

RESEARCH PROJECT TITLE: Assessing the Impact of Direct Seeding (No-Till) and Conventional-Till on Nitrogen Fertility, Soil, and Insect Responses

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PROJECT OBJECTIVES:

1. Compare hard red winter and spring wheat nitrogen fertilization responses from rates and timing of N application in a replicated NT and CT comparison.
2. Determine the impact of CT and NT on soil microclimate and fauna and document changes in key soil hydraulic and chemical properties.
3. Monitor pea leaf weevil abundance and damage in CT and NT pea.
4. Conduct controlled experiments in the laboratory and field trials to assess predation by specific ground-dwelling predators on pea leaf weevil.
5. Compare immigration of pea leaf weevil into NT and CT pea and test the effects of specific factors on immigration of pea leaf weevil into NT and CT pea.

KEY WORDS: Tillage, Varieties, Nitrogen Fertility, Soil Dynamics, Insects

STATEMENT OF PROBLEM: Information and new technologies about crop, fertility, variety, soil, insect and disease will help solve problems inherent in conservation practices, particularly NT, in the high rainfall areas of the Pacific Northwest. Past results show that varieties can respond differently to tillage and when evaluated in a replicated trial, those variety differences can be compared and quantified. Nitrogen fertilization is critical to obtain adequate protein and quality in hard winter and spring wheat, but timing and quantity of N fertilizer is not well studied in contemporary CT and especially NT systems. Understanding the influence of topography on C sequestration and nutrient distribution is necessary to achieve the most efficient application of nutrients to agricultural fields, especially in areas such as the Palouse that are characterized by rolling topography. The relation between macrofauna, porosity, and pore-size distribution in the early stages of NT operations are not known. Differences in population dynamics, crop losses, and variety specific response have not been characterized for Pea Leaf Weevil and other crop pests in replicated comparisons between CT and NT cereal production

systems in the PNW. The importance and dynamics of the natural enemies of insects have also not been fully quantified in replicated NT comparisons in the PNW.

ZONE OF INTEREST: Higher precipitation Palouse region of ID and WA.

ABSTRACT OF RESEARCH FINDINGS: Investigations were accomplished according to the proposals. Crops established well across treatments, with equivalent plant counts across crops in NT and CT. The CT winter wheat grain yielded 2 bu/acre less, 81 bu/acre, than in NT. Yields peaked with 00 lb/a applied N in CT and 150 lb/a N in NT. Protein was 0.6% lower in NT than CT in 2008 and 1.0% lower in 2007. Equivalent protein levels took 50 lb/acre more N in NT than CT. Hard red spring wheat yields were not influenced by application timing, nor overall for CT versus NT. Yield was highest at 175 lb/a N. Spring wheat grain protein was 0.5% lower in 2007 and 1.0% lower in 2008 in NT than CT. N fertilizer rates did not equilibrate between NT and CT and soft white spring wheat might be more cost effective with high N cost. Pea and lentil yields were not different between tillage treatments in 2008 and over 2006-2008. Earthworm densities were higher in NT than CT with 89% of the total collected in NT and 83% of cocoons. Earthworm density differences between CT and NT plots were seen in 2001 and are consistent across years. Soil moisture was higher in NT than in CT in the spring and increases earthworm activity. Soil bulk density was not different between tillage treatments. Pore size distribution or amount was also not different for 0-5" and 5-10" depths. In 2005 and 2006, significantly higher Pea Leaf Weevil (PLW) colonization occurred into plots without cereal residue and into plots planted earlier. Overall movement patterns suggest that CT peas attract more immigrating PLW enhancing early season PLW infestation of CT and changing crop yield. PLW emergence was greater in CT than in NT plots during both 2005 and 2006.

RESULTS AND INTERPRETATION: Previous results from earlier investigations of this study can be found in 2001 to 2007 STEEP annual reports. Agronomic results are also available on line at: <http://www.ag.uidaho.edu/cereals>

Experimental Site Management. At the Kambitsch farm north of Genesee, Idaho in 2008 a tillage comparison trial included six rates of nitrogen fertilizer applied in three management timings on hard red winter and hard white spring wheat, 12 varieties of spring dry pea, and 6 varieties of lentil. All treatments were evaluated in a replicated no-till (NT) versus conventional till (CT) comparison. Each crop was raised on the previous crop residue as part of the rotation winter wheat-spring wheat-pea from the previous year (2007). This three-year rotation and tillage treatments have been in place since the winter of 2000.

The hard red winter wheat variety 'Boundary' was seeded on 10 October, 2007 using a Flexi-coil Stealth opener, five row plot drill. A burn-down herbicide was applied prior to seeding and dry fertilizer was banded with the seed drill to give a 32-40-0-28 lb/a application under the treatment area. N fertilizer treatments were applied to winter wheat as 46-0-0 urea dry fertilizer broadcast applied just after planting for the fall application, at spring green-up, and at anthesis. Plots were harvested 29 August, 2008.

The hard white spring wheat variety 'Lolo' was seeded on May 12, 2008 after a burn-down herbicide application using a small plot drill with Flexi-coil shank openers. N fertilizer applications were applied after planting and at anthesis. Spring wheat was seeded with 32-40-0-28 lb/a fertilizer banded below the seed. No fertilizer was applied to the pea and lentil area seeded on May 12, 2008. The tillage treatment included a fall chisel plow about 8 inches

deep just prior to planting winter wheat and the remainder of the conventional till area was chisel plowed in late October. Two cultivations with a field cultivator/harrow were conducted prior to seeding in the conventional tillage area. The no-till treatment area was not disturbed except by seeding. In the bulk areas, 'Brundage 96' hard red winter wheat, 'Aaragorn' green pea, and 'Lolo' hard white spring wheat were seeded. Weed control included Metribuzin in the pea area, and Rhino and Harmony Extra at standard rates in the cereals. A few weed escapes were hand weeded. Overall, weed control was good and should not have had any impact on crop performance. Pea leaf weevil levels were not too high and did not need control, but pea seed weevil and aphids were controlled by an application of Capture at bloom. Peas, lentils, and spring wheat were harvested 2 September, 2008.

Over winter there were very limited vole populations and Zink Phosphide bait stations were not used as in past years. The winter wheat established well and survived the winter well. The spring crops were seeded late but crop establishment was uniform and typical. Cool temperatures after seeding into the summer prevailed with a normal late summer. Soil moisture was good early, but overall below normal and was very limited for spring crops during reproductive and grain fill stages during hot weather.

Variety and N fertilizer responses: Stephen O. Guy

Winter wheat. Soil samples taken just before planting showed residual soil nitrogen, both nitrate and ammonium, in the top two feet of soil in CT was 73 lb/a and in NT was 64 lb/a for 2007 (Table 1) and was 71 lb/a in CT and 84 lb/a in NT in 2008 (Table 2). When grain yield results for 2007 were combined across nitrogen fertilizer treatments, CT produced 66 bu/a, but NT was not significantly higher at 70 bu/a (Table 1). N fertilizer application timing did not appear to make a difference in CT, but in NT the 70% fall/30% spring application timing gave higher yields than the other two application timings. Fertilizer rate influenced yield in CT producing 62 bu/a at 50 lb/a applied N and raising to 69 bu/a at 125 lb/a of N. In NT, the low rate also yielded 62 bu/a, and peaked at 150 lb/a N giving 75 bu/a. The NT yields were higher than the CT yields for the 100, 150, and 175 lb/a N application rates. There was a three-way interaction ($P=0.027$) of tillage-timing-rate for yield and it appears in this interaction that in NT the 70%/30% split fertilizer timing gave the greatest differences among rates going from 65 bu/a for the two lowest fertilizer rates to 80 bu/a for the 125 and 150 lb/a N rates. Across the tillage and application timing treatments, the fertilizer rates that gave the highest yields were the 125 and 150 lb/a N rates. It appears that it is more critical for yields to have optimum rates of N fertilizer in NT than CT.

Grain test weight averaged 61.0 lb/bu in CT and 61.6 lb/bu in NT (Table 1). This high test weight shows that there was adequate moisture for grain yield, but yield was determined by early adverse weather conditions. There was no significant effect of fertilizer timing on test weights. Test weights declined as N fertilizer rate increased in CT, but were highest at 61.9 lb/bu with 100 lb/a of N in NT. Test weights were higher in NT than CT for all the fertilizer rates except the two lowest rates. Test weight was also higher in NT, 59.3 lb/bu, than CT, 58.7 lb/bu, in 2008 (Table 2) with no significant effects.

Protein is critical for hard red wheat and grain samples were lower for protein in all treatments and averaged 1.0% lower in NT than CT in 2007 (Table 1) and there was not an interaction among any of the factors. In 2008, grain protein was also lower in NT than CT by 0.6% and that trend was consistent across treatments. When rates and protein levels are compared between tillage treatments, the equivalent protein levels are achieved in NT with

an additional 50 lb/a of N when compared to CT. This could amount to a significant increase in inputs or decreased value from NT compared to CT when growing hard red winter wheat. It would be prudent for NT producers of winter wheat to grow lower protein classes of wheat rather than high protein and take advantage of occasional premium with low protein soft white varieties.

Plant stands were evaluated for representative treatments and showed equivalent stands between NT and CT with more than adequate populations for yield in all years and treatments. Seed hardness, plant height, seed weight, crop biomass and harvest index were all not significant different among any of the treatments, but were typical for this crop performance. There was a difference for 125 and 150 lb/a of N rates for number of heads, with more heads in NT than CT indicating better tillering. In 2008, grain yield was 80.9 in CT and 83.1 in NT, but not significantly different and there was no interaction for yield, timing, and/or N rate. Yield appeared to peak at 100 lb/a in CT and 150 in NT. Also showing that there could be a greater need for N availability in NT than CT. This N could be needed due to more straw breakdown during the crop growth period in NT and that some of that residue may be converting to the organic matter pool and thus tying up nitrogen that will then add to crop performance and N availability in the future. Because organic matter has other crop performance benefits, this should be viewed as a wise investment. These results also show that growing high protein hard red winter wheat may be more difficult in NT and in the high rainfall areas, soft white wheat might be a better choice due to the advantage of low protein. In 2008, low protein soft white wheat was not always grown, but would be easier to obtain in NT than in a CT system.

Table 1. Hard Red Winter Wheat Performance with Nitrogen Rate and Application Timing in Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2007.

| Nitrogen Treatment | Seed Yield | | Test Weight | | Seed Protein | | Seed Hardness | | Plant Height | |
|--------------------------------------|---------------|-----|-----------------|-------|--------------|-------|---------------|------|--------------|----|
| | CT | NT | CT | NT | CT | NT | CT | NT | CT | NT |
| | ---bu/acre--- | | -----lb/bu----- | | ---- % ---- | | --0-100--- | | ----g/200--- | |
| <u>N Fert. Timing</u> | | | | | | | | | | |
| 100% Fall | 65 | 68 | 61.0 | 61.5 | 11.2 | 10.1* | 51 | 50 | 29 | 29 |
| 70% Fall, 30% Spring | 67 | 73* | 61.0 | 61.7 | 11.2 | 10.2* | 51 | 51 | 28 | 29 |
| 60% Fall, 25% Sp., 15% Anthesis | 66 | 69 | 61.1 | 61.7 | 11.0 | 10.1* | 52 | 50 | 28 | 28 |
| LSD .05 | 3 | 3 | n.s. | n.s. | 0.6 | 0.6 | n.s. | n.s. | 1 | 1 |
| <u>N Fert. Rate (lb/acre)</u> | | | | | | | | | | |
| 50 | 62 | 62 | 61.4 | 61.5 | 10.3 | 9.3* | 51 | 48 | 28 | 28 |
| 75 | 67 | 64 | 61.1 | 61.6 | 10.7 | 9.5* | 51 | 49 | 29 | 28 |
| 100 | 65 | 72* | 61.1 | 61.9* | 11.1 | 10.1* | 51 | 52 | 28 | 29 |
| 125 | 69 | 73 | 60.9 | 61.6* | 11.4 | 10.5* | 52 | 51 | 28 | 29 |
| 150 | 68 | 75* | 60.8 | 61.8* | 11.7 | 10.5* | 51 | 52 | 29 | 30 |
| 175 | 65 | 72* | 60.7 | 61.3* | 11.9 | 11.0* | 52 | 51 | 28 | 29 |
| LSD .05 | 5 | 5 | 0.4 | 0.4 | 0.6 | 0.6 | n.s. | n.s. | 1 | 1 |
| Average | 66 | 70 | 61.0 | 61.6 | 11.2 | 10.2* | 51 | 50 | 28 | 29 |
| CV | 9 | | 0.9 | | 3 | | 6 | | 4 | |

| Table 1. continued Nitrogen Treatment | Seed Weight | | Heads | | Biomass | | Harvest Index | |
|--|-------------|------|------------------|------|-------------|-------|---------------|------|
| | CT | NT | CT | NT | CT | NT | CT | NT |
| | ---g/200--- | | ----#/sq.ft.---- | | ---- % ---- | | ---0-100--- | |
| <u>N Fert. Timing</u> | | | | | | | | |
| 100% Fall | 7.8 | 8.0 | 42 | 50 | 10260 | 11220 | 0.48 | 0.49 |
| 70% Fall, 30% Spring | 7.9 | 8.0 | 44 | 54 | 10700 | 11950 | 0.49 | 0.49 |
| 60% Fall, 25% Sp., 15% Anthesis | 8.0 | 8.2 | 40 | 51 | 9870 | 11170 | 0.50 | 0.49 |
| LSD .05 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| <u>N Fert. Rate (lb/acre)</u> | | | | | | | | |
| 50 | 8.2 | 8.3 | 39 | 46 | 9870 | 10310 | 0.50 | 0.49 |
| 75 | 7.9 | 8.2 | 41 | 44 | 10400 | 10090 | 0.50 | 0.49 |
| 100 | 7.9 | 8.2 | 41 | 51 | 10140 | 11710 | 0.50 | 0.49 |
| 125 | 7.9 | 8.0 | 44 | 58* | 10880 | 12840 | 0.47 | 0.48 |
| 150 | 7.7 | 8.1 | 44 | 58* | 10430 | 12620 | 0.49 | 0.49 |
| 175 | 7.7 | 7.7 | 43 | 53 | 10040 | 11100 | 0.49 | 0.48 |
| LSD .05 | n.s. | n.s. | 12 | 12 | n.s. | n.s. | n.s. | n.s. |
| Average | 7.9 | 8.1 | 42 | 52 | 10280 | 11440 | 0.49 | 0.49 |
| CV | 3 | | 15 | | 14 | | 5 | |

* No-Till values followed by an asterisk are significantly different the Conventional till.

Table 2. Hard Red Winter Wheat Performance with Nitrogen Rate and Application Timing in Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2008.

| Nitrogen Treatment | Seed Yield | | Test Weight | | Seed Protein | | Plant Height | |
|--------------------------------------|---------------|------|---------------|------|--------------|-------|--------------|-------|
| | CT | NT | CT | NT | CT | NT | CT | NT |
| | ---bu/acre--- | | ----lb/bu---- | | ---- % ---- | | ----g/200--- | |
| <u>N Fert. Timing</u> | | | | | | | | |
| 100% Fall | 81.7 | 84.3 | 58.7 | 59.3 | 11.1 | 10.4 | 31.5 | 32.9* |
| 70% Fall, 30% Spring | 80.5 | 82.5 | 58.8 | 59.3 | 10.9 | 10.2 | 31.5 | 32.1* |
| 60% Fall, 25% Sp., 15% Anthesis | 80.3 | 82.5 | 58.7 | 59.3 | 10.7 | 10.2 | 31.5 | 32.0 |
| LSD .05 | n.s. | n.s. | n.s. | n.s. | 0.2 | 0.2 | 0.6 | 0.6 |
| <u>N Fert. Rate (lb/acre)</u> | | | | | | | | |
| 50 | 76.8 | 73.1 | 58.9 | 59.2 | 10.1 | 9.7 | 30.9 | 31.5 |
| 75 | 80.7 | 82.4 | 59.0 | 59.3 | 10.3 | 9.8 | 31.3 | 31.9 |
| 100 | 83.6 | 83.2 | 58.8 | 59.4 | 10.8 | 10.1 | 31.7 | 32.5 |
| 125 | 81.4 | 85.1 | 58.5 | 59.3 | 11.2 | 10.4 | 31.7 | 32.5 |
| 150 | 79.9 | 87.0 | 58.6 | 59.3 | 11.4 | 10.7 | 31.7 | 32.4 |
| 175 | 82.8 | 87.8 | 58.6 | 59.3 | 11.6 | 10.9 | 31.9 | 33.1 |
| LSD .05 | n.s. | n.s. | n.s. | n.s. | 0.2 | 0.2 | n.s. | n.s. |
| Average | 80.9 | 83.1 | 58.7 | 59.3 | 10.9 | 10.3* | 31.5 | 32.3 |
| CV | 9 | | 0.8 | | 3.5 | | 3 | |

* No-Till values followed by an asterisk are significantly different the Conventional till.

Spring Wheat. Soil sampling in the top two feet before April 2007 planting showed an average of 77 lb/a available N in the NT and 70 lb/a in the CT area. In 2008 soil sampling showed 110 lb/a available N in NT and 101 lb/a in CT. Average grain yield in 2007 over all nitrogen fertilizer treatments was not different at 56 bu/a in CT and 51 bu/a in NT (Table 3). All fertilizer N application timings produced the same yields and the rates over 100 lb/a have slightly higher yields than the lower rates in CT. In NT timing did not significantly change yield, and the highest yields were over 100 lb of applied N. Yields in NT were lower in the lower fertilizer rates than the lower rates in CT. This shows that there is a similar yield potential in NT versus CT, but if the fertilizer rate is too low, yields will drop off more in NT than CT. There were no interactions of tillage with timing, tillage with rate, and rate with timing for yield. These results follow trends of the winter wheat study. In 2008, yields averaged 30 bu/a in CT and 34 bu/a in NT and these values were not significantly different (Table 4). These low yields show the effects of limited available water that reduced plant growth and grain filling. There were no other effects of treatments on yield except for an increase in yield due to applied N rate, as expected.

Grain test weight in 2007 averaged 60.5 lb/bu in CT and 60.8 lb/bu in NT (Table 3). The high test weight indicates that early hot conditions caused reduced yield potential, but conditions were adequate during grain filling. Test weights declined as N fertilizer rate increased in both NT and CT. Test weights were highest in the 70:30 split applications in both tillage treatments. 2008 test weights were 59.0 lb/bu in CT and significantly higher at 61.3 lb/bu in NT (Table 4). Test weight was not affected by fertilizer timing or rate, but was consistently higher in NT. This could be attributed to additional available water in NT than CT, especially during grain filling.

Seed protein was lower in NT than CT by 0.5% in 2007 and 1.9% in 2008 (Tables 1&2). Across rates of N application, there was greater protein in CT than NT and in 2007 equivalent protein levels were achieved at 25-50 lb/a higher rates in NT, but in 2008, protein levels did not overlap from the lowest in CT to the highest in NT. This shows that even with high fertilizer rates and split applications, there are conditions that create low protein hard wheat in NT and it is easier to attain protein in CT than NT. It might be beneficial for growers to consider soft white spring wheat rather than hard varieties in NT, especially when nitrogen fertilizer prices are high.

Plant heights were short at an average 29 inches in both CT and NT in 2007 and 25 inches in 2008 (Tables 3&4), reflecting growing conditions. Plant stands were evaluated for representative treatments and showed equivalent stands between NT and CT with more than adequate populations for yield. Seed weights were not different between CT and NT, but declined as N rate increased and were highest for the one split timing of N application 70% spring and 30% applied at anthesis. Heads density, crop biomass, and harvest index were not different for any treatments or interactions, although the average biomass was 9390 lb/a for CT and 8550 lb/a for NT showing the lower growth for NT.

Table 3. Hard Red Spring Wheat Performance with Nitrogen Rate and Application Timing in Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2007.

| Nitrogen Treatment | Seed Yield | | Test Weight | | Seed Protein | | Seed Hardness | | Plant Height | |
|--|---------------|------|---------------|-------|--------------|-------|---------------|------|--------------|------|
| | CT | NT | CT | NT | CT | NT | CT | NT | CT | NT |
| | ---bu/acre--- | | ----lb/bu---- | | ---- % ---- | | --0-100-- | | ----g/200--- | |
| <u>N Fert. Timing</u> | | | | | | | | | | |
| 100% Planting | 56 | 53 | 60.3 | 60.6 | 12.6 | 11.9* | 54 | 53 | 29 | 29 |
| 70% Plt, 30%Anthesis planting, 20lb/a Ant. | 56 | 49 | 60.7 | 61.0 | 12.0 | 11.4* | 55 | 52 | 29 | 28 |
| LSD .05 | n.s. | n.s. | 0.2 | 0.2 | 0.2 | 0.2 | n.s. | n.s. | n.s. | n.s. |
| <u>N Fert. Rate (lb/a)</u> | | | | | | | | | | |
| 50 | 50 | 45* | 61.3 | 61.6 | 11.5 | 11.0* | 55 | 54 | 28 | 28 |
| 75 | 56 | 46* | 61.0 | 61.3 | 11.7 | 11.1* | 55 | 52 | 29 | 28 |
| 100 | 56 | 50* | 60.8 | 60.9 | 12.3 | 11.6* | 55 | 52 | 28 | 28 |
| 125 | 58 | 55 | 60.3 | 60.4 | 12.6 | 12.1* | 54 | 52 | 29 | 29 |
| 150 | 57 | 54 | 60.2 | 60.3 | 12.7 | 12.3* | 55 | 52 | 29 | 29 |
| 175 | 60 | 57 | 59.6 | 60.0* | 13.3 | 12.7* | 56 | 54 | 29 | 29 |
| LSD .05 | 3 | 3 | 0.3 | 0.3 | 0.3 | 0.3 | n.s. | n.s. | 1 | 1 |
| Average | 56 | 51 | 60.5 | 60.8 | 12.3 | 11.8 | 55 | 53 | 29 | 29 |
| CV | 9 | | 0.8 | | 3 | | 4 | | 4 | |

Table 3. continued

| Nitrogen Treatment | Seed Weight | | Heads | | Biomass | | Harvest Index | |
|--|-------------|-----|------------------|------|-------------|------|---------------|------|
| | CT | NT | CT | NT | CT | NT | CT | NT |
| | ---g/200--- | | ----#/sq.ft.---- | | ---- % ---- | | ---0-100--- | |
| <u>N Fert. Timing</u> | | | | | | | | |
| 100% Planting | 6.5 | 6.4 | 51 | 50 | 9390 | 9130 | 0.44 | 0.43 |
| 70% Plt, 30%Anthesis planting, 20lb/a Ant. | 6.8 | 6.6 | 49 | 47 | 9400 | 8100 | 0.44 | 0.43 |
| LSD .05 | 0.1 | 0.1 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| <u>N Fert. Rate (lb/acre)</u> | | | | | | | | |
| 50 | 7.0 | 6.9 | 46 | 39 | 7980 | 7000 | 0.45 | 0.44 |
| 75 | 7.0 | 6.8 | 49 | 43 | 9060 | 7690 | 0.44 | 0.44 |
| 100 | 6.8 | 6.5 | 48 | 48 | 9330 | 8520 | 0.44 | 0.43 |
| 125 | 6.5 | 6.4 | 51 | 51 | 9550 | 9100 | 0.43 | 0.43 |
| 150 | 6.4 | 6.3 | 53 | 55 | 10070 | 9180 | 0.44 | 0.42 |
| 175 | 6.2 | 6.1 | 56 | 54 | 10370 | 9820 | 0.41 | 0.42 |
| LSD .05 | 0.1 | 0.1 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| Average | 6.7 | 6.5 | 50 | 48 | 9390 | 8550 | 0.43 | 0.43 |
| CV | 4 | | 12 | | 11 | | 4 | |

* No-Till values followed by an asterisk are significantly different the Conventional till.

Table 4. Hard White Spring Wheat Performance with Nitrogen Rate and Application Timing in Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2008.

| Nitrogen Treatment | Seed Yield | | Test Weight | | Seed Protein | | Plant Height | |
|--|---------------|------|---------------|-------|--------------|-------|--------------|------|
| | CT | NT | CT | NT | CT | NT | CT | NT |
| | ---bu/acre--- | | ----lb/bu---- | | ---- % ---- | | ----g/200--- | |
| <u>N Fert. Timing</u> | | | | | | | | |
| 100% Planting | 30 | 34 | 58.7 | 61.2 | 12.8 | 10.6 | 24 | 25 |
| 70% Plt, 30%Anthesis planting, 20lb/a Ant. | 29 | 34 | 59.4 | 61.4 | 12.2 | 10.7 | 25 | 25 |
| LSD .05 | n.s. | n.s. | n.s. | n.s. | 0.3 | 0.3 | n.s. | n.s. |
| <u>N Fert. Rate (lb/a)</u> | | | | | | | | |
| 50 | 29 | 26 | 59.5 | 62.2 | 12.0 | 10.0 | 25 | 25 |
| 75 | 28 | 35 | 59.0 | 61.5 | 12.5 | 10.5 | 25 | 25 |
| 100 | 27 | 35 | 58.9 | 61.4 | 12.4 | 10.7 | 25 | 25 |
| 125 | 34 | 34 | 59.4 | 61.0 | 12.5 | 10.9 | 25 | 25 |
| 150 | 28 | 36 | 58.2 | 60.9 | 13.1 | 11.0 | 25 | 26 |
| 175 | 31 | 38 | 58.7 | 61.0 | 13.0 | 11.3 | 25 | 25 |
| LSD .05 | 5 | 5 | n.s. | n.s. | 0.4 | | n.s. | n.s. |
| Average | 30 | 34 | 59.0 | 61.3* | 12.6 | 10.7* | 25 | 25 |
| CV | 19 | | 1.6 | | 6.3 | | 5 | |

* No-Till values followed by an asterisk are significantly different the Conventional till.

Dry pea. The 2008 tillage X variety comparison trial yielded 2125 lb/acre in CT and 1920 lb/acre in NT averaged across pea varieties (Table 5). Although not statistically different, this lower yield in NT is different than the yield relationship in 2006 and 2005 when NT yielded more than CT, but similar to 2007. The weather conditions could have contributed to the higher yields in CT with slightly quicker growth and bloom dates that were then truncated by hot, dry conditions. ‘Monarch’ and ‘Banner’ (early varieties), ‘Karita’, and ‘Aaragorn’ were the highest yielding green pea varieties in CT and were also highest in NT. In NT and CT, ‘Stirling’ without seed treatment (Stirling NST) was not different, but the yellow pea variety ‘Rex’ yielded 225 lb/a less without seed treatment in NT compared to seed treated. This agrees with results of 2007 showing that seed treatment may be more needed and more beneficial in NT than CT. This implies a disease loss due to fungal colonization of the seed before or soon after emergence that the applied fungal seed treatments reduced. ‘Rex’ and ‘Carousel’ were the highest yielding yellow varieties in both CT and NT. There was no interaction of tillage and variety for any of the pea variables, but all variables had differences among varieties.

Seed weights averaged 21.6 g/100 seeds in both CT and NT. Karita, ‘Joel’, Banner, and Aaragorn had the highest seed weights. Plant stands were not different between tillage treatments and averaged nearly 10 plants/ft². These plant stands are more than adequate especially for a low yield potential, dry year. Vine lengths were short probably due to weather conditions and averaged 22 and 23 inches across CT and NT. Canopy heights were mostly lower than vine lengths especially for the long vine types ‘Columbian’, ‘Joel’, and ‘Shawnee’. The larger than usual differences between vine length and canopy height could be

due to a delayed harvest from August rain that left the mature crop in the field longer than usual and subject to lodging forces.

Average yields across the past three years of testing are presented in Table 6 for varieties that are common across those years. Average yields for 2006 were significantly higher in NT than CT, but lower in 2007 and 2008. A three year average shows 1885 lb/acre in CT and 1735 lb/acre in NT. Across years, the highest yielding green variety was Karita in NT and Joel in CT. Of the Yellow varieties, Rex performed the best. The largest yield difference between NT and CT was for Joel at 250 lb/acre less in NT. It appears that the difference between variety performance in NT and CT is small at most for these well adapted, productive varieties. Further analysis shows that the early varieties tend to perform more consistently across years in both tillage systems.

Table 5. Pea Variety Performance Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2008.

| Variety | Seed Yield | | Seed Weight | | Vine Length | | Canopy Ht. | | Erect Index | |
|---------------------------|------------------|---------|---------------|---------|---------------|---------|--------------|---------|--------------|---------|
| | Conv-Ti | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| Green Pea | ----lbs/acre---- | | ----g/100---- | | Plants/sq.ft. | | ---inches--- | | ---inches--- | |
| Aaragorn | 2125 | 1815 | 20.4 | 19.5 | 18.5 | 20.0 | 15.8 | 16.5 | 0.85 | 0.83 |
| Banner | 2205 | 2125 | 19.5 | 20.5 | 22.0 | 22.8 | 15.3 | 18.3 | 0.70 | 0.81 |
| Columbian | 1670 | 1370 | 18.2 | 19.0 | 32.8 | 30.8 | 11.3 | 10.8 | 0.35 | 0.37 |
| Joel | 2185 | 1755 | 21.9 | 21.1 | 25.8 | 33.8 | 12.0 | 11.3 | 0.34 | 0.34 |
| Karita | 2070 | 2025 | 25.4 | 25.6 | 18.0 | 19.8 | 14.8 | 16.5 | 0.82 | 0.85 |
| Table 5 con't | | | | | | | | | | |
| Monarch | 2140 | 1835 | 19.0 | 19.0 | 17.5 | 18.3 | 12.3 | 16.0 | 0.70 | 0.84 |
| Stirling | 1630 | 1700 | 19.6 | 20.2 | 25.3 | 18.0 | 12.3 | 14.8 | 0.81 | 0.86 |
| Stirling NST ¹ | 1590 | 1685 | 19.7 | 20.2 | 14.8 | 18.3 | 11.5 | 14.8 | 0.80 | 0.83 |
| Yellow Pea | | | | | | | | | | |
| Carousel | 2590 | 2310 | 25.2 | 24.9 | 19.0 | 20.5 | 15.8 | 17.8 | 0.83 | 0.87 |
| Rex | 2580 | 2410 | 24.1 | 24.3 | 20.3 | 21.8 | 13.8 | 14.5 | 0.69 | 0.69 |
| Rex NST ¹ | 2560 | 2185 | 24.5 | 24.4 | 18.3 | 19.5 | 14.8 | 13.0 | 0.82 | 0.67 |
| Shawnee | 2155 | 1790 | 22.0 | 21.1 | 32.3 | 33.5 | 9.5 | 10.5 | 0.30 | 0.32 |
| Average | 2125 | 1920 | 21.6 | 21.6 | 22.0 | 23.1 | 13.2 | 14.5 | 0.67 | 0.69 |
| LSD (0.05) | 440 | | 1.3 | | 3.8 | | 2.0 | | 0.13 | |
| CV | 15 | | 4.3 | | 12 | | 10 | | 13 | |

*No-Till values followed by an asterisk are significantly different than Conventional till.

Table 6. Three Year Pea Yield Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, for 2006-2008.

| Variety | 2006 | | 2007 | | 2008 | | 2006-2008 | |
|--------------------------|---------------------|---------|-----------|---------|-----------|---------|-----------|---------|
| | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| <u>Green Pea</u> | ----- lb/acre ----- | | | | | | | |
| Aragorn | 1230 | 1230 | 2265 | 2080 | 2125 | 1815 | 1875 | 1710 |
| Columbian | 1070 | 1260 | 2070 | 2020 | 1670 | 1370 | 1605 | 1550 |
| Joel | 1490 | 1410 | 2260 | 2020* | 2185 | 1755 | 1980 | 1730* |
| Karita | 1420 | 1370 | 2300 | 1950* | 2070 | 2025 | 1930 | 1780 |
| Monarch | 870 | 1100* | 2430 | 2090* | 2140 | 1835 | 1815 | 1675 |
| Stirling | 970 | 1030 | 2130 | 1885 | 1630 | 1700 | 1575 | 1540 |
| <u>Yellow Pea</u> | | | | | | | | |
| Carousel | 1440 | 1280 | 2370 | 2170 | 2590 | 2310 | 2135 | 1920* |
| Rex | 1280 | 1510* | 2515 | 2140* | 2580 | 2410 | 2125 | 2020 |
| Shawnee | 1440 | 1470 | 2175 | 1850 | 2155 | 1790 | 1925 | 1705* |
| Average | 1245 | 1295 | 2280 | 2025 | 2130 | 1890 | 1885 | 1735 |
| LSD (0.05) | 230 | | 230 | | 440 | | 175 | |

* No-Till values followed by an asterisk are significantly different the Conventional till.

Lentil. Lentil yields in 2008, averaged across varieties, were 1285 lb/acre in CT and 1210 lb/acre in NT, and compares to a 1335 lb/acre average in 2007, but is much higher than the 580 lb/acre average in 2006 (Tables 7 and 8). ‘Richlea’ was highest yielding in both CT and in NT. Average results from the past three years show similar yields of 1090 lb/acre in NT and 1065 lb/acre in CT, but ‘Eston’ yielded significantly less in NT than CT.

Seed weights averaged 5.3 g/100 in CT and 5.6 g/100 in NT a significant difference and all varieties except Eston and Richlea were significantly higher in NT than CT for seed weight. ‘Riveland’ and Merrit had the largest seed. As with other crops in this trial in most years, seeds size is larger in NT than CT and can impart a market or quality advantage to NT management systems. Lentil plant stands were slightly lower in NT than CT, but were adequate across the trial for yield. Plant heights averaged 2 inches taller in NT than CT, but were not significantly different. Lentil performance was about average, and reflects growers’ results for the area.

Hot, dry weather conditions were less of a stress on lentil than pea. At this location, the 2008 results would again support growing Richlea, Pardina and Merrit varieties for different market classes and they consistently perform well. They are productive, consistent and grow well under both CT and NT conditions. Averaged across three years, all varieties have equivalent yields in NT and CT. Lentils should work well in NT production and have proven to be a good rotation crop with wheat.

Table 7. Lentil Variety Performance Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2008.

| Variety | Seed Yield | | Seed Weight | | Plant Stand | | Plant Height | |
|-------------------|------------------|---------|---------------|---------|---------------|---------|--------------|---------|
| | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| | ----lbs/acre---- | | ----g/100---- | | Plants/sq.ft. | | ---inches--- | |
| Brewer | 1060 | 985 | 5.8 | 6.1* | | | 13.5 | 15.0 |
| Eston | 1355 | 1020* | 3.3 | 3.5 | 11.8 | 9.5 | 12.8 | 16.3 |
| Pardina | 1240 | 1180 | 3.6 | 4.0* | | | 11.3 | 12.5 |
| Merrit | 1165 | 1140 | 6.4 | 6.9* | 12.0 | 11.2 | 13.0 | 14.5 |
| Riveland | 1230 | 1340 | 7.5 | 7.8* | | | 14.0 | 16.5 |
| Richlea | 1660 | 1590 | 5.2 | 5.3 | 12.0 | 10.6 | 13.8 | 15.0 |
| Average | 1285 | 1210 | 5.3 | 5.6* | 12.0 | 10.4* | 13.0 | 15.0 |
| LSD (0.05) | 295 | 295 | 0.2 | 0.2 | n.s. | n.s. | 1.7 | 1.7 |
| CV | 16 | | 2.9 | | 22 | | 8.2 | |

Table 8. Three Year Lentil Yield Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, for 2006-2008.

| Variety | 2006 | | 2007 | | 2008 | | 2006-2008 | |
|-------------------|---------------------|---------|-----------|---------|-----------|---------|-----------|---------|
| | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| | ----- lb/acre ----- | | | | | | | |
| Brewer | 530 | 600 | 1265 | 1335 | 1060 | 985 | 950 | 975 |
| Eston | 520 | 670* | 1170 | 1440* | 1355 | 1020* | 1015 | 1045 |
| Merrit | 510 | 660* | 1490 | 1440 | 1165 | 1140 | 1055 | 1080 |
| Pardina | 590 | 650 | 1460 | 1375 | 1240 | 1180 | 1095 | 1070 |
| Richlea | 580 | 720* | 1365 | 1570* | 1660 | 1590 | 1200 | 1295 |
| Average | 545 | 660* | 1350 | 1430 | 1295 | 1185 | 1065 | 1095 |
| LSD (0.05) | 120 | 120 | 170 | 170 | 295 | 295 | n.s. | n.s. |

* No-Till values followed by an asterisk are significantly different the Conventional till.

Entomology: Nilsa A. Bosque-Pérez, Sanford D. Eigenbrode, Ryan P. Hanavan, Dennis J. Schotzko. The pea leaf weevil (PLW), *Sitona lineatus* (L.), is a major pest of peas, *Pisum sativum* L., in eastern Washington and northern Idaho. In previous field surveys, PLW abundance and injury to the crop have been shown to be lower in peas grown using no-tillage (NT) methods than in peas grown using conventional tillage (CT). Our studies have been aimed at assessing the potential mechanisms to explain this pattern. It is possible that PLW colonization rates are greater into CT fields than into NT fields due to weevil responses to differences in albedo between the two tillage systems. It is also possible that PLW colonization rates, damage to the crop, or both, are greater in CT because of tillage-related effects on plant quality. To test the first mechanism, pre-ovipositional colonization by PLW was measured in plots of CT pea augmented with cereal residue to mimic the albedo of NT, or left untreated. Experiments were conducted at

the University of Idaho Parker farm. Residue treatments were tested over peas planted on two dates and a no-pea control. In 2005 and 2006, significantly higher PLW colonization occurred into plots without cereal residue and into plots planted earlier. This suggests that the presence of residue interferes with PLW colonization of pea plots. To test the second mechanism, preferences of PLW adults for pea tissue from NT- and CT-grown peas and peas planted on two different dates were measured in choice tests in the laboratory. There was a significantly higher level of notching on plants grown under CT conditions. This is potentially due to greater overall leaf surface area. In the field, the CT plants emerged before the NT plants and as a result were potentially more apparent to PLW. To test these results we used the same experimental design and replaced the CT and NT peas with peas grown under CT conditions and planted 10 days apart. The peas grown in the first planting date had similar levels of notching as the CT grown peas in the first experiment. The plants with greater leaf surface area are potentially more attractive to adult PLW.

We also investigated colonization, movement and crop injury in peas grown using CT compared to NT practices. Experiments were conducted at the University of Idaho Kambitsch experimental farm and farmer's fields. Bi-directional pitfall and aerial traps were used to assess movement patterns of adult PLW into CT and NT peas during the 2005 and 2006 growing seasons. Feeding damage to the crop was also assessed. Aerial movement was greatest in May in both years and significantly more PLW were captured moving into CT than into NT plots during this early period of crop growth. Crop feeding damage was also significantly greater in CT than in NT plots in the early season. PLW movement among plots appeared to occur mostly by ground locomotion. Significantly more PLW were captured in directional pitfall traps entering NT plots from CT plots than the reverse during the period following peak aerial movement and peak plant damage in both years. Overall movement patterns suggest that peas in CT, which emerge earlier and are larger during the period of peak PLW aerial movement, attract more immigrating PLW. This leads to greater PLW infestation of CT fields at a time critical for plant development. Such early infestation ultimately reduces crop yield.

We further assessed CT and NT fields for their adequacy in maintaining PLW populations over the course of the growing season. Adult female PLW produce 2,000-3,000 eggs per year, which are deposited on the soil surface near the base of host plants. Upon hatching, first instar larvae move down through the soil in search of the root nodules of newly developing pea plants. Absolute adult and larval densities were measured in pea fields throughout the growing season and later compared to absolute emergence densities. We found no difference in adult and larval densities between tillage regimes during 2005. Sampling was conducted earlier in the season in 2006 and significantly higher adult and larval absolute densities were observed in CT than in NT. PLW emergence was also significantly greater in CT than in NT plots during both 2005 and 2006. Factors contributing to these weevil emergence differences are not fully understood but might include differential establishment or greater mortality due to natural enemies. Studies conducted in grower's fields confirmed the on-station work that showed significantly greater early season adult colonization in CT fields compared to NT fields. CT pea fields had significantly greater mean larval and pupal densities, greater mean feeding damage and greater mean adult PLW emergence. Our results indicate NT-grown peas are more likely to escape severe PLW infestations.

Additional tests were conducted to assess densities of ground beetles in pea fields. Densities of abundant ground beetles were assessed at the Kambitsch experimental farm, in the spring and summer of 2005 and 2006. Three carabid species, *Poecilus scitulus*, *Poecilus*

lucublandus, and *Pterostichus melanarius*, were found to be present in both CT and NT pea plots. Further tests were conducted to examine the ability of each of three ground beetles to consume PLW and whether any of the three ground beetles prefer living or dead PLW. Experiments were conducted in cages in the laboratory. All carabid species showed PLW consumption, although they showed greater preference for dead PLW, than for live ones. Cages with *Pt. melanarius* had the least amount of PLW notching while control cages without any predators had the greatest level of notching. *Pterostichus melanarius* fed on PLW, other *Pt. melanarius* and the two *Poecilus* spp.

Soil Properties: Jodi Johnson-Maynard and Karl Umiker

Methods. Prior to spring field operations in 2006, two 4.3-cm diameter soil cores were taken to a depth of 60 cm using the Giddings Probe. The cores were cut into 10-cm thick depth increments. The oven dried soil weight and volume of each 10-cm core increment were used to calculate bulk density. In the spring of 2007, two 8.6-cm diameter cores were taken from each plot from the 0-to 10-cm and 10-to 20-cm depths. The cores were placed on a bed of glass beads (<30 μ m diameter) connected to a hanging water column. The moisture content of the cores was noted at several suctions as the hanging water column was lowered to 100cm. The volume of drainable pores was then calculated for pores with diameters of 30-50, 50-100, 100-500, 500-1000, and >1000 μ m. Also in the spring of 2007, earthworm and cocoon densities were measured from two 18-cm diameter by 50-cm deep pits per plot. Soil gravimetric water content was measured on samples collected 3 weeks prior to earthworm sampling.

Results. Eighty-nine percent of earthworms and 83% of the total cocoons collected in 2007 (Figure 1) were in conservation tillage (ConsT) plots. Preference of earthworms toward the ConsT system was apparent as early as 2001, when tillage practices had only been in place for 1 year, and 75% of earthworms were found in ConsT plots. As shown in the previous STEEP report, winter precipitation and thus soil moisture, are positively correlated to earthworm densities. Drier periods, such as the winter/spring of 2007 should favor higher earthworm density in ConsT systems where the mulch layer preserves soil moisture over the winter. Spring soil moisture was highest in ConsT plots (Figure 2). Although soil moisture is often similar between tillage treatments by July, greater winter/spring moisture in ConsT plots should lead to a longer period of earthworm activity.

Soil properties can be influenced by a change from conventional (CT) to conservation tillage, however soil bulk density, measured prior to spring operations, was not different between tillage treatments at any depth (Figure 3). Soil bulk density values were typical of the region's soils ranging from 0.95 to 1.57 g/cm³. Average density values tended to increase with increasing soil depth. Although there was little variability in replicate cores within a plot, plot-to-plot variability was greater possibly due to textural differences across the field.

Pore-size distribution can be influenced by tillage either directly through disturbance or indirectly through tillage effects on earthworms and other soil-dwelling fauna. Although tillage did not significantly influence pore-size distribution in the 0-to 10 (Figure 4a) or 10-to 20-cm depths (Figure 4b), the same trends in pore-size distribution existed at both depths. Earthworm channels would be expected to have pores greater than 500 μ m in diameter, however the largest volume of pores occurred within a pore-size diameter of 100-to 500- μ m suggesting soil type or other organisms might have a greater impact on drainable pores. Increased earthworm density under ConsT has not been sufficient to impact porosity at our scale of measurement.

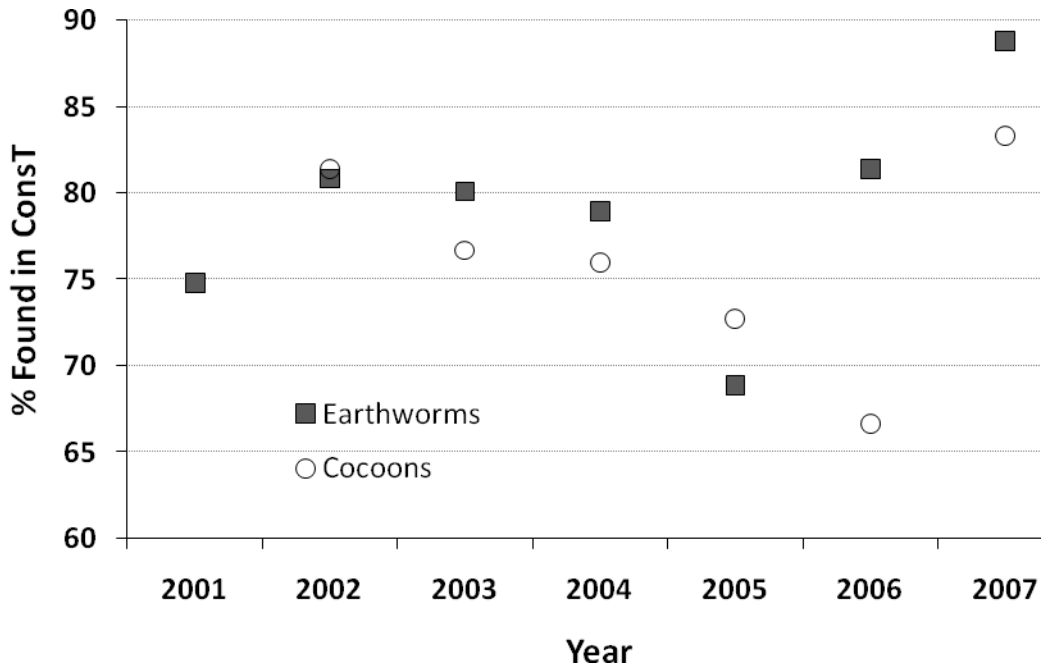


Figure 1. Percentage of total earthworms and earthworm cocoons found each spring in conservation tillage plots. Earthworm cocoons not measured in 2001.

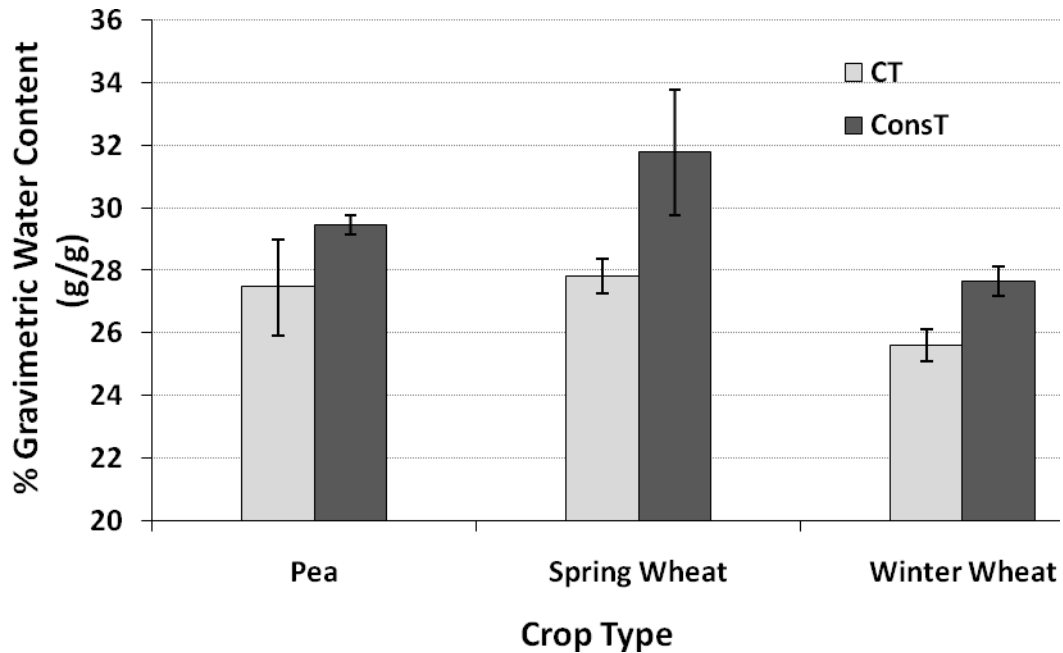


Figure 2. Gravimetric water content measured on 3/29/07, prior to any spring tillage operations. Three replicate probe samples taken per plot.

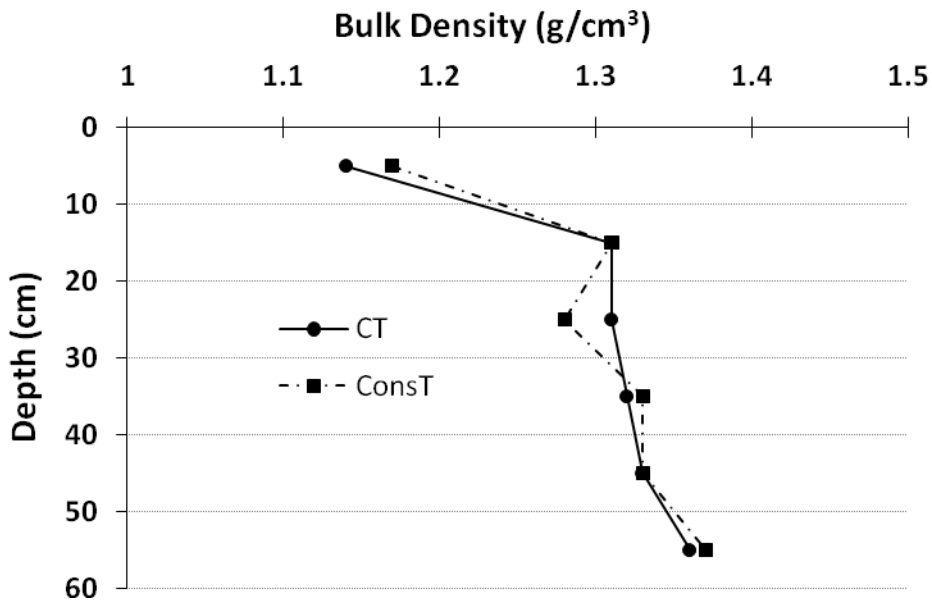


Figure 3. Soil bulk density from Giddings Probe cores collected spring 2006. Densities measured across each 10-cm depth increment. Significant differences in bulk density between tillage treatments were not detected at $\alpha=0.05$.

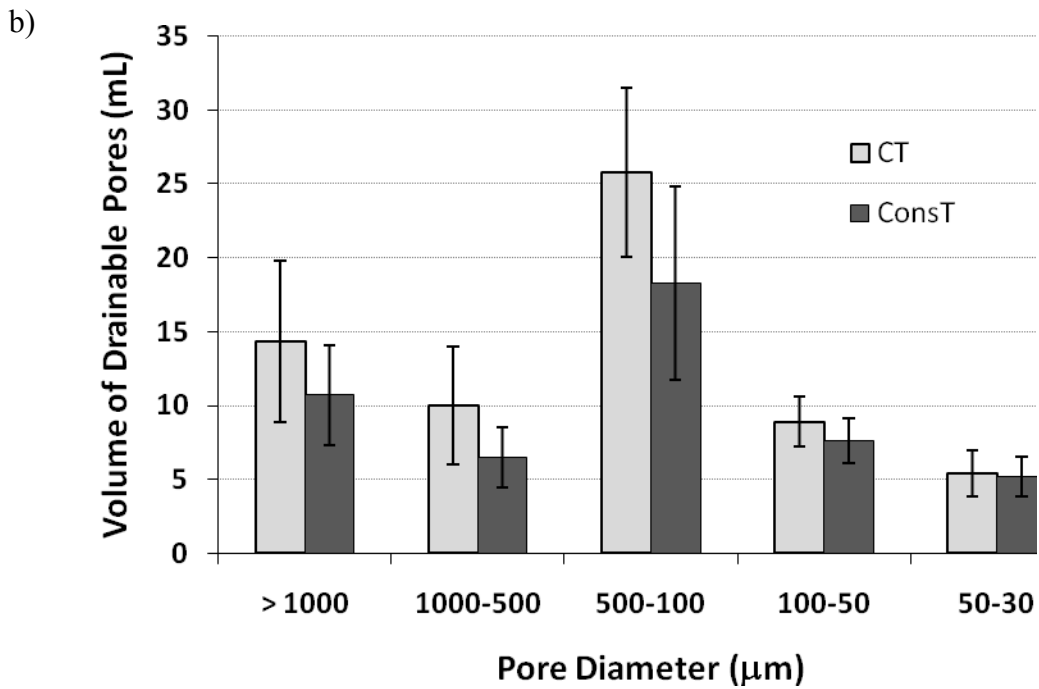
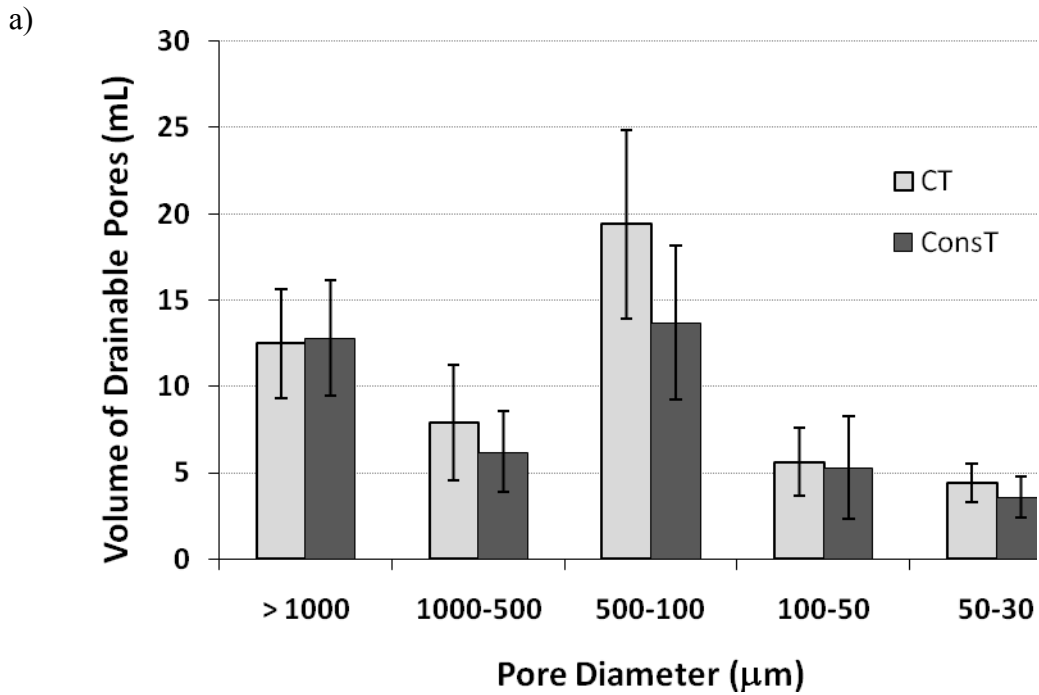


Figure 4. Volume of drainable pores within pore-size diameter ranges for 8.6-cm diameter cores collected at the a) 0-to 10-cm and b) 10-to 20-cm depth. Significant differences between tillage treatments, within a pore-size range were not detected.

OUTCOMES AND IMPACTS: Many outcomes and impacts from this project are ongoing and not fully realized because there is still analysis, summarization, publication, and extension activities ongoing. This includes journal articles in progress and much work is still in the analysis stage because there was data collected in 2008. Never the less, there have been outcomes and impacts from journal publications that have impact on the scientific community and beyond, extension programs that present the results that are still being implemented by growers, and some direct results that are presented in Table 9. This shows the impact of the variety work in this project and how that information, along with information from other sources is utilized by growers to make decisions on their farming operations. When there are inquiries about varieties and with the new emphasis on nitrogen fertilizer management in direct seeding systems, this study provides good information for responses for those inquiries that is based in a valid tillage comparison.

Table 9. Summarized responses from a 2007 survey on the N. Idaho variety evaluation program. 78 responses are summarized from individuals that represent <400,000 crop acres.

| <u>Question</u> | <u>% Response</u> |
|--|-------------------|
| Has your knowledge about varieties increased as a result of this program? | 100 |
| Is the information you gained useful in your occupation or business? | 97 |
| Is this information highly valuable? | 56 |
| Is this information moderately valuable? | 40 |
| Total of highly and moderately valuable - | 96 |
| Will this information be used in management decisions in the upcoming crop season? | 89 |
| <u>Have you used variety information for decision on your farm or business?</u> | <u>96</u> |

The population dynamics of the pea leaf weevil as influenced by tillage have been characterized. We have determined the length of time required before earthworm density significantly increases once the conversion to no-till is made. Our measurements also represent some of the most detailed data sets available from the Palouse on changes in soil physical properties with the adoption of no-till management. Additionally, we have documented the impact of tillage practices on carbon storage in the soil profile. Presentations have been made to growers and the scientific community at numerous venues including grower's field days and professional society meetings. Peer-reviewed papers have been published (see Publications). Information from our work is helping growers manage pest populations to optimize productivity under reduced-tillage systems. The proportion of cereal and cool-season legume crops' acreage planted under reduced-tillage practices in northern Idaho has increased over the last 5 years. Soil carbon data will be used in on-going efforts to gain recognition of the Palouse as a certified cropping region. This is a necessary step that will allow Idaho and Washington farmers to participate in carbon credit training programs.

INTERACTIONS WITH OTHER RESEARCHERS: The results from these studies have been presented at many extension, education, and scientific venues. The number and extent of is interaction can be evaluated by reviewing the presentations listed in this report and in previous STEEP reports on this project. This creates interaction with peers that are interested and

conducting similar investigations. When this occurs, there are interactions, exchange of ideas and potential collaboration of further investigations and educational programming. This study site was also used by other investigators besides the PIs. In 2008 Ed Bechinski's graduate student used the site for a ground dwelling beetle investigation for her thesis problem.

PUBLICATIONS:

2008 report Publications and Presentations (Since the previous report):

Publications

- Hanavan, R.P. 2008. The influence of agricultural practices and diverse perennial habitats on the biology and ecology of the pea leaf weevil, *Sitona lineatus* (L.) (Coleoptera: Curculionidae). PhD Dissertation, University of Idaho.
- Hanavan, R.P., N.A. Bosque Pérez, D.J. Schotzko, S.O. Guy, and S.D. Eigenbrode. 2008. Early-season aerial adult colonization and ground activity of pea leaf weevil (Coleoptera: Curculionidae) in pea as influenced by tillage system. *Journal of Economic Entomology*. 101: 1606-1613.
- Hanavan, R.P., N.A. Bosque Pérez, and D.J. Schotzko. 2008. New reproductive host, *Lupinus polyphyllus* L. (Leguminosae), for the pea leaf weevil, *Sitona lineatus* (L.) (Coleoptera: Curculionidae) and first record of feeding on European plum, *Prunus domestica* L. (Rosales: Rosaceae), in Idaho. *Pan-Pacific Entomologist* (In Press).
- Guy, S.O., M. Lauver, and D. Finkelnburg. 2008. 2007 Small Grain and Grain Legume Report. 58 pages. Research Bulletin 170. Univ. of Idaho, Moscow, ID.
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- Hanavan, R.P., N.A. Bosque-Pérez, D.J. Schotzko, and S.D. Eigenbrode. 2005. Influence of two different tillage systems on pre-ovipositional immigration and colonization of pea by the pea leaf weevil, *Sitona lineatus* (L.) (Coleoptera: Curculionidae). Annual Meeting Entomological Society of America. Fort Lauderdale, Florida, December 15-18, 2005.
- Hanavan, R.P., N.A. Bosque-Pérez, and S.D. Eigenbrode. 2006. Assessment of *Sitona* spp. in diverse elements of the Palouse landscape. Second Annual Palouse Behavior, Ecology and Evolution Research Symposium, Pullman, Washington, April 30, 2006.
- Hanavan, R.P., N.A. Bosque-Pérez, S.D. Eigenbrode, and D.J. Schotzko. 2006. Cereal residue and planting date-related factors affecting colonization and consumption of pea, *Pisum*

- sativum* L., by the pea leaf weevil, *Sitona lineatus* (L.) (Coleoptera: Curculionidae). Annual Meeting Entomological Society of America, Indianapolis, Indiana, Dec. 9-13, 2006.
- Hanavan, R.P., N.A. Bosque-Pérez, S.D. Eigenbrode, and D.J. Schotzko. 2007. Emergence of the pea leaf weevil, *Sitona lineatus* L. (Coleoptera: Curculionidae), is influenced by tillage system. Entomological Society of America Pacific Branch Annual Meeting, Portland, Oregon, March 25-28, 2007.
- Hanavan, R.P., N.A. Bosque-Pérez, S.D. Eigenbrode, and D.J. Schotzko. 2007. Ground and aerial movement of adult pea leaf weevil, *Sitona lineatus* (L.) (Coleoptera: Curculionidae) as influenced by tillage system. Entomological Society of America Annual Meeting, San Diego, California, December 9-13, 2007.
- Guy, S.O. and M. Lauver. 23 January, 2008. Lentil variety response to tillage treatments in Idaho. Poster presentation. 2008 Pacific Northwest Direct Seed Conference. Kennewick, WA
- Guy, S.O. 13 February, 2008. Agronomic performance and variety update for Pea, Barley, Spring Wheat, and Camelina. Nez Perce Co. cereal school. Lewiston, ID
- Guy, S.O. 14 February, 2008. Agronomic performance and variety update for Pea, Barley, Spring Wheat, and Camelina. Lewis/Idaho Co. cereal school. Greencreek, ID