Science Societies

# Does increased seeding rate benefit winter wheat when sowing is delayed?

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*Photo courtesy of Shutterstock/Fotokostic.*


Delayed winter wheat planting is often met with higher seeding rates, yet researchers found this long-standing recommendation may not consistently pay off. Learn how planting date, tillering, and modern wheat varieties influence yield potential.

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Winter wheat is an important forage and grain crop, commonly planted in the Great Plains of the United States. This crop has a unique life cycle. Planting occurs in early fall, allowing early growth followed by a period of dormancy during the winter months. Growth resumes in the following spring.

Sowing date plays a critical role in how the crop is established and the ultimate yield. Sowing may be delayed due to adverse environmental conditions, such as drought. It may also be delayed for weed management or to allow for double cropping systems. When sowing date is delayed, growers are encouraged to increase the seeding rate to ensure enough plants attain the growth needed to produce a viable crop in the spring.

“A lot of my research is based on what I learn from the needs of our farmers,” says Amanda de Oliveira Silva, associate professor and extension specialist for small grains at Oklahoma State University (OSU). “Based on older studies using older varieties of wheat, a very common recommendation is that when we delay planting, you should increase the seeding rate.”

Researchers at OSU sought to understand the actual benefit of increased seeding rate. They scoured published articles from around the world, and their findings suggest the traditional advice may not benefit most growers. The results are available in a recent article published in *Crop Science*, for which de Oliveira Silva served as senior author.

## What are the anticipated benefits of increased seeding rate for winter wheat?

Winter wheat planting typically takes place in the fall between September to November in the Northern hemisphere. Seeds are often sown in crop stubble or no till conditions. Growers are advised to aim for a critical seeding rate high enough to maximize yield, often based on a weight rate. In Oklahoma, this rate is around 60 lb/ac for grain-only systems.

*As the fall progresses, young winter wheat plants germinate and grow through tillering. The gradual decrease in temperature acclimatizes or “hardens” the young*

*plants to withstand harsh winter conditions. Photo courtesy of Adobe Stock/Margaret Burlingham.*

As the fall progresses, the young plants germinate and grow through tillering, the natural process where the cereal plant grows extra side shoots or stems from their base.

The gradual decrease in temperature acclimatizes or "hardens" the young plants to withstand harsh winter conditions, when temperatures can drop below 0°F. The crop stubble also collects snow drifts, producing an effective blanket to protect the young plants during the winter.

The period of cold initiates vernalization, a period of dormancy triggered by temperatures that fall below 50°F for one to two months. Vernalization is necessary to initiate flowering in the spring.

The timing for sowing is critical to the success of the crop, but the timing is heavily dependent on the moisture condition of the soil. Drought conditions can delay the sowing date by a month or more, and changing weather patterns are increasing the likelihood of drought.

*"When you sow late, plants have less time to tiller and produce biomass before winter."*

"With climate change, weather patterns are changing around the world," said Israel Cyrineu, a graduate student in the de Oliveira Silva's lab at OSU and first author on the

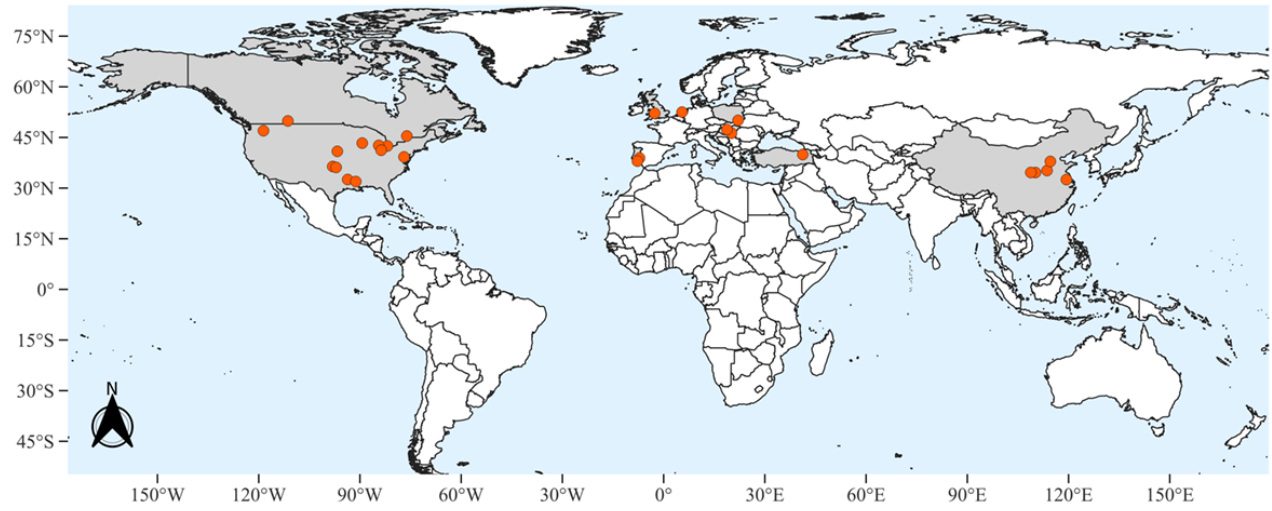
study. “When you sow late, plants have less time to tiller and produce biomass before winter.”

Delayed sowing may reduce seedling growth and establishment later in the season under colder temperatures. A reduction in crop establishment can ultimately decrease yield. To accommodate for this delay, growers are often encouraged to increase the seeding rate to compensate for reduced emergence, tillering, and growing cover; however, de Oliveira Silva’s recent research didn’t seem to jive with this advice.

The OSU researchers joined their Australian colleagues to examine what actually happens when growers follow the traditional advice and increase seeding rate for late sowing.

## How do past studies inform the present analysis?

The team identified 22 peer-reviewed studies published between 1990 and 2024 from around the world—10 studies conducted in North America, seven in Asia, and five in Europe. The wide geographic area ensured the data covered a range of environmental conditions. Cyrineu used the data from the studies, which included sowing date, seeding rate, and yield components, to understand how increased seeding rate affected yield when sowing is delayed.




*Map showing the locations evaluated in the study to understand outcomes of increased seeding rate under delayed sowing conditions for winter wheat. Source: Cyrineu et al., 2026.*

Cyrineu calculated the actual-to-additive ratio (ATAR) for each study. The ATAR is a measure of the individual effects of changes in sowing date (delayed planting) compared with changes in seeding rate (increased seeding rate) on grain yield. The team compared this value to a control approach, defined as the anticipated yield following normal sowing date and seeding rate for each region.

An ATAR value greater than 1 was considered synergistic, meaning the sowing date and seeding rate interacted to amplify yield responses. An ATAR value less than 1 is considered antagonistic, meaning the two components work together to diminish the yield response. The team applied an additive effect, positive or negative, to these descriptors to further expand on the results.

- a negative antagonistic interaction showed increased seeding rate mitigated yield reduction

- a negative synergistic interaction showed increased seeding rate increased yield reduction
- a positive antagonistic interaction showed increased seeding rate decreased yield gain
- a positive synergistic interaction showed increased seeding rate increased yield gain

**What do 35 years of research say about increased seeding rate?**

After evaluating 169 sowing and seeding relationships from the 22 papers, the team came to two clear conclusions. First, delayed sowing date does decrease yield. More importantly, they found increased seeding rate during delayed sowing rarely compensates for the yield decrease.

In short, 40% of the studies produced a negative additive effect that decreased yield. This result suggests the usual seeding rate was already close to or above the critical seeding rate required to maximize yield even for delayed sowing. The study found 25% of the results were negative antagonistic, meaning that increasing the seeding rate above the recommended rate produced a yield benefit. This suggests that a higher seeding rate was able to partially compensate for the yield reduction with late sowing.

*Delayed sowing date does decrease yield. More importantly ... increased seeding rate*

*during delayed sowing rarely compensates for the yield decrease.*

The remaining relationships were positive additive, but only 2% were positive synergistic. The team found that the potentially positive outcomes following delayed sowing may actually be aligned more with variations in weather patterns. Specifically, crops sown under negative weather conditions produced worse outcomes compared to wheat sown later in the season, a situation that is often observed in Oklahoma.

“What we observed in Oklahoma was similar to other environments around the world,” says Cyrineu. “It further strengthens our local observations.”

By examining yield characteristics, the researchers found that crops sown within the suggested sowing window produced a greater number of spikes per unit area compared with a crop sown more than 30 days outside this window, regardless of the seeding rate. Delayed sowing also affected germination, tillering, and tiller survival, ultimately reducing the number of productive tillers. Interestingly, increasing the seeding rate above than the recommended amount resulted in an increase in spike number per unit area, giving farmers the impression that the field has a better stand, but it also results in a reduction in grain number per spike, resulting in no yield benefit.

*A field of winter wheat sown in Oklahoma. The left side of the field was planted in October. The right side of the field was planted in December. Photo courtesy of Israel Cyrineu.*

This study did not investigate the role of nutrient management on yield outcomes. According to de Oliveira Silva, nitrogen can influence early growth, from germination to tillering. This information suggests nutrient management might be a more effective management strategy when sowing is delayed. Her team is working through that question now.

## What should growers do?

Thirty-five years of research suggest increased seeding rate may not provide the silver bullet that traditional advice suggests. The global findings reinforce that the standard seeding rate is typically sufficient even under delayed sowing scenario. The researchers also suggest that shoot biomass may offer a better understanding of yield response to delayed sowing and increased seeding rate.

So what should growers do?

de Oliveira Silva recommends growers talk with their CCA or local extension specialist to determine the best site-specific seeding rate recommendations. During the conversation, they should determine if current recommendations are based on old practices and old wheat varieties and whether this information has been updated. The CCAs or extension specialists should also bring to the conversation with growers new varieties that may be better adapted to changing environmental conditions.

While not part of the study, genetics could play an important role in how growers navigate delayed sowing in the future. According to de Oliveira Silva, researchers at OSU have developed a short-season variety of winter wheat that has been tailored for late planting in response to drier conditions. The plants mature rapidly from jointing to flowering. While the new variety has a slightly reduced yield compared with more established varieties, it provides a new approach to address adverse environmental conditions that are becoming more common.

“Current varieties are more resilient,” says de Oliveira Silva. “These varieties may be better able to tolerate changing environmental conditions and later planting dates than in the past when many management practices were developed.”

**Dig deeper**

Cyrineu, I. M., Sadras, V. O., Cossani, C. M., & de Oliveira Silva, A. (2026). Additive, synergistic, or antagonistic? Relationships between sowing date and seeding rate affecting yield of winter wheat. *Crop Science*, *66*, e70252. https://doi.org/10.1002/csc2.70252

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**1. According to the study, why might increasing seeding rate fail to improve yield in many late-sown winter wheat fields?**

a. Higher seeding rates increase winterkill.

b. Higher seeding rates reduce vernalization.

c. Increased spike density may be offset by fewer grains per spike.

d. Higher seeding rates reduce germination percentage.

**2. Which factor did the authors suggest could explain why some late-sown wheat crops yielded as well as or better than earlier-sown crops?**

a. More favorable weather conditions for the later-sown crop.

b. Increased tillering caused by delayed planting.

c. Reduced competition among plants at later planting dates.

d. Greater grain weight resulting from delayed vernalization.

**3. Which yield component was most consistently reduced when winter wheat was sown more than 30 days outside the recommended planting window?**

a. Thousand-kernel weight.

b. Number of spikes per unit area.

c. Test weight.

d. Harvest moisture content.

**4. Why do growers often perceive higher seeding rates as beneficial in delayed-sowing situations?**

a. They increase grain weight.

b. They increase grain number per spike.

c. They increase spike density, making stands appear stronger.

d. They eliminate the need for nitrogen fertilizer.

**5. Which yield component was found to decrease when seeding rates were increased above recommended levels?**

a. Plant height.

b. Root biomass.

c. Harvest index.

d. Grain number per spike.

*This quiz was drafted with AI assistance and reviewed by the editorial team for accuracy and appropriateness.*

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