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The Effect of Snow Depth on Winter Wheat Survival

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Hard red winter wheat production in North Dakota attracts an increasing number of farmers each year. Since the turn of the century, prospects for high yields, distribution of farm operations, weed control, and decreased soil erosion associated with winter wheat have led farmers and researchers to search for more hardy varieties and cultural practices which would make winter wheat a viable crop in the state. Several times during this period, acres seeded to winter wheat would approach 1-2 percent of the total North Dakota wheat acreage (North Dakota Agricultural Experiment Station, 1969), but the occurrence of cold winters with extensive winterkill limited production to the southwestern corner of the state. More recently, the release of new varieties and increased interest in reduced tillage has resulted in expanding winter wheat production through the state.

Materials and Methods

A field experiment was started in 1981 at Fargo to study the effects of tillage management on winter wheat survival. Two varieties of wheat, Roughrider and Centurk 78, were seeded in plots prepared with different tillage practices. The tillage practices consisted of conventional till (plow, disk and harrow), reduced tillage (disked), and no-tillage (seeding into small grain stubble).

The type of tillage determines the amount of residue left on the surface. Conventional tillage left very little surface residue. In the reduced tillage plot, residue was partially incorporated. No-tillage left most of the 6-8 inch stubble standing upright. The amount and height of residue directly affects the amount of snow that will be trapped. Snow cover is a valuable asset. It protects wheat plants from subzero temperatures and also improves the water status of the crop as growth resumes.

Winter wheat survival is directly related to the temperature of the plant crown. Severe damage or death will occur if the crown of a well hardened plant is exposed to temperatures below -4°F (Gullord **et al.** 1975). The critical temperature of a less hardy plant may be as high as 3°F. The crown is generally found about 1 inch below the soil surface.

Measurements of the soil temperature at the crown depth were made at three locations within each tillage plot. These temperaturs, along with a standard 5-foot air temperature, were monitored hourly using copper-constantan thermocouples wired to a data acquisition system. Snow depth measurements recorded after each snowfall, high wind or thaw made it possible to construct Figure 1.

Results

Figure 1 shows the relationship of air and soil temperatures for different snow depths. The regression lines can be used to predict the crown depth soil temperature from a given air temperature. For example, a 2-3 inch snow cover is needed to protect a plant with good hardiness characteristics from air temperatures approaching -30°F. For a less hardy variety, greater than 3 inches of snow will be needed. The regression line for greater than 4.5 inches of snow cover is included as it represents the conditions that occurred in the no-till plot.

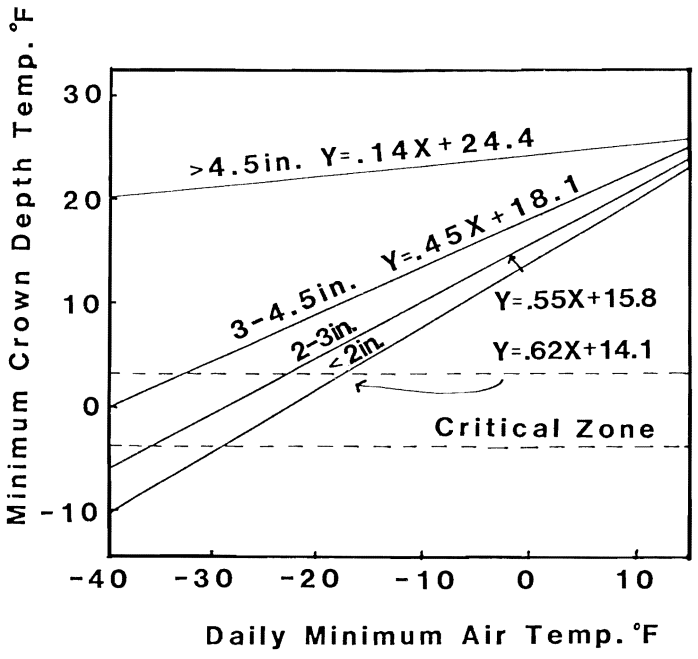

Figure 1. Comparison of minimum crown depth soil temperature and daily minimum air temperature with different snow depths.

Recorded snowfall for the 1981-82 winter at Fargo was neary double the normal 34 inches. December through March temperatures were below normal and January's average temperature was 13°F below normal. The coldest temperature -30°F, was recorded on February 3 and 5.

Wheat plant survival data for the experiment reinforce the regression lines. The plowed treatment without surface residue generally had less than 2 inches of snow cover and often was bare. Survival of Roughrider was only 5-10 percent and no Centurk 78 survived. Residue in the disked plot maintained 1-3 inches of snow cover and provided marginal protection for Roughrider (50-60 percent survival) but inadequate protection for Centurk 78 (20-30 percent survival). The no-till plot had greater than 4.5 inches of snow cover throughout the winter and complete survival of both varieties was observed. Yield data, presented in Table 1, reflect the survival rates of the wheat.

Table 1. Winter wheat yields at 12% moisture (bu/A)

	Treatment		
Variety	**Plow**	**Disk**	**No-Till**
Roughrider	14	44	52
Centurk 78	0	16	60

Conclusions

Winter wheat can be grown in North Dakota with limited risk of winterkill, provided tillage mangement insures a uniform snow cover of at least 3 inches. Seeding into standing stubble provided enough surface residue to insure adequate snow cover. Disking the stubble left some residue on the surface but did not trap enough snow to protect winter wheat from -30°F air temperatures.

Literature Cited

1. Gullord, M., C. R. Olein, and E. H. Everson. 1975. Evaluation of freezing hardiness in winter wheat. Crop Sci. 15:153-157.

2. North Dakota Agricultural Experiment Station. 1969. Winter wheat in North Dakota. North Dakota Agric. Exp. Stn. Bull. 478.