# THE EFFECT OF TILLAGE AND CROP RESIDUE MANAGEMENT ON GRAIN YIELDS

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Preliminary studies (Innovative Acres Report, 1983) have shown that grain yields of spring wheat were reduced by the presence of crop residues. This yield reduction was not overcome by N fertilization implicating other causitive factors such as phytotoxicity from decomposing residues and poor soil-seed contact (seed-bed preparation). The objective of this study was to investigate the interaction of crop residue application with the timing of the tillage operation for development of management practices which will overcome problems associated with yield reduction.

## EXPERIMENTAL METHODS

The field site was established in fall 1983 on a standing rapeseed stubble field at Tisdale (Tisdale clay loam) (Fig. 1). The plots consisted of four replicates of residue addition: 0, 4 and 8 T/ha; three tillage treatments: fall till, spring till and zero till, and three N application rates: 0, 40 and 80 kg N/ha. Mature barley residue containing 0.91% N was chopped to <5 cm and spread uniformly over the plot area in October. Tillage for straw residue incorporation and for seedbed preparation was carried out using a rotovator (8 cm depth). The zero till treatment was sprayed with Roundup and 2,4-D prior to seeding for weed control.

A small plot seeder with modified double disc openers to allow penetration of stubble and applied residues, and knife openers for N fertilizer placement, was used. Fertilizer N (46-0-0) was side banded at 10 cm depth between alternate seed rows (45 cm spacing) during the seeding operation at rates of 0, 40 and 80 kg N/ha. Monoammonium phosphate (11-51-0) was placed with the seed at rates recommended by soil test (30 kg $P_2O_5$/ha). NorLin flax was utilized as the test crop. In the spring prior to tillage and seeding, soil cores to 120 cm were obtained from the fall and zero till treatments for measurements of soil moisture (gravimetric) and mineral N levels (exchangeable $NH_4^+$ and $NO_3^-$).

At maturity, samples of above-ground plant material (four seed rows X 1 m) were harvested from each treatment. Air-dried samples were threshed for grain and straw yield estimation.

RESULTS

Soil moisture. Application of crop residues increased stored moisture in the surface 15 cm soil at spring seeding (Table 1). Leaving the residues on the soil surface resulted in greater increases compared to that where residues were incorporated (fall till). Fall tillage reduced moisture storage by 10% compared to that in the zero-till treatment. The presence of crop residues would reduce moisture losses from the surface soil by evaporation. Tillage did not significantly alter surface moisture levels in the 0 residue treatment.

Soil mineral N. The mineral N level in the surface 30 cm was 32.8 kg N/ha in fall increasing to 39 kg N/ha at spring sampling. Application of crop residues significantly increased mineral N levels in the surface soil compared to that in unamended soil (Table 2). The increased mineral N may be due to enhanced mineralization of soil organic matter under a more moist environment, and to mineralization of residue N. The 4 and 8 T/ha crop residue amendments supplied 36 and 72 kg N/ha, respectively, to the soil and would be potentially mineralizable. Furthermore, accumulation of mineral N was significantly greater under the zero till system compared to that which had been tilled in the fall.

Effect of added residue. Application of crop residues significantly ($P < 0.1$) increased flax yields for all rates of N fertilizer addition (Table 3). The 4 T/ha amendment increased yields by an average of 12% over all tillage and N fertilizer treatments; doubling the residue amendment increased yields an additional 3%, however the yield increase was not statistically significant. The yield increases where residues had been applied could be attributed to a combination of factors including increased surface soil moisture, increased inputs of nutrients (mainly N) and reduced surface soil crusting due to the protective effect of residues from heavy rainfall after seeding.

Effect of tillage. Flax yields under the fall tilled treatments were not significantly different from those in the treatments tilled in the spring. Furthermore, yields in the zero till treatments were similar to those in the tilled treatments. Therefore, the tillage operation and incorporation of crop residues, which would affect both soil physical and biological properties, was not a significant factor affecting flax yields.

## CONCLUSIONS

Grain yields can be altered by crop residue application, therefore management practices which maximize yields are required. Both soil physical properties (structure and moisture) and N fertility were enhanced by residue application, resulting in increased flax yields. Furthermore, in the presence of crop residues, yields were not affected by tillage and were comparable to those under zero till. Therefore, crop residue management would not appear to be a serious problem providing residues are spread uniformly and seeding equipment capable of ensuring good soil-seed contact is available.

Table 1. Spring soil moisture in the surface soil.

| Solum depth (cm) | Soil moisture storage (cm) | | | | | |
|---|---|---|---|---|---|---|
| | Straw (T/ha) | | | | | |
| | 0 | | 4 | | 8 | |
| | FT† | ZT† | FT | ZT | FT | ZT |
| 0-15 | 4.79 a* | 4.72 a | 4.87 a | 5.36 b | 5.01 c | 5.57 d |
| 15-30 | 5.38 a | 5.96 a | 5.19 a | 5.76 b | 5.35 a | 4.93 a |
| 0-30 | 10.2 a | 10.7 a | 10.1 a | 11.1 b | 10.4 a | 10.5 a |

†Fall till

†Zero till

*Treatments within a depth interval which have the same letter are not significantly different (P <0.1).

Table 2. Spring mineral N (exchangeable $NH_4^+$ + $NO_3^-$) in the surface soil.

| Solum depth (cm) | Soil mineral N (kg/ha) | | | | | |
|---|---|---|---|---|---|---|
| | Straw (T/ha) | | | | | |
| | 0 | | 4 | | 8 | |
| | FT† | ZT† | FT | ZT | FT | ZT |
| 0-15 | 19.8 a | 21.4 b | 21.6 b | 25.4 c | 21.8 b | 25.4 c |
| 15-30 | 18.2 a | 17.8 a | 24.6 b | 23.8 b | 26.8 c | 27.0 c |
| 0-30 | 38.0 | 39.2 | 46.2 | 49.2 | 48.6 | 52.4 |

†Fall till

†Zero till

*Treatments within a depth interval which have the same letter are not significantly different ($P < 0.1$).

Table 3. Effect of crop residue addition on grain yields of flax.

| Residue application rate (T/ha) | Grain yield (kg/ha) | | |
|---|---|---|---|
| | Tillage | | |
| | Fall | Spring | Zero |
| | **0 Nitrogen*** | | |
| 0 | 1145 | 1170 | 1096 |
| 4 | 1203 | 1243 | 1137 |
| 8 | 1383 | 1229 | 1163 |
| | **40 Nitrogen†** | | |
| 0 | 852 | 1345 | 1269 |
| 4 | 1356 | 1501 | 1484 |
| 8 | 1597 | 1346 | 1456 |
| | **80 Nitrogen** | | |
| 0 | 1566 | 1545 | 1778 |
| 4 | 1658 | 1557 | 1796 |
| 8 | 1666 | 1653 | 1812 |

*Applied urea-N (kg/ha)

†Problems with fertilizer application encountered

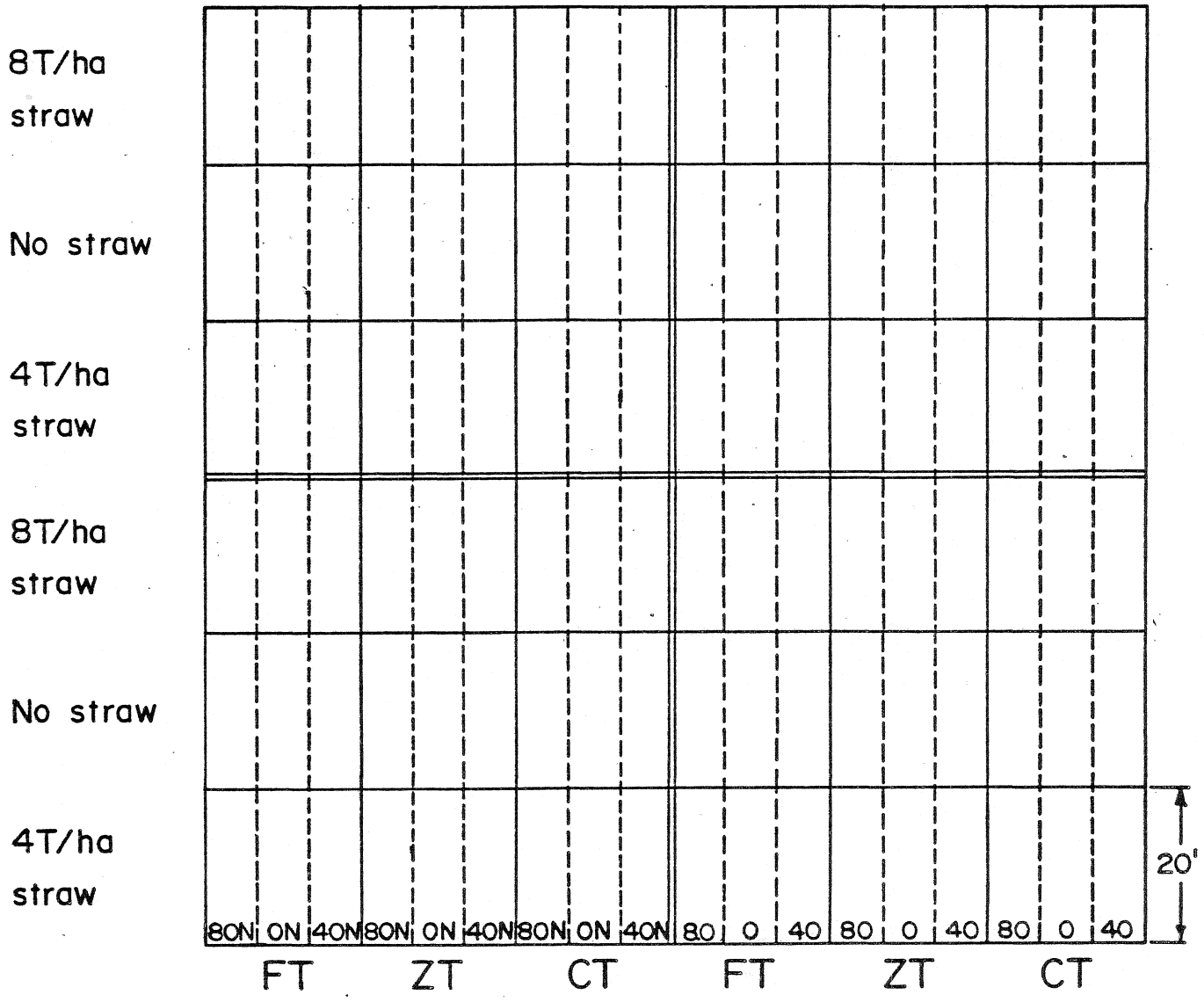


Figure 1. Design of the field plot at Tisdale