Issue 819

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Research and Extension

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eUpdate

09/18/2020

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. Weed management practices: Fall scouting for weeds

Weeds that escape control by in-season management practices can cause several problems, including the possibility of reduced harvest efficiency and crop yield. Even if these factors do not justify an herbicide application, it is important to consider the future costs of seeds produced by those escapes – particularly if those escaped weeds produce a lot of seed and/or are herbicide resistant.

Just a few escapes of species such as waterhemp or Palmer amaranth can have a big impact (Figure 1). For example, research conducted in Georgia showed that one female plant in five acres added about two million seeds per acre to the soil. Those seeds can have impacts for many years. It took six years of total Palmer amaranth control to deplete the seedbank by 98% in Texas. In some situations, scouting during the weeks leading up to harvest may provide an opportunity to remove these plants by hand to reduce the number of seeds in the soil.

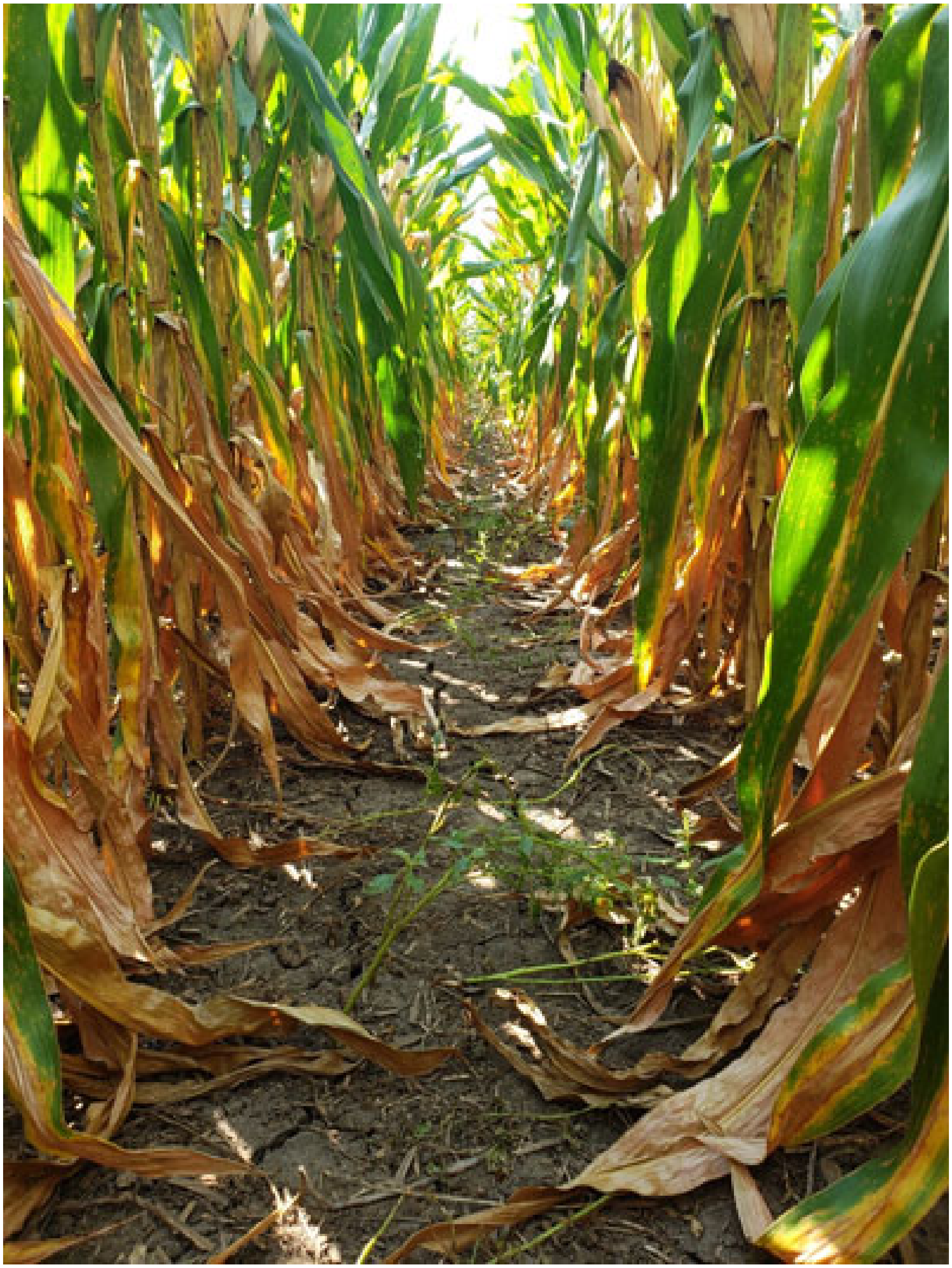

Figure 1. The waterhemp plants growing between these corn rows may not have reduced grain yield, but they will produce seed that must be controlled in future years. Photo by Sarah Lancaster, K-State Research and Extension.

Fall scouting can help plan for future control

Scouting for weeds at harvest, even if you simply make notes from the combine, is important for planning future weed management.

When scouting, make notes about:

- which weed species are present,
- where weed escapes are present, and
- any changes in the size or location of weed escapes.

Some observations might be the result of soil or environmental conditions, while others might suggest problems with the herbicide selection or application equipment. However, some of these escapes might indicate the presence of herbicide-resistant weeds in your field – especially if the same herbicide program has been used for a number of years. Two examples of observations that might indicate herbicide resistance are 1) a growing patch of a particular species, or 2) herbicide failure on a few plants of a single species that is normally controlled.

References: Bagavathiannan and Norsworthy, 2012

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2. Optimum sowing dates and seeding rates for wheat in Kansas

Ensuring optimum sowing date and seeding rate are two steps needed to help achieve the maximum wheat yield potential in a given growing season (Figure 1). Sowing date affects yield potential not only due to stand establishment and tiller formation, but especially as it changes the environment to which the crop is exposed at different phases of the cycle, affecting temperature and moisture regimes as well as disease pressure. Optimum seeding rate depends on sowing date and its adjustment is crucial to ensure the crop will maximize its yield potential.

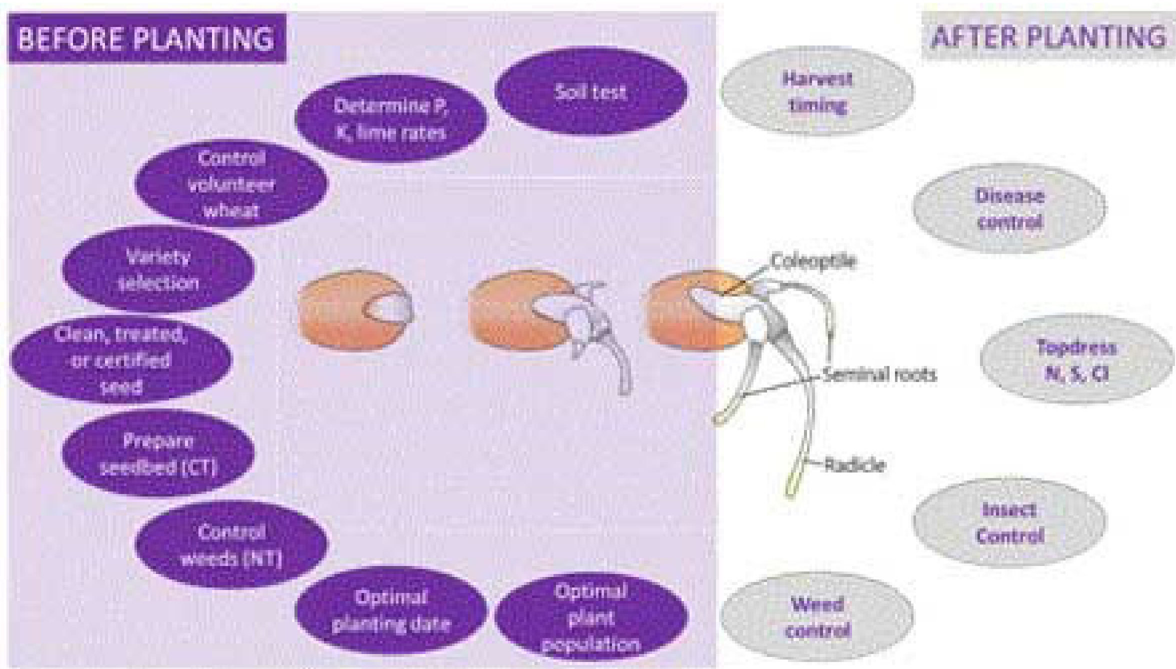

Figure 1. Best management practices before and after sowing to ensure maximum yield potential can be attained in a given growing season. Graphic by Romulo Lollato, K-State Research and Extension.

Sowing date

A) K-State recommendations

Optimum sowing date for winter wheat is quickly approaching for a large portion of Kansas (Figure 2). Depending on geographical location, optimum sowing window can start as early as September 10 and last until the end of September (northwest Kansas), or it can start as late as October 5 and last until October 20 (southeast Kansas). This gradient in sowing dates, with earlier dates in the northwest, is a function of temperature. Northwestern regions with higher elevations will have cooler air and soil temperatures earlier in the year as compared to southeastern regions.

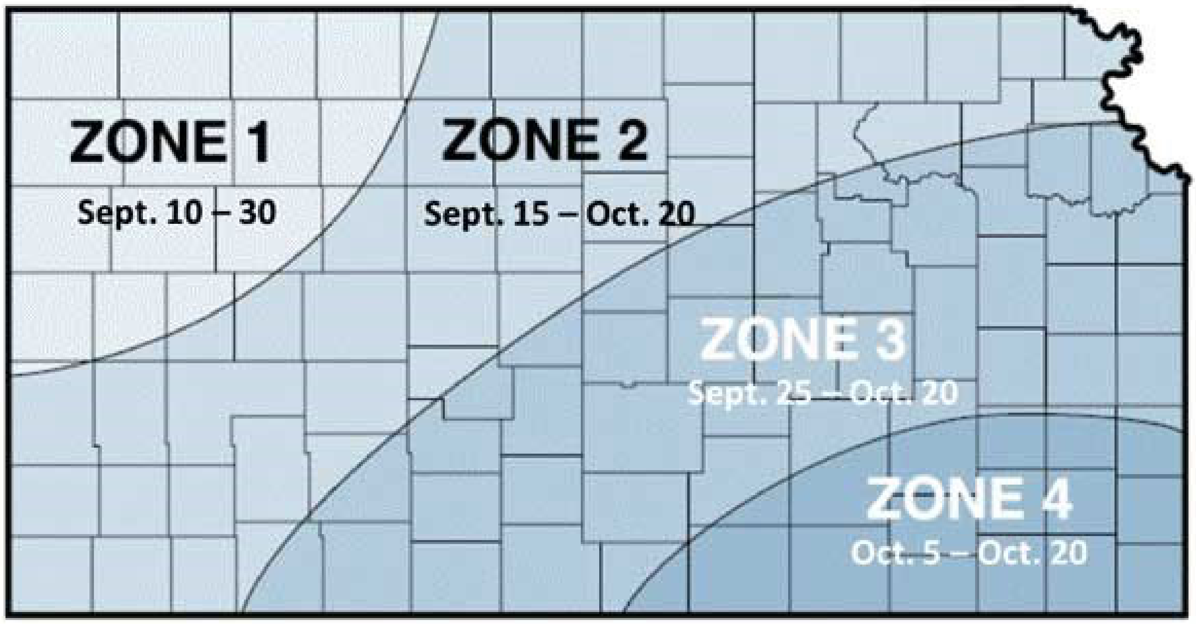

Figure 2. Optimum planting dates for winter wheat according to geographical location within Kansas. Figure adapted from KSRE publication L-818, Kansas Crop Planting Guide.

B) Actual Kansas wheat sowing dates

According to historical data released by the USDA-NASS crop progress reports, on average, producers in Kansas planted approximately 50% of the crop prior to October 4 and about 90% of the crop prior to October 25 during the 1994-2015 period (Figure 3).

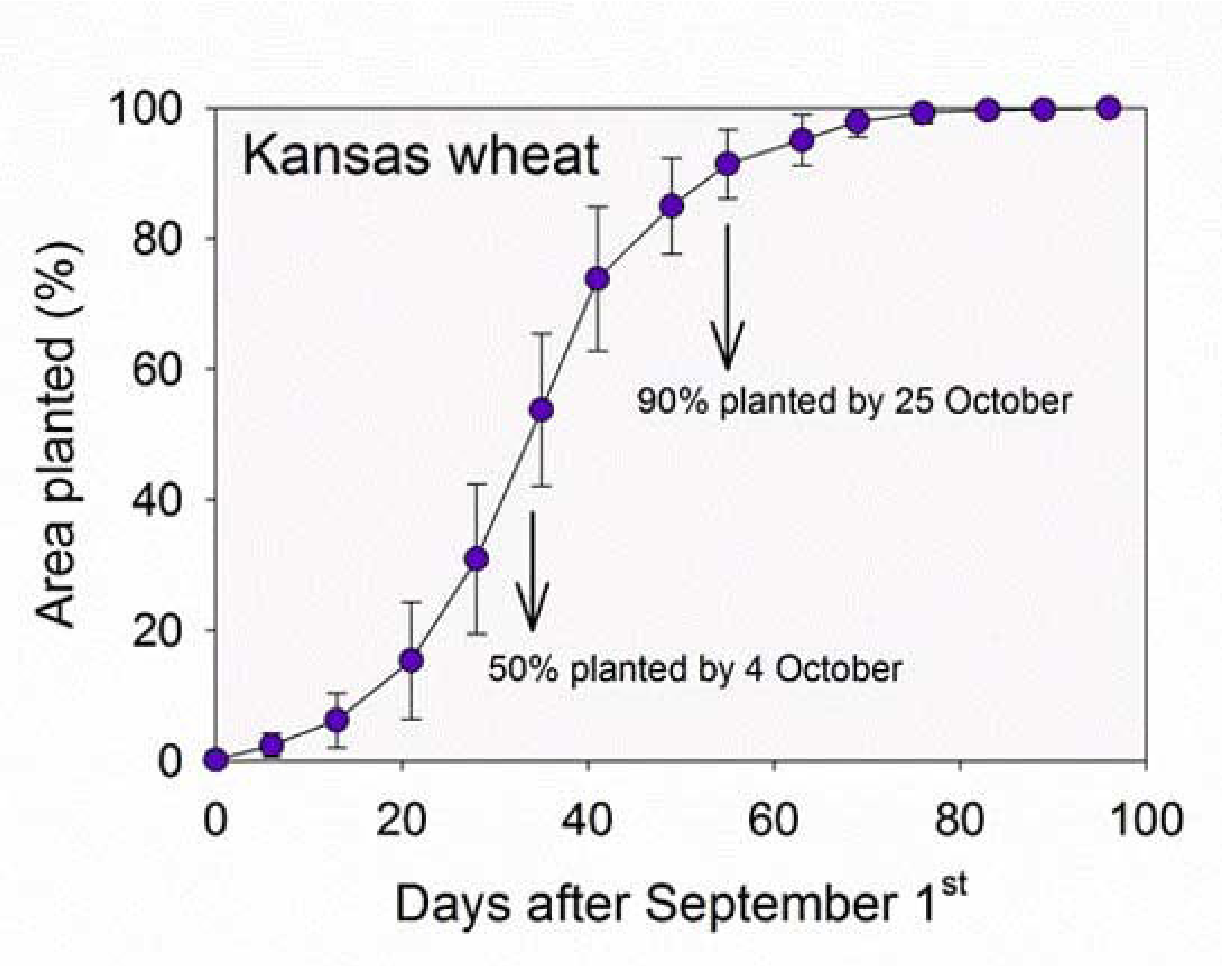

Figure 3. Average percent wheat area planted in Kansas after September 1st. Data represents average and standard deviation for percent planted area during the 1994 – 2015 period as reported by the USDA-NASS Crop Progress Reports (https://www.nass.usda.gov/Publications/National_Crop_Progress/).

Although 50% of the fields are, on average, planted by October 4, there is large year-to-year variability in percent planted area within the aforementioned date range (see error bars on Figure 3). This year-to-year variability is led by sowing conditions, as extremely moist or dry soils, may keep producers from sowing at the optimum planting date.

The largest variability of area planted in Kansas in the period 1994-2015 occurred between September 20 and October 15. During this period the difference in area planted between the earliest and the latest years on record was above 40% (Figure 4). In other words, while 50% of the wheat area was sown by September 21 in the earliest year on record, only 7% of the area was sown by the same date for the latest year on record. In the latest year, 50% wheat area sown was only achieved October 11. The variability in planted area was lower at earlier planting dates (before September 20), probably because most producers tend to wait until the optimum planting window with a smaller acreage planted early. Year-to-year variability in planted area also decreased towards the late planting window (after October 15), as most of the acreage had been planted by that time in most years.

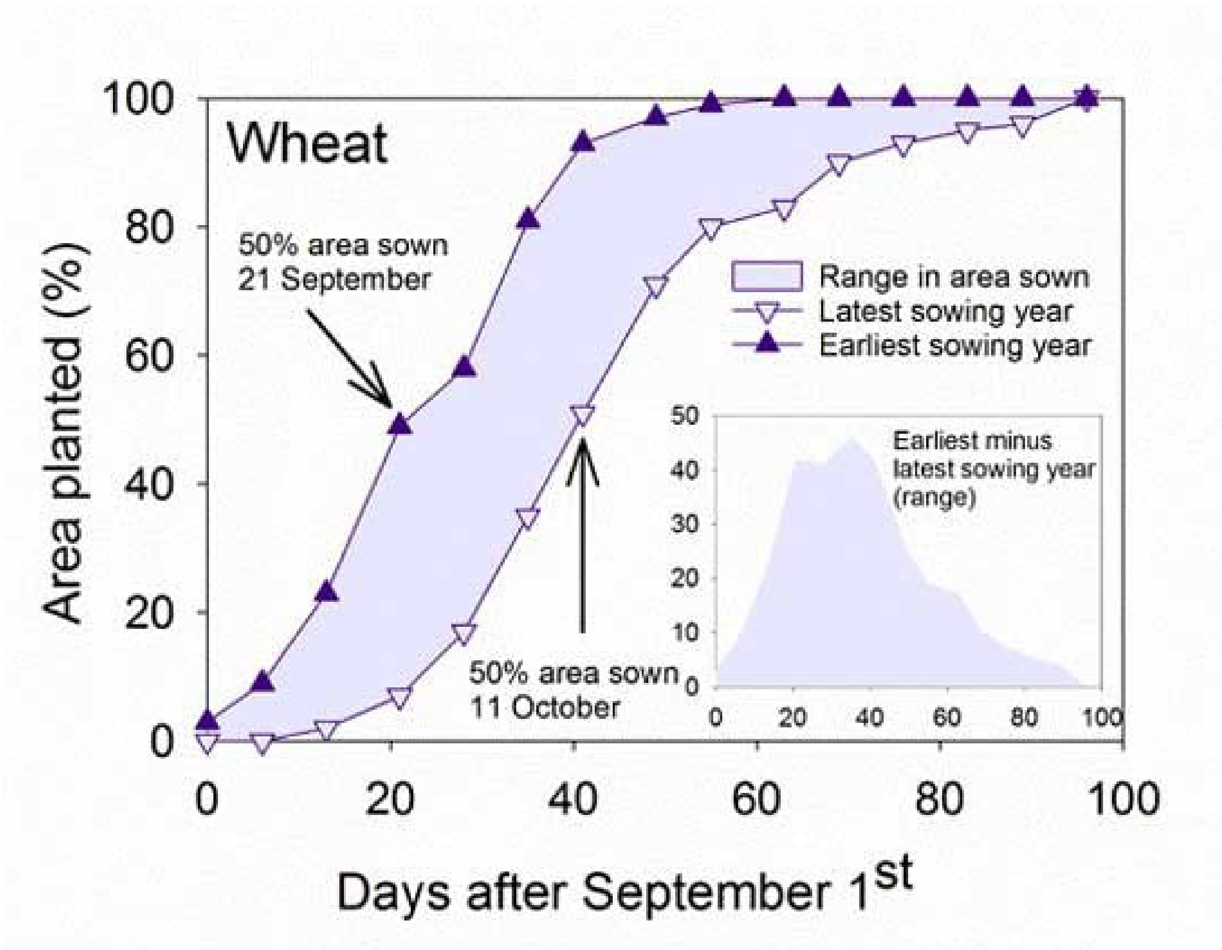

Figure 4. Percent wheat area planted in Kansas after September 1st for the earliest and latest years on record between 1994 and 2015 as reported by the USDA-NASS Crop Progress Reports (https://www.nass.usda.gov/Publications/National_Crop_Progress/). Range in area sown is shown as light purple area in the main graph. Inset shows the difference in percent area planted between the earliest and the latest sowing years on record.

C) Considerations of wheat growth affected by sowing date

1. Sowing wheat early: Sowing wheat at an earlier-than-optimal date can result in lush vegetative growth, which will require more water to maintain the canopy later in the growing season. For that reason, producers who graze their wheat are encouraged to plant wheat two or three weeks earlier than the optimal sowing date for grain. Early sowing can also lead to an increased incidence of fall pest infestation, such as Hessian fly, and diseases transmitted by certain vectors are more active in warmer temperatures, such as wheat streak mosaic (transmitted by wheat curl mites) and barley yellow dwarf (transmitted by aphids). The consequences of an earlier-than-optimal sowing date are discussed in "Early planting of wheat can lead to several problems" from eUpdate issue 818 on September 11, 2020.

2. Sowing wheat at the optimal time: The optimal sowing time differs year-to-year due to environmental conditions, such as temperature and precipitation, but the optimal winter wheat sowing range for different regions in Kansas is shown in Figure 2. Sowing wheat at the optimal time stimulates the right amount of fall tiller formation, as well as root development, to optimize yields while avoiding a lush vegetative growth. Fall-formed tillers contribute more to yield potential than spring-formed tillers, therefore it is crucial that about 3 to 5 tillers are well established before winter. Additionally, this tiller formation, combined with good crown root system development prior to winter dormancy, increases the winter hardiness of the crop, and the chances of winter survival.

3. Sowing wheat late: Many reasons may lead producers to plant wheat late. Double-cropping wheat following a late-harvested summer crop, such as soybean or sorghum, is common in many regions of Kansas. Delayed planting date due to environmental conditions, such as low or high soil moisture levels, may also occur. When wheat is sown past the optimal window, it is generally sown into colder soils and the crop is exposed to cooler air temperatures during the fall. Sowing into colder soils will delay wheat emergence, so the importance of a seed fungicide treatment increases as planting date is delayed. Additionally, the crop will experience decreased fall tiller formation because wheat development is dependent on temperatures (Figure 5). An increase in seeding rates in these circumstances is warranted.

Figure 5. Difference in fall growth due to planting date following summer crops. Photos were

taken December 8, 2016 from neighboring fields which were sown in early October in no-till following corn (left photo) or late October no-till following soybeans (right photo). Photos by Romulo Lollato.

Seeding rate

Optimum seeding rate varies with geographical location in Kansas, following the existing east-to-west precipitation gradient. If sown at the optimal date, optimum seeding rate should be about 1,125,000 – 1,350,000 seeds per acre in the eastern portion of the state, where annual precipitation is above 30 inches, or under irrigated conditions (Figure 6). Seeding rate should be decreased to 900,000 – 1,250,000 seeds/acre in the central region, where annual precipitation ranges between 20 and 30 inches. A further decrease in seeding rate should occur in the western third of the state where annual precipitation is less than 20 inches, for a final seeding rate between 750,000 and 900,000 seeds per acre in that region (Figure 6).

Seeding rate should always be discussed along with planting date, and in many times with soil fertility status as well. As mentioned above, later planting dates will decrease the potential number of fall tillers formed and grain yield will be more dependent on the main stem and maybe one or two tillers formed during the fall. Thus, seeding rate should be increased as planting date is delayed (for more information see "Management adjustments when planting wheat late" in eUpdate Issue 598).

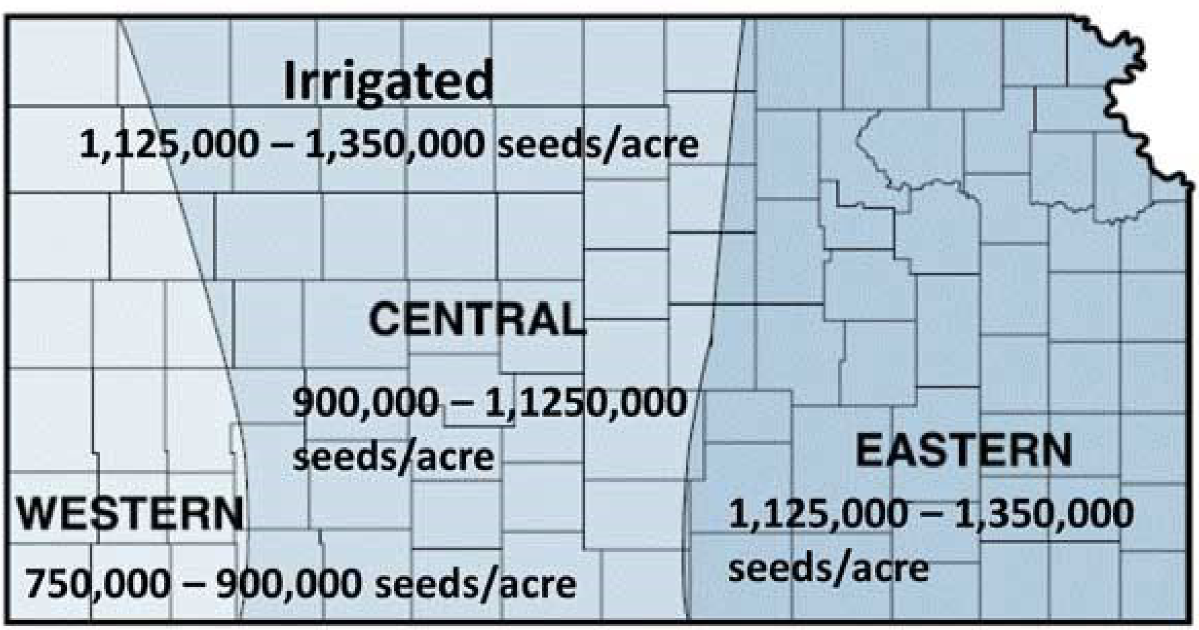

Figure 6. Optimum planting rates for winter wheat according to geographical location within Kansas. Figure adapted from KSRE publication L-818, Kansas Crop Planting Guide.

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3. Seed drill calibration to improve wheat seed distribution

Proper drill calibration can increase the chances of success of the wheat crop by ensuring the amount of seed planted per acre is close to the target.

There are several methods to calibrate seed drills. In this article, we discuss the stationary method, which is a simple 4-step method to calibrate a wheat drill prior to planting. In stationary drill calibration, a drill operation is simulated by turning the drive wheel freely above ground, weighing the seeds delivered from the drill spouts, and comparing to a targeted seed weight by length of drill-row. Note: some drills are designed so that using the stationary drill calibration method cannot be easily done and the drill needs to be operated to calibrate.

1. Determine seeding density.

Targeted seeding density varies within the State of Kansas based on annual precipitation. A target range of seeds per acre based on current K-State recommendations is shown in Table 1.

Table 1. Target seeding density for Kansas when the wheat crop is planted at the optimum sowing date, based on annual precipitation.

Annual precipitation (inches)	**Target seeding density** (seeds per acre)
> 20 in	675,000 - 900,000
20 - 30 in	900,000 - 1,125,000
>30 in	1,125,000 - 1,350,000
Irrigated	1,350,000 - 1,800,000

2. Determine the number of seeds in 50 drill-row feet based on row spacing and targeted seeding density.

Determine the number of linear row feet per acre based on the drill's row width (Table 2). Next, estimate the number of seeds to be collected in 50 drill-row feet based on row width and the target seeds per acre. This can be done by dividing the number of target seeds per acre by the number of linear row feet per acre based on row width and multiplying the result by 50. Percent emergence can be accounted for by dividing the result by the fraction of emergence (for example, dividing by 0.85 for 85% emergence). Table 2 shows calculations for selected row widths and targeted number of seeds per acre considering 85% emergence.

After determining the number of seeds to be collected from 50 drill-row feet, weigh the equivalent amount of seed of each variety you intend to plant. For instance, if the target is 675,000 seeds per acre and row width is 12 inches, a total of 775 seeds need to be planted in a 50 drill-row feet. Assuming 85% emergence, this number increases to 912 seeds (Table 2). Count and weigh 912 seeds from each variety. If no scale is available, place the 912 seeds in a clear graduated cylinder (i.e. a rain gauge) and mark the level for each variety.

Table 2. Seeds per 50 drill-row feet as function of row width and target number of seeds per acre. Feet of linear row per acre as a function of row width is also shown.

Row width (inches)	Feet of linear row per acre	Target number of seeds per acre					
		675,000	750,000	900,000	1,125,000	1,350,000	1,800,000
		Seeds per 50 drill-row feet					
6	87,120	456	506	608	760	912	1,215
7	74,674	532	591	709	886	1,063	1,418
7.5	69,696	570	633	760	950	1,139	1,519
8	65,340	608	675	810	1,013	1,215	1,620
10	52,272	760	844	1,013	1,266	1,519	2,026
12	43,560	912	1,013	1,215	1,519	1,823	2,431

3. Determine the number of wheel revolutions needed for 50 drill-row ft.

First, attach the seed drill to a tractor and raise the drill off the ground. Measure the drive wheel's circumference using a tape measure, and divide 50 drill-row feet by the length of the circumference to determine how many times the drive wheel needs to be rotated to account for 50 drill-row feet. For example, if the drive wheel's circumference is 7 feet, dividing 50 by 7 indicates that the wheel needs to be rotated 7.15 times to account for 50 drill-row feet. Mark a starting point in the wheel with tape (i.e. duct tape) to facilitate counting how many times the wheel is being turned. If the drill design won't allow turning the drive wheel, then measure and flag a 50' distance and catch the seed out of the seed tube as the drill is operated the measured distance.

4. Calibrate the drill.

Adjust the seed meter using the rate chart provided by the manufacturer for the desired seeding rate, which should result in a first approximation of final calibration. Add enough seed of the variety to ensure seed cups will remain covered throughout the calibration process. Rotate the wheel the number of revolutions needed to cover 50 drill-row feet as calculated in step 3 and collect the seed from each spout in a bucket or similar container. The more spouts and longer distance evaluated, the more accurate the calibration. Weigh the collected seed (or pour it in the marked graduated cylinder from step 2) and compare to the target seed per 50 drill-row feet as determined in step 2. If the collected seed weighs too low or too heavy compared to the target, adjust the metering system to deliver more or less seeds, respectively. Keep a record of the different seeding rates achieved at each setting for future reference. Repeat this process until the number of seeds delivered from the drill spouts matches the target established in step 2.

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4. Evaluate wheat seed size to improve wheat seeding density and final stand

Wheat seeding rate recommendations in Kansas have historically been in pounds of seed per acre, and vary according to precipitation zone. However, seed size can have an impact in the final number of seeds actually planted per acre. A variety with larger kernels, when planted in pounds per acre, will result in less seeds planted per acre and possibly thinner stands. If the weather and soil fertility during the growing season are not favorable for fall tiller formation and survival, the thinner stand might result in reduced grain yields. Examples of varieties with large kernels include WB4303, WB4458 and Ruby Lee. On the other extreme, a variety with small kernels can result in above-optimal stand establishment, increasing plant-to-plant competition for available resources such as water, nutrients, and incident solar radiation. Some varieties with typically small kernels include Duster and Byrd. Additionally, planting in seeds per acre can reduce seed costs when wheat kernel size is relatively small.

Seed size can be measured in terms of the number of seeds per pound. The "normal" range is about 14-16,000 seeds per pound, but it can range from less than 10,000 seeds per pound to over 18,000 seeds per pound. Although seed size is specific to each individual wheat variety, it can vary within variety depending on seed lot and seed cleaning process. Figure 1 compares three different wheat varieties and the seed size as affected by seed cleaning. For this simple study, the varieties Everest, WB Grainfield, and SY Wolf were evaluated at different times during the seed cleaning process:

- **'Unclean'** (harvested seed before cleaning)
- **'Air screened'** (seed following air cleaning or the blower)
- **'Mid gravity'** (seed from the low end of the gravity table)
- **'Top gravity'** (the seed from the top end of the gravity table)

It is clear from Figure 1 that wheat variety plays a major role in determining wheat kernel size as does the quality of seed cleaning. Overall, the number of seeds per pound decreased (or individual seed size increased) as the quality of the seed cleaning process increased.

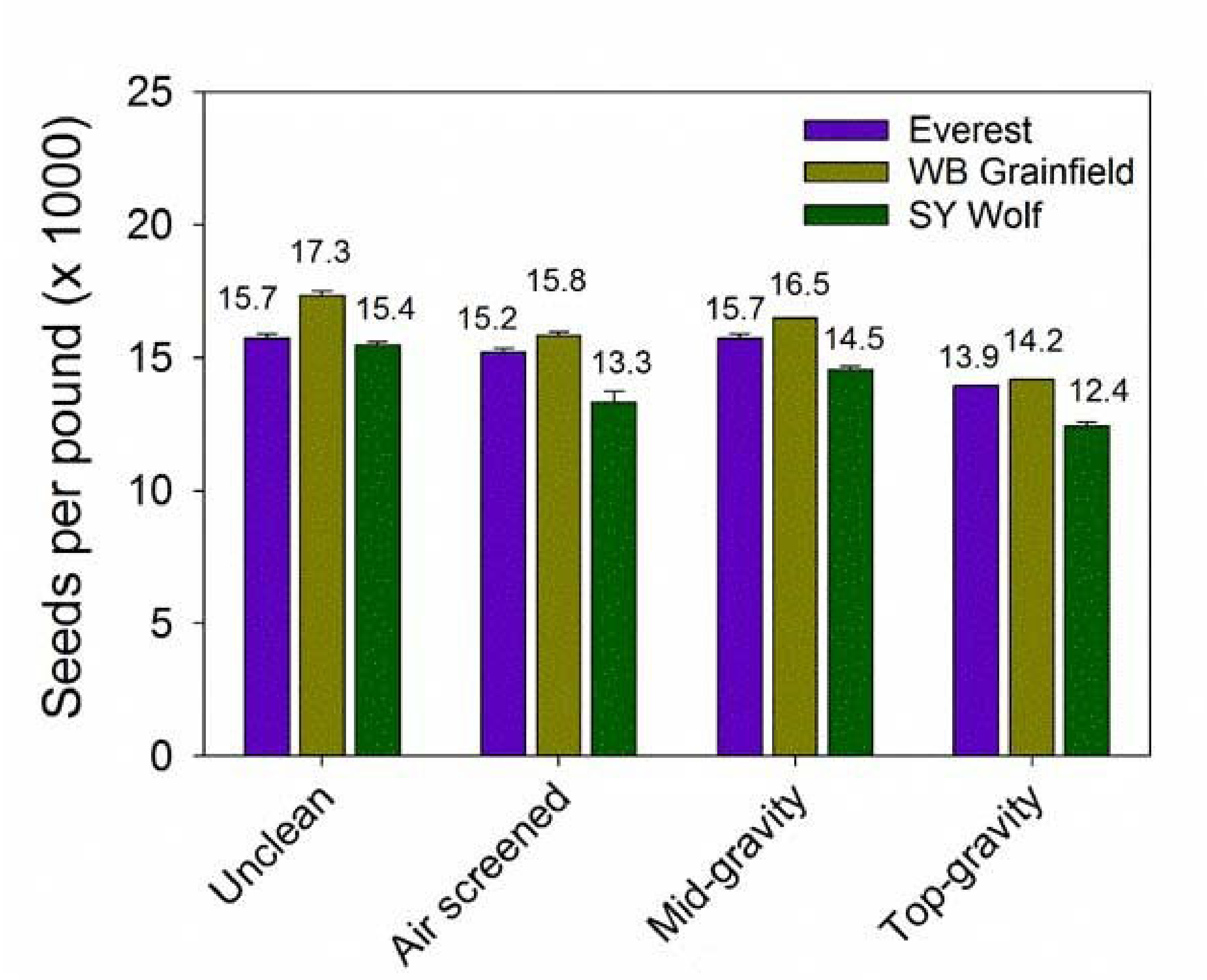

Figure 1. Effects of wheat variety and seed cleaning on final number of seeds per pound. Seed for this research provided by Ohlde seeds, research by Romulo Lollato.

Figure 2 highlights the two most contrasting treatments from the above study, the 'Unclean' WB-Grainfield (top figure, 17,335 seeds per pound) versus the 'Top-gravity' SY Wolf (bottom figure, 12,427 seeds per pound). To achieve the same number of seeds per acre, 'Top-gravity' SY Wolf would require a 39% increase in pounds per acre planted when compared to 'Unclean' WB-Grainfield. In other words, if both varieties are planted at a seeding rate of 75 pounds/acre, final number of seeds planted per acre will be 1.3 million seeds/acre for 'Unclean' WB-Grainfield and 930,000 seeds/acre for 'Top-gravity SY' Wolf. If the goal was to achieve 1.2 million planted seeds per acre, wheat would be over-seeded at about 8% for the smaller seed and under-seeded in about 22.5% for the larger seed. This assumes the same emergence rate for the cleaned and uncleaned seed, which would not necessarily be expected.

Figure 2. Differences in seed size between treatments 'Unclean' WB-Grainfield (17,335 seeds per pound; top photo) and 'Top-gravity' SY Wolf (12,427 seeds per pound; bottom photo). Photos by Romulo Lollato.

If planting occurs in seeds per acre, seed cleaning will actually increase stand establishment. The seeds above were no-tilled into heavy corn residue in an experiment during the 2015-16 growing season, with final seeding rate established in seeds per acre. The resulting stand counts are shown in Figure 3. These results indicate that the seed cleaning process increased stand establishment. These results were likely due to better seed quality as the cleaning process removed small and shriveled grains that may have lower vigor than larger, healthier grains. Regardless of planting in seeds per acre or pounds per acre, these results highlight the importance of measuring wheat seed size before planting to avoid the final amount of seeds planted per acre being too far away from the original target.

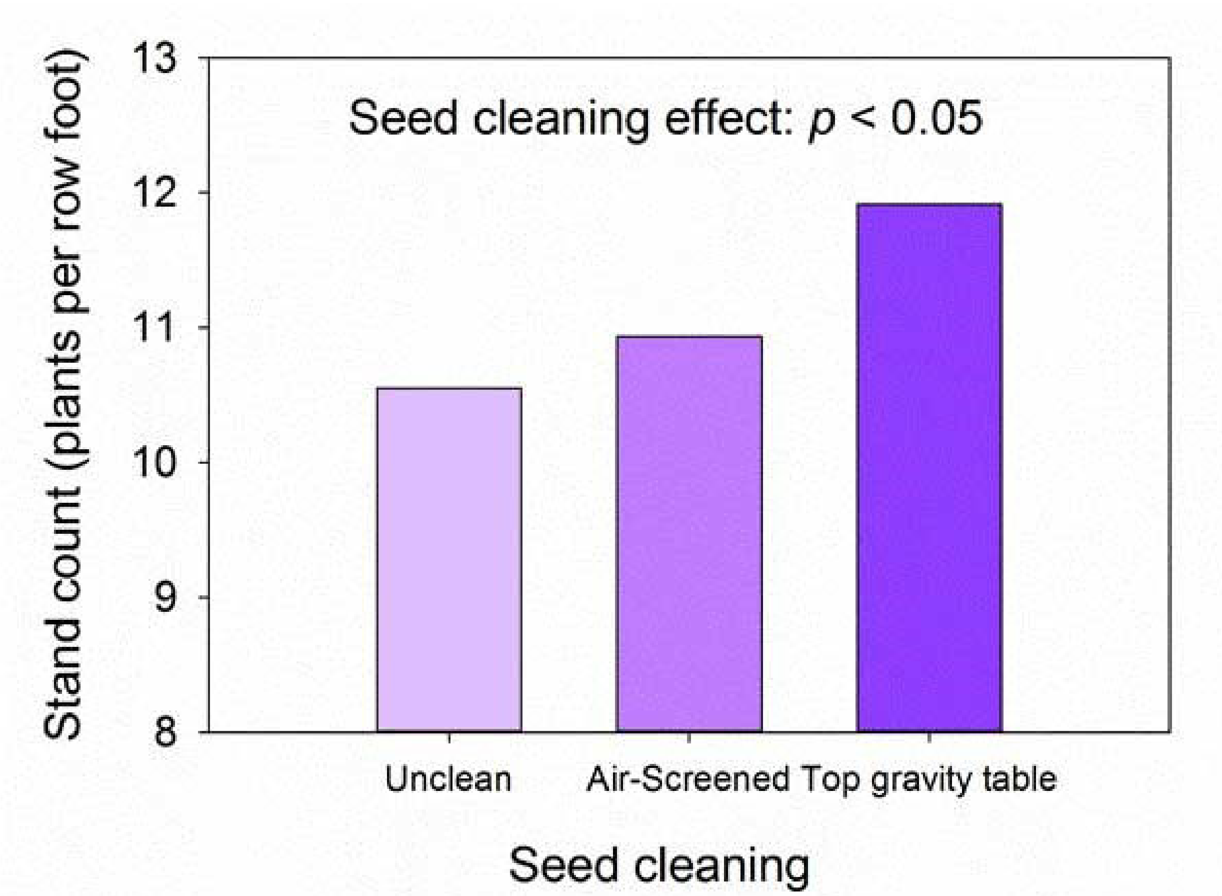

Figure 3. Final wheat stand establishment as affected by seed cleaning process. Plots were sown in seeds per acre, and the improved seed quality resultant from the cleaning process increased final stand establishment. Research by Romulo Lollato.

Certified seed, or seed submitted for germination testing, will have seeds per pound information available. However, an easy on-farm method to estimate the average seed weight of a seed lot is to collect several representative 100-seed samples and weight each 100–seed sample in grams. To calculate seeds per pound, divide the conversion factor 45,360 by the average weight the 100-seed samples. Samples should be collected from the lot as is, including large and small kernels in the same proportion as found in the seed lot. The targeted number of seeds per acre is then divided by the number of seeds per pound to determine the number of pounds to be planted per acre. The following table is a quick reference guide to adjust the planting rate in pounds per acre based on seed size and the targeted number of seeds planted per acre:

Table 1: Reference guide to adjust planting rate in pounds per acre

	Target planting rate (seeds per acre)				
	600,000	750,000	900,000	1,200,000	1,500,000
Seeds/lb	**Pounds of seed per acre**				
10,000	60	75	90	120	150
12,000	50	63	75	100	125
14,000	43	54	64	86	107
16,000	38	47	56	75	94
18,000	33	42	50	67	83
20,000	30	38	45	60	75

<u>How to use Table 1:</u>

A dryland wheat producer in western Kansas whose target may be 750,000 seeds per acre has a seed lot with large kernels, averaging 12,000 seeds per pound. Seeding rate in pounds per acre for this seed lot for a final placement of 750,000 seeds per acre should be ~63 lb/ac. The same producer, planting a different lot with smaller seeds averaging of 16,000 seeds per pound, should plant ~47 lb/ac to achieve the same final seed placement of 720,000 seeds per acre.

A wheat producer in eastern Kansas whose target may be 1.2 million seeds per acre has two seed lots, the first averaging 14,000 seeds per pound and the second, with slightly smaller kernels, averaging 16,000 seeds per pound. This producer should use a seeding rate of 86 lb/ac in the first seed lot and 75 lb/ac in the second seed lot to achieve the same final seed placement. In this case, both seed lots were in the "normal" range of about 14,000-16,000 seeds per pound, and a simple ±10% adjustment on the seeding rate should compensate for differences in seed size.

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5. Seeding rates for dryland wheat in western Kansas

From 2014 through 2018, a study was conducted at Garden City, Tribune, and Colby to evaluate wheat yield response to different varieties and seeding rates.

The objective of this study was to address the following questions:

1. **Are K-State seeding recommendations appropriate for current varieties?**
2. **Is there a need for variety specific seeding rates (other than adjusting for seeds per lb)?**
3. **Do seeding rate recommendations need to be region-specific?**

Study methods

Popular varieties representing a range of tillering potential were selected and seeding rates were selected to represent the range of rates known to be in use by producers. Four wheat varieties (TAM111 in 2016 and 2017, TAM114 in 2017 and 2018, Byrd, T158, and Winterhawk) were seeded at five seeding rates (30, 45, 60, 75, and 90 lbs/ac) at Garden City, Tribune, and Colby into no-till or reduced-till fallow in a wheat-sorghum-fallow rotation. Data were collected from 960 individual plots across 14 site-years (locations x number of years) throughout the course of the study. The 2014 study was preliminary, subsequently we chose to evaluate a wider range of seeding rates. For the purposes of evaluating seeding rate response curves, only data from 2015-2018 is reported in this article.

Discussion of results

The effect of **variety** and **seeding rate** on grain yield was examined for each site-year, along with the interaction of both variables. A significant **variety x seeding** rate interaction means that the optimal seeding rate depended on the variety. As expected, variety selection was important as it significantly affected grain yield in all 14 site-years. Similarly, yields responded to changes in seeding rate in 13 of 14 site-years (over a wide range of seeding rates we would typically expect a yield response). However, optimal seeding rate depended on the variety used in just two site-years.

These two site-years (Tribune 2015 and Garden City 2015) were during stripe-rust outbreaks and the plots were unable to be sprayed with fungicide. At these two site-years, higher seeding rates of the stripe rust-susceptible varieties were able to partially compensate for the effects of the rust, resulting in different yield responses to seeding rate. In summary, varieties responded similarly to seeding rate in 12 of the 14 site-years.

Effect of location on yield

While location affected the overall yield level, with yields increasing in the order of Garden City < Tribune < Colby, location did not affect the overall yield response to seeding rate. As shown in Figure 1, the seeding rate response curve is similarly shaped for all locations when averaged across years and varieties.

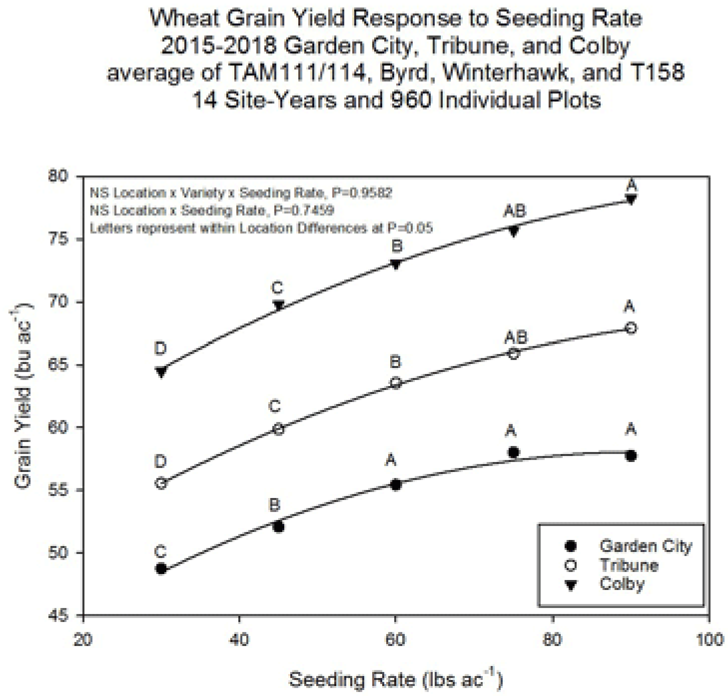

Figure 1. Seeding rate response by location.

In Figure 1, data points within a location that have the same letter are not statistically different. For example, at Garden City there was no difference between the 60, 75, or 90 lb/ac rates, while all three of those rates were higher yielding than the 45 lb/ac rate, which was higher yielding than the 30 lb/ac rate. At Tribune and Colby, there was no significant difference in grain yield between the 60 and 75 lb/ac rates, however the 90 lb/ac rate was significantly higher than the 60 lb/ac rate. With location and variety selection not playing a significant role in optimal seeding rate, all data were then combined to look at the overall response to seeding rate (Figure 2.)

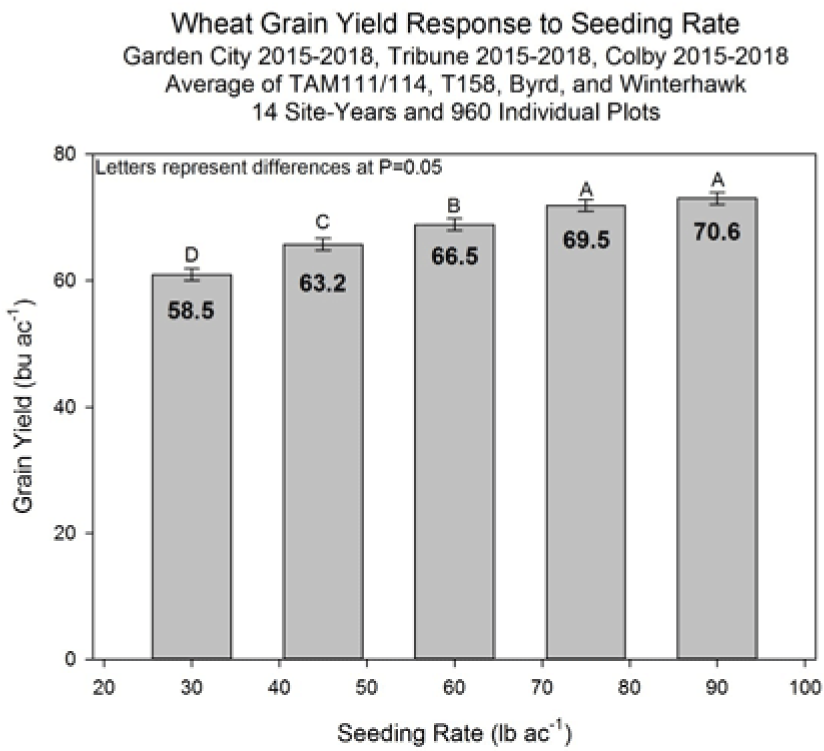

Figure 2. Effect of seeding rate on grain yield, averaged across varieties and site-years.

When the response to seeding rate was evaluated (Figure 2), grain yield significantly increased with increasing seeding rate up through the 75 lb/ac seeding rate. Yield between the 90 and 75 lb/ac rate were not significantly different. When translated into a seeds/ac basis, these seeding rates would have been 452,000, 678,000, 903,000, 1.13 million, and 1.36 million on average.

Important points to keep in mind

1. This study was conducted on a lb/acre basis. However, the range in seed size was modest (an average seed size of 15,056 +/- 19%) when compared to the differences between seeding rates. Conducting the study on a seeds/ac basis would not have significantly changed the shape of the overall seeding rate response curve.
2. The fields used in this study are managed to be non-fertility limiting, however they are not excessive in their fertility and have no history of manure or compost application. Fields with excessive soil test phosphorus levels will likely result in additional fall tillering and thus satisfactory performance might be obtained from seeding rates lower than what these results suggest are optimal. Differences in soil fertility levels, the use of unreplicated vs. replicated trials, and perhaps planting date are likely factors in lower optimal seeding rates reported by others.
3. Due to the dry seeding conditions experienced during the course of this study, seed was often dusted in, or planting was delayed until a rain event. Therefore, emergence was often later than what would be obtained from planting on the optimal planting date into good moisture. Previous work by K-State in Colby has shown the importance of increasing seeding

rates as planting is delayed due to reduced opportunity for tillering. This may be why the distinction between the 60 and 75 lb/ac or the 90 lb/ac rate is not clear cut.

Summary of key results

1. The data collected is not supportive of variety-specific seeding rates (other than adjusting for seeds/lb which remains a K-State recommendation).
2. The seeding rate response curve was similar across varieties and locations for three sites in western Kansas.
3. Across all site-years, 75 lb/ac (an average of 1.13 million seeds/ac) was sufficient to maximize grain yields. When broken down by location, 60 lb/ac (an average of 903,000 seeds/acre) was sufficient to maximize grain yields at Garden City, while at Tribune and Colby the optimal rate appears to lie near 75 lb/ac (approximately 1.13. million seeds/ac).

Producers are often worried about having stands that are too thick, thus an excessive use of soil water in the fall. This is a very valid concern. However, one must also be aware of the two-edged sword. If good growing conditions occur in the spring, there are physical limits to how many kernels per head can be set and maximum kernel weight. If there is a shortage of heads/acre due to an insufficient stand and/or lack of fall tillering, yield will be left on the table in a good year.

Note: Expenses for this study at Colby were funded by the Cover Your Acres Winter Conference.

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