NO-TILL: PROMISE AND PROBLEMS

R.P. Schneider, F. Sobolik, and N. Riveland

Residue management is a major factor affecting no-till cropping systems. Residue left standing may retain snow during the winter, thereby increasing stored plant available water at planting. North Dakota data showed a 3-fold increase in plant available water where 14 inch residue remained during the winter.

The concept of no-till or reduced tillage has gained wide attention as energy demands in agriculture increase. The concept, though not new, has shown great promise in the corn-belt regions of the United States. Only in recent years has the practice been implemented in the Northern Great Plains and Canada. As energy costs have increased, farmer awareness to simplified tillage approaches has increased. With the advent of these new planting techniques some problems, previously not seriously dealt with, have also developed.

A natural question which arises related to no-till is residue management at harvest. What can be done with the straw that is carried through the combine? Do we spread the residue with some type of harrow or can it be left in place? Experiences of those trying the no-till system in the U.S. and Canada indicate that combine modifications to accomplish efficient straw spreading are necessary to give uniform residue distribution. Otherwise some tillage is needed to facilitate seeding in average to heavy residues. We must also evaluate the optimum height of standing residue.

In most of North Dakota plant-available stored water in the soil is the major factor determining whether a farmer can plant successive crops or if he should fallow the soil. Information related to residue height may be misused if the total amount of residue is not considered. The amount of residue remaining also influences plant-available soil water and soil temperature. As the height of residue increases, the amount of snow entrapment also increases, and as the amount of residue increases, evaporation of water declines.

This can have beneficial or deleterious effects depending on the season. If a large amount of snow is retained, planting date may be delayed due to excess soil water in the surface and colder soil tem-

Dr. Schneider is Assistant Professor of Soils, Sobolik, is Area Extension Agent-Soils, and Riveland is Agronomist, Williston Experiment Station.

peratures. The buffering effects of increased residues and water causes soils to cool more slowly during the winter and to warm more slowly in the spring. During dry periods the retention of snow by standing stubble from the previous crop benefits the farmer by increasing the amount of available water in the soil at planting and increases the possibility of a successful crop. The important consideration, however, is whether the added stored water insures a successful crop that year.

During the fall of 1976 these concepts were incorporated in a residue height study at the Williston Experiment Station. Heights of standing residue were 14 inches, 7 inches, and none where tillage knocked down and incorporated some of it. This effort showed significant increases in available stored water as the height of residue increased (Table 1). Soil temperatures did not differ by planting date because the surface soil had become quite dry. With more usual springtime conditions, or an earlier planting date, effects may have been different.

Residue remaining after no-till planting hard red spring wheat where residue had been knocked down.

The winter soil temperature differences observed were a function of snow cover and were directly related to residue height (Figure 1). The greater the height of residue, the warmer the soil was during the winter and early spring. This study was initiated under very dry conditions and produced one collection of results. Another study was initiated during October 1977 with opposite conditions prevailing. The soil had approximately 1.0 inch of available soil water at inititation. Data related to soil temperature and available water are being collected to further evaluate residue height management.

Because some residue remains upright and some may be lying on the soil surface, an appropriate grain drill must be selected to place the seed into moist soil to insure germination. Several drills have been manufactured which penetrate a firm soil and operate in dense residue. These drills seem to work reasonably well, as has been discussed by Deibert and others in another article in this issue.

Residue remaining after no-till planting hard red spring wheat in 14-inch residue.

The no-till concept must also deal with weed control. Careful evaluation of the weed population at harvest may dictate the use of a fall applied herbicide such as glyphosate. This practice not only reduces the weed problem but helps conserve the fall precipitation by reducing plant use of water. Careful observation of weed problems before planting and during the growing season must be made to insure that weeds will not limit crop production.

Nutrient availability will also be influenced by the changes in tillage which produce different residue — soil relationships. Nitrogen, phosphorus and potassium availability may be affected by residue management, but N is expected to be the most pronounced. Questions related to source of N, rate of N and time of application are critical factors related to no-till agriculture. Some research information in North Dakota has shown that the N source urea applied in the fall without incorporation did not perform as well as ammonium nitrate. These differences do not always occur and we are researching the causative factors and how to minimize the problems. If residue is allowed to remain standing during the winter and early spring, some natural decay and sloughing of residue occurs. This creates a new environment at the soil surface. Soil temperatures may be cooler because of excess residue on the surface or the accumulation of water. Nutrient responses as influenced by these parameters have not been fully evaluated.

Table 1. The effect of residue height on plant available soil water and yield of Waldron wheat, Williston, 1977.

Height (in)	4/14/77 H_2O (in/4 ft)	Yield (bu/a)
0	.56	6.9
7	.93	9.6
14	1.86	11.0
LSD .05	.16	1.6

Table 2. The effect of residue height and N rate on the yield, % protein and monetary value of Waldron wheat, Williston, 1977.

Residue height & N rate	Yield[1]	Protein	Crop Value[2]	Fert. Cost[3]	Increase due to Residue & N
in - lb/a	bu/a	%	$/a	$/a	$/a
0 (.56 in stored H_2O)					
0	6.6	14.4	19.07	—	—
25	7.3	15.3	21.68	3.75	- 1.14
50	7.1	17.0	22.22	7.50	- 4.35
7 (.93 in stored H_2O)					
0	9.4	14.0	26.70	—	7.63
25	10.6	15.1	31.27	3.75	8.45
50	10.9	16.0	33.25	7.50	6.68
14 (1.86 in stored H_2O)					
0	8.4	13.8	23.77	—	4.70
25	11.3	14.8	33.00	3.75	10.18
50	12.2	16.0	36.60	7.50	10.76

[1] *Yield reduced due to hail and low stored soil water.*

[2] *Minneapolis priced 2/24/78.*
13% — 2.83, 14% - 2.84, 15% - 2.94, 16% - 3.05, 17% - 3.13, 58-60 lb. .01/lb

[3] *N rate only variable. Price .15/lb N*

The Williston experiment also indicated the value of adequate N (Table 2). As the farm operator increases soil water through snow management, added amounts of N fertilizer can increase his yield and profit. The 1977 crop, though receiving damaging hail prior to stem elongation of the plants, showed an N-residue height interaction. The application of N was shown to be beneficial only when water had been stored during the winter months. Continuation of the residue and N study during 1977-78 will also include N source evaluations. Nitrogen source and rate studies are also being continued at four locations during the 1977-78 season. The information gathered will increase knowledge of the effectiveness of fall and spring applied N materials.

Placement of N and other fertilizers is also important in a no-till system. Some drill modifications by individual farmers have permitted band application of fertilizer beside and below the germinating seed. The approach reduces the number of passes over the field and allows the farmer to place his fertilizer in the surface root zone. However, damage can be caused by excessive N rates in the seed rows.

Many of the problems discussed here can or will be answered in the near future. Others may require longer periods of time and more intense research efforts. Each farm operator must realize that although the no-till system can be very effective, it surely will not be applicable to every situation.

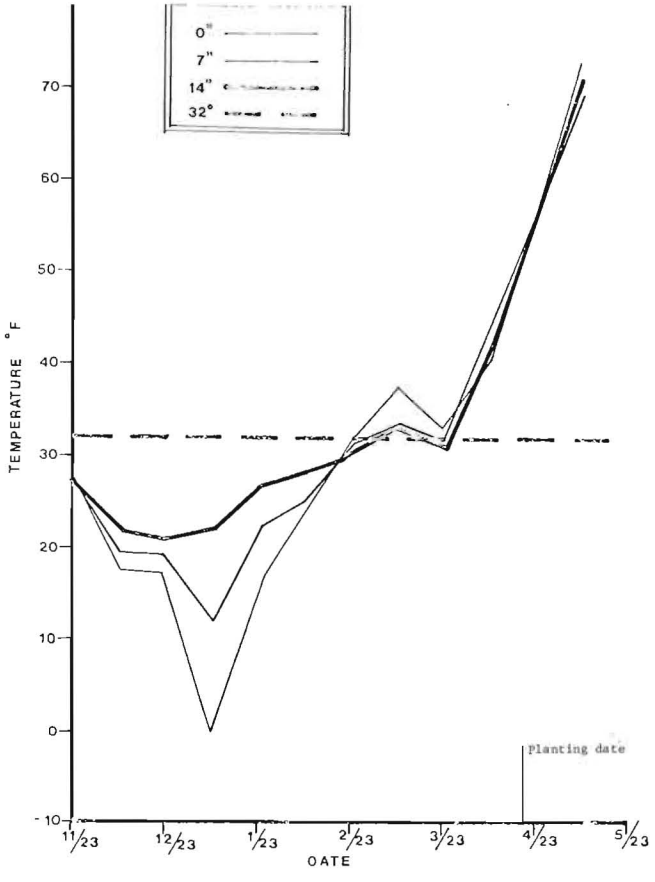

Figure 1. The effect of residue height on the soil temperature at the 2 inch depth as a function of time, Williston, 1977.