WASHINGTON STATE UNIVERSITY
GRANT/ADAMS COUNTY EXTENSION

High Residue Farming under Irrigation
2008 field trial report

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In cooperation with Mike Goodwin, Sam Krautscheid, Alan Williamson, and Stetner farms.

Purpose

1. To demonstrate, under irrigation, the feasibility of direct seeding corn into wheat stubble and measure the effects on crop yield and soil quality
2. To investigate the relationship between corn growth, soil temperature, and residue cover
3. To determine the results of strip-tilling on the soil

Methods

Direct seeded corn demonstration

North Site

- Location: Grant County, W. side of Dodson Rd, between Rd 8 and 8.5 NW
- Soil: Ephrata/Malaga gravely sandy loam
- Cropping system
  - 2007: Spring wheat, Express, 79 bu/ac, all residue left in field (residue equivalent to 139 bu/ac field), 5000-7000 lb residue/ac
    - Sudangrass/volunteer wheat cover crop, winterkilled
  - 2008: Grain corn, Pioneer, 37Y12, 98 day relative maturity. Planted May 5.
    - Stand evaluation. Planted at 42,000 +/-1000 seeds/ac according to monitor, May 28 stand at 38,509 plants/ac
- Other
  - Earthworms, (nightcrawlers and others) seeded fall of 2007
  - Soil quality measurements, spring of 2007

South Site

- Location: Franklin County, S. side of Coyan Rd, between Warehouse and Buehler
- Soil: Shano silt loam
- Cropping system

- 2007: Spring wheat, Express, 139 bu/ac, all residue left in field, 5000-7000 lb residue/ac
  - Sudangrass/volunteer wheat cover crop, winterkilled
- 2008: Grain corn, Pioneer, 37Y12, 98 day relative maturity, planted May 7.
  - Stand evaluation. Planted at 41,000 +/-1000 seeds/ac according to monitor, May 28 stand at 38,880 plants/ac

- Other
  - Earthworms, (nightcrawlers and others) seeded fall of 2007
  - Soil quality measurements, spring of 2007

Equipment

- Custom harvest of wheat, no special equipment
- Corn planter, JD 1730 modified for high residue levels:
  - JD heavy duty down pressure springs (on original planter)
  - JD row cleaners
  - Keeton seed firmers with Exapta Mojo wires
  - Exapta closing wheels
  - Pop-up fertilizer system

Modified WSU planter

Direct seeding corn

Soil temperature measurements

Soil temperatures at the 2″ depth were monitored for the full season at the High Residue Farming demo sites (two fields in corn after wheat) and during the spring in three farmers' fields, also planted to corn. Hobo data loggers connected to either one or two temperature probes were used to collect the data. Three or four locations in each field were used with a pair of temperature probes at each location, one under residue and one under bare soil. Due to a limited number of data loggers, we could not monitor temperatures at all sites at the same time.

Soils varied with the three farmer fields being either Quincy fine sand or Royal loamy fine sand. The North Demo field soil is an Ephrata/Malaga gravely sandy loam and the South Demo field soil is a Shano silt loam. All fields were under center pivot sprinkler irrigation systems.

The demonstration fields were in wheat in 2007 with corn direct seeded in 2008. At each logger location, one probe was placed under a bare soil area was created by removing all residue without tillage. The other probe was placed beneath existing residue.

The farmer fields were all strip-tilled, one in the fall and two in the spring. At each logger location, one probe was placed beneath the soil in the strip (mostly bare soil) while the other probe was placed beneath the undisturbed residue in the center between the strips.

Soil penetration resistance measurements

Soil penetration resistance was measured before planting in four fall strip-tilled fields and after planting in two spring strip-tilled fields. All of the fields were Quincy fine sand except one which was a Royal loamy fine sand. A hand operated penetrometer, with data logging and depth detection was used. Measurements were taken on either in early spring when soil moisture was at field capacity due to winter precipitation (fall strip-tilled fields) or ~24 hours after irrigation in spring strip-tilled fields. Measurements were taken to a depth of 18″ (when that could be achieved) at 0, 3, 6, 9, and 15″ from the center of the tilled strip moving towards the adjacent strip. The strips/planted rows were on 30″ spacing. Measurements were taken at 4-7 locations within each field and measurements at each depth and location averaged.

Results and Discussion

Direct seeded corn demonstration

North site corn yield: 5.2 tons (15.5%), 184 bu/ac

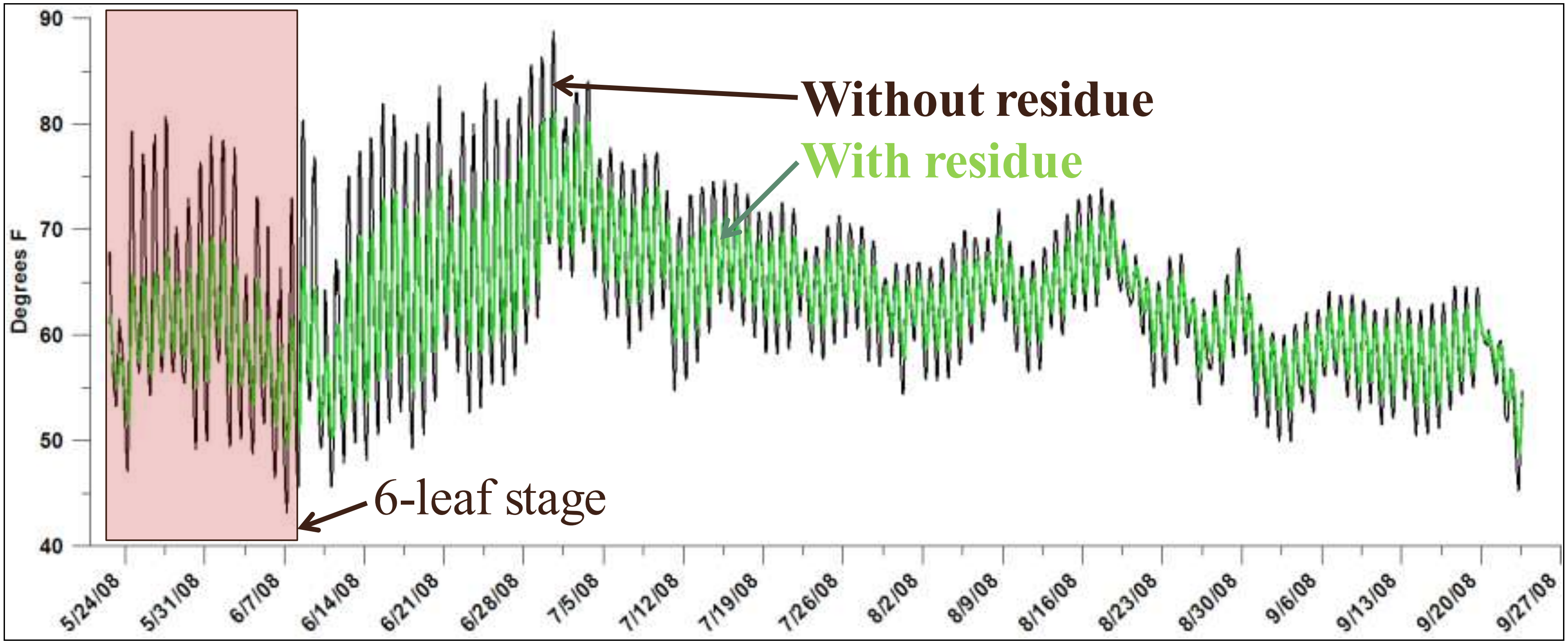
South site corn yield: 6.2 tons/ac (15.5%), 222 bu/ac

Our goal of successfully direct seeding corn into the undisturbed wheat stubble was met as shown by the successful stand establishment. However, the yields were lower than our target, mainly due to cooler than normal weather during the 2008 spring and summer. Compared to the 10-year average, the 2008 season was 12-16 days shorter based on corn growing degree days and early planted corn suffered from prolonged cold weather and even killing frosts in the Columbia Basin.

There are several areas that we think could have improved our 2008 crop: better pre-plant weed control and early fertility, better late weed control, and possibly using a slightly shorter maturity variety. We will implement practices to address these issues as these fields are direct seeded back into corn in 2009

Soil temperature measurements

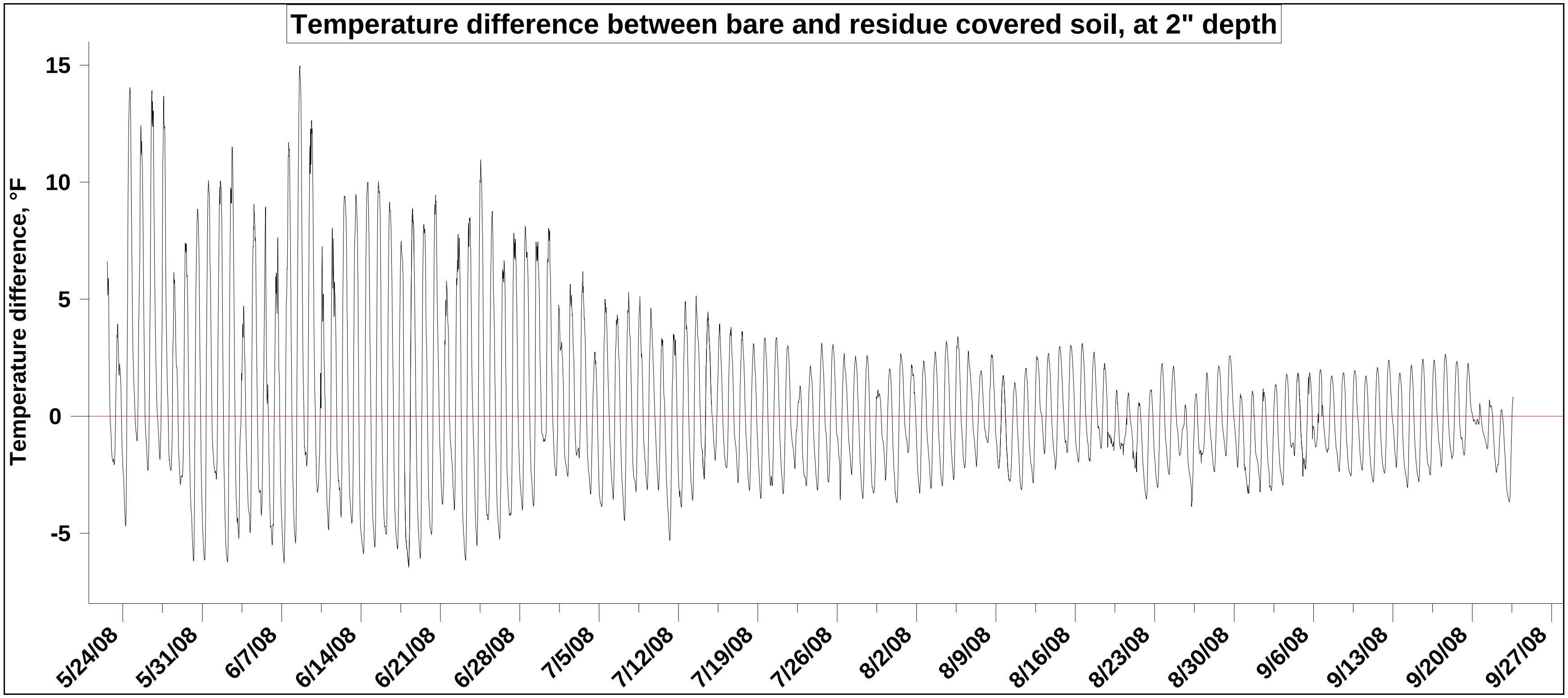
In the comparison of the temperature of untilled soils, bare or residue covered, our measurements showed that the daily range of the temperature of the bare soil was greater than that of the residue covered soil. The high temperatures were higher and the low temperatures were lower for the bare soil as the residue moderated daily temperature changes. This can be seen throughout the season, even after the canopy closed around the beginning of July:



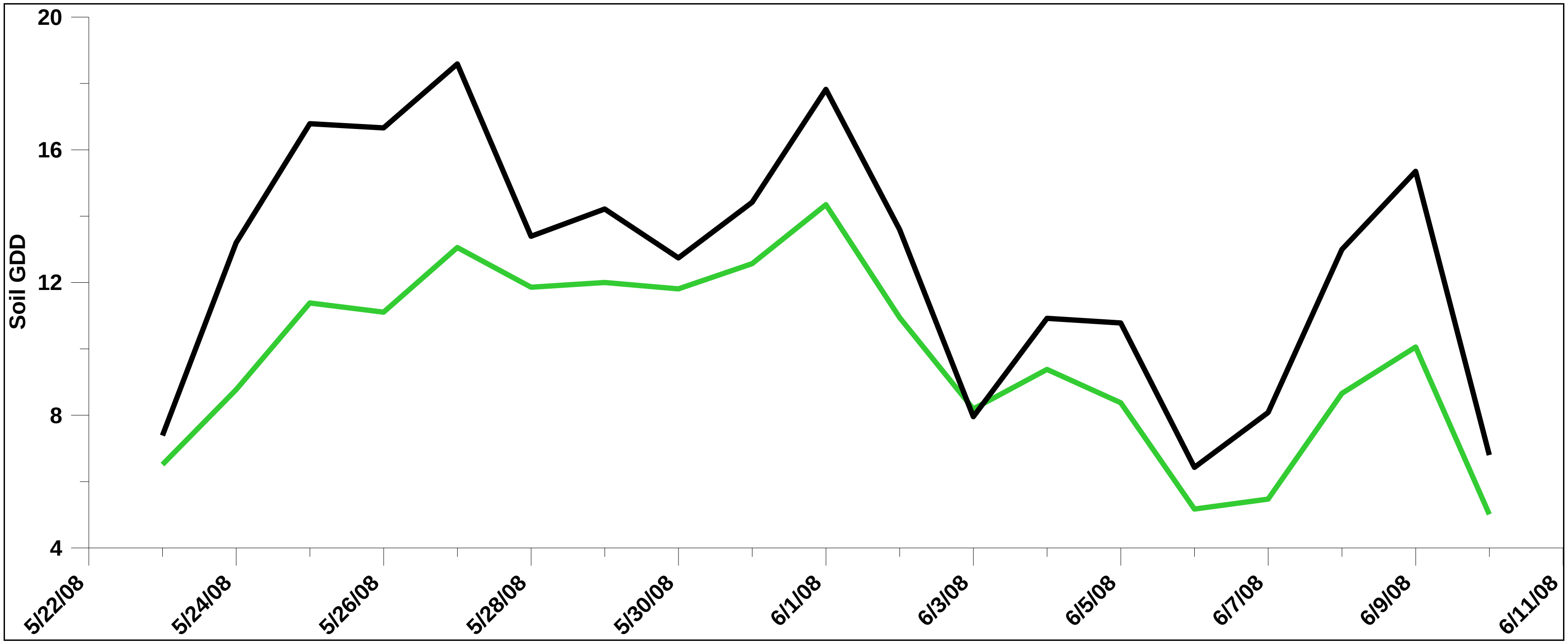
(Only data for South site is shown. Results from the North site were similar)

While this may be important in the ability of the residue cover to reduce evaporation through the season, for corn growth, the soil temperature is most important before the 6-leaf stage. At this stage, the corn plant's growing point emerges from below ground and is mainly affected by air, not soil temperature.

For this critical period from planting to 6-leaves, the higher daily high temperatures in the bare soil overcome the lower daily lows when compared to covered soil

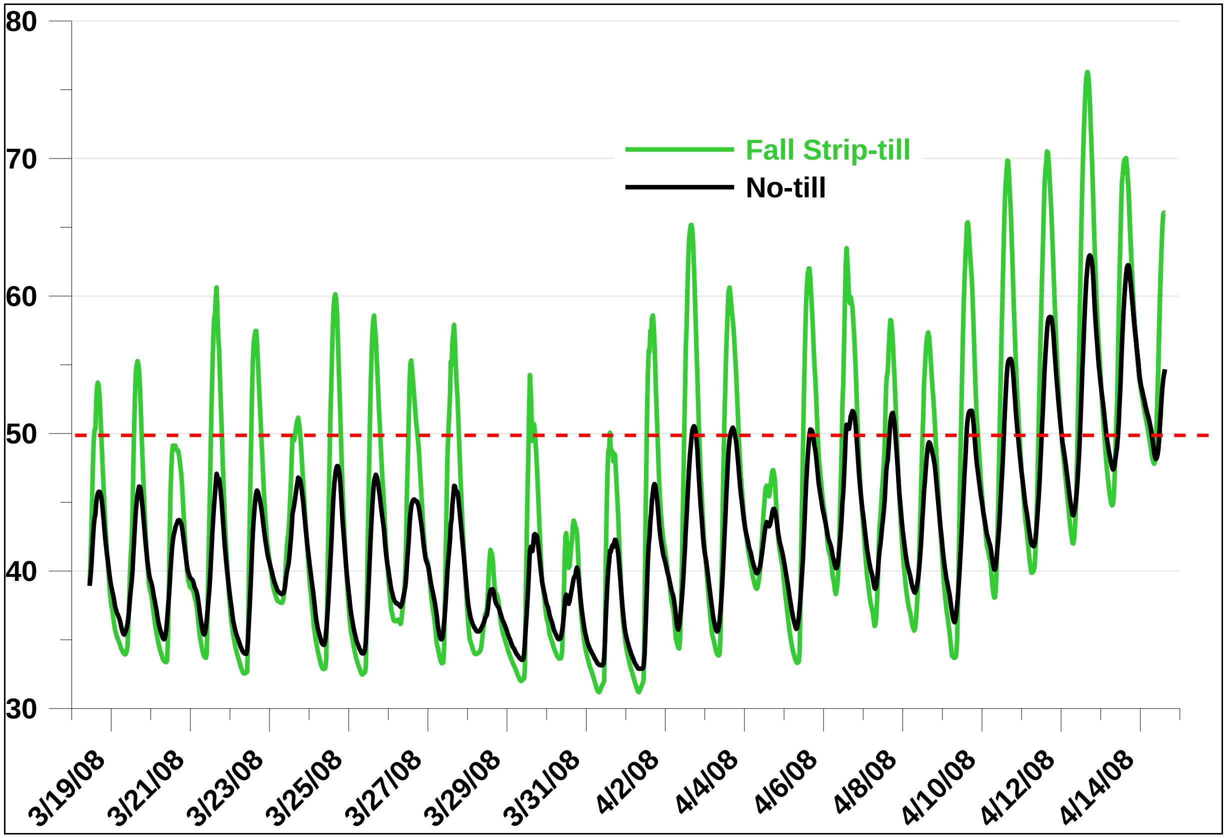


resulting in greater soil growing degree days for the bare soil:

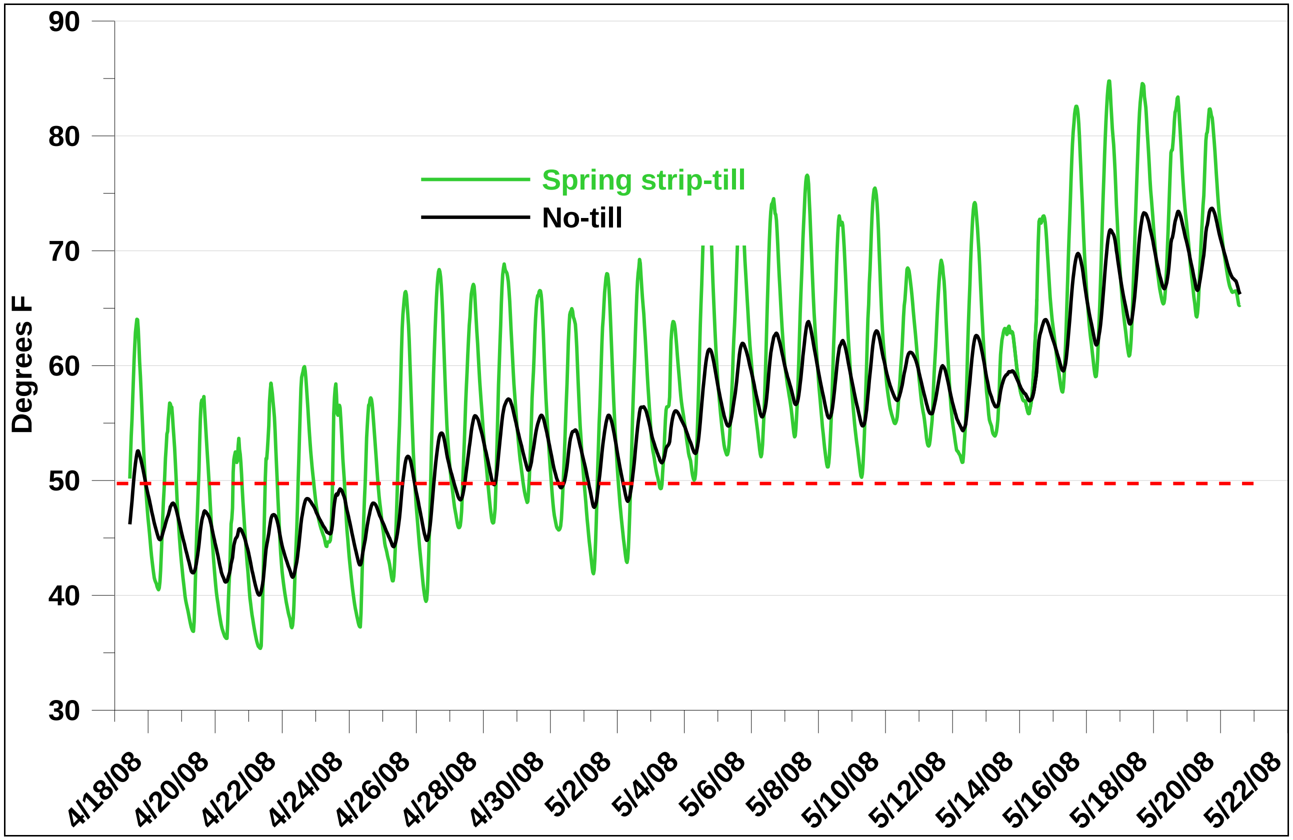


This suggests that removing residue without tilling the soil can significantly increase soil temperature in the spring. Whether tillage with residue removal would increase temperatures even more should be investigated.

In the comparison between tilled soil without residue (strip-till strips) and untilled soil with residue cover (centers between strips) similar results are found. The daily highs are higher and the lows are lower in the tilled soil without residue than in the untilled soil with residue, for both fall strip-till,



and spring strip-till:



Spring strip-till
No-till
Degrees F
90
80
70
60
50
40
30
4/18/08
4/20/08
4/22/08
4/24/08
4/26/08
4/28/08
4/30/08
5/2/08
5/4/08
5/6/08
5/8/08
5/10/08
5/12/08
5/14/08
5/16/08
5/18/08
5/20/08
5/22/08

The implications of this data in determining when to plant corn vary depending on which criteria are used. Several of the criteria used by Midwest extension agronomists are compared below:

Criteria for Corn Planting:	**Recommended planting date (2008)**	
At least 50 °F at 7 am*	**Strip-till**	**No-till**
Spring strip-till 1, after corn	6-May	**2-May**
Spring strip-till 2, after corn	4-May	**29-Apr**
Fall strip-till, spring wheat c.c.	> April 14	> April 14
**Temperature in no-till soil almost always greater than strip-till soil at 7 am*		
55 °F at 1 pm		
Spring strip-till 1, after corn	**16-Apr**	2-May
Spring strip-till 2, after corn	**23-Apr**	2-May
Fall strip-till, spring wheat c.c.	**29-Mar**	13-Apr
50 °F for 12 hours		
Spring strip-till 1, after corn	**25-Apr**	26-Apr
Spring strip-till 2, after corn	**25-Apr**	26-Apr
Fall strip-till, spring wheat c.c.	**10-Apr**	12-Apr
Average daily temp. at least 50 °F (two consecutive days better)		
Spring strip-till 1, after corn	**25-Apr**	26-Apr
Spring strip-till 2, after corn	**17-Apr***	27-Apr
Fall strip-till, spring wheat c.c.	**10-Apr**	12-Apr
**Next day meeing criteria: 25-Apr*		

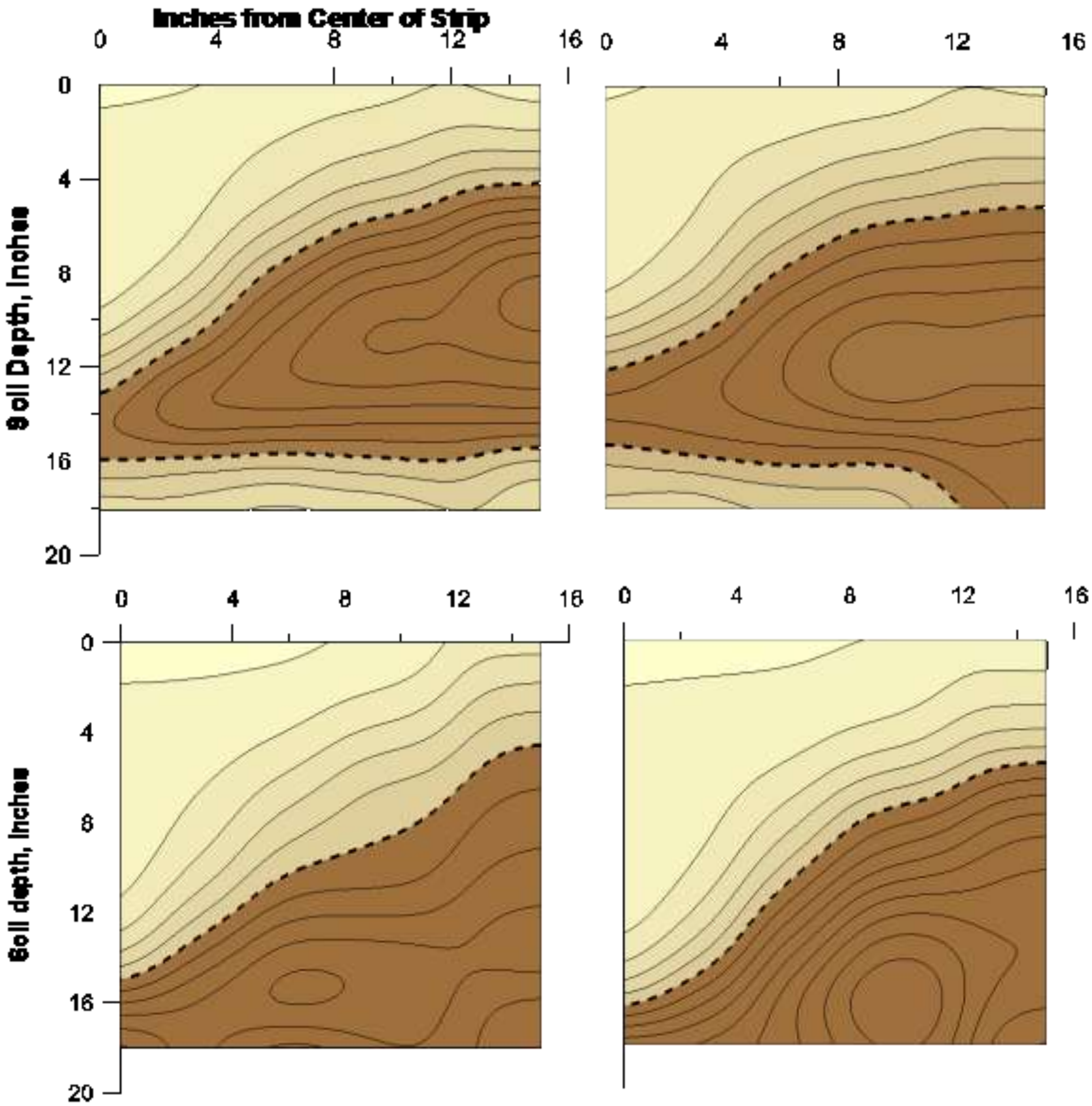
The following conclusions can be drawn from our data:

- Strip-till warms the soil by removing the residue cover. The tillage effect on temperature is not clear.
- "Spot checks" of soil temp. (checking it at a certain time each day, are unreliable, but are used probably because they are easier to take than measurements over a period of time.
- In 2008, no-till would have delayed planting by ~2 days in these fields (depending on the criteria used)

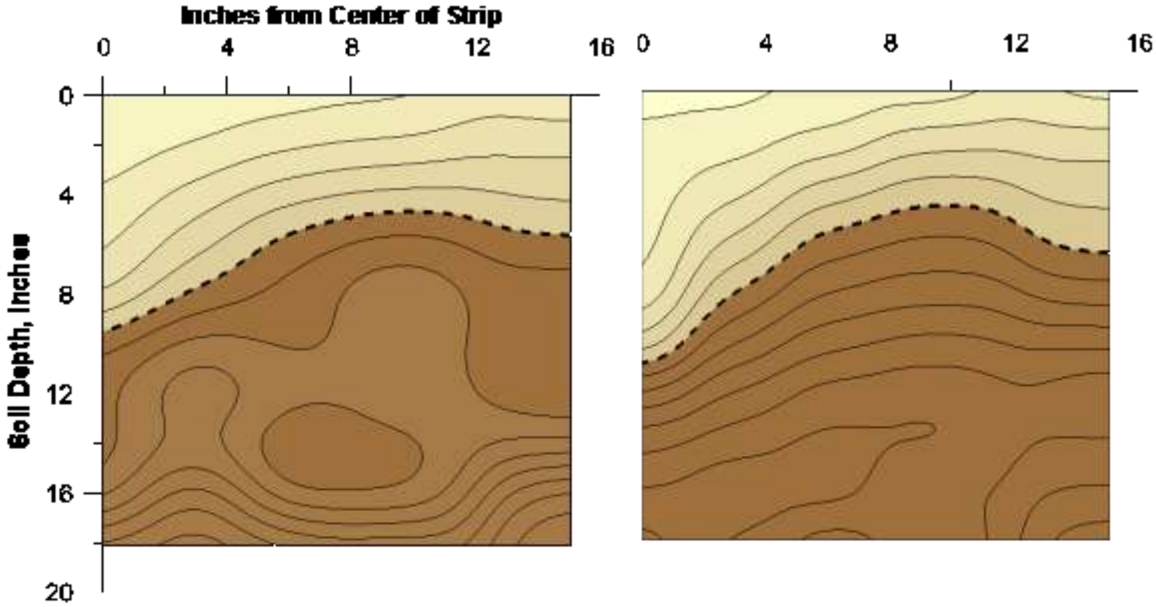
- The soils after fall strip-till are warmer than after spring strip-till, but the earlier dates meeting the criteria in fall strip-till would have been too early this year given later weather.
- Soil temperature measurements over time combined with weather forecasts may give the best results
- Soil under corn residues is cooler than under wheat residues

Soil penetration resistance measurements

The soil penetration profiles show the approximate location of soil that might restrict root growth (dotted line is 300 psi and darker brown areas are >300 psi). The results for fall strip-till:



are different from those in spring strip-tilled fields:



Because both fall and spring strip-till measurements were not taken in the same field, we cannot say for sure what caused the differences. However, one plausible explanation for the differences is that the soil in the fall was dryer and therefore fractured out from the tillage point at a lower angle than wetter spring soils. Wetter soils in the spring may also have resulted in some compaction between the strips as seen by the humps in the profiles. Equipment differences could also explain some of the differences.

This method seems to have some value in evaluating strip-tillage effectiveness and will be expanded in coming years.

Thanks to Stetner farms, Sam Krautscheid, Williamson farms, and Mike Goodwin for allowing me access to their fields.

Address questions to Andy McGuire, WSU Extension, amcguire@wsu.edu, 509.754.2011 ext. 413.

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