## RESEARCH PROGRESS REPORT

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

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INTERIM REPORT project funded FY06-08 – interim report.

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, 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 red winter and spring wheat, but timing and quantity of N fertilizer is not well studied in CT and especially NT. 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: Experimental investigations were carried out according to the proposals. For crop year 2007, pea and lentil varieties, and hard red spring and winter wheat response to nitrogen fertilizer rate and timing; soil properties and biology; and insect studies were evaluated in the replicated No-Till (NT) versus Conventional-Till (CT) comparison located at the Kambitsch research farm near Genesee, Idaho. Additional studies on Pea Weevil were also conducted. All crops were established well in both tillage systems, with equivalent plant counts for all crops in NT and CT as in previous years. The CT hard red winter wheat grain yield was 4 bu/acre less, 66 bu/acre, than the NT yield. Yield was highest in NT when nitrogen fertilizer timing was 70% fall and 30% spring applied. Yields peaked with rates of 125 lb/a applied N in CT and at 150 lb/a N in NT. Grain test weights tended to decrease, and plant heights tended to increase as N fertilizer rates increased, but there was no influence of application timing. Test weights were higher in NT than CT for the 100 to 175 lb/a N fertilizer rates. Hard red spring wheat yields were not influenced by application timing, nor overall for CT versus NT. Yield was highest at the 175 lb/a N rate and yields were greater in CT than NT at the lowest three N rates. Grain test weight declined in both CT and NT as N rate increased. Pea yield averaged 2280 lb/a in CT and 2040 lb/a in NT, not significantly different. 'Stratus' and 'Camry' were the high yielding varieties in NT, but 'Monarch' and 'Karita' were highest in CT. Over three years, 'Joel' and Stratus were highest yielding in CT and NT. Average yields over three years were 1615 lb/acre for both CT and NT.  Seed weights, plant stand, vine length, and canopy height were very similar between NT than CT. Lentil yields were 1295 lb/a in NT and 1375 lb/a in CT. 'Merrit' yielded the most in CT and 'Richlea' was highest in NT. Lentil seeds weights were higher in NT than CT, but plant stand and height were similar. Lentil yields across three years average 1040 lb/a in CT and 1115 lb/a in NT and yields were higher in NT than CT for 'Brewer', 'Eston' and 'Pennell'. As in previous years, earthworm densities were higher in NT than CT with 89% of the total collected in NT and 83% of cocoons were collected in NT. Differences in earthworm population density between CT and NT plots were seen as early as 2001 and have been consistent across years. Soil moisture was higher in NT than in CT in the spring and should lead to a longer period of 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 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 early season PLW infestation of CT plots at a critical period for pea development that ultimately influences crop yield. 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.

Four refereed journal article were published from this study in 2007 in addition to many abstracts, proceedings, extension reports, and presentations.

**RESULTS AND INTERPRETATION:**

Previous results from earlier investigations of this study can be found in 2001 to 2006 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 a tillage comparison trial included six rates of nitrogen fertilizer applied in three management timings on hard red winter and 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 in 2007. Each crop was raised on the previous crop residue as part of the rotation winter wheat-spring wheat-pea from the previous year (2006). 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 October 10, 2006 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. N fertilizer treatments were applied to winter wheat as 46-0-0 urea dry fertilizer broadcast applied one week after planting for the fall application, on March 21, 2007 for the spring application, and on June 12, 2007 for the anthesis application.

The hard red spring wheat variety 'Jefferson' was seeded on April, 19, 2007 after a burn-down herbicide application using a small plot drill with Flexi-coil shank openers. N fertilizer applications were applied May 1, 2007 for the after planting application and on June 29, 2007 for the anthesis timing. 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 April 19, 2007. 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' winter wheat, 'Monarch' pea, and 'Jefferson' spring wheat were seeded. Weed control included a 2.5 oz/acre rate of Pursuit 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 not too high and did not need control, but pea seed weevil and aphids were controlled by an application of Capture at bloom.

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 had a normal seeding date and crop establishment was uniform and typical. However, high temperatures in June during later flowering could have impacted seed set. Soil moisture was good for most of the first portion of the crop season, but became limited for spring crops during reproductive and grain fill stages during hot weather.

*Variety and N fertilizer responses: Stephen O. Guy and Mary Lauver*

*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. When grain yield results for 2007 were combined across nitrogen fertilizer treatments, CT produced 66 bu/a, but NT was not significantly lower at 70 bu/a (Table 1). These values were slightly lower than last year and reflect the hotter and dryer 2007 growing conditions. 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. This high test weight shows that there was adequate moisture for grain yield, but yield was determined by early adverse weather conditions. This may be supported when harvest samples are analyzed for seed weight, number of spikes, biomass, and harvest index. There was no significant effect of fertilizer timing on test weights. Test weights declined as N fertilizer rate increased in both 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. Plant heights were short, also reflecting growing conditions, and tended to increase across fertilizer rates in NT. Protein is critical for hard red wheat and grain samples will be analyzed for protein and hardness. Some samples might also be subjected to end-use quality analyses at a later date. Plant stands were evaluated for representative treatments and showed equivalent stands between NT and CT with more than adequate populations for yield.

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[1] | | Seed Hardness[1] | | Plant Height | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| | ---bu/acre--- | | -----lb/bu----- | | ---- % ----- | | ---0-100--- | | ----g/200--- | |
| **N Fert. Timing** | | | | | | | | | | |
| 100% Fall | 65 | 68 | 61.0 | 61.5 | | | | | 29 | 29 |
| 70% Fall, 30% Spring | 67 | 73* | 61.0 | 61.7 | | | | | 28 | 29 |
| 60% Fall, 25% Sp., 15% Anthesis | 66 | 69 | 61.1 | 61.7 | | | | | 28 | 28 |
| **LSD .05** | 3 | 3 | n.s. | n.s | | | | | 1 | 1 |
| | | | | | | | | | | |
| **N Fert. Rate (lb/acre)** | | | | | | | | | | |
| 50 | 62 | 62 | 61.4 | 61.5 | | | | | 28 | 28 |
| 75 | 67 | 64 | 61.1 | 61.6 | | | | | 29 | 28 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 65 | 72* | 61.1 | 61.9* | | | | | 28 | 29 |
| 125 | 69 | 73 | 60.9 | 61.6* | | | | | 28 | 29 |
| 150 | 68 | 75* | 60.8 | 61.8* | | | | | 29 | 30 |
| 175 | 65 | 72* | 60.7 | 61.3* | | | | | 28 | 29 |
| **LSD .05** | 5 | 5 | 0.4 | 0.4 | | | | | 1 | 1 |
| Average | 66 | 70 | 61.0 | 61.6 | | | | | 28 | 29 |
| CV | 9 | 9 | 0.9 | 0.9 | | | | | 4 | 4 |

[1] Values for 2007 are not analyzed at the time of reporting (November 5, 2007).
*NT values different than CT at P=0.05.

*Spring Wheat.* Soil sampling in the top two feet before April 2007 planting showed 77 lb/a available N in the NT and 70 lb/a in the CT area. Average grain yield, over all nitrogen fertilizer treatments, was not different at 56 bu/a in CT and 51 bu/a in NT (Table 2). All fertilizer N application timings produced the same yields yield 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 over100 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. Grain test weight averaged 60.5 lb/bu in CT and 60.8 lb/bu in NT. The high test weight indicates that early hot conditions caused reduced yield potential, but conditions were adequate during grain filling. This may be supported when harvest samples are analyzed for seed weight, number of spikes, biomass, and harvest index. 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. Plant heights were short at an average 29 inches in both CT and NT, reflecting growing conditions, and were only slightly different among fertilizer rate treatments. Protein is critical for hard red wheat and grain samples will be analyzed for protein and hardness. Some samples might also be subjected to end-use quality analyses at a later date. Plant stands were evaluated for representative treatments and showed equivalent stands between NT and CT with more than adequate populations for yield.

Table 2. Hard Red Spring Wheat Performance with Nitrogen Rate and Application Timing in Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2006.

| Nitrogen Treatment | Seed Yield | | Test Weight | | Seed Protein[1] | | Seed Hardness[1] | | Plant Height | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| | ---bu/acre--- | | -----lb/bu----- | | ---- % ----- | | ---0-100--- | | ----g/200--- | |
| **N Fert. Timing** | | | | | | | | | | |
| 100% Planting | 56 | 53 | 60.3 | 61.6 | | | | | 29 | 29 |
| 70% Plt, 30%Anthesis | 56 | 49 | 61.7 | 61.0 | | | | | 29 | 28 |
| planting, 20lb/a Ant. | 56 | 51 | 60.6 | 60.7 | | | | | 29 | 28 |
| **LSD .05** | ns | ns | 0.2 | 0.2 | | | | | ns | ns |

| | | | | | | |
|---|---|---|---|---|---|---|
| **N Fert. Rate (lb/a)** | | | | | | |
| 50 | 50 | 45 | 61.3 | 61.6 | 28 | 28 |
| 75 | 56 | 46 | 61.0 | 61.3 | 29 | 28 |
| 100 | 56 | 50 | 60.8 | 60.9 | 28 | 28 |
| 125 | 58 | 55 | 60.3 | 60.4 | 29 | 29 |
| 150 | 57 | 54 | 60.2 | 60.3 | 29 | 29 |
| 175 | 60 | 57 | 59.6 | 60.0 | 29 | 29 |
| **LSD .05** | 3 | 3 | 0.3 | 0.3 | 1 | 1 |
| Average | 56 | 51 | 60.5 | 60.8 | 29 | 29 |
| CV | 9 | 9 | 0.8 | 0.8 | 4 | 4 |

[1] Values for 2007 are not analyzed at the time of reporting (November 5, 2007).

*Dry pea*. The tillage comparison trial yielded 2280 lb/acre in CT and 2040 lb/acre in NT averaged across pea varieties (Table 3). Although not statistically different, this lower yield in NT is different than the yield relationship in 2006 and 2005 when NT yielded more thn CT. Six of the twelve varieties had higher yields in CT than NT. 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 conditions. 'Monarch' (a very early variety), 'Karita', 'Camry', and 'Aaragorn' were the highest yielding green pea varieties in CT and 'Camry', 'Stratus', and Karita were highest in NT. In NT, Stratus without seed treatment (Stratus NST) yielded less than when standard seed treatment was applied by 255 lb/a, or about 14% higher yield. This shows the benefit of applying seed treatment fungicides for yields and no seed treatment also produced plant stands about 2 plants per square foot lower than when seed treatment was applied. 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 19.9 g/100 seeds in CT and 20.0 g/100 seed in NT, but were not significantly different. Seed weights were about 5% lower than last year, again probably due to moisture and temperature patterns. Karita, Stratus, and Camry had the highest seed weights and the seed weight. Plant stands were not different between tillage treatments and averaged 10.2 plants/ft$^2$. 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 24 inches across CT and NT. Canopy heights were similar to vine lengths except for the long vine types 'Columbian', 'Joel', and 'Shawnee'.

Average yields across the past three years of testing are presented in Table 4 for varieties that are common across those years. Average yields for 2005 were significantly higher in NT than CT and numerically higher in 2006, but lower in 2007. A three year average shows 1615 lb/acre in both CT and NT. Across years, the highest yielding green variety was Stratus in NT and Joel in CT. Of the Yellow varieties, Rex performed the best. The largest yield difference between NT and CT was for Monarch at 90 lb/acre. It appears that the difference between variety performance in NT and CT is small at most for these well adapted, productive varieties.

Table 3. Pea Variety Performance Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2007.

| | Seed Yield | | Seed Weight | | Plant Stand | | Vine Length | | Canopy Ht. | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variety | Conv-Till | 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 | 2265 | 2080 | 19.2 | 18.5 | 11.2 | 11.2 | 24 | 24 | 24 | 24 |
| Camry | 2275 | 2310 | 21.0 | 21.0 | 10.5 | 10.4 | 19 | 19 | 19 | 19 |
| Columbian | 2070 | 2020 | 17.4 | 18.5 | 10.1 | 10.6 | 29 | 34 | 17 | 17 |
| Joel | 2260 * | 2020 | 19.0 | 18.8 | 9.4 | 10.6 | 36 | 37 | 19 | 19 |
| Karita | 2300 * | 1950 | 22.6 | 22.9 | 10.6 | 11.1 | 23 | 23 | 23 | 23 |
| Monarch | 2430 * | 2090 | 17.3 | 17.6 | 9.3 | 10.3 | 18 | 18 | 18 | 18 |
| Stirling | 2130 * | 1885 | 17.5 | 17.4 | 12.1 | 12.2 | 18 | 18 | 18 | 18 |
| Stratus | 2240 | 2110 | 21.5 | 22.0 | 10.3 | 9.3 | 19 | 20 | 19 | 20 |
| Stratus NST[1] | 2145 * | 1855 | 21.5 | 21.8 | 8.1 | 7.3 | 19 | 18 | 19 | 18 |
| **Yellow Pea** | | | | | | | | | | |
| Carousel | 2370 | 2170 | 21.1 | 20.8 | 10.9 | 10.4 | 28 | 24 | 28 | 24 |
| Rex | 2515 * | 2140 | 22.5 | 22.8 | 8.8 | 8.5 | 23 | 24 | 20 | 20 |
| Shawnee | 2175 | 1850 | 18.9 | 18.7 | 11.2 | 10.8 | 34 | 32 | 12 | 12 |
| **Average** | 2280 | 2040 | 19.9 | 20.0 | 10.2 | 10.2 | 24 | 24 | 19 | 19 |
| **LSD (0.05)** | 230 | 230 | 0.7 | 0.7 | 1.5 | 1.5 | 3 | 3 | 2 | 2 |
| **CV** | 11 | 11 | 3.5 | 3.5 | 14 | 14 | 14 | 14 | 12 | 12 |

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

Table 4. Three Year Pea Yield Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, for 2005-2007.

| | 2005 | | 2006 | | 2007 | | 2005-2007 | |
|---|---|---|---|---|---|---|---|---|
| Variety | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| **Green Pea** | lb/acre | | | | | | | |
| Columbian | 1330 | 1100 | 1070 | 1260 | 2070 | 2020 | 1490 | 1460 |
| Joel | 1470 | 1690 | 1490 | 1410 | 2260* | 2020 | 1740 | 1710 |
| Karita | 1180 | 1460 | 1420 | 1370 | 2300* | 1950 | 1630 | 1595 |
| Monarch | 1430 | 1810* | 870 | 1100* | 2430* | 2090 | 1575 | 1665 |
| Stirling | 1140 | 1270 | 970 | 1030 | 2130* | 1885 | 1415 | 1395 |
| Stratus | 1570 | 1760 | 1330 | 1450 | 2240 | 2110 | 1715 | 1775 |
| **Yellow Pea** | | | | | | | | |
| Rex | 1430 | 1490 | 1270 | 1510* | 2515* | 2140 | 1740 | 1715 |
| Shawnee | 1210 | 1510* | 1440 | 1470 | 2175 | 1850 | 1610 | 1610 |
| **Average** | 1345 | 1510 | 1235 | 1325 | 2265 | 2010 | 1615 | 1615 |
| **LSD (0.05)** | 290 | 290 | 230 | 230 | 230 | 230 | 150 | 150 |

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

*Lentil.* Lentil yields in 2007, averaged across varieties, were 1295 lb/acre in CT and 1375 lb/acre in NT, and compares to a 580 lb/acre yield average last year and 1320 lb/acre in 2005 (Tables 5 and 6). 'Pardina' was highest yielding in CT, but 'Brewer' was highest in NT and significantly higher than the CT Brewer yield. Average results from the past three years show similar yields of 1115 lb/acre in NT and 1040 lb/acre in CT, but Brewer, 'Eston', and 'Pennell' produced higher yields in NT than CT. Seed weights averaged 4.6 g/100 in CT and 4.9 g/100 in NT a significant difference and all varieties except Eston and 'Pardina' were significantly higher in NT than CT for seed weight. 'Pennell' 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 similar between tillage treatments and adequate across the trial for yield. Plant heights averaged the same between tillage treatments with little variability. Lentil performance was about average, and reflects growers' results for the area. Weather conditions, particularly high heat, were less of a stress on lentil than pea. At this location, the 2007 results would again support growing Pardina and Merrit varieties for the two major market classes, although the old standard Brewer performs well too. They are productive, consistent and grow well under both CT and NT conditions. Averaged across three years, Pardina and Merrit both have equivalent yields in NT and CT, while Brewer yielded over 135 lb/acre more in NT than CT.

Table 5. Lentil Variety Performance Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2007.

| | Seed Yield | | Seed Weight | | Plant Stand | | Plant Height | |
|---|---|---|---|---|---|---|---|---|
| Variety | 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 | 1265 | 1335 | 5.0 | 5.3* | 10.9 | 12.3 | 13.5 | 12.5 |
| Eston | 1170 | 1440* | 3.0 | 3.2 | 12.8 | 15.2 | 13.5 | 13.3 |
| Merrit | 1490 | 1440 | 5.5 | 5.8* | 11.3 | 13.4 | 13.3 | 13.0 |
| Pardina | 1460 | 1375 | 3.3 | 3.5 | 11.1 | 13.7 | 11.5 | 11.5 |
| Pennell | 1020 | 1085 | 6.4 | 6.7* | 12.9 | 15.3 | 15.5 | 14.5 |
| Richlea | 1365 | 1570* | 4.7 | 5.1* | 12.4 | 13.3 | 15.3 | 15.0 |
| **Average** | 1295 | 1375 | 4.6 | 4.9* | 11.9 | 13.9 | 13.8 | 13.3 |
| **LSD (0.05)** | 170 | 170 | 0.2 | 0.2 | ns | ns | 1.2 | 1.2 |
| **CV** | 12 | 12 | 2.4 | 2.4 | 16 | 16 | 8.9 | 8.9 |

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

Table 6. Three Year Lentil Yield Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, for 2005-2007.

| | 2005 | | 2006 | | 2007 | | 2005-2007 | |
|---|---|---|---|---|---|---|---|---|
| Variety | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till | Conv-Till | No-Till |
| | ----------------------------------- lb/acre ----------------------------------- | | | | | | | |
| Brewer | 1370 | 1630* | 530 | 600 | 1265 | 1335 | 1055 | 1190* |
| Eston | 1090 | 1140 | 520 | 670* | 1170 | 1440* | 925 | 1085* |
| Merrit | 1440 | 1330 | 510 | 660* | 1490 | 1440 | 1145 | 1145 |
| Pardina | 1450 | 1460 | 590 | 650 | 1460 | 1375 | 1165 | 1160 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pennell | 1210 | 1210 | 330 | 570* | 1020 | 1085 | 855 | 955* |
| Richlea | 1310 | 1200 | 580 | 720* | 1365 | 1570* | 1085 | 1165 |
| | | | | | | | | |
| **Average** | 1310 | 1330 | 510 | 650* | 1295 | 1375 | 1040 | 1115 |
| **LSD (0.05)** | 150 | 150 | 120 | 120 | 170 | 170 | 80 | 80 |

Entomology: *Nilsa Bosque-Perez, Sanford Eigenbrode, Ryan Hanazan, Tim Hatten, Dennis Shotzko*

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. 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 in 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 evaluated. 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 early season PLW infestation of CT plots at a critical period for pea development that ultimately influences 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. Our results suggest NT-grown peas are more likely to escape severe PLW infestations.

Additional tests were conducted to assess densities of four abundant ground beetles, *Pterostichus melanarius, Poecilus lucublandus, Poecilus scitulus,* and *Calosoma cancellatum (Coleoptera: Carabidae),* in pea fields and examine potential relaitonships with PLW densities in two tillage systems. Densities of abundant ground beetles were assessed at the Kambitsch experimental farm, in the spring and summer of 2005 and 2006. 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 all 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. *Pt. melanarius* fed on PLW, other *Pt. melanarius* and the two *Poecilus spp*.

<u>Soil Properties:</u> *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 (<30µm 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 >1000µm. 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. Dryer 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/cm$^3$. 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 µm in diameter, however the largest volume of pores occurred within a pore-size diameter of 100-to 500-µm 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.

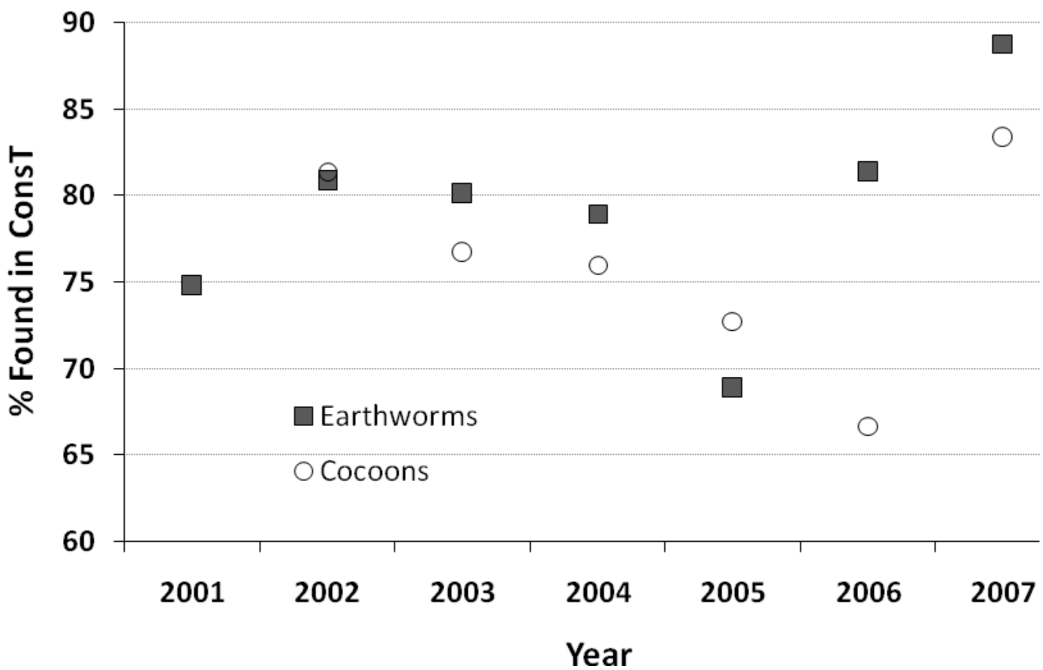



Figure 1. Percentage of total earthworms and earthworm cocoons found each spring in conservation tillage plots. Earthworm cocoons not measured in 2001.

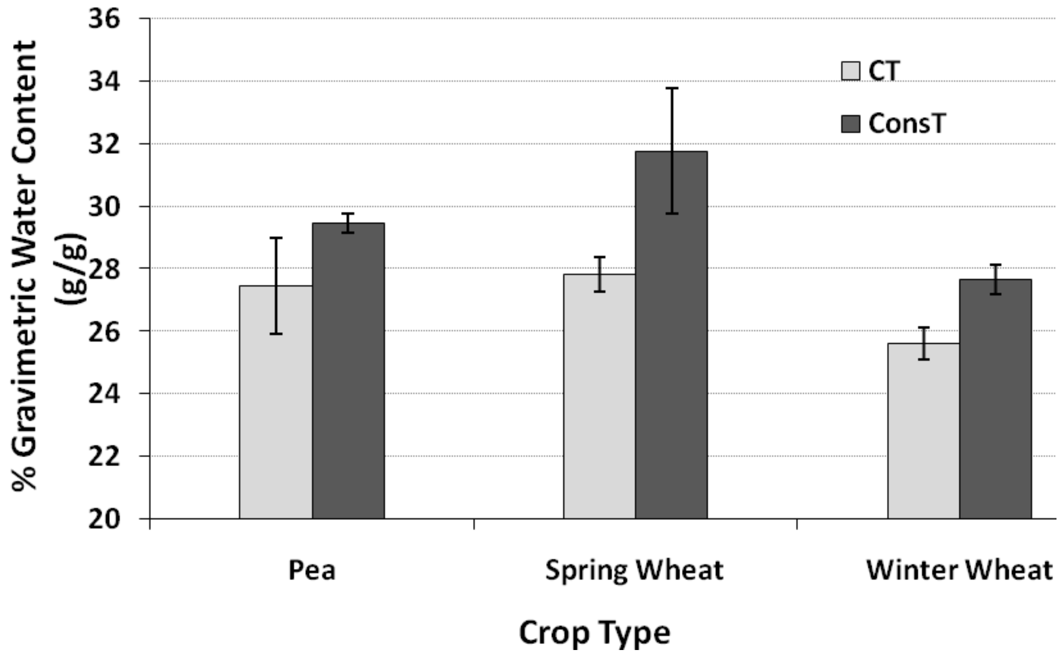



Figure 2. Gravimetric water content measured on 3/29/07, prior to any spring tillage operations. Three replicate probe samples taken per plot.

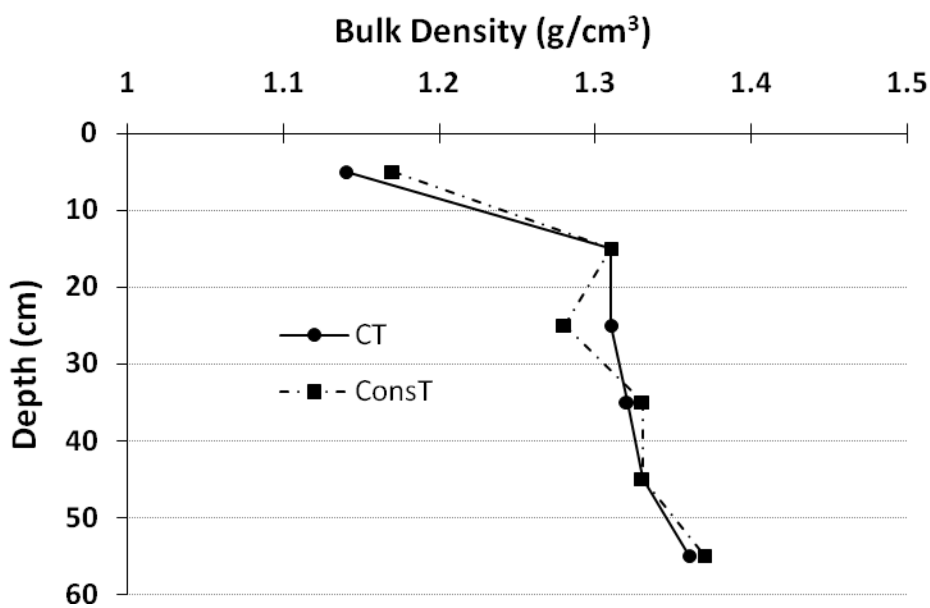
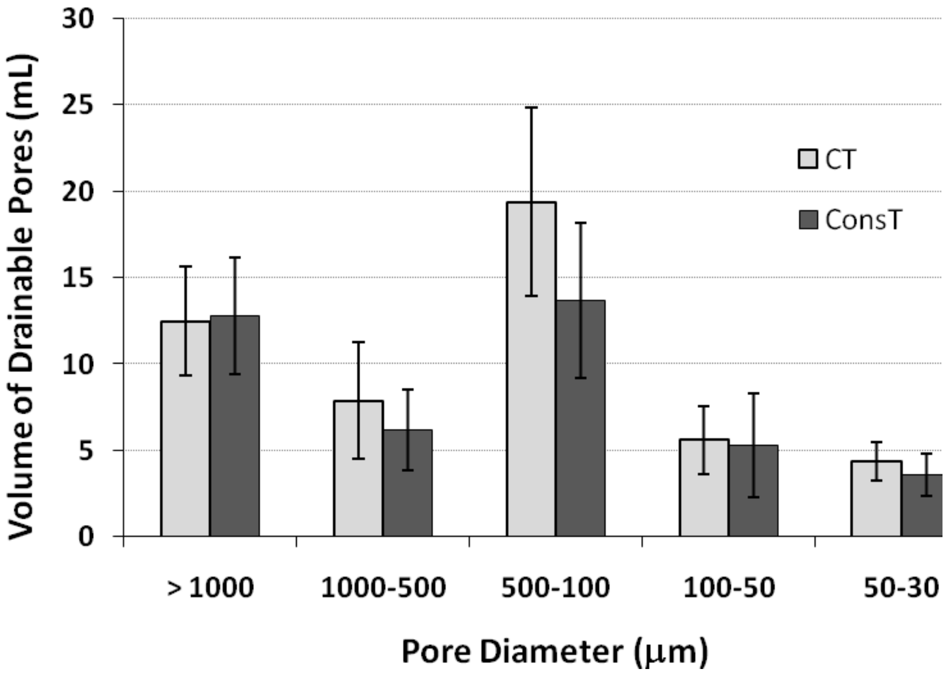



Figure 3. Soil bulk density from Giddings Probe cores collected spring 2006. Densities measured across each 10-cm depth increment. Significant differences in bulk density between tillage treatments were not detected at $\alpha$=0.05.

a)




b)

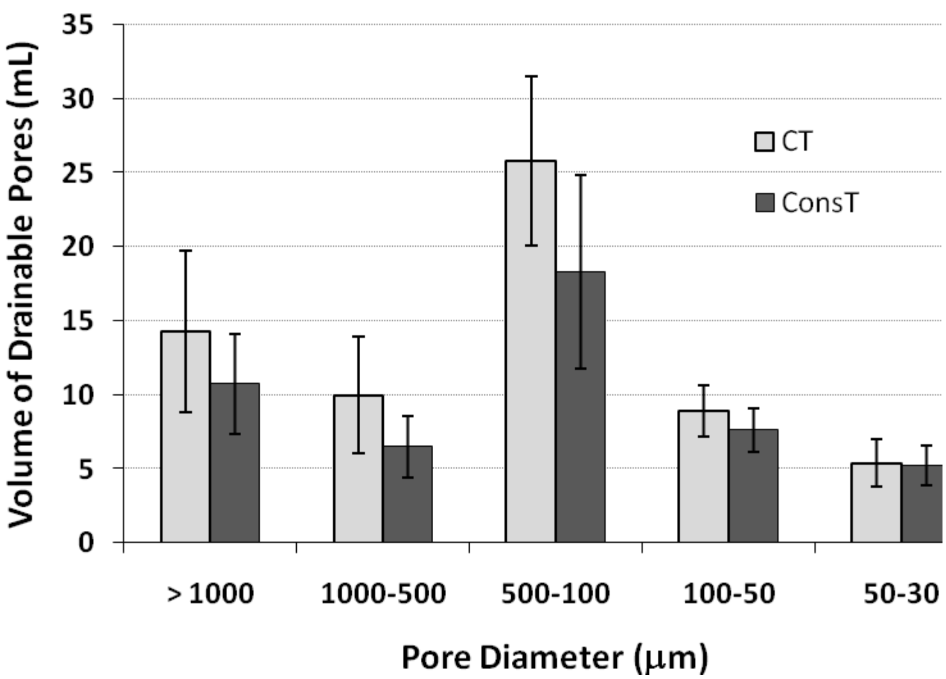



Figure 4. Volume of drainable pores within pore-size diameter ranges for 8.6-cm diameter cores collected at the a) 0-to 10-cm and b) 10-to 20-cm depth. Significant differences between tillage treatments, within a pore-size range were not detected.

*<u>Publications and Presentations (Since the previous report):</u>*

*Publications*

Hatten, T.D., N.A. Bosque-Pérez, J. Johnson-Maynard, and S.D. Eigenbrode. 2007. Tillage differentially affects the capture rate of pitfall traps for three species of carabid beetles. *Entomologia Experimentalis et Applicata* 124: 177-187.

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*Presentations*

Guy, S.O. and M. Lauver. November , 2006. Lentil variety response to tillage treatments in Idaho. Poster presentation. 2006 American Society of Agronomy Meetings, Indianapolis, IN.

Guy, S.O. and M. Lauver. 11 January, 2007. Lentil variety response to tillage treatments in Idaho. Poster presentation. 2007 Pacific Northwest Direct Seed Conference. Kennewick, WA

Guy, S.O. 13 February, 2007. Agronomic performance and variety update for Pea, Barley, Spring Wheat, and Camelina. Boundary Co. cereal school. Bonners Ferry, ID

Guy, S.O. 14 February, 2007. Agronomic performance and variety update for Pea, Barley, Spring Wheat, and Camelina. Nez Perce Co. cereal school. Lewiston, ID

Guy, S.O. 15 February, 2007. Agronomic performance and variety update for Pea, Barley, Spring Wheat, and Camelina. Lewis/Idaho Co. cereal school. Greencreek, ID

Guy, S.O. and M. Lauver. 26 June, 2007. Lentil variety response to tillage treatments in Idaho. Poster presentation. 2007 PREEC/Parker farm field day, Moscow, ID

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