Planting Date Effects on Tiller Development and Productivity of Wheat

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Keywords
Keeping up with research; 86 (Sept. 1985); Kansas Agricultural Experiment Station contribution; no. 86-71-S; Planting date; Tiller development; Wheat; Productivity

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D. E. Thiry, Rollin G. Sears, James P. Shroyer, and Gary M. Paulsen
Planting date greatly affects grain yield of wheat by influencing development and survival of tillers. Early planting causes excessive tillers, which have low survival, low harvest index, and low grain yield. Late planting causes inadequate fall tillers, which are not compensated for by spring tillers that have a low harvest index and low grain yield. Planting wheat within the optimum period promotes development and survival of fall and spring tillers that have high harvest index and high grain yield.

### Table 3. Mean plot grain yield and kernel weight of Jagger and 2137 wheat varieties planted on four dates.

| Planting date (1995) | Grain yield (bu/a) | Kernel weight (lng) |
|----------------------|-------------------|-------------------|
| Sept. 28             | 39.0              | 24.2              |
| Oct. 11              | 57.7              | 29.3              |
| Oct. 28              | 54.8              | 29.1              |
| Nov. 13              | 30.2              | 27.7              |
| LSD (0.05)           | 4.9               | 2.8               |

### Table 4. Correlation coefficients among survival and yield characteristics of Jagger and 2137 wheat varieties planted on four dates.

| Factor               | Correlation coefficient (r) |
|----------------------|----------------------------|
| Maximum              |                            |
| Fall tillers         | 0.948** 0.847              |
| Spring tillers       | 0.572 -0.121               |
| Surviving            | 0.725 0.119 -0.611 0.421   |
| Productive           | 0.572 -0.099               |
| Maximum              | 0.840 0.320 -0.365 0.551   |
| Fall tillers         | 0.660 -0.032               |
| Productive           | 0.903* 0.510 -0.101 0.660  |
| Maximum              | 0.401 0.705 0.282 0.718   |
| Spring tillers       | 0.667 0.949* 0.844 0.981*  |
| Productive           | 0.401 0.705 0.282 0.718   |
| Total spikes         | 0.770 0.028 0.914*         |

** Former graduate student, former professor, and professors, Department of Agronomy, respectively.

** Contribution no. 02-276-S from the Kansas Agricultural Experimental Station.

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** Planting date effects on tiller development and productivity of wheat

D.E. Thiry, R.G. Sears, J.P. Shroyer, and G.M. Paulsen*

Much of the grain yield of wheat occurs on tillers that develop from buds in the axils of lower leaves. Under normal conditions, as much as 70% of the grain yield comes from the fall tillers. Tillering also enables the plant to adapt to different conditions. Few tillers develop when moisture, nutrition, and other conditions are poor, whereas numerous tillers that increase the yield potential form when conditions are favorable.

Date of seeding greatly affects development of tillers in winter wheat. Seeding during the optimum period, which ranges from September 10-20 in northeastern Kansas to October 5-20 in southeastern Kansas, enables wheat to form sufficient but not excessive tillers. Early seeding results in too many fall tillers, which may compete with each other, become diseased, and deplete soil moisture so that grain yields are low. Late seeding gives plants little time to develop tillers, resulting in inadequate numbers of spikes/bu etc for high yields the following spring.

Senescence and death might eliminate excessive tillers that form during the fall. Conversely, if too few tillers develop during fall, additional tillers may form during spring. However the yield potential may differ between tillers that develop during fall and those that develop during spring. The objective of this experiment was to determine the effect of fall seeding date on development and survival of tillers during the fall and spring and to measure the productivity of fall tillers and spring tillers of winter wheat.
PLANTING DATE EFFECTS ON TILLER DEVELOPMENT AND PRODUCTIVITY OF WHEAT

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Table 4. Correlation coefficients among survival and yield characteristics of Jagger and 2137 wheat varieties planted on four dates.

| Factor Surviving | Fall tillers | Correlation coefficient (r) | Spring tillers |
|-----------------|--------------|----------------------------|----------------|
| Maximum         | 0.948**      | 0.963**                    | 0.949*         |
| Surviving       | 0.847        | 0.840                      | 0.844          |
| Total spikes    | 0.725        | 0.593                      | 0.667          |
| Grain yield     | 0.119        | 0.107                      | 0.941*         |
| Kernel wt       | -0.611       | -0.365                     | 0.927*         |
| LSD             | 0.421        | 0.551                      | 0.579          |

*Former graduate student, former professor, and professors, Department of Agronomy, respectively.

Conclusions

- Planting date greatly affects grain yield of wheat by influencing development and survival of tillers.
- Early planting causes excessive tillers, which have low survival, low harvest index, and low grain yield.
- Late planting causes inadequate fall tillers, which are not compensated for by spring tillers that have a low harvest index and low grain yield.
- Planting wheat within the optimum period promotes development and survival of fall and spring tillers that have high harvest index and high grain yield.

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The experiment was conducted on Clark clay-loam soil in a soybean-wheat rotation at Hutchinson, Kansas. Two hard red winter wheat varieties, Jagger and 2137, were planted on four dates in the fall of 1995 (Table 1). The first date, September 28, 1995, was the last date that was free of the recommended insecticide and fungicide. September 25 to October 20. The second date, October 11, was one day after the latest leaf-fall date. The last two dates, October 28 and November 11, were after the recommended period. Wheat varieties were planted at 60 in. of seed per plot with a variety of seed drill rows (long. Plots received 70 lbs N/acre and 25 lbs P/acre before planting and 50 lbs N/acre in February 1996. The experiment was arranged in a randomized complete block design with four replications.

A 12-in.-long segment was randomly marked in the four inner rows of each plot when plants emerged. The number of plants in each segment was counted, and the newest leaves of the main shoot and tillers identified with a permanent marker throughout the fall and winter. Tillers that developed until March 5, when plants came out of dormancy, were considered fall tillers. Main shoots were also designated as tillers because of difficulty in distinguishing them as the season progressed. Tillers that developed after March 5 were considered spring tillers; and those that continued to develop a spike with grain, as noted at harvest, were considered productive tillers. The maximum number of fall tillers was recorded when it became evident that they would not develop further, but before they became dormant in late fall. Tillers from the latter two dates did not form any tillers before they became dormant, but those from the October 28 seeding developed a few tillers over winter. Only 46 and 65% of the fall tillers on the plants from the first two dates, respectively, survived the winter, whereas 100% of the fall tillers on plants from the last two dates survived. About 50 to 60% of the surviving fall tillers from the two dates formed spikes, while approximately 80% of the surviving tillers from the last two dates were prolifically tillered, as the third date, and 68% of the spring tillers from the fourth date produced grain. The total number of productive spikes ranged from 260 to 552 yd² or 1.8 tillers per plant from the first date planted, with only 0.7 tillers per plant from the last date planted. Damage to fall tillers may have stimulated development of spring tillers in some cases. Disease and insect incidence was very low throughout the growing season.

Weather for Jagger and 2137 was printed, since results for these two varieties were nearly identical (Table 1). Plants from the first two dates tillered profusely, most of the tillers became dormant in late fall. Plants from the latter two dates did not form any tillers before they became dormant, but those from the October 28 seeding developed a few tillers over winter. Only 46 and 65% of the fall tillers on the plants from the first two dates, respectively, survived the winter, whereas 100% of the fall tillers on plants from the last two dates survived. About 50 to 60% of the surviving fall tillers from the two dates formed spikes, while approximately 80% of the surviving tillers from the last two dates were prolifically tillered, as the third date, and 68% of the spring tillers from the fourth date produced grain. The total number of productive spikes ranged from 260 to 552 yd² or 1.8 tillers per plant from the first date planted, with only 0.7 tillers per plant from the last date planted. Damage to fall tillers may have stimulated development of spring tillers in some cases. Disease and insect incidence was very low throughout the growing season.

The maximum number of fall tillers was recorded when it became evident that they would not develop further, but before they became dormant in late fall. Harvest index was calculated as the ratio of the weight of both the straw and grain to the total weight of all plants. The straw and grain weights were determined on 1000-kernel subsamples from each plot. The straw and grain weights were determined on 1000-kernel subsamples from each plot. The straw and grain weights were determined on 1000-kernel subsamples from each plot.

Plots seeded on November 13 tilled inadequately during both fall and spring and had too sparse of a stand to produce a high yield of grain. The low number of tillers for these plots illustrated the need for increasing the seeding rate when wheat is planted late. Tillers that are small and do not tiller will not produce a high grain yield. A high percentage of the fall tillers were productive fall tillers, and kernels/yd² was also correlated with the number of maximum fall tillers and productive spring tillers (Table 2). Total kernel number was positively correlated with the number of productive fall tillers, maximum spring tillers, and kernels/yd². Kennet y/d² was also correlated with maximum spring tillers and was the only trait that was correlated with grain yield.

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Table 1. Mean date and number of plants that emerged; maximum, surviving, and productive fall tillers; maximum, surviving, and productive spring tillers; and total productive spikes by Jagger and 2137 wheat varieties planted on four dates.

| Planting date | Fall tillers | Spring tillers | Tiller at | Harvest index | Kernels per (x) | Kernel at (mg) |
|---------------|-------------|---------------|----------|---------------|----------------|---------------|
|               | Number      | Number        | date     |               |                |               |
| Sept. 28      | 0.92        | 0.84          | 0.34     | 23.6          | 20.2          |
| Oct. 11       | 0.78        | 0.66          | 0.44     | 24.7          | 24.6          |
| Oct. 28       | 0.82        | 0.66          | 0.44     | 24.7          | 24.6          |
| Nov. 13       | 0.98        | 0.73          | 0.43     | 27.6          | 27.6          |

Plants planted on September 28 produced high levels of tillering during both fall and spring. However, the low percentage that formed spikes indicated that competition among the numerous tillers was intense. This intense competition for sunlight and other water and nutrient factors made the need for compensating for the inadequate tillering during the fall evident. The straw and grain weights were determined on 1000-kernel subsamples from each plot. The straw and grain weights were determined on 1000-kernel subsamples from each plot. The straw and grain weights were determined on 1000-kernel subsamples from each plot.

High yields were obtained after the intermediate planting dates and after the latest possible. Plots planted on September 28, 1995, combined excellent emergence, a high number of productive fall tillers per plant, and a high number of productive spring tillers to produce a high grain yield. Fall tillers from the last planting were particularly important; 69% of the total grain yield was from them and only 31% from the third date. Spring tillers were most important in plots seeded on October 28. A high percentage of the fall tillers were productive, but the number was too low to produce high grain yields. However, the tillers that proliferated during the fall compensated for the inadequate tillering of the spring tillers. In contrast, the October 11 planting, 44% of the grain yield was from fall tillers and 56% from spring tillers. Pots seeded on November 13 tilled inadequately during both fall and spring and had too sparse of a stand to produce a high yield of grain. The low number of tillers for these plots illustrated the need for increasing the seeding rate when wheat is planted late. Tillers that are small and do not tiller will not produce a high yield of grain. A high percentage of the fall tillers were productive fall tillers, and kernels/yd² was also correlated with the number of maximum fall tillers and productive spring tillers (Table 2). Total kernel number was positively correlated with the number of productive fall tillers, maximum spring tillers, and kernels/yd². Kennet y/d² was also correlated with maximum spring tillers and was the only trait that was correlated with grain yield.

It is clear that planting date greatly affects yield of wheat, and much of that effect occurs through the development, survival, and harvest of tillers. Plants during the optimal period encourage the development, survival, and harvest of tillers, which reduces competition among tillers, and promotes a high harvest index. Early planting increases competition, and leads to a low harvest index. Late planting decreases tillering and does not encourage the tillers that develop during spring to be small with a low harvest index.
The experiment was conducted on Clark clay-loam soil in a six-row wheat plot at the Kansas State University Agricultural Experiment Station. The experiment was conducted on Clark clay-loam soil in a six-row wheat plot at the Kansas State University Agricultural Experiment Station.

Methods

Procedures

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