Stubble Configuration Effects on Water Conservation and Crop Yields for Stubble and Fallow

B.G. McConkey, D.J. Ulrich, and H.W. Cutforth
Semiarid Prairie Agricultural Research Centre, Swift Current

INTRODUCTION

Using snow trapping practices to increase soil water conservation and subsequent crop yields is an recognized practice for stubble cropping in the Brown and Dark Brown soil zones. However, sculpturing cereal stubble to trap snow is not widely practised, for a large part, because producers do not believe snow trapping is worthwhile for fallow and they may not have decided at harvest whether they will recrop. If snow trapping was shown to benefit crop production on fallow, snow trapping would be a more attractive routine practice. Producers also need to know how snow trapping with tall stubble after direct combining compares with the more studied cereal stubble trap strip system.

RESEARCH QUESTIONS

1. *Does snow trapping entering the fallow period benefit soil water conservation and crop yields? Would chemical fallow differ from tilled fallow?*

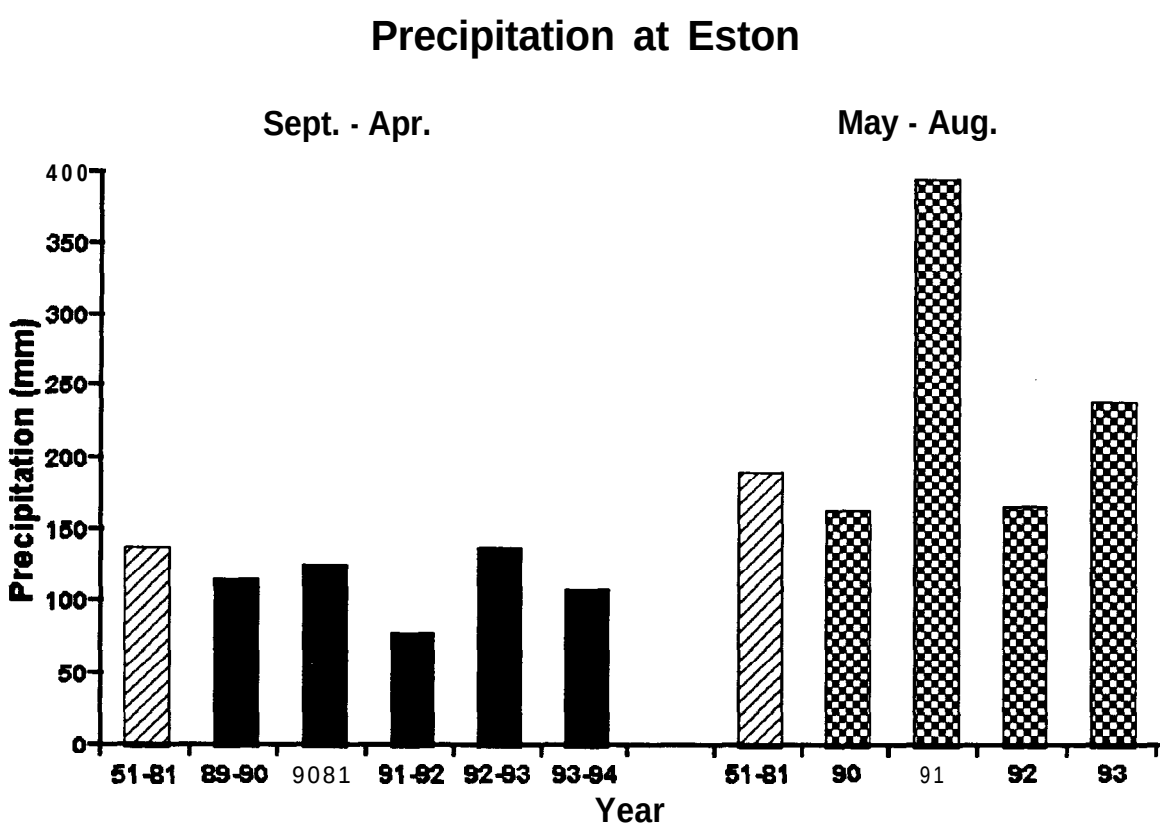
2. *Are cereal stubble trap strips superior to uniform tall cereal stubble?*

MATERIALS AND METHODS

The study was conducted from fall 1989 to spring 1994 within a fallow-durum-durum rotation at Eston, SK on Regina-Sceptre heavy clay complex (Rego Dark Brown and Brown) on moderately rolling terrain. Each phase of the rotation was present each year. Stubble configurations were: tall stubble (mean height=40 cm, range=30 to 60 cm), conventional short stubble (mean height=19 cm, range=14 to 24 cm), and trap strips (90 cm wide strips of tall stubble spaced 6 m apart within conventional height stubble). All field operations were performed with full-size farm machinery, except final stubble treatments, which were cut from uniform tall stubble with a fail mower. Six adjacent experiments were involved: one for each phase in the rotation having only chem fallow (all weed control with herbicides) and one for each phase of the rotation having only min-till fallow (weed control in fall and spring with herbicides followed by 2 to 4 tillage operations with heavy-duty cultivator). Each experiment was randomized complete block (RCB) with 5 replicates. Plot sizes were 50 x 50 m although all measurements were confined to the centre 30 x 30 m area leaving the outer 10 m of each plot as a border. For the crop on stubble phase, the two adjacent experiments distinguished by past fallow methods were pooled to form a single RCB experiment with 10 replicates. The crop on fallow results for 1990 are not included since the stubble treatments had not been in place at the start of the fallow period. 'Kyle' durum was blanket seeded across all experiments for each rotation phase at 100 kg/ha in early

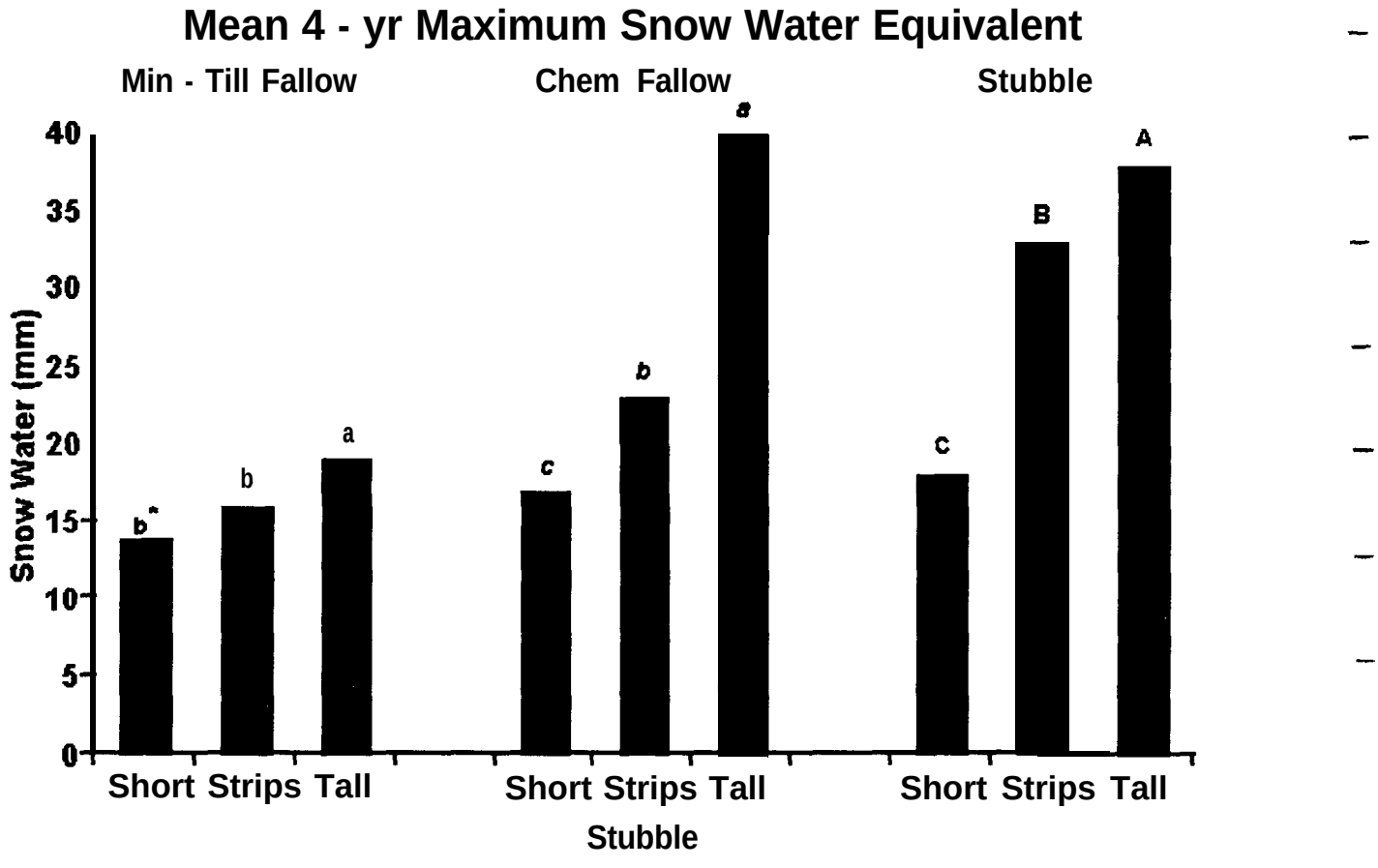
May with a discer and then harrow-packed. Fertilizer and herbicides were applied according to general recommendations for the area. Grain and straw yields were determined from four 1 x 0.5 m subsamples per plot. Soil moisture was measured from 5-cm diameter soil cores to 1.2 m in late April and late October each year. One or two snow surveys were conducted each winter whenever the likely maximum snow depth was judged to have occurred.

RESULTS



All winters had average to below-average precipitation. Growing season precipitation varied from slightly below average in 1990 and 1992 to above average in 1991 and 1993. Precipitation was well distributed so the crops never experienced extended periods of drought stress, particularly the crop on fallow. Temperatures were average to above average in the winter and average to below average during the growing season (data not shown). Therefore, the results from this study pertain to conditions with low to moderate snow trapping potential and little expectation of large crop yield responses to stored soil water.

Because the years were relatively similar, there were no important Year x Stubble treatment interactions so all results will be presented as means across years.

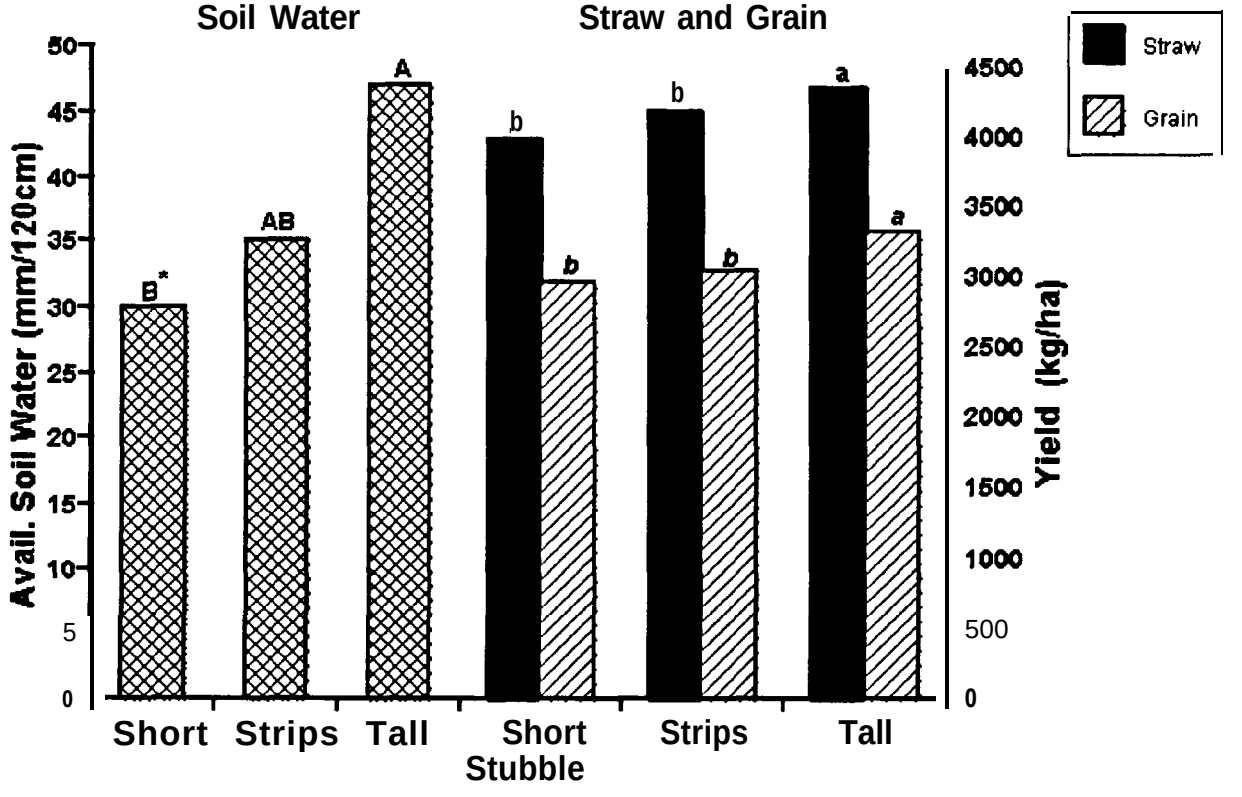


***Treatments not having the same letter for each and font case are significantly different (P<0.05)**

On chem fallow and stubble, tall stubble was more effective at trapping snow than strips while strips were better than short stubble. Because many stems had fallen down due to decomposition or wheel traffic, the strips were not much more effective for trapping snow than short stubble over the second winter of fallow. On min-till fallow, a few tall upright straws that had been re-anchored by tillage provided marginally better conservation of snow than either strips or short stubble.

Unrealistic amounts of snow drifting onto the plots and affecting results was not an issue in this study because of the experimental design and the use of snow trapping practices in surrounding fields.

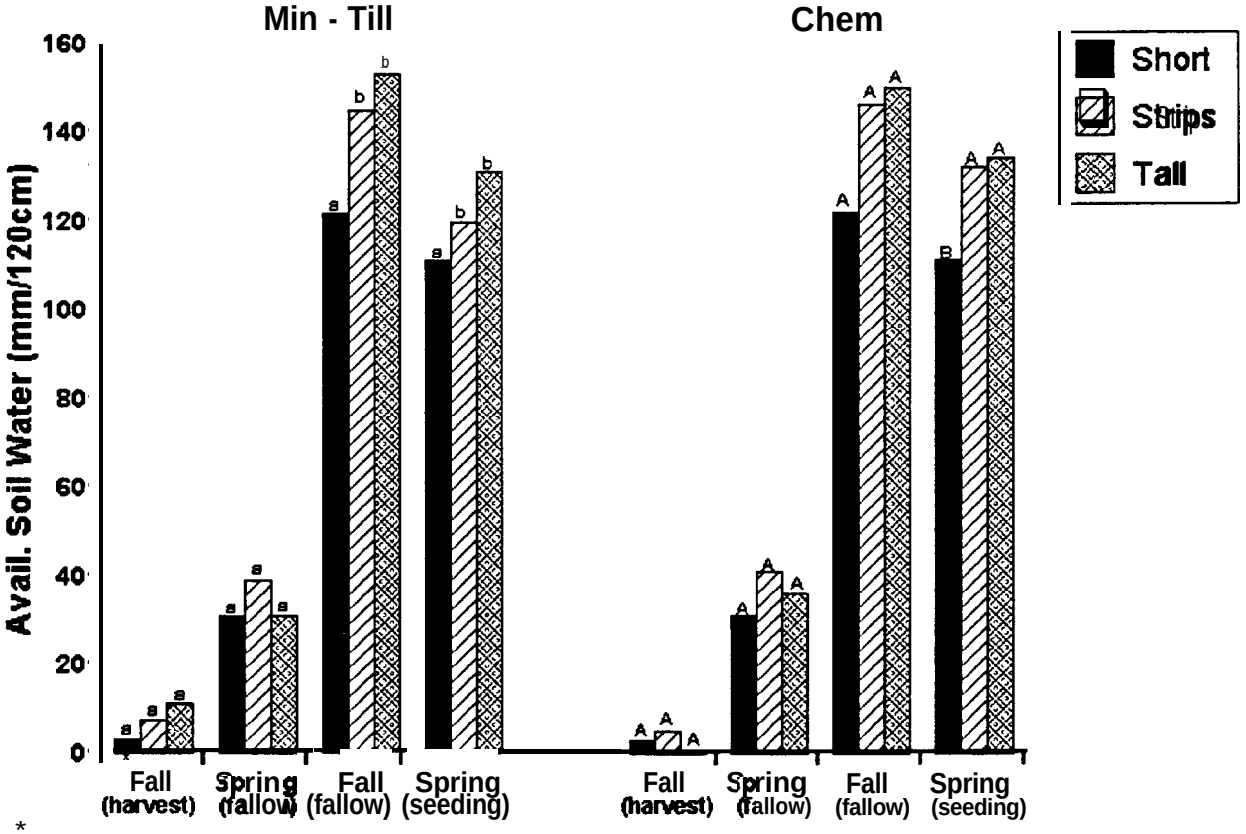
Mean 4 - yr Water Conservation and Straw and Grain Yield for Stubble



* **Treatments not having the same letter for each font and case are significantly different (P<0.05)**

Tall stubble was superior to strips or short stubble for increasing water conservation and crop yields for stubble. The yield increase from tall stubble (300 kg/ha) is greater than expected based on the increase in spring soil water (i.e. yield increase=20 kg/ha/mm vs. 5 to 10 kg/ha/mm from other snow trapping studies). During April soil sampling, we often noticed that the soil under the tall stubble treatments was almost completely thawed while that under short stubble was usually frozen from 50 to 100 cm (the soil under the strips had an intermediate and variable degree of thawing). The insulating effect of trapped snow explains the warmer soils under tall stubble. Warmer soils in the spring may provide an important growth advantage for early-seeded crops on heavy clay soils.

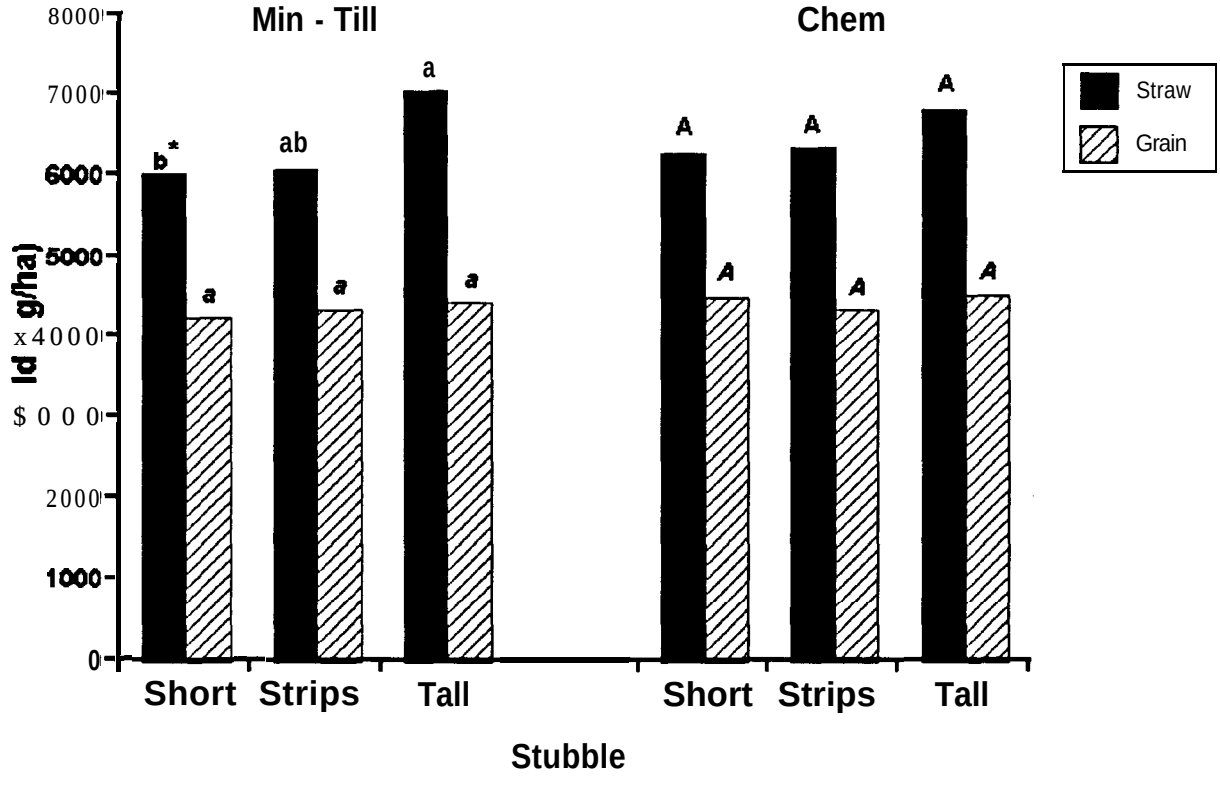
Mean 4 - Yr Soil Water Conservation For Fallow



* Treatments not having the same letter for each case and time are significantly different (P<0.05)

Snow trapping practices increased mean soil water conservation about 25 mm for both min-till and chem fallow by the spring of the crop year. Surprisingly, most of the extra water conservation occurred between late April and late October. Tillage would have erased the stubble treatment effects by July on min-till fallow. Thus, these results suggest the major benefit of snow trapping with configured cereal stubble is to reduce wind at the soil surface thereby decreasing soil water evaporation from April until July. Despite measured differences in snow retention, all stubble treatments on both fallow methods averaged about the same amount of soil water loss over the second winter of fallow.

Mean 3 - yr Straw and Grain Yields for Fallow



*Treatments not having the same letter for each font and case are significantly different ($P<0.05$)

Tall stubble on min-till fallow increased straw yields compared with short stubble but did not affect mean grain yield (although grain yields were significantly higher for tall than short stubble in 1992, data not shown). On chem fallow, there was also a trend toward greater straw yields with tall stubble. The increased crop biomass production for tall stubble can be explained by greater soil water at seeding and possible increases in soil temperatures. We speculate that in growing seasons with more drought stress, the crop on tall-stubble fallow would more effectively translocate the greater accumulated plant biomass to the kernels and thereby increase grain yield.

CONCLUSIONS

1. Snow trapping with tall cereal stubble or trap strips increased soil water conservation for both min-till and chem fallow compared with short stubble. This improvement was attributed to better water conservation over the first winter of fallow plus reduced evaporation of soil water from April until July. Snow trapping over the second winter of fallow on chem fallow did not provide any additional soil water conservation benefit relative to conventional short stubble.

2. Total crop yield was higher on both fallows with tall cereal stubble compared with either traps strips or conventional short stubble. This effect may be partly explained by possible higher soil temperatures under tall stubble. In this study with favourable growing season precipitation amount and timing, the increase in total crop growth did not consistently translate into higher grain yields.

3. With the low to moderate snow trapping potential experienced, tall stubble was superior to either short stubble or trap strips for increasing soil water conservation and grain yields for stubble crops.

ACKNOWLEDGEMENTS

We are indebted to Gary Schweitzer, Eston, for lending his land, labour, farm machinery, and production expertise. Funding support was provided by the Canada Department of Energy, Mines, and Resources. We also thank D. Reimer for his conscientious and dedicated technical support.