Final Project Report
to the
Wheat Research and Promotion Board

December, 2001

Title: **Effect of Conservation Tillage, Seeding Depth and Crop Residue on Wheat Stand Establishment, Yield and Test Weight**

Termination Project: **Completed 3-year proposal emphasizing yield evaluation and wheat stand retention.**

Priority Area: #2 Agronomic Research

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Soybean residue treatments, seedbed preparation, seeding depth and wheat varieties were evaluated in this experiment. Every year wheat and soybeans were seeded in a replicated experiment at both NEREC near Keiser and Pine Tree Experiment Station near Colt. Wheat and soybeans were grown successfully at both locations, except soybeans failed to germinate due to drought at NEREC in 2000. Three or 4-year soybean and wheat residue accumulations never interfered with proper drill operation in the no-tillage plots using a John Deere 750 No-til drill. During this time period spring weather was favorable and, in no case, were subsequent wheat stands affected by the spring cold spells. The greatest limitation, and by far, the greatest practical consideration was maintaining good surface drainage plots at both experiment station locations.

Wheat growers had indicated difficulty maintaining an adequate wheat stand and making comparable yields with direct-seeded (no-tillage) wheat prior to the beginning of this project. Two varieties, two seeding depths and direct seeding vs. conventional seedbed preparation were compared in this experiment. For the environment and the locations chosen on a prairie silt loam and a clay soil, direct-seeded wheat was equivalent to preparing a seedbed (In a soybean rotation that produced 2 crops every year.). Refer to Table 1 to compare no-tillage yields to those with prepared seedbed treatments

Both harvest and seeding timing with respect to soil moisture and proper equipment flotation were essential to avoid rutting the soil Slight depressions retained water on both prairie silt loam and Sharkey clay; they reduced wheat emergence slightly but areas of excessive moisture continued to thin wheat stands throughout the winter and into early spring. This affected all yields, but poor drainage impacted direct-seeded treatments more than tilled preparation. Current UA CES wheat budgets include $7.89 per acre for a land plane operation in wheat seedbed preparation; this can be a very profitable item in maintaining high wheat yields on fields similar to the experiment locations

After 4 years, ruts and other soil depressions caused either by the borrow ditches or berms from contour levees used for soybean irrigation or traffic for seeding and harvesting reduced wheat populations and yields. Wet-natured soils that were selected at both locations were intended to be representative of wheat-producing prairie silt loams and clay alluvial soils. The residual moisture in the soil profile after soybean irrigation was completed usually delayed wheat seeding and, especially, caused difficulty on the clay soil experiment at NEREC. During the fall of 2000, insufficient moisture was available to germinate wheat in the conventionally prepared plots. When rainfall did come well into November, it rained excessively and the stand was extremely poor.

Three criteria for excellent no-tillage wheat are (1) good surface drainage (2) seed properly to obtain a satisfactory wheat stand and (3) control weeds. If care had not been exercised to avoid ruts, drainage problems might have been a greater issue immediately.

Possibly the most significant result of this experiment is the consistent advantage of wheat seeded deep (1 to 1 ½ in) compared to shallow (1/4 to ¾ in). Table 2 illustrates yield data from each year and location, showing equal or better response from deep wheat placement. Some currently-marketed no-till drills are not adequately equipped for heavy crop residue or soil variability. Consistent emergence and yields are only possible by cutting completely through the previous crop residue and placing wheat at least 1 inch deep. Bouncing drill openers and improper adjustment may contribute to poor stands and significantly poorer yields if growers don't exercise care with direct seeding wheat.

With proper planning, fertilizer can either be spread when the soil is firm enough to support equipment, or flown onto the wheat on a timely basis, to avoid creating any ruts. Fertilizer and herbicide application was vital because no cultivation was used during the 3-year experiment at NEREC and the 4-year experiment at Pine Tree. Diseases prone to attack wheat, especially no-tillage wheat, were monitored throughout the period of this project but it is uncertain whether they caused yield reductions. Scab, leaf rust, stripe rust, tan spot and other diseases were identified but not in significance before 2001. Tilt was applied according to scouting recommendations on two occasions. Disease infection levels were generally very low, generally unrelated to treatments and having no effect on yield. Note that the greatest evidence of tan spot disease occurred during the spring of 2001 as summarized in Table 3. Possibly, disease may have curtailed wheat yields from the 3rd crop at both locations. Slightly lowered yields may also have been related to deteriorating field surface drainage at both locations and an April 2000 hail storm at Pine Tree.

The first attempt to seed Sharkey clay at NEREC was unsuccessful because of excessive rainfall and soil moisture. Attempts to plant well into December caused mud to stick and "ball" up and consequently only 3 rotations were grown at NEREC compared to 4 rotations at Pine Tree.

Soil resistance to root penetration downward through soil increases as a result of the amount and timing of equipment traffic and tillage, rainfall, irrigation and possibly other factors. Recently, serious concern about compacted soil in relation to tillage or the elimination of seedbed tillage prompted an evaluation of the silt loam soil profile in this study. The ability of roots to penetrate soil layers of 200 psi soil strength or greater is greatly limited, always during periods of inadequate or excessive rainfall.

In these tests a soil disking and a soil finishing operation was completed twice a year on the conventional treatments. The direct-seeded plots had no tillage since the spring of 1997 when the soybean crop previous to the study was seeded. All soybeans and wheat were seeded in 7 ½ inch drill spacing with a John Deere 750 No-till drill. Fertilizer or ground-based spraying were applied to all plots simultaneously. Table 4 shows that the seedbed preparation hasn't changed soil strength significantly throughout the duration of the experiment. In other words, the resistant soil layer at 5 7 inches deep really isn't significantly different that the conventional treatments at 6.65 inches.

Projecting whether organic matter accumulation increased or soil structure develops over a longer period than 4 years is not appropriate. However, when these plots were abandoned, and the entire area tilled, the no-tillage treatments had a mellow, friable characteristic that the station director had not encountered elsewhere on the Pine Tree Experiment Station. If the soil quality improved, no benchmarks had been established other than depth to 200 psi soil strength; however, scientific literature has consistently reported that biological activity rapidly increases after a soil has been direct-seeded for at least 3 to 5 years.

Conclusions

1. No-tillage wheat establishment produced equally good wheat yields for at least two crops. Infestations of disease and/or gradual growth of poorly drained areas contribute to yields that possibly were slightly reduced.
2 No-tillage wheat was equally thrifty compared to conventionally prepared soil seeded adequately deep. Wheat yields averaged 2 bu/A greater on clay and 2 ½ bu/A greater on silt loam when seeded 1 to 1 ½ inches deep compared to seed placed only ¼ to ¾ inches deep.
3. No-tillage seeding was advantageous, eliminating at least $8.63 seedbed preparation coost At the current value of wheat ($2.83 /bu) the reduced cost applied to each experiment yield each year generates an average net income increase of $7.22 per acre for direct seeding.
4 Monitoring disease and weed infestations is a vital management aspect and, should either disease or weeds appear in a no-tillage field (or for that matter any field), pest controls may rapidly increase above the $7.22 per acre return from no-tillage.

Summary

1. The timeliness of all operations was vital, especially in an attempt to grow 2 no-tillage crops every year.
2. Direct-seeding wheat (deep) is a more reliable approach than approaches that require conventional tillage. Some soils are forgiving, but tillage released crucial moisture when clay was seeded in October, 2000; when excessive rain came less than 10 percent of the wheat seeded emerged. This stand failure occurred on a clay soil when it was too wet and too late to reseed.
3. Surface drainage can reduce or eliminate a wheat stand, certainly impairing wheat emergence and cutting yields.
4. Additional data was added to the research base on wheat disease infestations and should provide guidance to wheat producers. It appears that thorough scouting may identify emerging disease symptoms before they impact wheat yield and grower income.
5 Jaypee, Mallard, Shiloh and Pioneer 2691 wheat varieties all produced good no-tillage yields, equivalent to that from conventionally prepared seedbeds.
6. Ryegrass can establish itself in any wheat field but it is a persistent weed and especially troublesome in no-tillage wheat. A good weed control program should include identifying infestation early. Timely Sencor or Hoelon treatments can prevent economic loss.

7. Practically, field slopes that drain well, are excellent no-tillage wheat options If traffic is controlled to prevent compaction, growers may experience soil improvement, better tilth and economical production before disease becomes an economic factor
8. Take-all, scab, leaf rust, stripe rust, tan spot and other diseases may require a grower to skip wheat production the season after it is identified. But if wheat is profitable, tillage following soybeans may allow the grower to continue another year of wheat production. Again, disease should be closely monitored, because experience has shown that when weather conditions favor a disease organism, conventionally prepared fields may experience economic loss as well as those that have not been tilled for years.

Table 1 No-tillage (direct seed) and conventional (disk and finish) seeding methods compared across all treatmets at NEREC and Pine Tree Experiment Station.

	Year				
	'98	**'99**	**'00**	**'01**	**Average Yield**
Seeding	Pine Tree wheat yield (bu/A)				
Direct seed	65.15	55.56	49 25	48 81	**53.94**
Disk & finish	60 10	51 56	59 18	50 21	**52.76**
Seeding	NEREC wheat yield (bu/A)				
Direct seed	-	60.88	56.59	46.57	**52.68**
Disk & finish	-	56 84	56 43	50.00	**54.42**

Table 2. Shallow (1/4 – ¾ in) and deep (1 – 1 ½ in) wheat seeding depths compared across all treatments at NEREC and Pine Tree Experiment Station.

	Year				
	'98	**'99**	**'00**	**'01**	**Average Yield**
Seeding Depth	Pine Tree wheat yield (bu/A)				
Shallow	62.10	60.56	49.69	48.77	**55.28**
Deep	63.15	65.13	52 62	50.02	**57.73**
Seeding Depth	NEREC wheat yield (bu/A)				
Shallow	-	58 86	-	46.29	**52.67**
Deep	-	58.86	-	50.33	**54.60**

Table 3 Percentage of the wheat canopy leaves affected by tan spot disease symptoms in 2001.

Seedbed preparation	NEREC*	Pine Tree**
Direct seed	27.1 %	17.2 %
Disk & finish	7.8 %	8.7 %

* Lower canopy (Flag-3 and lower leaves) affected on 4-17-01

** Upper canopy affected (Flag, Flag-1 and Flag-2 leaves) affected on 5-14-01

Table 4. Comparison of soil strength (resistance to penetrometer) after 4 crops each of wheat and irrigated soybeans at the Pine Tree Experiment Station.

Treatment	Mean depth (in) to 200 psi soil strength
Conventional	6.65
No-tillage (4 years)	5.70