Objective: #8: Develop awareness and acceptance of best management practices via on-farm testing of improved technologies in farmers' fields, extension outreach programs, and other educational materials.

Title: High Residue Farming in Irrigated Systems for Wind Erosion Management

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Abstract of Research Findings
Our objectives this year were to demonstrate the feasibility of direct seeding corn into undisturbed corn stubble and to investigate the relative effects of residue removal and tillage on soil temperature in the seed zone. The demonstration took place on two fields in the Columbia Basin. At the first field planted, residue occasionally plugged the row cleaners despite numerous adjustments. They were finally removed and planting proceeded without problems on both fields. However, because of the high residue conditions in the planting row, we had to set the planter to get the seed into the soil in the deepest residue which meant that in areas with less residue cover the seed was planted deeper, up to 3”. The combination of high residue, cooler than normal spring temperatures and deep planting in some areas delayed emergence for up to 27 days after planting. Crop stand however was adequate at 34,556-35,380 plants per acre, reduced 11.5-13.6% from seeding rates. Yields ranged from 5.2 to 6.1 tons per acres (15.5% moisture). These are respectable given the conditions but not quite competitive with yields in tilled fields. Moving residue off of the row might reduce or eliminate this difference.

Soil temperatures at 2” depth were monitored at replicate sites in a fall strip-tilled field in the strip, in between strips, and in between strips with residue removed. The results showed that fall strip-tilled soil was warmer than either the untilled soil with or without residue cover. However, soil that had the residue removed just before planting was nearly as warm as the fall strip-tilled soil. The untilled, residue covered soil was the coolest. Removing residue warmed the soil much more than tillage: +1.0 °F from tillage, +6.6 °F from removing residue, and +7.0 °F from removing residue and tillage on average.

Objectives
1. To demonstrate, under irrigation, the feasibility of direct seeding corn into corn stubble and measure the effects on crop yield and soil quality.
2. To investigate the effects of tillage and residue removal on soil temperatures in strip-tilled fields.
3. To transfer direct seeding technology to irrigated farming regions of the Columbia Basin.

**Methods and Materials**

**Objective 1**

**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, 37Y 12, 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 (5.2% loss from seeding rate)

  2009: Grain corn, Pioneer, 37K 11, 99 day relative maturity. Planted April 22. Emergence after approx. 25 days
  - Stand evaluation. Planted at 40,000 +/- 1000 seeds/ac according to monitor, June 15 stand at 34,556 plants/ac (13.6% loss from seeding rate)

**North Site**
- Location: Grant County, W. side of Dodson Rd, between Rd 8 and 8.5 NW
- Soil: Ephrata/M alaga gravelly 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, 37Y 12, 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 (8.3% loss from seeding rate)

  2009: Grain corn, Pioneer, 37K 11, 99 day relative maturity. Planted April 24. Emergence after approx. 27 days.
  - Stand evaluation. Planted at 40,000 +/- 1000 seeds/ac according to monitor, June 15 stand at 35,380 plants/ac (11.5% loss from seeding rate)

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

**Equipment**
- Custom harvest of corn, 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 Thompson closing wheels
- Pop-up fertilizer system (Five gallons per acre, 3-6-3 + Zn)

**Residue management**

No tillage was done between harvest and planting. Residues were left as they were found after harvest.

**Planting**

Everything on the planter worked well except the row cleaners. They would occasionally plug with residue and stop turning. They would then act like a rake piling up residue in front of them. After this occurred several times (at the South site), despite our adjustment of the height of the row cleaners, we finally took them off completely. The planter then proceeded to plant without problems. The North site was planted completely without row cleaners. Planting depth was somewhat deep, 2-3”, to account for the non-uniform depth of residue over the field and the fact that the depth gauge wheels were on top of the residues.

One thing that probably exacerbated the plugging of the row cleaners was the stalks that were knocked down in front of the planter by the tractor wheels, planter drive wheels (in front of the tool bar) and by the planter tool bar and row marker support bars. This was particularly a problem at the South site where 3’ tall stalks had been left standing after the previous harvest. A stalk tipper made to help with this condition ended up making it worse by knocking all the stalks down in front of the planter. It was soon removed. Stalks left 12-18” high would have diminished or eliminated this problem.

**Objective 2**

Soil temperatures at the 2” depth (seed zone) were monitored in a fall strip-tilled field, Quincy fine sand, under center pivot irrigation. Hobo data loggers connected to either one or two temperature probes were used to collect the data. Four locations were used with three temperature probes at each location, two centered between the strips, one under bare ground (residue removed by hand, -residue, -tillage), one under the normal residue (+residue, -tillage), and one probe in the center of the tilled strip under bare soil (-residue, +tillage).
Objective 3
Direct seeding and strip-till technology, including the knowledge gained through the on-farm research conducted as part of this project, was transferred to farmers in the Columbia Basin through the following:
1. Two high residue farming systems field days in June.
2. A High Residue Farming under Irrigation workshop in December.

Results and Discussion
Objective 1
South site corn yield: 6.06 tons/ac (15.5%), 216 bu/ac, harvested in mid-November.
North site corn yield: 5.2 tons/ac (15.5%), 186 bu/ac, harvested Nov. 20 at 18% moisture.
Our goal of successfully direct seeding corn into undisturbed corn residue was met as shown by the successful stand establishment. Getting a stand was not a problem with the equipment that is described above. The yields, however, while respectable given the conditions, were lower than desired and were not quite competitive with clean tillage systems. We believe that the reduced yield was due to the very slow emergence of the crop. Most of the plants at both sites took 25-27 days to emerge from the cool soils and heavy residue cover.
There are several changes that we believe would improve these results:
1. Given our Northern latitude and that corn is a tropical crop, everything that can be done to warm the soil at and after planting, within the system constraints, should be done. This means moving the residue off of the row at or just before planting. Tillage will not warm the soil near as much as removing the residue (see temperature results below) and would eliminate many of the benefits we are after.
   a. Removal of the residue would be easier after it is cut, either by the opener disks, in which case standard row cleaners would not work, or by a banded fertilizer application disk accompanied by row cleaners running in front of the openers. The latter system is used successfully by farmers in the Midwest. The former system would require a new arrangement of row cleaners and customized brackets.
   b. Planting down the old rows may both reduce the amount of residue encountered by the opener disks and diminish problems with cutting stalks because the wheels would be running between the rows, not on the old stalks.
   c. Cut stalks to 12-18” height at harvest.
   d. Plant rows North and South so that newly planted rows are not always shaded by standing stubble/stalks.

Objective 2
The following conclusions can be made from the soil temperature data:
- Fall strip tilled soil was warmer than either the untilled soil with or without residue cover. However, soil that had the residue removed just before planting was nearly as warm as the fall strip-tilled soil.
- The untilled, residue covered soil was the coolest
- Removing residue warmed the soil much more than tillage:
  - Tillage: +1.0 °F
  - Removing residue: +6.6 °F
- Removing residue and tillage: +7.0 °F
- Once the plant grows to a certain height, it shades the soil beneath it (bare row), cooling it

The average daily maximum soil temperatures and growing degree days in the following graphs show these differences.
Accumulated soil growing degree days (corn, 50/86) over the observation period (averages of all locations):

- No residue, tilled: 765.6
- No residue, untilled: 740.0
- Residue, untilled: 581.0

Conclusions:
1. Remove residue in spring at planting in a narrow (3-6”) band above seed. This would result in
   - Warmer soil
   - Conservation of soil moisture compared to removing residue in the fall
2. Till above seed at planting – this can be done with spiked closing wheels on the planter. This warms up soil further.

Objective 3
A total of 81 people attended the field days and workshop. In addition, the results of the field demonstrations and research, and workshop digests were posted to a high residue farming webpage and publicized in newsletters.

Publications and Presentations
Experiment Station Research and Extension Reports

Popular Publications