North Dakota

# Tillering Patterns in Spring Wheat and the Need for Phosphorus

By R.J. Goos

*North Dakota studies show that phosphorus (P) fertilizer, preferably banded with or near the seed, is usually needed by spring wheat for complete initiation of critical T1 and T2 tillers, even on high P testing soils.*

**WINTER WHEAT** differs in many ways from spring wheat. In the Great Plains it usually emerges in late September or October when conditions are cooling, days are getting shorter, and there is a long time for tiller initiation to occur before head differentiation. Thus, winter wheat normally produces many productive heads per plant.

Spring wheat differs in almost all of these aspects. It is normally planted in April or May, when the soil is warming and the days are getting longer. There isn't much time between emergence, tillering, and head differentiation. Therefore, the number of productive tillers per plant is usually much lower than winter wheat. Spring wheat farmers compensate for this fact with heavier seeding rates.

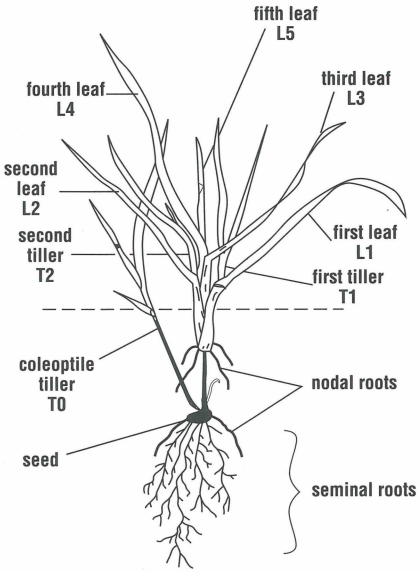


**Figure 1. A young wheat plant, at the 4.4 leaf stage of the main stem.**
**Source: Klepper et al., *Agronomy Journal* 74:790.**

## Tillering in Spring Wheat

There are two types of stems (culms) in wheat. A wheat plant has a main stem and a variable number of tillers. Wheat tillers in an orderly way. At the seed piece there are three nodes. One node can form a tiller, termed the coleoptile or T0 tiller (**Figure 1**). The other two nodes can form adventitious roots. The plant decides whether or not to initiate this tiller when the main stem has about 2 to 2.5 leaves. Most varieties grown in North Dakota don't initiate a high percentage of T0 tillers.

At the base of the first leaf there are five nodes. One of these nodes can form a tiller, called the T1 tiller. The other four nodes can produce adventitious roots. This is a vigorous, productive, and important tiller. The plant decides whether or not to produce this tiller when the main stem has about 2.5 leaves.

There are also five nodes at the base of the second leaf. Again, one node can produce a tiller, the T2 tiller. The other four nodes can produce adventitious roots. The plant decides whether or not to initiate this tiller position at about the 3.5 leaf stage. This is the single most important tiller of spring wheat.

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The initiation of important tiller positions like the T1 or T2 tillers is **not** automatic. If wheat is under stress between the 2 to 3.5 leaf stage of the main stem (only 2-3 weeks after emergence), these critical tillers and the adventitious roots associated with them may not be formed. There is no mechanism to initiate these tillers and roots later in the growing season. Stresses that reduce tiller initiation include seeding too deeply, inadequate fertility, soil compaction, heat or drought.

Many other tillers can be produced later in the growing season. Late appearing tillers include the T3 tiller, formed at the base of the third leaf, and the T10 tiller, formed at the base of the T1 tiller. However, these and other late-forming tillers are often too immature to form a head when the main stem gives the order to do so (about the late 4 or early 5 leaf stage). These late tillers either abort during hot weather in July or linger to form green, immature, nuisance heads at harvest. Late-forming tillers are no substitute for the critical T1 and T2 tillers in spring wheat.

## Spring Wheat Tillering and Yield

The degree of tillering determines the number of heads per acre, an important yield component. An average spring wheat yield of 35 bu/A can be produced with about eight main stems per foot of row (assuming 6-inch row spacing) and the average of one vigorous tiller per plant.

However, for a high yield potential, a good stand of main stems and a high (>90 percent) initiation of the T1 and T2 tiller positions are needed. With a 6-inch row spacing, there should be about 12 plants per foot of row. A 90 percent initiation of T1 and T2 tillers is a practical goal.

## The Role of Phosphorus in Spring Wheat Tillering

Phosphorus fertilization has long been known to "stimulate tillering" in spring wheat. Recently, though, we have learned more about the nature of this "stimulation."

**Figures 2 and 3** show the effects of drill-applied P on T1 and T2 tiller initiation by two wheat varieties. "Marshall" is an old, late-maturing variety known for its relatively high production of tillers. "Butte 86" is typical of the early-maturing daylength-insensitive varieties popular today. **Figures 2 and 3** show the effects of P fertilization on T1 and T2 tiller production on low and high P testing soils, respectively. In both cases, drill-applied P promoted initiation of these two critical tillers. Both varieties responded to drill-applied P, but Marshall required less.

**Figure 4** shows the relationship between soil test level (Olsen P) and T1 and T2 tiller initiation of wheat on six sites of differing soil test levels in North Dakota. The varieties were "Butte 86", "Grandin", or "Stoa". The P rate was 30 or 40 lb $P_2O_5$/A, drilled with the seed.

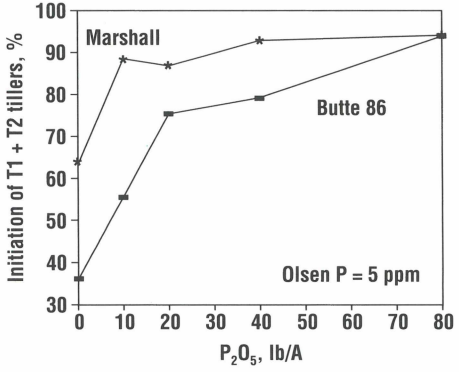


**Figure 2. Effect of drill-applied P on T1 and T2 tiller initiation by spring wheat, low P soil. Dickinson, ND, 1992.**

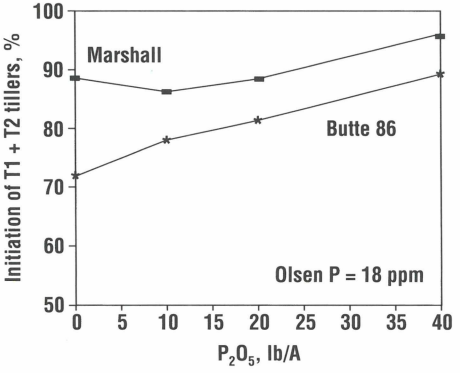


**Figure 3. Effect of drill-applied P on T1 and T2 tiller initiation by spring wheat, high P soil. Dickinson, ND, 1991.**

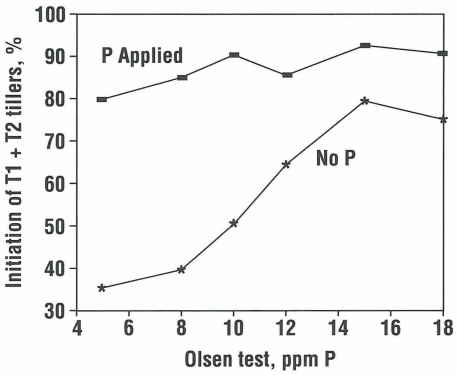


**Figure 4. Effect of drill-applied P on T1 and T2 tiller initiation by spring wheat at six sites of differing soil test levels. North Dakota, 1990-1992.**

The graph shows that at low soil test levels . . . less than 12 parts per million (ppm) . . . there was a great improvement in T1 and T2 initiation with drill-applied P. However, even at high soil test levels, there was still a 10 to 20 percent better initiation of T1 and T2 tillers with P fertilization.

The principle demonstrated in **Figure 4** agrees with the observation that there is a starter effect of P in spring wheat, even at high soil test levels. It was observed long ago that there can be early growth responses and modest yield increases to drill-applied P even with high soil test P levels. A modest improvement in T1 and T2 tillering with P fertilization at high soil test levels could account for much of this starter effect on grain yield.

### Summary

Spring wheat grows for only a very short time between emergence and head differentiation. The main stem and only two tiller positions, the T1 and T2 tillers, account for virtually all of the grain yield of this crop. Phosphorus fertilizer, preferably banded with or near the seed, is usually needed for complete initiation of these critical tillers, even on high P testing soils. ■

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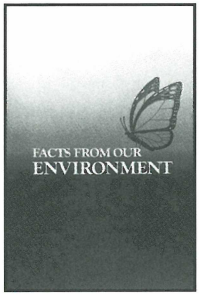


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