Plant temperature of canola direct seeded into standing stubble

Herb Cutforth, Sangu Angadi, Brian McConkey and Doug Judiesch

SPARC, Agriculture and Agri-Food Canada, Swift Current, SK

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Introduction

Standing stubble changes the microclimate in which crops grow and the changes are dependent upon the height of the stubble (Aase and Siddoway 1980; Caprio et al. 1985; Cutforth and McConkey 1977; Cutforth et al. 2002). Standing stubble increases the grain yield of wheat, pulses and canola and yields tend to increase as stubble height increases. Because of the limited water supply in the semiarid prairie, water use is independent of stubble height. Therefore, differences in grain yield are a direct result of the effects of stubble height on microclimate. Compared to cultivated stubble, tall standing stubble reduces potential evaporation by reducing solar radiation and wind speeds near the soil surface; the differences are more pronounced in the earlier growth stages. Tall stubble, compared to cultivated stubble, increases the proportion of evapotranspiration transpired by the growing crop.

Objective

Observations of reductions in potential evapotranspiration, wind and solar radiation by tall standing stubble compared to cultivated stubble prompted us to characterize plant (stem) temperature of canola growing in tall and cultivated stubble.

Methods

Argentine canola (Arrow) was direct-seeded into tall (30 cm) standing stubble and cultivated stubble in early spring of 2001 and 2002 at Swift Current, SK. Plant temperature was measured by inserting a small thermocouple into the stem of the canola seedlings at 10-15 cm above the soil surface. The seedlings were beginning to bolt and were thus still well protected by the tall stubble. Hourly wind velocities at 0.15, 0.50, 1.00 and 2.00 m above the soil surface were measured with anemometers. Hourly solar radiation above the canopy and solar radiation reaching the soil surface (approximately 7 cm above the ground) were measured using 1 m long tube solarimeters. Hourly air temperatures 0.15, 0.50, 1.00 and 2.00 m above the soil surface were measured with thermocouples.

Results

Microclimate was significantly affected by the stubble height at the time plant temperatures were measured (data not shown). Compared to the cultivated treatment, tall stubble reduced wind speed by approximately 70% at 15 cm. Tall stubble reduced the daily total amount of incoming solar radiation measured at about 7.5 cm above the soil surface by about 10%. Air temperatures were not significantly different, although they tended to be lower in tall compared to cultivated stubble.

Generally, on sunny days, plant temperatures for canola grown in tall stubble were as much as 5°C higher than for canola grown in cultivated stubble (Fig. 1 and 2). However, on cloudy (overcast) days, plant temperature differences were minimal. The magnitude and the diurnal pattern of the temperature differences was dependent upon water availability. In 2001, an extremely dry year, plant temperatures for canola grown in tall stubble were higher than for canola grown in cultivated stubble from sunrise to sunset on sunny days (Fig. 1). On sunny days in 2002, a wet year, compared to cultivated stubble, plant temperatures for canola in tall stubble were lower for a few hours in the morning and then higher until later in the afternoon (Fig. 2). On sunny days, plant temperatures were greater than air temperatures over a large portion of the day (Fig. 1 and 2). In 2002, the dip in air temperature corresponds to a rainy period during which there were no differences in plant temperatures between stubble treatments (Fig. 2).

At this time we don=t know the reasons for the differences in plant temperature. We suggest that incident solar energy is probably the main driving force for the differences, whereas differences in efficiencies of the mechanisms used to dissipate the incident energy contribute to maintaining the differences. Increased wind speed over a surface will reduce the width of the boundary layer and increase the rate of heat loss from the surface by increasing the rate of latent (evaporative) and conductive energy exchange. Because wind speeds are reduced by up to 70% in tall compared to cultivated stubble, evaporative and conductive cooling of canola in tall stubble will be much less than for canola in cultivated stubble. Therefore, plant temperatures of canola in tall stubble will be higher than for canola in cultivated stubble.

Conclusions

On sunny days, stem temperatures of canola seeded in tall stubble were higher than for canola seeded in cultivated stubble. Mid-day temperatures of canola seedlings growing in tall stubble were as much as 5°C higher than canola seedlings growing in cultivated stubble.

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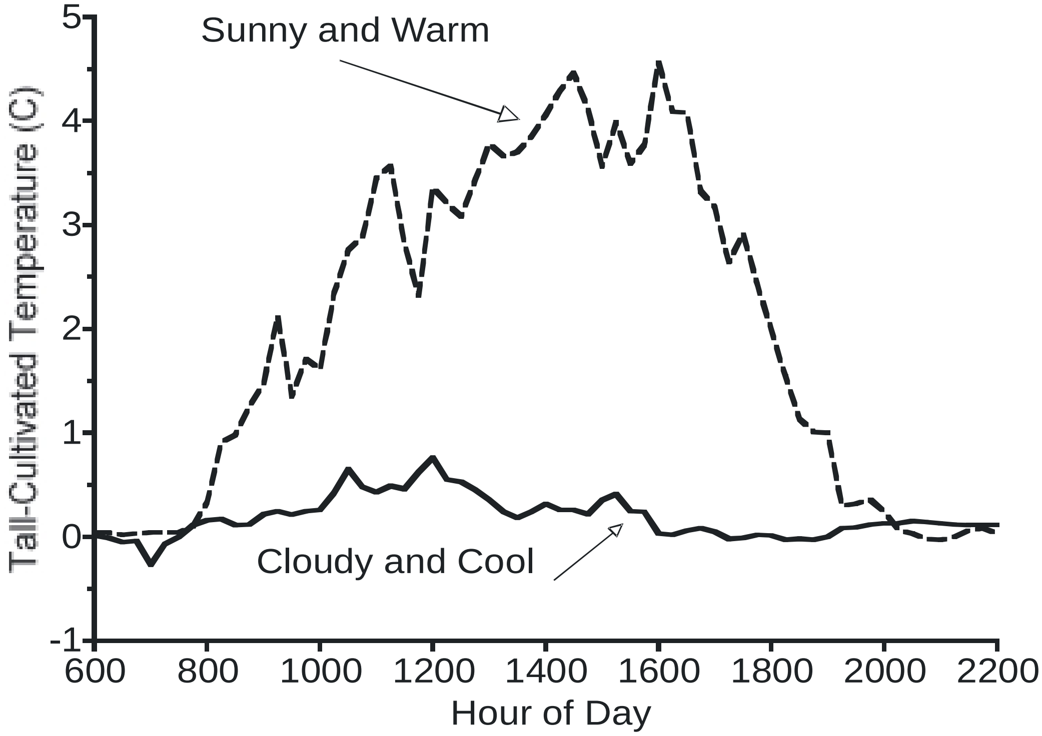
Aase, J.K. and Siddoway, F.H. 1980. Stubble height effects on seasonal microclimate, water balance, and plant development of no-till winter wheat. Agric. Meteorol. 21: 1-20.

Caprio, J.M., Grunwald, G.K. and Snyder, R.D. 1985. Effect of standing stubble on soil water loss by evaporation. Agric. For. Meteorol. 34: 129-144.

Cutforth, H.W. and McConkey, B.G. 1997. Stubble height effects on microclimate, yield, and water use efficiency of spring wheat grown in a semiarid climate on the Canadian prairies. Can. J. Plant Sci. 77:359-366.

Cutforth, H.W., McConkey, B.G., Ulrich, D., Miller, P.R. and Angadi, S.V. 2002. Yield and water use efficiency of pulses seeded directly into standing stubble in the semiarid Canadian Prairie. Can. J. Plant Sci. 82: 681-686.



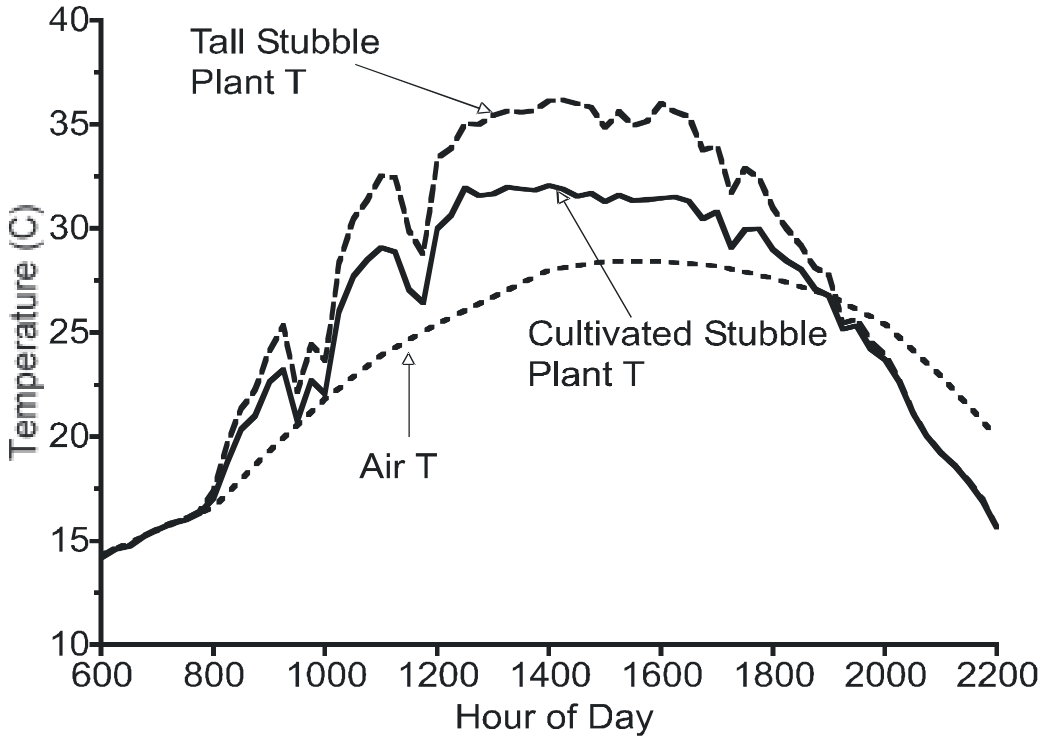


Figure 1: Diurnal plant temperature for canola grown in tall (30 cm) stubble minus the diurnal plant temperature for canola grown in cultivated stubble on a sunny and warm day, and on a cloudy and cool day in 2001 (top). The actual diurnal plant temperatures for canola grown in the tall and cultivated stubble on the sunny and warm day, and diurnal air temperature measured 2 m above ground (bottom).

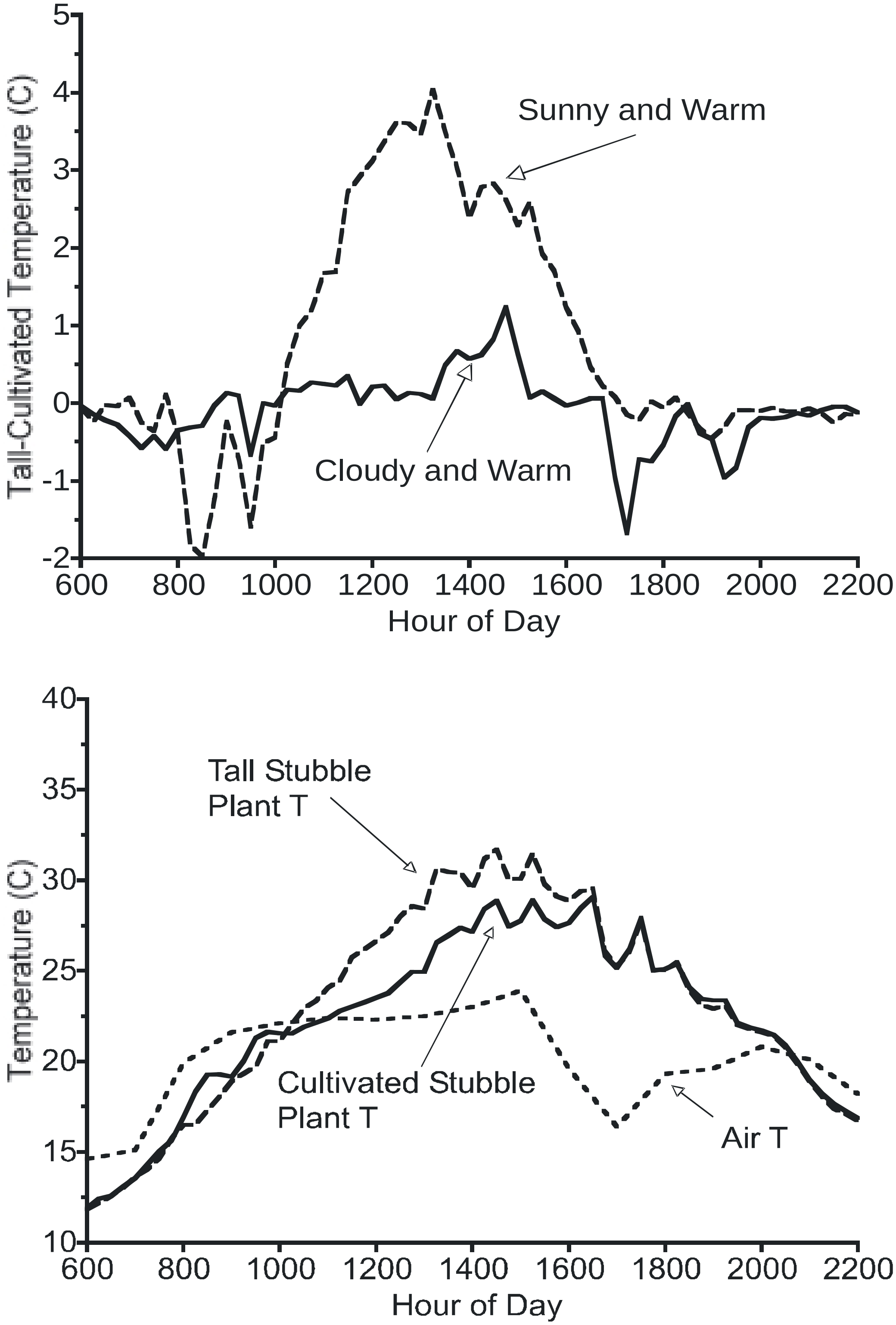


Figure 2: Diurnal plant temperature for canola grown in tall (30 cm) stubble minus the diurnal plant temperature for canola grown in cultivated stubble on a sunny and warm day, and on a cloudy and cool day in 2002 (top). The actual diurnal plant temperatures for canola

grown in the tall and cultivated stubble on the sunny and warm day, and diurnal air temperature measured 2 m above ground (bottom).