PHYSIOLOGICAL BASIS FOR YIELD REDUCTION DUE TO NO-TILL WINTER WHEAT PRODUCTION IN KENTUCKY

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Introduction:

Soft red winter wheat is an important part of the cropping system in Kentucky. This crop is planted at a time when labor and time are in short supply due to competing needs of other important field operations required during this period. No-till (NT) wheat systems provide substantial time, labor and energy savings as well as erosion-control benefits, especially on rolling crop land. Irrespective of these benefits, lower yields under NT, although not consistent, have been reported.

Tillage operations change the crop's growing environment and can thereby impact how the plant functions. An understanding of the physiological factors that limit yield under NT production systems may be useful in designing genetic or agronomic measures necessary to optimize yield under NT.

No-till production systems maintain crop residue on the soil surface; this could negatively affect crop growth. For example, surface residue can reduce water evaporation from the soil and maintain soil temperatures cooler in the fall and slow soil warming in the spring. Cooler soil temperatures in the fall and spring could delay emergence, seedling development and retard vegetative growth, all of which have been observed under NT wheat production. Lack of tillage could result in increased soil compaction and bulk density, factors that may influence root growth and which can ultimately impact nutrient uptake or water stress in dry years, factors that may ultimately reduce total biomass accumulated. The objective of our study was to determine the physiological basis for yield reduction under NT of soft red winter wheat in Kentucky**.**

Materials and Methods:

Two experiments were conducted at two locations in Kentucky in 2004, 2005 and 2006. Main plots were no-till and conventional tillage (CT) systems. In the first experiment, the split plots were four varieties with different heading dates (Table 1). In the second experiment, split plots were two varieties and split-split plots were three seeding rates. Grain yield, harvest index, and tiller number were measured at maturity.

Results and Discussion:

NT wheat systems resulted in similar or slightly lower wheat yields than did CT systems (Fig. 1). This effect of tillage on yield was dependent on the location and the year of production suggesting that environmental factors such as soil and weather can modify the impact of NT production systems on grain yield. However, physiological changes occurred in the wheat crop when grown

Table 1. Characteristics of variety tested in Exp. 1 and 2.		
Variety (Source)	**Year of cultivar release****	**Heading (Days after 1 April)****
Sisson* (Virginia Tech.)	2000	30
25R49 (Pioneer Hi Bred)	2000	33
25R23* (Pioneer Hi Bred)	2001	36
Sarah (Exsegen)	2000	39

* Used in both Exp. 1 and 2.
** Data source: 2002 Kentucky Small Grains Variety Trials.

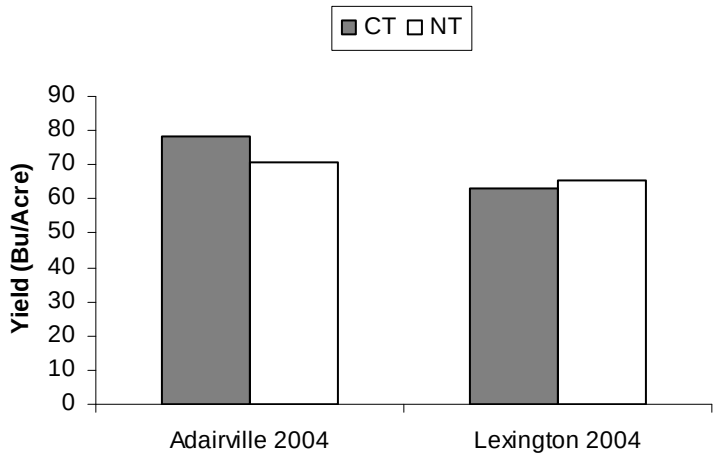
under NT, and these changes were consistent in response to NT across the different years and locations tested. For example, harvest index (HI, the proportion of biomass allocated to seed) was lower for NT systems than for CT systems in both experiments (Fig. 2). In a similar manner no-till practices also increased tiller density (Fig. 3). Considering the positive relationship between tillers and heads per unit area, it could be expected that more tillers would increase yield. However, in the current study, more tillers sometimes resulted in lower yields. How could this be possible?

Wheat physiologists proposed an ideal architecture for a wheat canopy that would lead to high yields. This proposed ideal of wheat architecture (developed by Donald in 1968), suggested that tillers may be detrimental to wheat yield because they increase the plants' internal competition for assimilates between the developing head and younger, non-productive tillers. This would mean that fewer of the plant's resources would be allocated to the seed. Consistent with this hypothesis, both a decrease in HI and an increase in tiller numbers were observed under NT in this study. If that scenario happens without an increase in biomass, lower yields are to be expected.

Conclusion:

The slightly lower yield sometimes measured under NT may be explained as a physiological response of the crop to NT production systems as follows: NT production systems increase the likelihood that soft red winter wheat will produce more tillers. This tillering growth habit may divert assimilates away from grain production to vegetative growth and thereby result in lower yields (when biomass accumulation cannot compensate). Options for further work on enhancing soft red winter wheat yields under NT could include genetics (e.g. varieties with lower tillering potential) and/or agronomy (e.g. an adjustment in spring nitrogen splits).

A



B

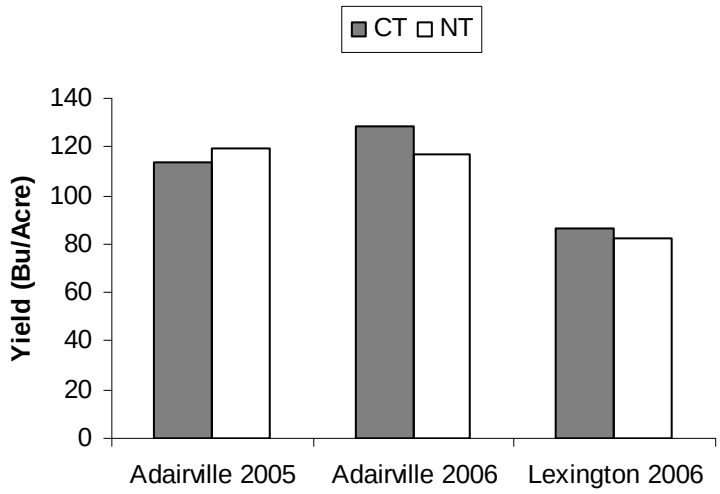
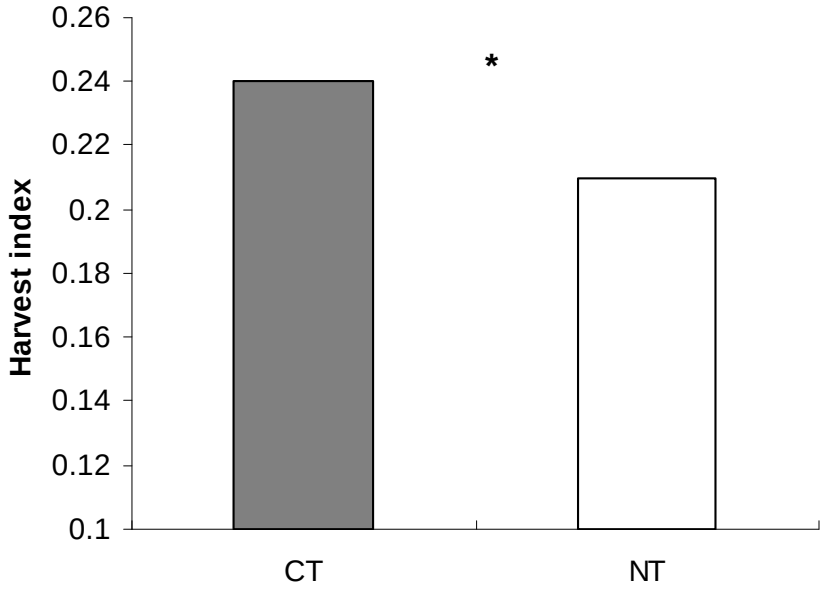


Fig. 1. Grain yield of soft red winter wheat in (A) Exp. 1 and (B) in Exp. 2 under conventional (CT) and no till (NT) production system. The yields in (A) are means across four varieties and the yields in (B) are means across two varieties and three seeding rates.

A.



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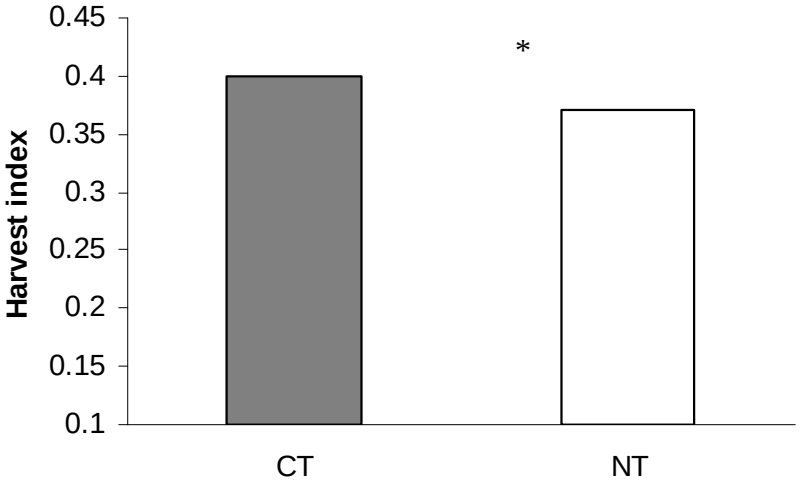

Fig 2. Harvest index (HI) of (A) four winter wheat varieties at two locations in 2004 and (B) two winter wheat varieties grown at three locations/year, all under either a conventional (CT) or no-till (NT) production system. * represents significant difference between the two tillage systems at $p < 0.05$.

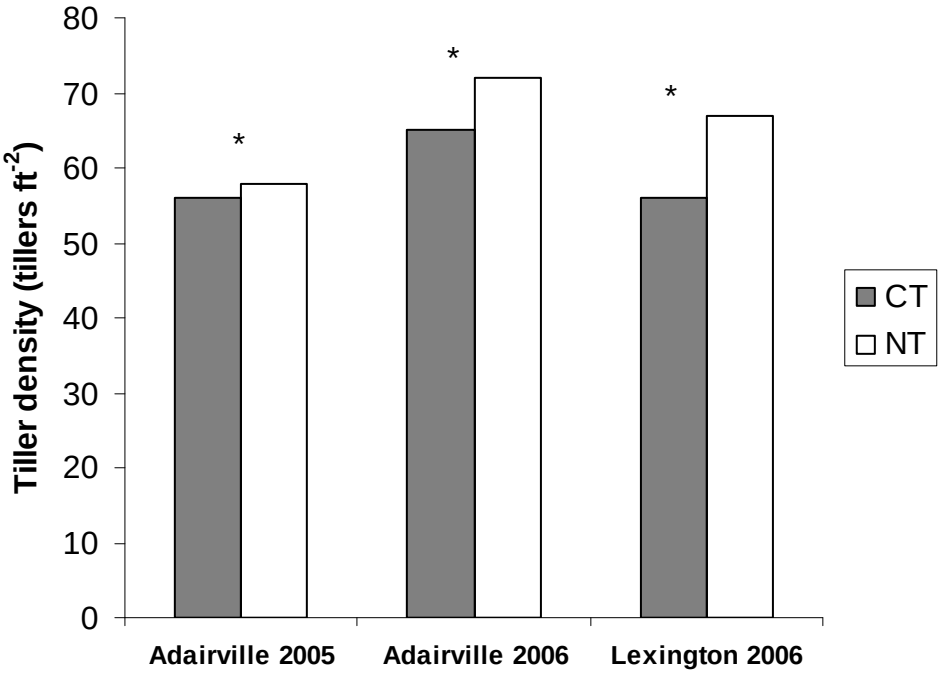

Fig. 3. Tiller density of two soft red winter wheat varieties grown in three environments under either a conventional (CT) or a no-till (NT) production system. Means across three seeding rates. * represents significant difference between the two tillage systems at $p < 0.05$.