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## **No-Till Can Reduce the Risk of Heat Stress in Wheat**

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No-till farming (NT) is increasing in the Canadian Prairies in recent years because of the economic and environment benefits and its potential to sequester atmospheric carbon into the soil. Because surface residue and stubble act as insulation and impedes the exchange rate of thermal energy between the soil and the atmosphere, lower root-zone temperatures in the NT fields compared with that in the conventionally tilled (CT) fields were widely observed in the spring. Some studies found that low temperatures under NT persisted to the mid-season or throughout the whole growing season. Little attention, however, has been paid to the impact of the cooling effect of NT on the grain yield of wheat. The objective of this study was to investigate if NT could alleviate heat stress and benefit yield.

### **MATERIALS AND METHODS**

Data were collected between 2000 and 2003 from continuous wheat plots from the Sustainable Cropping Systems Research Study site located on a Thin Black Chernozemic clay loam near Three Hills, Alberta. Each year, the CT system was usually tilled once prior to seeding to prepare the seedbed and once or twice after harvest to turn under residues. The NT system did not use tillage and the crop was seeded into the previous year's standing stubble with a low disturbance John Deere 752 disc drill. The wheat cultivar was AC Barrie. Soil moisture was taken before seeding at the depths of 0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm, and 90-120 cm by gravimetric method. In the growing season soil moistures at 0-15 cm in 2000 and at 0-6 cm in other three years were measured by a time domain reflectometry probe and a Theta probe, respectively, usually once a week. Hourly soil temperatures were measured at 5 cm in each plot. Heat stress index (HSI) was calculated on the basis of the accumulation of hourly soil temperatures greater than a critical temperature (20°C).

### **RESULTS AND DISCUSSION**

Pre-seeding soil water contents were relatively low in 2000 through 2002 compared with 2003. The treatment of NT had higher moisture from 0-15 cm through 30-60 cm than CT every year, but not significant in most cases. Treatment differences

were small generally at deeper depths. The NT had higher near-surface soil moisture than CT in the early part of the growing season every year, but not significant in most cases.

Soil temperatures at 5 cm under NT were consistently lower than that under CT over the growing seasons (Fig. 1). At the vegetative stage, the relatively cool soil under NT may not have severe impact on the growth because it was very seldom lower than 2°C. Extremely high soil temperatures (>25°C) at 5 cm were observed during 21 to 27 days after seeding in the CT treatment in 2001 with the highest of 31.3°C, which could be harmful to the root system. The maximum temperature under NT during this period was only 23.1°C. At the ear development stage, extremely high soil temperatures at 5 cm were observed in the CT treatment in 2001 with the highest of 32.2°C, while the highest was only 25.2°C in the NT treatment. Again in 2002, some very high hourly soil temperatures occurred in the CT treatment with the highest of 31.4°C compared with 25.6°C in NT. Heat stress at this stage can impair terminal spikelet initiation and cause pollen sterility; and therefore, result in kernel number reduction. At the grain growth stage, the occurrence of chronic heat stress (>20°C) at 5 cm under CT was more than that under NT every year. In 2001 and 2002, plants experienced heat shock (>32°C) under CT, but not under NT (Fig. 2). Heat stress at this stage can cause both abortive kernel and shortened grain filling duration, so as to reduce kernel number and kernel weight. The NT treatment consistently had lower HSI than CT. HSIs at 5 cm under CT and NT were 851°C h and 592°C h in 2000, 1280°C h and 610°C h in 2001, 2402°C h and 1278°C h in 2002 and 785°C h and 275°C h in 2003, respectively.

In the four years of the study, the highest average yield was 2720 kg ha<sup>-1</sup> in 2003, followed by 2065 kg ha<sup>-1</sup> in 2001, 1966 kg ha<sup>-1</sup> in 2000 and the lowest was 679 kg ha<sup>-1</sup> in 2002 (Fig. 3). Increases of yield by NT practice were 44% in 2000, 18% in 2001, 147% in 2002 and 3% in 2003.

Correlation analyses showed that there was a significantly linear relationship between HSI at grain growth stage and yield (Fig. 4). It appears that heat stress is one of the factors affecting wheat yield in the Canadian Prairies. The cooling effect of NT can reduce the severity and duration of heat stress, especially during the grain growth stage, which might be one of the reasons that the yield of NT was higher than or equal to that of CT.

## REFERENCES

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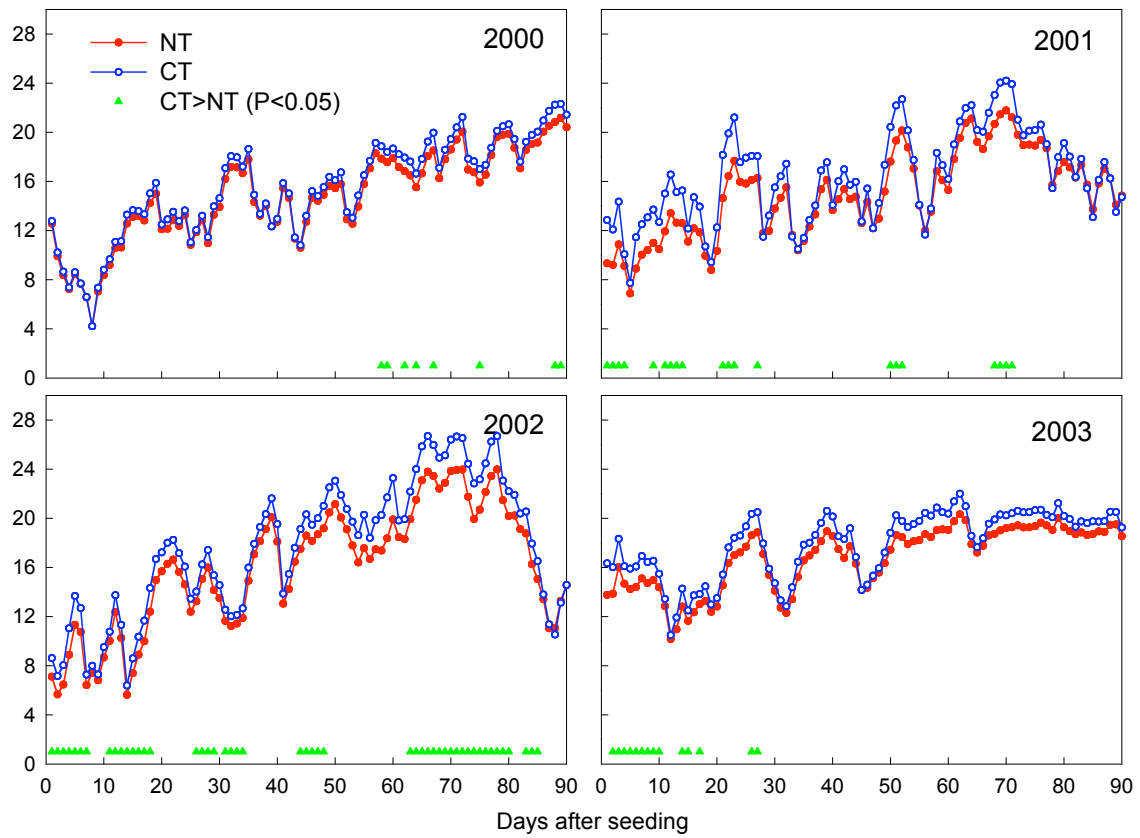


Fig. 1. Daily soil temperature at 5 cm.

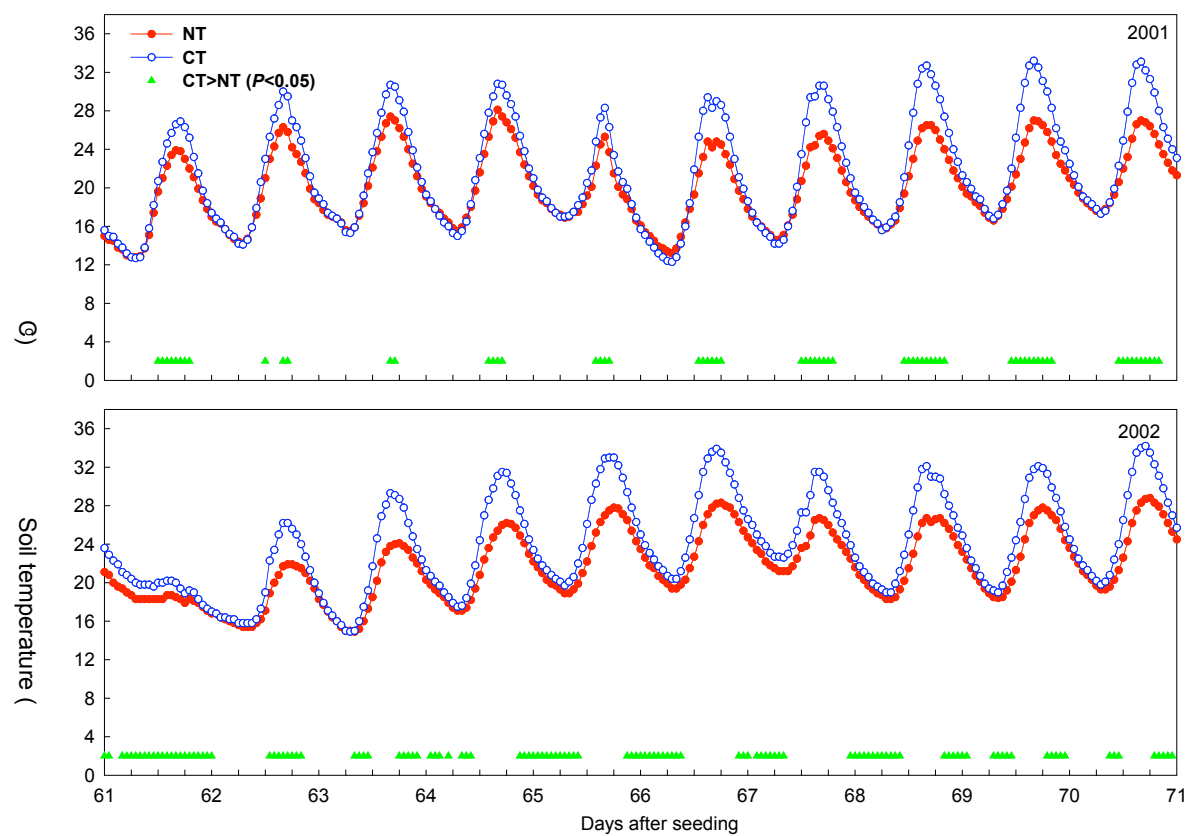


Fig. 2. Hourly soil temperature at 5 cm.

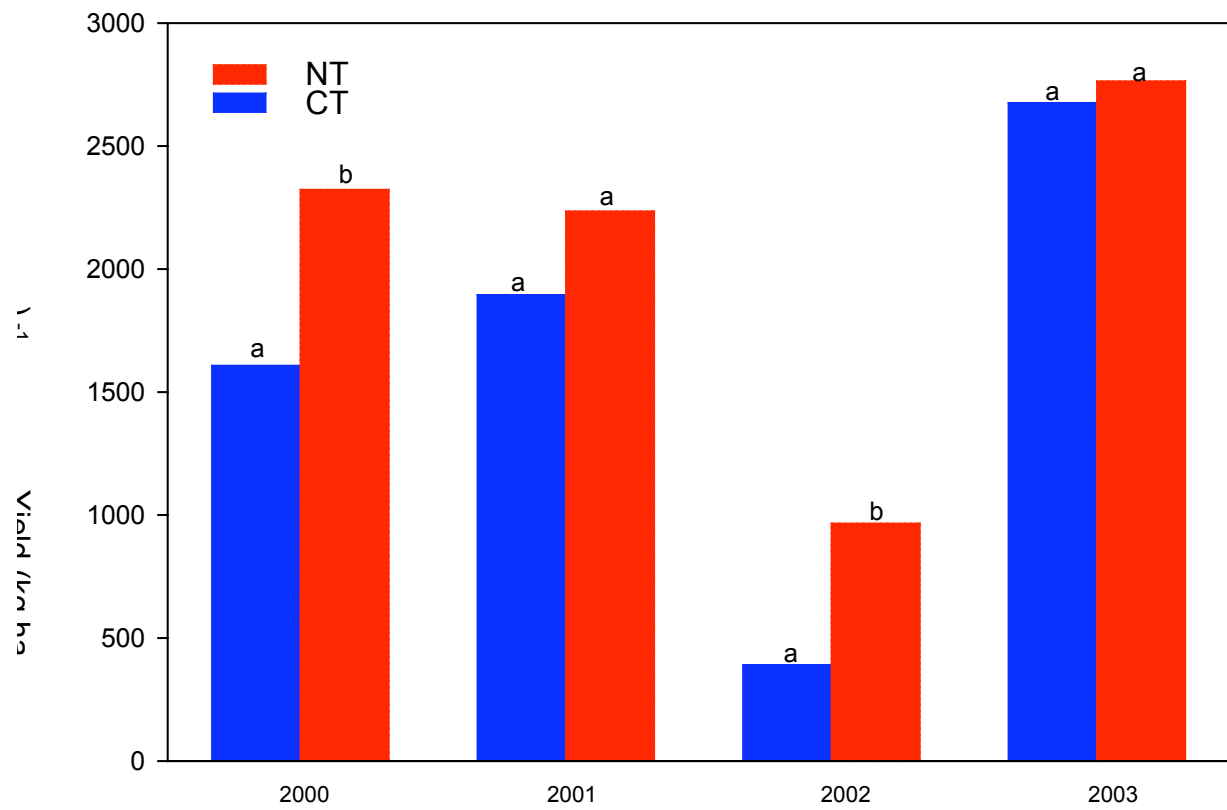


Fig. 3. Grain yield.

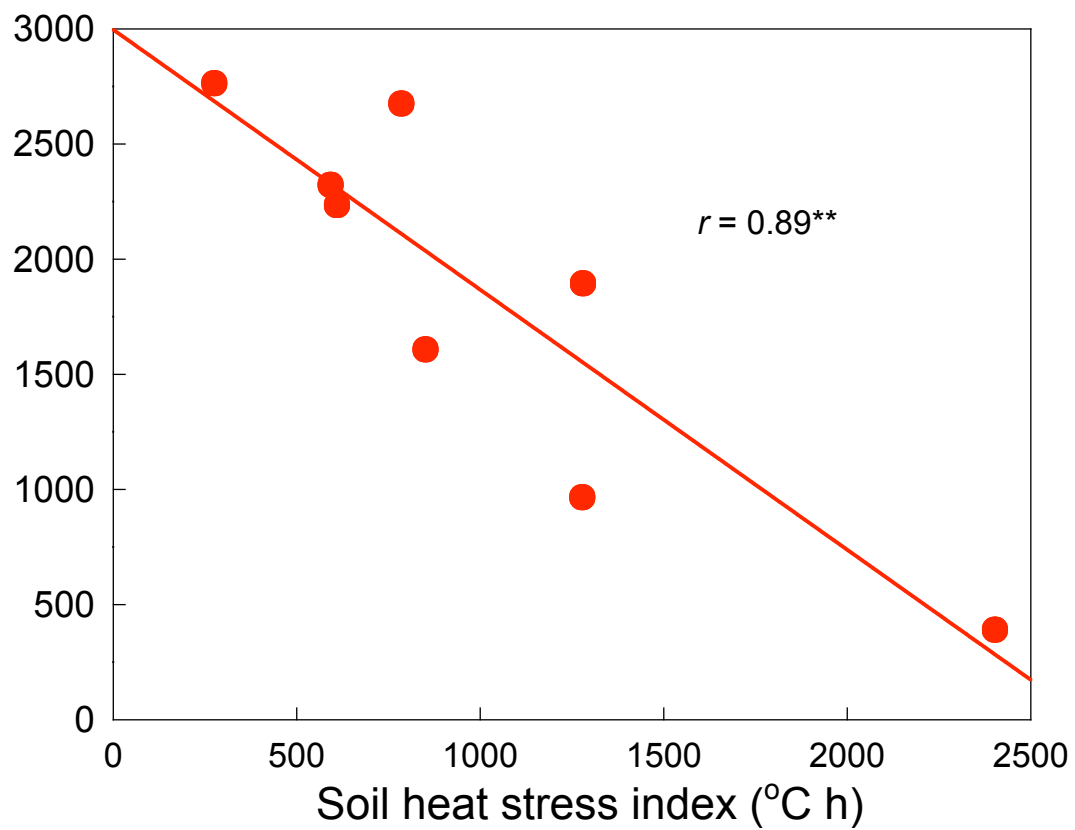


Fig. 4. Relationship between HSI at 5 cm at grain growth stage and yield.