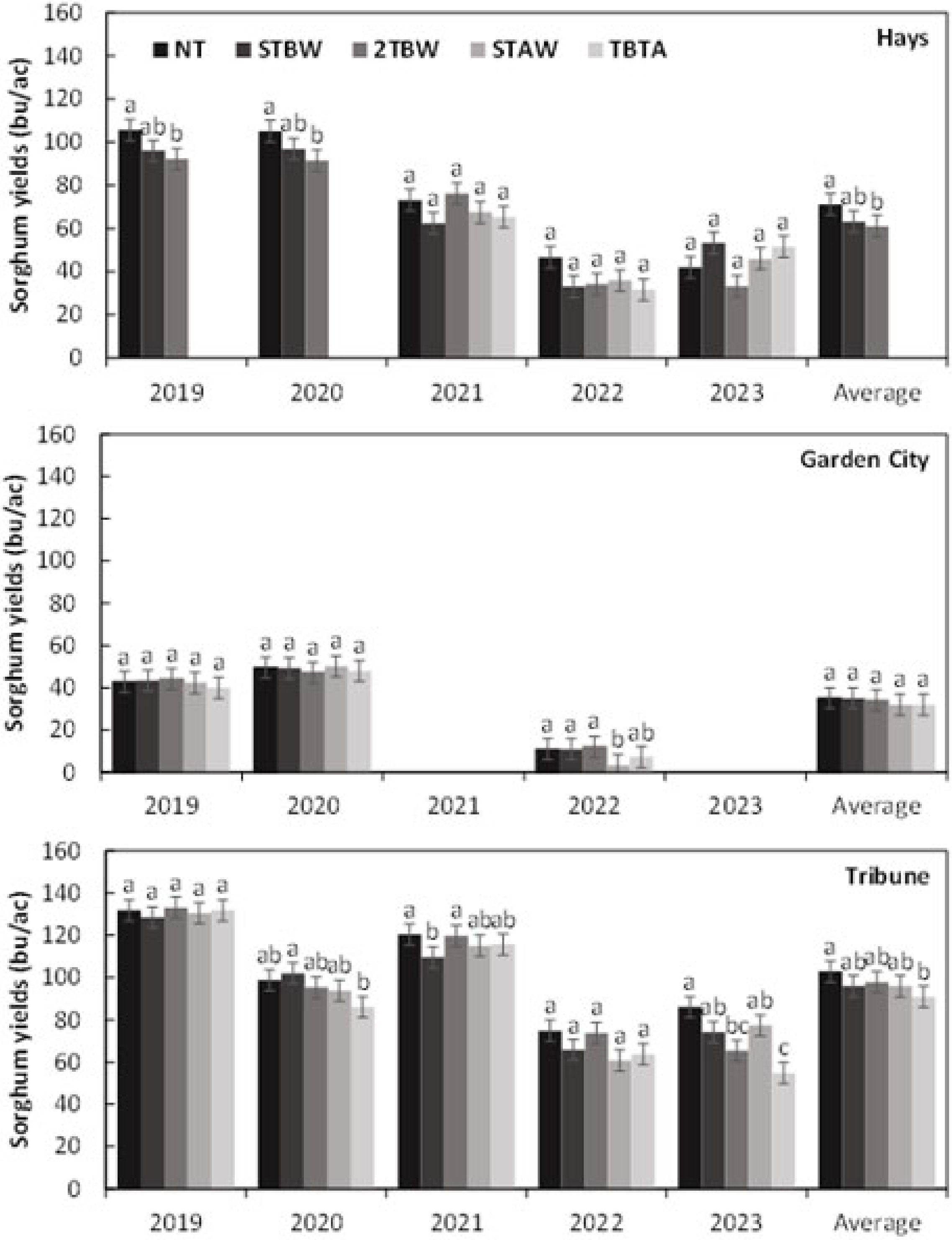

Figure 2. Occasional tillage[†] effects on grain sorghum yields at Hays, Garden City, and Tribune, KS from 2019 to 2023.

[†]NT, no-tillage; STBW, one pass before wheat; 2TBW, two pass before wheat; STAW, one pass after wheat; TBTA, one pass before wheat followed by one pass after wheat.

Summary

Overall, occasional tillage had no negative effects on soil properties but decreased soil penetration resistance. Tillage effects on subsequent wheat yields were infrequent, but results at Garden City suggest yields might be greater with STBW compared to NT. However, grain sorghum yields were occasionally reduced with 2TBW or TBTA at Hays and Tribune. Occasional tillage could be an effective tool for farmers to manage difficult-to-control and HR weeds. However, farmers should be mindful of best management practices when implementing occasional tillage:

1. Occasional tillage with a sweep plow should be timed when soil erosion risk is lowest. In western Kansas, the best time is in summer fallow before winter wheat planting.
2. Timing is critical to ensure successful control of perennial grass weeds. Tillage should be implemented with a sweep plow equipped with pickers, operated at shallow depth, on a hot, dry day with no chances for rain for several days following tillage.
3. The tillage depth should be kept shallow (1-2 inches) to control perennial grass weeds (most are shallow-rooted) and prevent the burying of crop residue. Deeper tillage may only spread and bury rhizomatous weeds like field bindweed or johnsongrass, increasing management challenges.
4. The frequency of occasional tillage will depend on the crop rotation as well as the time it takes for issues to resurge after returning to NT management.

For more detailed information on this study, please refer to:

- "Occasional Tillage in a Wheat-Sorghum-Fallow Rotation" in the 2021 Kansas Agricultural Experiment Station Research Reports: Vol. 7: Iss. 7. https://newprairiepress.org/kaesrr/vol7/iss7/1/
- "Occasional Tillage in a Wheat-Sorghum-Fallow Rotation: 2022 Growing Season" in the 2023 Kansas Agricultural Experiment Station Research Reports: Vol. 9: Iss.6. https://newprairiepress.org/kaesrr/vol9/iss6/4/

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4. World of Weeds: Snow-on-the-mountain

The showy, white foliage of snow-on-the-mountain (*Euphorbia marginata*) is very noticeable in late summer, and you may see it right now on roadsides and in pastures. In fact, it is sometimes used as an ornamental. However, this plant can be toxic to humans and cattle. Honey produced by bees that have foraged on snow-on-the-mountain is called 'jalapeno honey' because it can burn when swallowed. Snow-on-the-mountain is a member of the Spurge family, which also includes poinsettias, toothed spurge, and hophornbeam copperleaf.

Ecology

Snow-on-the-mountain is a warm-season annual plant that is native to the Great Plains but has spread east of the Mississippi River and west of the Rocky Mountains. It is found throughout Kansas in disturbed areas of pastures, roadsides, or near streams. This plant prefers partially shaded areas but can grow in direct sun. It can thrive in a range of soil textures but is most abundant in limestone soils. Cattle generally will not eat snow-on-the-mountain because of the bitter taste. However, it may be consumed in hay, resulting in scours, weight loss, hair loss, and blisters. Mourning doves eat the seeds and are not harmed.

Identification

Stout, light green stems can reach 1 to 4 feet tall (Figure 1). The lower part of the stems is typically not branched and has no hairs. When the stem is broken, or the leaves are removed from the stem, a milky latex sap is released. This sap can be very irritating to the skin (Figure 2).

Figure 1. Snow-on-the-mountain growth habit. Photo by Jeanne Falk Jones, K-State Research and Extension.

Figure 2. White sap from broken stems. Photo by Jeanne Falk Jones, K-State Research and Extension.

The leaves are 1.5 to 4 inches long and 0.5 to 1.5 inches wide. They are oval to egg-shaped with a pointed tip and smooth margins. The leaves are attached directly to the stem at the base of the leaf (sessile). The lower leaves are mostly green and alternately arranged on the stem (Figure 3). The upper leaves are whorled (opposite where branches fork) and have wide, white margins.

Figure 3. An example of an upper leaf with a wide, white margin. Photo by Sarah Lancaster, K-State Research and Extension.

The small flowers on a snow-on-the-mountain plant can often be overlooked by thinking the white and green bracts near the top of the stem are the flower. However, the flowers are quite inconspicuous. One female flower and 35 to 60 male flowers are contained in receptacles about 3/8-inch wide that have 3 to 5 white "petals", each with a green, oblong to kidney-shaped gland at the base. The receptacles are surrounded by large bracts with a broad band of white edging, sometimes entirely white (Figure 4). The bracts are modified leaf-like structures below the flower and form flat-topped clusters at the ends of the branches. Stems within the flowering branches are covered in hairs.

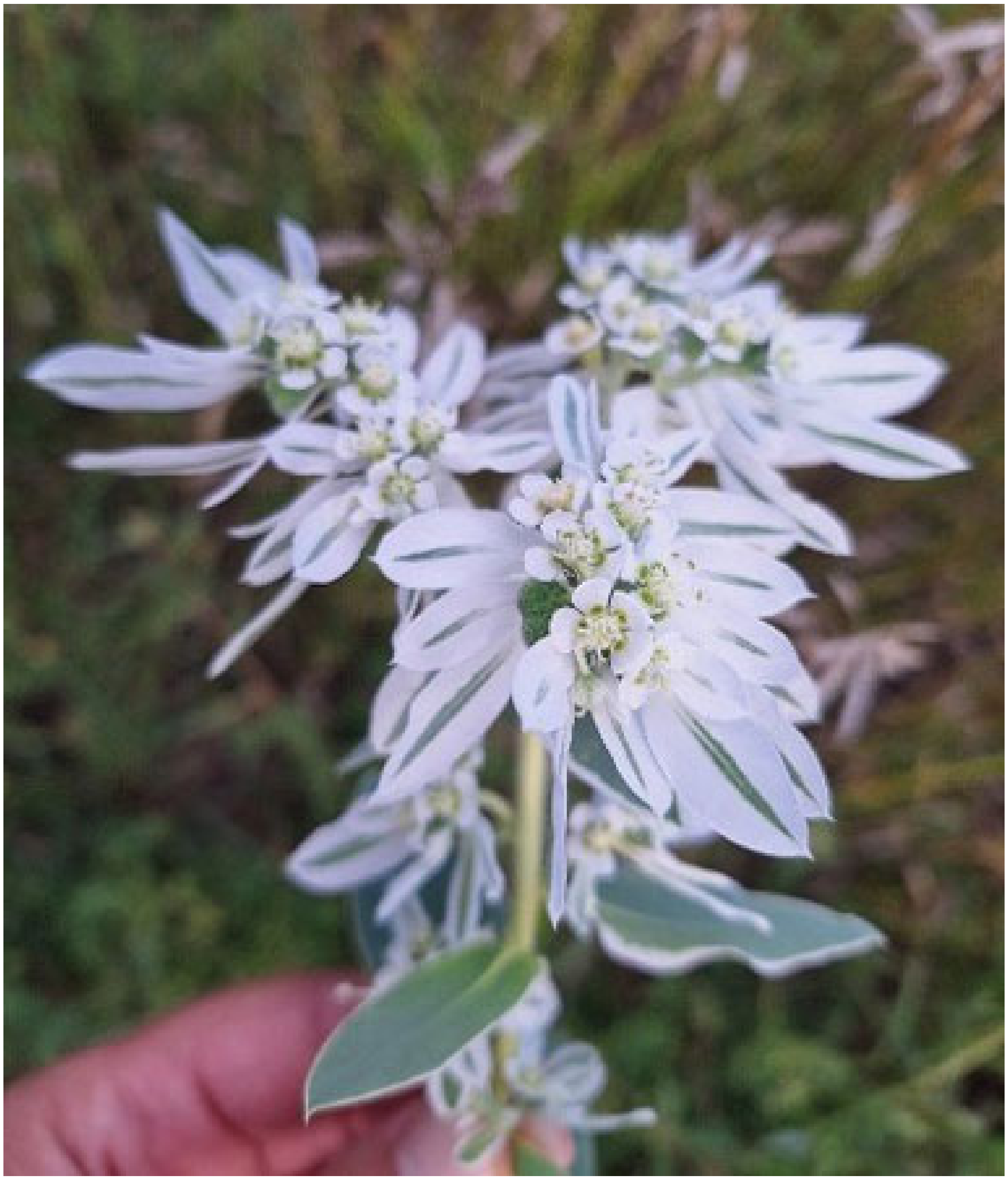

Figure 4. Bracts and flowers. Photo by Sarah Lancaster, K-State Research and Extension.

Rounded capsules contain the seeds. Capsules are about 0.2 inches long and usually covered in short hairs (Figure 5). Capsules are initially green, drying to dark gray. The seeds are spherical to egg-shaped, about 0.125 inch long, and dark gray. A single seed is contained in each of 3 capsule sections.

Figure 5. Capsules contain the seeds and are initially green and usually covered in fine, short hairs (right center of the photo). Photo by Jeanne Falk Jones, K-State Research and Extension.

Management

Snow-on-the-mountain is controlled by Group 4 herbicides such as DuraCor (aminopyralid + florpyrauxifen-benzyl), Grazon P+D (picloram + 2,4-D), and GrazonNext HL (aminopyralid + 2,4-D).

For more detailed information, see the "2024 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland" guide available online at https://bookstore.ksre.ksu.edu/pubs/SRP1183.pdf or check with your local K-State Research and Extension office for a paper copy.

The use of trade names is for clarity to readers and does not imply endorsement of a particular product, nor does exclusion imply non-approval. Always consult the herbicide label for the most current use requirements.

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